Eagle Mountain Gold Project, Guyana

Environmental Impact Assessment Report: Volume 4

PREPARED FOR

Stronghold Guyana Inc.
(subsidiary of Mako Mining Corp.)

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AIR
NOISE
SOILS
WATER
BIO
SOCIAL
CULTURAL

APPENDIX A EMERGENCY PREPAREDNESS AND RESPONSE PLAN

Eagle Mountain Gold Mine Project, Guyana

Environmental Impact Assessment Report: Appendix A Emergency Preparedness and Response Plan

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1. EMERGENCY RESPONSE PLAN

1.1 INTRODUCTION

As the Project has identified physical elements, aspects and facilities that will generate impacts, Stronghold Guyana must establish an Emergency Preparedness and Response Plan (EPRP), describing the emergency situations that could occur at the Project. The purpose of the EPRP is to ensure Stronghold Guyana, and appropriate and relevant third parties, are prepared to respond to accidental and emergency situations associated with the project in a manner appropriate to prevent and mitigate any harm to people and/or the environment.

1.1.1 PURPOSE

This EPRP describes the detailed response to the potential critical incidents. Each of these detailed responses includes the following information:

- The main "threats" associated with the incident;
- How the incident may be notified (aside from emergency telephone/ radio call);
- Alarms or methods to alert persons of an emergency;
- The management response required (i.e., who should be notified, what action should be taken);
- Any special instructions; and
- Possible contacts with specialist advice.

The EPRP must define at minimum the main instructions about what to do, who is required to do it, when to do it, including:

- Authority and responsibility of key personnel in charge of emergency situations;
- The emergency response team (e.g., fire response personnel, first aid personnel, environmental response team, etc.);
- The external emergency resources (e.g., fire department, police department, health services, contractors, etc.);
- The emergency equipment at disposal (e.g., first aid kits, spill control kits, etc.) and listed documents (e.g. personnel, emergency escape floor plan/map, chemical mapping);
- The maintenance program of the emergency equipment;
- Emergency instructions to be respected in order to limit the consequences;
- All details pertaining to awareness and training, including signalisation;
- A drill frequency for each identified emergency situation; and
- Instructions to conduct external communication.

Detailed procedures for responding to emergency situations (e.g., emergency team call-out, evacuation, establishing an incident control emergency centre, etc.) are also mentioned below.

These should be used as a guide only and are not "all inclusive". That is, there may be additional response steps, or the steps may be in a different order of execution, depending on the circumstances of the individual emergency situation.

An emergency is a situation, which can escalate rapidly, and if not brought under control quickly, may result in serious injury, death or major property damage. The purpose of the EPRP is to mitigate loss, harm or damage following serious incidents.

1.1.2 OBJECTIVES

The objectives of the EPRP are as follows:

- To ensure that all risks to the safety and health of personnel arising from foreseeable emergency situations have been identified;
- To ensure that preventative measures are in place to minimise the risk of a serious incident occurring;
- To ensure that measures are in place to minimise the impact should a serious incident occur and provide guidelines regarding responsibilities and procedures to be followed in the event of a serious incident; and
- To ensure that the rehabilitation of the working environment can be carried out in appropriate time after all the planned actions have been taken for the collection and preservation of the evidence that will be required in the subsequent investigation of the incident.

1.2 SCOPE

1.2.1 APPLICABLE STANDARDS

The Project will comply with all applicable national standards including:

- Environmental Protection Act Cap 20:05 and Regulations 2000.
- Mining Regulations Act, administered by Guyana Geology and Mines Commission (GGMC) and the associated Codes of Practise (COP) for Contingency and Response Plan.

1.2.2 TYPES OF EMERGENCIES

The types of emergencies considered are provided in Table 1.1 and Table 1.2 for project specific and external emergencies respectively.

TABLE 1.1 TYPES OF EMERGENCIES (PROJECT SPECIFIC)

Emergency Response Triggers and Risks	
Major industrial accident	Single or multiple fatalities. Potential to escalate to crisis situation. Significant damage to equipment, infrastructure or business reputation.
Environmental pollution	Uncontrolled release of contaminants into air, sea, watercourses, land, or communities.
Hazardous material leakage	Injuries, illness, or environmental harm. Increased fire, vapor, and uncontrolled gas release. Damage to components, infrastructure, and equipment. Creation of hazardous waste requiring disposal.
Fire	Injuries, illness or environmental harm. Release of toxic fumes or residues. Uncontrolled explosion.

Emergency Response Triggers and Risks	
	Damage to components, infrastructure, equipment, archaeological sites or surrounding properties.
Explosions	Injuries, illness or environmental harm. Release of toxic fumes or residues. Potential to trigger explosions in surrounding facilities. Fires, landslides or all collapse.
Vehicle accident	Single or multiple fatalities. Environmental harm. Fires. Equipment damage resulting in production loss.
Fall from height or lifting equipment failure	Single or multiple fatalities. Suspension trauma requiring high-angle rescue. Equipment damage (crane, elevator).
Confined space rescue	Single or multiple fatalities. Access to trapped or injured workers.
Medical incident/ Pandemic	Uncontained infectious contagious disease or illness. Workforce, family or community illness resulting in production loss.
Landslides/ subsidence/ precipitation and flooding	Injuries, illness, entrapment or environmental harm. Damage to infrastructure or equipment.
Severe animal/ insect infestation	Team member being bitten or stung. Allergic reaction to bee/ wasp sting. Damage to equipment (particularly electrical e.g. could trigger failure of computers).
Severe electrical storm	Team members struck by lightning. Lightning initiating fire or explosion. Disruption to power/ security systems. Equipment drifting, machinery and infrastructure flooding.
Tailings dam wall failure	Disruption to production. Environmental impact. Potential impact on downstream land uses (i.e. third parties on public roads downstream of facility, land users downstream of facilities)

The above emergencies as a result can cause significant concern to employees due to reduced production, work stoppages and impacts on livelihoods. The Incident Control Team must frequently inform employees about the recovery operations plan. What is more, the Crisis Management Team should correspond and take the appropriate measures to deal with the effects of the Company's image/reputation.

TABLE 1.2 TYPES OF EMERGENCIES (EXTERNAL)

Potential Emergency Situations	
Heat wave	• Injuries or illness. • Explosion. • Production loss. • Water Management. • Increased Risk of fire ignition. • Equipment Damaged.

Potential Emergency Situations	
	• Power Outage/Failure.
Earthquake	• Injuries, psychological trauma or entrapment of personnel. • Increased risk of operational emergency. • Production loss or loss of critical utility services. • Damage to equipment and infrastructure, particularly tailings facilities. • Power Outage/Failure.
Flooding	• Injuries or illness. • Closure of operations. • Damage to equipment and infrastructure. • Increased risk of operational emergency. • Power Outage/Failure.
Possible Emergencies Caused by External Agents	
Threat/ Terrorism or malicious action/ Political Unrest	The installation may incur emergency situation caused by terrorist acts, acts of malicious threats and blackmail that: • May cause panic. • May cause psychological violence and intimidation. • May cause cessation of work. • May cause damage to facilities and equipment. • May cause injuries. • May cause fire. • May cause explosion.
Strike/ Occupation Protest	• May cause cessation of work. • May cause economic damage. • May cause material damage to the facility. • May cause friction or violence between the employees.

1.3 ROLES AND RESPONSIBILITIES

The roles and responsibilities of the various parties is provided in Table 1.3.

TABLE 1.3 ROLES AND RESPONSIBILITIES (EMERGENCY RESPONSE)

Role	Responsibilities
Incident Controller	• Appoint appropriate personnel to form the incident control group. • Determine the priorities and plan of action for dealing with the emergency with the primary concerns being the health and safety of all involved (employees, contractors, visitors, and members of the public) and fulfilling the company's legal obligations. • Ensure the operations log is available and all events are properly recorded. • Ensure that all information regarding the emergency that will be released to the public is firstly vetted and approved by the company's authorised spokesperson. • Monitor conditions in the affected area. • Notify and provide updates to corporate head office. • Notify and provide updates to union or health and safety representatives. • Coordinate the return of normal operations after all clear has been given. • The Incident Controller will authorise all movement in and out of the property except that of emergency vehicles. • Issue requests for mutual aid as required. • In the event a community evacuation is necessary the incident controller will alert the senior official in charge of the municipality emergency evacuation plan. • Report to Government agencies. • The Incident Controller is responsible for deciding if communication between the ICC and the operation center will be initiated so as to collect any information regarding counting that operation center possesses. In case that operation center participates and provides relevant to personnel counting information to the Incident control team, the incident controller gives the order to the log controller for requesting the appropriate information from the operation center. • In case the Incident Controller decides that the Incident control team will not use this leg of communication with the operation center, then he will give the order to the log controller to create a smaller team which will deal only with the counting procedure directly. • In any from the cases, the Incident Controller can use all the resources that the operation center has to deal with the emergency situation. • Obtain a list of any missing employees (from the log controller).
Incident Log Controller	The incident Log controller is designated by the incident controller. The operations log is intended to be a progressive record of events from the start of the incident through to its termination. The following information should be recorded: • The date and time the incident was reported, by whom, and the message. • All subsequent developments as they occur. • The arrival and departure of senior officials. • Record all conferences and decisions made. • Any other items he/she is instructed to record. • Instructions given to officials during rescue operations and other activities mainly in the undertaken actions.

Role	Responsibilities
	• Ensure the incident controller reads and initials the operations logbook. • At any time, the operations log controller is unsure of any statement he/she is recording, the accuracy of the statement should be verified by the incident controller in charge. • All logs and diaries relevant to the emergency must be forwarded to the Incident Log controller to assist him to prepare a final report. • Answers all telephone calls and radio communications to the incident control center and records the content and time of the communication.
Rescue Team Briefing Officer	Rescue Team Briefing officer appointment is determined by the Incident Controller. The Rescue Team briefing officer must have experience of mine rescue, surface rescue, procedures/practices and must be familiar with the operations and site layout. The Search and Rescue Team Briefing Officers take direct instructions from the incident controller and will be the sole contact between the incident control Center and the rescue teams he/she is responsible for the following: • Provides instructions for rescue action plan from incident control group to the rescue teams. • Provides appropriate information on the emergency to the rescue teams from the incident control group. • Ensures all service/equipment requirements are catered for. • Coordinate fire-fighting services with rescue operations. • Coordinate mine rescue operations. • Coordinate search for missing persons. • Provide a list of distributors of specialised rescue equipment. • Advise the incident controller when mutual aid assistance is required. • Coordinate clean-up operations. • Assist with training activities. • Maintain a log of all actions taken for presentation to the log controller.
Environmental Manager	The head of department (Environmental manager or designate). Specific duties include: • Assists the Incident Control Group, he/she will assist and advise with the implementation of the emergency response plan of action with the environmental health and safety of all being the prime concern. • Mobilise environmental support team. • Oversee execution of emergency call out lists for all environmental support personnel. • Ensure all actions/events carried out are properly recorded. • Liaise and assist Rescue Team Briefing officer as required. • Suggestion to liaise with the government agencies if requested by the incident controller. • Assist with completion of incident investigation reports (Post emergency).
HR Manager	The head of department (Human Resources (HR) manager or designate). Specific duties include: • Assists the Incident control group, he/she will assist with the implementation of the emergency response plan of action with the health and safety of all being the prime concern. • Mobilise HR support team, social worker, media officer and personnel coordinator.

Role	Responsibilities
	• Oversee execution of emergency call out lists for all HR support personnel. • Ensure all actions/events carried out are properly recorded. • Liaise with media if requested by the incident controller.
Maintenance Manager	The head of department (Maintenance manager or designate). Specific duties include: • Assists the Incident control group, he/she will assist with the implementation of the emergency response plan of action with the health and safety of all being the prime concern. • Mobilise maintenance support team. • Execute emergency call out lists for maintenance support personnel. • Ensure all actions/events carried out are properly recorded. • Liaise and assist all control group members Briefing as required. • Liaise with Mine operations managers to establish status of all services and utilities on surface. • Liaise with Mine operations managers to control the provision all services and utilities services that may assist with the safe execution of the emergency action plan. • Provide maintenance personnel support to Rescue Team briefing officer as required. • Supply all necessary drawings and plans for the incident control group. • Assist safety manager with incident investigation reports (Post emergency).
Operations Manager	The head of department (operations manager or designate). Specific duties include: • Assists the Incident control group with the implementation of the emergency response plan of action with the health and safety of all being the prime concern. • Mobilise operations support team. • Oversee execution of emergency call out lists for operations support personnel. • Ensure all actions/events carried out are properly recorded. • Liaise and assist Rescue Team Briefing officer as required. • Liaise with Maintenance manager to establish status of all services and utilities on surface. • Liaise with Maintenance manager to control the provision all services and utilities services that may assist with the safe execution of the emergency action plan. • Provide operations personnel support to Rescue Team briefing officer as required. • Suggestion to liaise with government agencies if requested by the incident controller. • Supply fire and rescue composite plans for the incident control group. • Assist safety manager with incident investigation reports (Post emergency).
Health, Safety & Training Manager	The head of department (Safety Manager or designate). Specific duties include: • Along with the appropriate personnel from the Incident control group, he will assist with the implementation of the emergency response plan of action with the health and safety of all being the prime concern. • Mobilise health, safety support team.

Role	Responsibilities
	• Communication with the facility security manager regarding any Health and Safety matters in the site. • Oversee execution of emergency call out lists for all support personnel. • Ensure all actions/events carried out are properly recorded. • Communicate and assist Rescue Team Briefing officer as required. • Instruct company lead medic and medical support team in readiness for casualty treatment. • Liaise with government agencies (mines Inspector) if requested by the incident controller. • Complete incident investigation reports (Post emergency).

1.4 LOCATIONS

1.4.1 INCIDENT CONTROL CENTRE

At the Project site, there should be an office or meeting room location designated to be used as the Incident Control Centre in the event of an emergency.

In certain circumstances such as fire, earthquake, or chemical spill it may not be safe or practical to use the designated Incident Control Centre. There are also circumstances when it may be necessary for a temporary Incident Control Centre to be established nearer to the scene of an emergency. In either of these situations, it will be necessary to quickly locate a suitable alternative facility and arrange for transfer of the necessary resources required for incident coordination. Functions and characteristics of the Incident Control Centre as well as specific items and equipment required are detailed in the tables below.

TABLE 1.4 INCIDENT CONTROL CENTRE FUNCTIONS AND CHARACTERISTICS

Function	Characteristics
The function of the Incident Control Centre may include the following:	Incident control room should have the following characteristics:
Assess the severity of the emergency.	Sufficient space and accommodations.
Evaluate what has already been done.	Security.
Determine the future actions to be taken in order of priority.	Auxiliary power supply.
Allocate resources to the area.	Access to washrooms/toilets.
Determine what additional equipment is required and coordinate its movement to the scene.	Communications systems i.e. Fax machine, telephone system, satellite connection.
Arrange for the prompt notification of the appropriate external agencies. Maintain a close liaison with the person coordinating the operations at the scene.	Internet Connection.
Ensure that all the relayed instructions, forms, reports, telephone conversations and documentation are properly tabulated for filing as permanent record.	Protected against weather phenomenon if it's possible.

TABLE 1.5 INCIDENT CONTROL CENTRE ITEMS AND EQUIPMENT REQUIRED

Specific Items and Equipment	
Items and equipment to be readily available in incident control room may include:	
• Site-specific Emergency response procedures, protocols, or information.	• Information source for weather report, wind direction or forecasts.
• Emergency organisational chart (including position and function)	• Material Safety Data Sheets.
• Directory of mutual aid groups.	• Contingency plan to warn and evacuate community.

Specific Items and Equipment	
• Directory of resources and equipment.	•
• Directory of government agencies.	• Composite rescue plans for surface operations.
• Emergency lighting.	• Locations of hazardous materials.
• Adequate internal telephone lines.	• Building and facility plans showing locations of utility services.
• Adequate external telephone lines.	• Plans for road systems and main gates.
• Telephone lines, preferably mobile connection for transmitting only to prevent incoming calls from flooding the lines.	• Plans for main shut off valves, switches for water, gas
• Directory of trained personnel.	• Register of rescue equipment and locations.

1.4.1.1 ASSIGNMENT OF DUTIES

To avoid confusion, it is important to organise in advance an Incident Control Team.

Each person should be allocated a role and responsibilities in keeping with his/her normal functions. Ideally, their part in the emergency plan would be an extension of their everyday duties.

Back-ups will have to be identified for every person in the group in order to compensate for shift rotation, vacation and absenteeism.

1.4.1.2 EMERGENCY INCIDENT CONTROL GROUP

The Emergency Incident Control Group would normally consist of a small gathering of senior management representatives. The Incident Control Group will direct all emergency/disaster operations from a pre-determined control center. Their primary function is to advise the incident controller (manager) and offer counsel in their particular area of expertise.

The following personnel or their designated alternates would typically make up the Emergency Incident Control Group:

TABLE 1.6 INCIDENT CONTROL GROUP PERSONNEL

Incident Control Group	Support Groups to All Incident Control Group Members
• Mine General Manager	• Lead Medic/Nurse, Company
• Mill Operations manager (Incident Controller)	• Environmental Staff
• Maintenance Manager	• HR Staff
• Health, Safety & Training (HST) manager	• Maintenance supervisors
• Environmental Manager	• Mill Ops Foremen and Supervisors
• HR Manager	• Mine rescue captain
• Communications and Incident log controller	• Safety officers
	• Operations Centre

Incident Control Group	Support Groups to All Incident Control Group Members
	• Emergency Response (ER) Coordinator

1.4.2 OPERATION CENTRE

The Operation Centre is the primary contact point for the reporting of an emergency incident. The Operation Centre will be located at the mine site and is manned 24/7. The specific functions and resources required in the Operation Centre are as follows:

TABLE 1.7 OPERATION CENTRE FUNCTIONS AND RESOURCES

Function	Resources Needed
The function will be the following:	Items and equipment to be readily available:
• To act as first responder in emergency incident.	• Emergency organisational chart that includes position and function.
• Warning the IC, HST Manager, ER coordinator of each site for coming up local extreme weather event and the type of the weather event.	• Reliable source of local forecast weather.
• Provide a notification to all employees about the condition of the access and exit road from and to the facilities from local villages.	• Emergency Response Team shift list. (Security control center needs to be provided with this list to assist the IC in case that Emergency response teams need to be activated under the order and instructions of the IC).
• To communicate with Incident Control Centre (ICC), providing all appropriate information when emergency incident occurs.	• Adequate internal/external telephone lines.
	• Telephone lines for transmitting only to prevent incoming calls from flooding the lines.
• Carry out all direct instructions from the ICC or from incident control group personnel.	• Call out lists for all emergency key personnel.
	• Call out lists for department personnel.
• Record all actions taken during the emergency event utilising procedures incorporated within the emergency response plan.	• Composite rescue plans for surface operations.
	• Plans for road systems and main gates.

1.4.3 INCIDENT SAFE STAGING AREA

The Incident Control Team will determine the location of an incident safe staging area.

The incident safe staging area provides a base of operations from which rescue and recovery work advances into a surface incident area and from where communications is maintained with the ICC and with search and rescue teams.

Factors to consider for location of a safe staging area:

1. Be sure the safe staging area is located in assured fresh air with consideration to location and nature of incident, wind direction etc.
2. Easily accessible with suitable transportation.
3. Suitable communication system.
4. Adequate space and free of foreseeable hazards.

1.4.4 RESCUE STATION

The Eagle Mountain Gold Project will have an established mine rescue station, for mine rescue personnel. The facilities coordinator is responsible for site-specific facilities and associated equipment.

The facilities shall only be used for mine rescue or training activities.

TABLE 1.8 MINE RESCUE STATION EQUIPMENT

Rescue Station	
The Mine Rescue Station should be equipped with:	Team members PPE:
• Sufficient number of complete suits of breathing apparatus (Closed Circuit Breathing Apparatus (CCBA))	• 1 complete CCBA set.
• Sufficient oxygen for this apparatus.	• 2 pairs of overalls.
• Oxygen Booster refiling. (Electrical/Mechanical)	• 1 knife.
• One set of reviving apparatus. (Mars/Care vent Resuscitator)	• 1 pair of boots.
• One first aid and trauma kit.	• 1 Safety helmet.
• Not less than 12 miners' lamps.	• 1 Safety belt.
• Suitable devices for making immediate determinations of gases.	• 1 waterproof notebook.
	• 1 watch.
• Eight (8) communication radios.	• 1 lanyard.
• Portable cable communication device.	• 1 pair of safety glasses
• Guaranteed communications to Incident Control Centre.	• 1 pair of flame-retardant overalls.
• The mine rescue station also stores specific specialised mine rescue equipment	

1.4.5 OTHER FACILITIES

Other facilities which may be required include:

- Muster Station & Shift Bosses Office: Designated area where personnel assemble during an emergency, with guaranteed communications to the incident control center.
- Designated Family Room: An isolated comfortable room suitably located on site that can accommodate victims' families during an emergency event.
- Media Centre: An isolated room suitably located on site away from the family room that can accommodate media and press members during an emergency event.

1.5 EMERGENCY RESPONSE EQUIPMENT

1.5.1 MINES RESCUE

The following equipment will be required:

- The mines rescue equipment will be held at the rescue station. An inventory list of the equipment, both at the rescue station and individual operations, shall be maintained by the mine rescue captains under the supervision of the emergency response Coordinator.
- Firefighting vehicles
- Medical facilities and equipment; including ambulance and medical facility.
- Communication systems including an operational telephone system. Operational radio system that links the open pit mine with the foreman's office. A Tetra Radio communications system that links Mine Surface and Plant locations only. The network coverage should sufficiently cover all site areas.

1.6 EDUCATION AND TRAINING

All personnel shall completely understand their roles and responsibilities within the emergency preparedness and response plan. To facilitate the implementation of the EPRP, the following actions are planned:

- EPRP refresher training every 2 years.
- New employee's induction training.
- Contractor's induction training.
- A target minimum number of 15 % of the workforce are trained in basic first aid.
- Fire extinguisher training for offices personnel every 2 years.
- Fire safety teams training every year from fire brigade.
- Surface Emergency Response teams training sessions annually according to the training program.
- Evacuation drills (4) for each shift, (2) for each Plant, (2) for all the administration offices.
- Review Interface Arrangements with local emergency services and local community representatives.

All training programs are the direct responsibility of the health, safety and training manager and safety department personnel.

The Health, Safety and Training Manager shall ensure that all staff are trained on the EPRP and clearly understand their roles and responsibilities. They shall also implement any changes to the emergency prevention and planning measures outlined in the EPRP.

Under the EPRP, ensure community members and public health and safety response authorities are briefed on potential emergency event scenarios, participate in consequence mapping and management response planning, take part in appropriate mock emergency event scenarios, and provide any additional support to communities and local response authorities as needed. Training and mock scenarios should occur at least annually.

1.7 NOTIFICATIONS AND COMMUNICATION

All notifications and communications will be controlled by the incident controller and /or personnel instructed by the incident controller within the incident command and support groups.

1.7.1 COMMUNICATION WITH COMMUNITIES

All communications and notification to community members will be the responsibility of the HR manager and/ or personnel instructed by the HR manager.

Communication and notification will be:

- Accurate and precise, presenting factual information to the family members.
- Updated periodical briefing as emergency incident action progresses.
- Updated if circumstances of the emergency incident change.
- Disclose the EPRP as part of the EIA disclosure package

1.7.2 COMMUNICATION WITH MEDIA

Any communication with representatives of the Press or media outlets will be made by the company's authorised spokespeople, as approved by Stronghold Guyana.

No other personnel may make statements, comments, or express opinions to any external party about the emergency incident.

1.7.3 COMMUNICATION WITH GOVERNMENT AGENCIES

Communication and notification to government agencies will be the responsibility of Stronghold Guyana.

1.7.4 EMPLOYEE SUPPORT

Post incident counselling will be made available by the company to any employees, or family members who may be affected emotionally by the emergency incident.

1.7.5 RE-ESTABLISHING OPERATIONS

The re-establishment of operations after the termination of an emergency will be the responsibility of the incident controller in collaboration with his management team, corporate management, and government agencies.

1.7.6 POST INCIDENT INVESTIGATION

The post-incident investigation will take place immediately after the emergency incident has terminated. This will be the responsibility of the operations management team.

The objective will be to determine, through root cause analysis, preventative actions that can be implemented to reduce the risk of re-occurrence.

This may involve the addition or amendment of emergency response procedures within the emergency response plan, and they should be implemented as an immediate priority.

Company legal team will be responsible for addressing any legal/ regulatory issues that may arise due to the emergency incident.

1.8 EMERGENCY RESPONSE PLANS

Stronghold Guyana is committed to ensuring that the ERP covers all potential failures and associated E&S impacts including natural hazards, landslides, leaks, spills, fire and vehicle collisions. For dam failure, Stronghold Guyana, in alignment with the Mining Association of Canada's Towards Sustainable Mining (TSM) and Global Industry Standard on Tailings Management (GISTM) standards, will be completing the following studies:

- Complete a dam breach inundation study
- Identify people staying close to the dam in what is called the "self-rescue zone" and how to get them out. It is noted that there will be no local communities present in the Project Area during project activities.
- Identify people working and living within the dam breach zone outside our concession and setup an early warning system.
- As per Global Industry Standard on Tailings Management (GISTM), release the Dam breach analysis to key stakeholders
- As per GISTM schedule, hold a desktop and onsite drill involving key stakeholders
- With key stakeholders' set up a rescue plan for those who cannot be reached easily or are not able to safe themselves.

Hazardous materials controls include spill prevention, control and countermeasures plan (SPCC), secondary containment, drip trays, specialised training, inspections, shut-off valves, spill kits, etc.

Transport of cyanide will be undertaken via escort with the transport vendor having followed the required cyanide training and be audited regularly. Fuel will be transported in approved fuel trucks.

Cyanide products will be transported by an ICMC (International Cyanide Management Code) approved contractor. Drivers will be trained in emergency spill response, but also defensive driving. The trucks will have GPS which will track speeds and speeds will be limited. The road will be upgraded to allow for longer line of sight as well as berms will be placed along the road at dangerous locations. To mitigate risks, Stronghold Guyana will develop transport and fleet management plans.

The following provides the emergency response plans for the different types of incidents:

TABLE 1.9 ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE

ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE		
• Establish an incident command center and assemble incident control group.		
• Inform and assemble incident control support group.		
• Evacuate incident area.	• Account for all personnel.	• Assess and treat any casualties.
Gather all necessary information relative to the incident:		
• Incident location.		
• Spilled Material Safety Data Sheet (MSDS) information.		
• Personnel missing.		

ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE	
Carry out briefing with HAZMAT team's captains.	
Instruct HAZMAT teams to:	
1. Secure incident area.	
2. Barricade incident area.	
3. Establish zoning of incident area.	
4. Isolate all ignition sources in the incident area.	
5. Isolate the spillage source.	
6. Contain the spillage.	
7. Clear up the spillage.	
8. Decontaminate the incident area.	
9. Decontaminate HAZMAT personnel.	
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	
Additional Information: • Emergency response to environmental incident resulting from the transport of concentrate shall be the responsibility of certified contractors. Stronghold Guyana may be requested to assist during response to incidents involving concentrate. • Road Shipments: Contractors are subject to the requirements of Guyana. A review of certification and compliance status shall be completed annually.	

TABLE 1.10 ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE (CHEMICAL SPILL)

ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE (CHEMICAL SPILL)	
Chemical:	
• Is unknown.	• Is highly toxic or reactive.
• Poses an immediate significant risk to health.	• Involves injury to personnel in the vicinity.
• Involves a fire hazard outside a fume hood or an explosion risk.	
• Response and cleanup of are beyond the expertise and ability of personnel in the immediate area or Facilities personnel, and the equipment and materials for adequately containing and cleaning up the spill are not available.	
Instruct HAZMAT teams to:	
1. Attend to any injured or contaminated persons and remove them from exposure.	
2. Alert people in the immediate area to evacuate.	
3. Provide as much of the following information:	
• Location of the incident.	• Name of person discovering the spill.
• Time and type of incident (e.g., spill, fire).	• Any injuries.

ENVIRONMENTAL EMERGENCY, HAZMAT SPILLAGE / DISCHARGE (CHEMICAL SPILL)	
• The time of the spill.	• Name and quantity of the chemical(s) involved.
• The cause of the spill.	• The weather conditions.
• Possible hazards to human health, or the environment, outside the facility.	• Control measures taken.
• Whether a fire or explosion hazard is deemed to exist.	• If the spill is contained.
• Any environmental effects that have or could occur.	
4. Use eyewash or safety showers in other areas as needed to rinse spilled chemicals off people.	
5. Barricade/Flag the area.	
6. Place physical guards at a safe distance.	
7. If spill material is flammable, turn off ignition and heat sources if that can be done safely.	
8. If danger is believed sufficient – activate the nearest fire alarm (unless there is a chance of explosion from the chemical spill) and evacuate the building. If there is a possibility of explosion by activating the fire alarm, evacuate the building manually by alerting others by voice.	
9. Close doors to affected area.	
10. Do not touch any harmful substance. Take precautions to protect yourself if necessary.	
11. Isolate contaminated individuals and treat as per MSDS. Isolate affected persons and keep on site. If required, summon a First Aid Officer.	
12. Assist the emergency response personnel and supply the Material Safety Data Sheet/s if the chemical/s are known.	
13. In conjunction with expert assistance, minimise the spread of contamination and commence decontamination/clean up procedures.	
All sites are equipped with spill kits. The kit may include:	
• A barrier to contain a spill such as clean, dry sand or a commercial product.	
• Reagents necessary for decontamination procedures e.g., Calcium carbonate.	
• Personal protection equipment including protective clothing.	
• Chemically resistant gloves.	
• Safety glasses.	

TABLE 1.11 MAJOR EARTHQUAKE

MAJOR EARTHQUAKE	
• Establish incident command Centre and assemble incident control group.	
• Inform and assemble incident control support group.	
• Account for all personnel.	
• Gather all necessary information relative to the incident:	
• 1. Incident location.	• 2. Personnel missing

MAJOR EARTHQUAKE	
• Instruct all site personnel to gather at safe assembly points.	
• Instruct Rescue team briefing officer to mobilise all rescue teams.	
• Establish safe staging area for rescue teams.	
Rescue Team Briefing officer ensures safe staging area has:	
1. Guaranteed communications with Incident control centre. Guaranteed fresh air	
2. Guaranteed route for escape.	
3. Adequate space for rescue team assembly.	
4. Provisions for rescue teams.	
5. Necessary rescue equipment to be utilised by the rescue teams.	
6. Support personnel as required.	
• Rescue Team Briefing officer, briefs rescue teams on emergency action plans.	
• Under instructions from the incident controller, Rescue Team briefing officer deploys rescue teams from safe staging area to carry out rescue/recovery missions following the precise instructions of the emergency action plans.	
Secure entry exits to site.	
• Treat casualties with medical care if required.	
• Mobilise external resources if required (fire dept, ambulance, police)	
• Control communications in and out of site.	
• Establish family meeting area if required.	• Establish media meeting area if required.
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	
Additional Considerations: • Planning: Document the locations from where gas, electricity, water, steam, process gas/liquid, and fire protection systems can be safely shut off. Consider that many employees may be under panic and strive to escape. • Immediate Response: Survey the facility for unsafe conditions, including combustible material in contact with or near ignition sources, equipment damage, significant building damage, piping and conduit damage. Disconnect or repair damaged piping or utilities as a matter of urgency. Recognise that loss of utilities such as electric power and gas service can conceal damage to these systems, which can become ignition or fuel sources when the utility is restored. Maintain as much as possible automatic fire protection in service by minimising the number of valves shut to control leakage, and immediately repairing damaged fire protection systems. Monitor emergency equipment (e.g., fire pump, emergency generator, radio equipment, etc.) and other pieces of equipment that remain in service for proper operation and any abnormalities, such as overheating. • Business Resumption: Conduct salvage operations with the understanding that the danger of a fire is the greatest shortly after an earthquake. Prohibit hot work until fire protection systems are restored or risk assessments have been completed. Survey systems protected by earthquake-actuated shutoff valves for damage before and immediately after resetting the shutoff. Follow proper procedures for safe start-up and monitoring operation of equipment that was shut down.	

TABLE 1.12 MAJOR FLOOD

MAJOR FLOOD	
• Establish incident command Centre and assemble incident control group.	
• Inform and assemble incident control support group.	
Gather all necessary information relative to the incident:	
1. Incident location.	2. Personnel missing
• Instruct all personnel to gather at safe assembly points.	• Account for all personnel.
• Instruct Rescue Team briefing officer to mobilise all rescue teams.	
• Establish safe staging area for rescue teams.	
Rescue Team Briefing officer ensures safe staging area has:	
1. Guaranteed communications with incident control centre.	
2. Guaranteed fresh air.	
3. Guaranteed route for escape.	
4. Adequate space for rescue team assembly.	
5. Provisions for rescue teams.	
6. Necessary rescue equipment to be utilised by the rescue teams.	
7. Support personnel as required.	
• Rescue Team Briefing officer, briefs rescue teams on emergency action plans.	
• Under instructions from the incident controller, rescue team briefing officer deploys rescue teams from safe staging area to carry out rescue/recovery missions following the precise instructions of the emergency action plans.	
• Secure entry / exit to site.	
• Treat casualties with medical care if required.	
• Mobilise external resources if required (fire dept, ambulance, police)	
• Control communications in and out of site.	

TABLE 1.13 MAJOR LANDSLIDE

MAJOR LANDSLIDE	
• Establish incident command centre and assemble incident control group.	
• Inform and assemble incident control support group.	
Gather all necessary information relative to the incident:	
1. Incident location.	2. Personnel missing
• Instruct all site surface personnel to gather at safe assembly points.	• Account for all personnel.
• Instruct Rescue Team briefing officer to mobilise all rescue teams.	

MAJOR LANDSLIDE	
• Establish safe staging area for rescue teams.	
Rescue team briefing officer ensures safe staging area has:	
1. Guaranteed communications with incident control centre.	
2. Guaranteed fresh air.	
3. Guaranteed route for escape.	
4. Adequate space for rescue team assembly.	
5. Provisions for rescue teams.	
6. Necessary rescue equipment to be utilised by the rescue teams.	
7. Support personnel as required.	
• Rescue team briefing officer, briefs rescue teams on emergency action plans.	
• Under instructions from the incident controller, Rescue Team briefing officer deploys rescue teams from safe staging area to carry out rescue/recovery missions following the precise instructions of the emergency action plans.	
• Secure entry / exit to site.	
• Treat casualties with medical care if required.	
• Mobilise external resources if required (fire dept., ambulance, police)	
• Control communications in and out of site.	
• Establish family meeting area if required.	• Establish media meeting area if required.
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	

TABLE 1.14 SERIOUS VEHICLE INCIDENT

SERIOUS VEHICLE INCIDENT		
• Establish incident command centre and assemble incident control group.		
• Inform and assemble incident control support group.		
Gather all necessary information relative to the incident:		
1. Incident location.	2. Number of vehicles involved	3. Number of Personnel injured & types of injuries.
• Immediately contact external resources (fire dept., ambulance and police). All members of the incident control team must be made aware that an off-site incident is always under the direct control of the police. The role of Stronghold Guyana emergency response personnel and incident control / support teams is to provide assistance under the direction / authorisation of the police commander at the incident scene. If Stronghold Guyana's emergency response personnel arrive at an incident scene before police have arrived, preventive measures may be taken, under the instructions of the Stronghold Guyana incident commander to pre-empt escalation of the emergency.		
• Inform appropriate government agencies and maintain communication throughout the emergency.		

SERIOUS VEHICLE INCIDENT	
• Secure entry and exit to the emergency scene.	
• Instruct lead medic to mobilise medical support personnel.	
• Instruct rescue team briefing officer to mobilise Mine rescue teams.	
• Incident control group mobilise all first aid qualified personnel.	
• Lead medic instructs medical support personnel to prepare medical facilities to expect delivery and further advanced medical treatment of casualties.	
• Lead medic briefs medical personnel on actions to be taken.	
• Rescue Team Briefing officer briefs mine rescue teams on actions to be taken.	
• Lead medic deploys medical personnel and qualified first aiders to carry out prioritised casualty care following the precise instructions from the incident controller.	
• Rescue team briefing officer deploys rescue teams to carry out extrication of casualties from vehicles and assistance to medical personnel if required until the appropriate government agencies arrive on site.	
• Incident controller instructs ops support personnel to provide assistance with casualty transportation to surface medical facilities.	
• Secure entry / exit to site.	
• Control communications in and out of site.	
• Establish family meeting area if required.	• Establish media meeting area if required.
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	

TABLE 1.15 SURFACE FIRE

SURFACE FIRE		
• Establish incident command centre and assemble incident control group.		
• Inform and assemble incident control support group.		
Gather all necessary information relative to the incident:		
1. Incident location.	2. Personnel missing.	3. Type of fire.
• Instruct all surface site personnel to report to fire assembly points.		
• Account for all personnel.		
• Inform appropriate government agencies as required.		
• Instruct rescue team briefing officer to mobilise surface firefighting and mine rescue teams.		
• Establish safe staging position for firefighting and mine rescue teams.		
Rescue Team Briefing officer ensures staging position has:		
1. Guaranteed communications with incident control centre.		
2. Guaranteed fresh air.		

SURFACE FIRE	
3. Guaranteed route for escape.	
4. Adequate space for firefighting and mine rescue team assembly.	
5. Provisions for rescue teams.	
6. Necessary rescue equipment to be utilised by the rescue teams.	
7. Support personnel as required.	
• Rescue Team Briefing officer's briefs firefighting and mine rescue teams on emergency action plan.	
• Under instructions from the incident controller, rescue team briefing officer deploys firefighting and mine rescue teams from staging area to carry out firefighting and rescue missions following the precise instructions of the emergency action plan.	
Secure entry/ exits to site.	
• Treat casualties with medical care if required as expected until the emergent transportation to the Hospital.	
• Control communications in and out of site.	
• Establish family meeting area if required (well away from affected area).	• Establish media meeting area if required (well away from affected area).
• Inform corporate crisis management team as required.	
• Complete incident report log.	

TABLE 1.16 MAJOR PROLONGED POWER OUTAGE

MAJOR PROLONGED POWER OUTAGE	
• Establish incident command centre and assemble incident control group.	
• Inform and assemble incident control support group.	
Gather all necessary information relative to the event:	
• 1. Effected locations.	• 2. Personnel missing
• If required instruct all site surface personnel to gather at safe assembly points	• Account for all personnel.
• Instruct rescue team briefing officer to mobilise all rescue teams and have them on standby if rescue, recovery or HAZMAT operations are required.	
• Under instructions from the incident controller, Incident control support group deploy support personnel to utilise standby generators to provide temporary power supplies to all essential services at the operation.	
• Secure entry and exit to site.	
• Treat casualties with medical care if required as expected until the emergent transportation to the Hospital.	
• Utilise support personnel to maintain essential services.	
• Mobilise external resources if required. (fire dept., ambulance, police)	
• Control communications in and out of site.	

MAJOR PROLONGED POWER OUTAGE	
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	

TABLE 1.17 MAJOR MEDICAL EMERGENCIES / SERIOUS INJURIES

MAJOR MEDICAL EMERGENCY / SERIOUS INJURIES			
• Establish incident command centre and assemble incident control group.			
• Inform and assemble incident control support group.			
Gather all necessary information relative to the incident:			
1. Incident location.	2. Number of Personnel injured.	3. Types of injuries.	4. Personnel missing.
• If necessary, evacuate the mine or surface facilities.		• Account for all personnel.	
• Mobilise external resources if required (fire dept, ambulance, police)			
• Instruct lead medic to mobilise medical support personnel.			
• Instruct Rescue Team briefing officer to mobilise mine rescue teams.			
• Incident control group mobilise all first aid qualified personnel.			
• Lead medic instructs medical support personnel to prepare medical facilities to except delivery and further advanced medical treatment of casualties.			
• Lead medic briefs medical personnel on actions to be taken.			
• Rescue Team Briefing officer briefs mine rescue teams on actions to be taken.			
• Lead medic deploys medical personnel and qualified first aiders to carry out prioritised casualty care following the precise instructions from the incident controller.			
• Rescue Team Briefing officer deploys rescue teams to assist medical personnel enabling appropriate prioritised treatment for casualties.			
• Incident controller instructs ops support personnel to provide assistance with casualty transportation to surface medical facilities.			
Secure entry and exit to site.			
• Control communications in and out of site.			
• Establish family meeting area if required.		• Establish media meeting area if required	
• Inform corporate crisis management team as required.			
• Complete incident report log.			

TABLE 1.18 EXTREME WEATHER EVENT

EXTREME WEATHER EVENT
• Establish incident command center and assemble incident control group.

EXTREME WEATHER EVENT	
• Inform and assemble incident control support group.	
• Gather all necessary information relative to the event:	
1. Affected locations.	2. Personnel missing
• If required Instruct all site surface personnel to gather at safe assembly points.	• Account for all personnel.
• Instruct Rescue Team briefing officer to mobilise all rescue teams.	
• Establish safe staging area for rescue teams.	
Rescue Team Briefing officer ensures safe staging area has:	
1. Guaranteed communications with Incident control centre.	
2. Guaranteed fresh air.	
3. Guaranteed route for escape.	
4. Adequate space for rescue team assembly.	
5. Provisions for rescue teams.	
6. Necessary rescue equipment to be utilised by the rescue teams.	
7. Support personnel and equipment as required.	
• Rescue Team Briefing officer, briefs rescue teams on emergency action plans.	
• Under instructions from the incident controller, Rescue Team briefing officer deploys rescue teams from safe staging area to carry out rescue/recovery missions following the precise instructions of the emergency action plans.	
Secure entry and exit to site.	
• Treat casualties with medical care if required as expected until the emergent transportation to the Hospital.	
• Utilise support personnel to maintain essential services.	
• Mobilise external resources if required (fire dept, ambulance, police)	
• Control communications in and out of site.	
• Establish family meeting area if required.	• Establish media meeting area if required.
• Inform appropriate government agencies as required.	• Inform corporate crisis management team as required.
• Complete incident report log.	

TABLE 1.19 EXPLOSION

SURFACE EXPLOSION		
• Establish incident command centre and assemble incident control group.		
• Inform and assemble incident control support group.		
Gather all necessary information relative to the incident:		
1. Incident location.	2. Personnel missing.	3. Type of fire.

SURFACE EXPLOSION	
• Instruct all surface site personnel to report to fire assembly points.	
• Account for all personnel.	
• Inform appropriate government agencies as required.	
• Instruct Rescue Team briefing officer to mobilise surface firefighting, HAZMAT and mine rescue teams.	
• Establish safe staging position for firefighting and mine rescue teams.	
• Rescue Team Briefing officer ensures staging position has:	
1. Guaranteed communications with incident control centre.	
2. Guaranteed fresh air.	
3. Guaranteed route for escape.	
4. Adequate space for firefighting and mine rescue team assembly	
5. Provisions for rescue teams.	
6. Necessary rescue equipment to be utilised by the rescue teams.	
7. Support personnel as required.	
• Rescue Team Briefing officer's briefs firefighting and mine rescue teams on emergency action plan.	
• Under instructions from the incident controller, Rescue Team briefing officer deploys firefighting and mine rescue teams from staging area to carry out firefighting, HAZMAT and rescue missions following the precise instructions of the emergency action plan.	
Secure entry and exit to site.	
• Treat casualties with medical care if required as expected until the emergent transportation to the Hospital.	
• Control communications in and out of site.	
• Establish family meeting area if required (well away from affected area).	• Establish media meeting area if required (well away from affected area).
• Inform corporate crisis management team as required.	
• Complete incident report log.	

TABLE 1.20 MAJOR STRIKE ACTION

MAJOR STRIKE ACTION			
• Establish incident command centre and assemble incident control group.			
• Inform and assemble incident control support group.			
Gather all necessary information relative to the incident:			
1. Incident location.	2. Numbers of strikers.	3. Injured personnel.	4. Account for Personnel.
• Immediately request external resources (police).			

MAJOR STRIKE ACTION
• Incident controller instructs facilities Security manager to instigate security procedures for control of entry and exit to site.
Secure entry and exit to site.
• Control communications in and out of site.
• Establish media meeting area if required.
• Incident controller instructs ops support personnel to provide assistance to security personnel where required as to support in maintenance and repair any damage caused from sabotage or to support firefighting caused by strike actions or third parties.
• Inform corporate crisis management team as required.
• Complete incident report log.

TABLE 1.21 CIVIL UNREST

CIVIL UNREST (PROTESTESTORS)			
• Establish incident command centre and assemble incident control group.			
• Inform and assemble incident control support group.			
Gather all necessary information relative to the incident:			
1. Incident location.	2. Numbers of protestors	3. Injured personnel.	4. Personnel missing.
• If necessary, evacuate the mine or surface facilities.		• Account for all personnel.	
• Immediately request external resources (police).			
• Incident controller instructs Security facilities manager to instigate security procedures for control of entry and exit to site.			
• Incident control group mobilise all first aid qualified personnel.			
• Lead medic instructs medical support personnel to remain on standby for potential injuries.			
• Incident controller instructs ops support personnel to provide assistance to security personnel where required as to support in maintenance and repair any damage caused from sabotage or to support firefighting caused by strike actions or third parties.			
Secure entry and exit to site.			
• Control communications in and out of site.			
• Establish family meeting area if required		• Establish media meeting area if required	
• Inform corporate crisis management team as required.			
• Complete incident report log.			

1.9 EPRP REVIEW AND TRAINING

The EPRP shall include a plan for periodic revision and updates. The health, safety and training manager shall ensure that the EPRP is revised and updated annually.

A thorough and immediate review after each exercise, drill, or after an actual emergency will point out areas that require improvement.

Changes in plant infrastructure, processes, materials used in the operations and key personnel are occasions for updating the plan.

The mine and surface layout rescue plans will be reviewed and reissued on a six (6) monthly basis to ensure they remain current.

1.10 MANAGEMENT AND MONITORING MEASURES

1.10.1 MANAGEMENT APPROACH

Table 1.22 lists the control measures that will be implemented within this framework within the construction, operation, and closure phases respectively.

TABLE 1.22 MANAGEMENT CONTROLS FOR EMERGENCY EVENTS (CONSTRUCTION)

Applicability / Activity	Control Description	Responsible Parties	Means of verification
Impacts from emergency events	An emergency response plan will be prepared which clearly identifies possible emergency scenarios, sets out actions to be taken in the event of an emergency, and defines resources that will be made available to respond to an emergency event. It will include management plans and procedures, such as a contamination management and response plan, and a community health, safety and security plan	EHS Manager	Emergency Response Plan
Impacts from flooding events	Undertake regular (preferably daily) routine on- and off-site inspections, where receptors (including roads) are nearby, to monitor infrastructure conditions (e.g. monitor levees, floodwalls), record inspection results and make the log available to local authorities upon request;	EHS Manager	Emergency Response Plan
Impacts from flooding events	Perform regular site inspections to monitor compliance with permit requirements and record inspection results and make an inspection log available to the local authority when asked upon request. Regulators will be informed as part of regulatory reporting and engagement obligations. This will include monitoring protocols and periodic results where required and requested;	EHS Manager	Emergency Response Plan
Impacts from flooding events	As far as practicable, plan site layout so that the power plant is elevated and protected from contamination to watercourses	EHS Manager	Emergency Response Plan
Impacts from flooding events	Ensure facilities near riverbanks are protected against frequent flooding events predicted to increase with climate change	EHS Manager	Emergency Response Plan
Impacts from flooding events	Erect adequate barriers around ancillary facilities or at the site boundary at sufficient and effective heights	EHS Manager	Emergency Response Plan
Impacts from landslides	Undertake regular (preferably daily) routine on- and off-site inspections, where receptors (including roads) are nearby, to monitor infrastructure conditions (e.g. monitor levees, floodwalls), record inspection results and make the log available to local authorities upon request	EHS Manager	Emergency Response Plan
Impacts from landslides	Perform regular site inspections to monitor compliance with permit requirements and record inspection results and make an inspection log available to the local authority when asked upon request. Regulators will be informed as part of regulatory reporting and engagement obligations. This will include monitoring protocols and periodic results where required and requested	EHS Manager	Emergency Response Plan

Applicability / Activity	Control Description	Responsible Parties	Means of verification
Impacts from landslides	Revegetation of land cleared for construction to increase soil stability	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	All hazardous material and waste storage areas, as well as fuel storage and dispensing areas, should be constructed and equipped with secondary containment systems with bund capacity in excess of 110 percent of the liquid volume stored there. Floors should be sealed and all areas roofed to prevent the bunds filling with rain	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Emergency response kits to control any fuel/oil spill should be readily available across the Project area	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Immediately notify relevant authorities, emergency responders, and anyone else who may be affected by the spill	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Clean up and dispose of the contaminated materials in accordance with local regulations and guidelines	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Conduct regular training programs for employees to ensure they are familiar with spill response procedures	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Develop and maintain comprehensive emergency response plans that include spill response protocols	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Ensure equipment is readily available on site to clean any spillages, and clean up spillages as soon as reasonably practicable after the event	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Provision of secondary containment for components (tanks) of the hazardous material storage system, to the extent feasible	EHS Manager	Emergency Response Plan
Impacts from leaks and spills	Cyanide use should be consistent with the principles and standards of practice of the International Cyanide Management Code	EHS Manager	Emergency Response Plan
Impacts from traffic accidents	Survey the current use and traffic along old Potaro-Konawaruk Road and existing mine site access roads	EHS Manager	Emergency Response Plan
Impacts from traffic accidents	Prepare a Traffic Management Plan	EHS Manager	Emergency Response Plan
Impacts from traffic accidents	Reinforce the existing Access Road to ensure it is suitable to support both haulage vehicles and is still accessible for community use	EHS Manager	Emergency Response Plan

Applicability / Activity	Control Description	Responsible Parties	Means of verification
Impacts from fire and explosion	Avoid burning waste materials by open fires - only use approved incineration methods	EHS Manager	Emergency Response Plan
Impacts from fire and explosion	An appropriate firefighting system will be provided at the construction site. The fire extinguishers are placed at strategic locations such as site offices, laydown areas, etc. Besides this, an emergency response plan will be developed for the Project during the construction phase	EHS Manager	Emergency Response Plan
Impacts from fire and explosion	Storage of incompatible materials (acids, bases, flammables, oxidisers, reactive chemicals) in separate areas, and with containment facilities separating material storage areas	EHS Manager	Emergency Response Plan
Impacts from fire and explosion	Storage of hazardous materials in an area of the facility separated from the main production works	EHS Manager	Emergency Response Plan

1.10.2 MONITORING MEASURES

Monitoring activities will focus on key indicators to enable assessment of whether mitigation measures related to emergency response are having the desired outcomes. The Key monitoring measures and Key Performance Indicators (KPIs) are:

- Audit implementation of safety plans and SOPs, including EPRP, and mine safety measures (KPI: Number of violations and corrective actions, Target: Continuous improvement in audit scores);
- Monitor community members, government, and other stakeholders' participation in appropriate mock emergency event scenarios (KPI: Number of mock emergency event scenarios organised, % participation by invited community members, government and other stakeholder representatives);
- Monitor grievances received and stakeholder engagement records to identify stakeholder concerns regarding mine and dame safety, and emergency preparedness (KPI: Total number and change (increase / decrease) in number of complaints received, Target: Year on year improvement); and
- Monitor changes in availability of emergency medical care, both regularly and during any emergency events.

ERM HAS OVER 140 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

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Belgium
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Brunei
Canada
Chile
China
Colombia
France
Germany
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kenya
Malaysia
Mexico
Mozambique
Netherlands
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APPENDIX B CONCEPTUAL REHABILITATION AND CLOSURE PLAN

Eagle Mountain Gold Project, Guyana

Environmental Impact Assessment Report: Appendix B Conceptual Rehabilitation and Closure Plan

PREPARED FOR

Stronghold Guyana Inc.
(subsidiary of Mako Mining Corp.)

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1. PRELIMINARY REHABILITATION AND CLOSURE PLAN

1.1 INTRODUCTION

This Preliminary closure plan has been developed and reinforces Stronghold Guyana's commitment to best-practice. A detailed project description can be found in Volume 1: Chapter 2 of the EIA Report.

1.1.1 PURPOSE OF THIS DOCUMENT

This document aims to embed best-practice closure planning into the Project, whilst also satisfying national legislation and guidelines. It largely follows the format set out in ICMM (2019) and incorporates aspects from other good international industry practice.

This report has the following structure:

- Introduction;
- Regulatory Setting;
- Closure Vision, Principles and Objectives;
- Closure Activities;
- Closure Criteria;
- Post Closure Maintenance and Monitoring;
- Proposed Closure Schedule;
- Closure Liability Estimate; and
- Recommendations.

It should be noted that at this Stage, the Closure Criteria and some other components are yet to be fully defined. In these instances, a list of recommendations (Section 1.10) has been detailed for future updates of the closure plan at the back of this chapter.

1.1.2 ASSUMPTIONS AND LIMITATIONS

The Closure Plan includes various assumptions, as is normal for the stage of the Project. Where relevant, these assumptions are highlighted in the report and are summarised below:

- A preliminary closure vision, principles, objectives and post-mining land use (PMLU) have been proposed at the preliminary level.
- It is assumed that the tailing storage facility (TSF) embankments will be constructed to closure design, therefore requiring no future regrading.
- Closure criteria are yet to be developed and will be done at the next iteration of the closure plan.
- It is assumed that there is sufficient and adequate material on site to perform remediation activities.

1.2 REGULATORY SETTING

1.2.1 NATIONAL LEGISLATION AND GUIDELINES

The Guyana Geology and Mines Commission (GGMC) amended its mining regulations in 2005. These amended regulations and the Mining Act 1989 apply to the Project. The GGMC granted Stronghold Guyana an Eagle Mountain Prospecting License (EMPL) for the Project. Once the

EIA is approved by the EPA and GGMC, a mining license would be issued to recover gold in the Eagle Mountain area. 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 the following:

- Use of Poisonous Substances
- Requirements for Environmental Management for Large and Medium-Scale Mining
- Requirements for Environmental Management for Small-Scale Mining
- General Requirements
- Protected Areas
- Pollution Control
- Offences and Penalties

The GGMC has a Code of Practice (COP) for Mine Reclamation and Closure Plans (August 2010). Closure objectives are defined by Section 3.2 in the COP:

Ensuring that mine sites are restored to a satisfactory condition by:

- Eliminating/removing unacceptable health hazards and ensuring public safety
- Limiting the production and circulation of substances that could damage the receiving environment
- In the long-term, trying to eliminate the need for maintenance and monitoring
- Restoring the site to a condition in which it is visually acceptable to the community
- Reclaiming the areas where infrastructures are located for future use.

EPA Guyana have also produced guidance in relation to the EIA process. In terms of mine closure planning, the guidance states that a description of the Project rehabilitation and closure phase shall be provided in the EIA along with a description of activities associated with this phase accounting for environmental and social considerations. The preliminary closure plan provided in the EIA must include the following details:

- Regulatory framework guiding the closure program.
- Overview of installations that will be decommissioned, including consideration of potential infrastructure that may be safely repurposed or transitioned for community or local use.
- Proposed closure options/methods and environmental and social considerations, including socioeconomic programming, workforce changes and closure-specific opportunities considering the ever-evolving international best practices.
- Proposed methods for disposal and removal of waste.
- Proposed environmental and social monitoring programs post closure.
- Proposed reclamation activities to be conducted during operation and closure phases outlined in a Reclamation Plan.

1.2.2 INTERNATIONAL STANDARDS

International good practice that will be referenced to for closure planning can be found in the following various documents including:

- Sustainability Policy and Standards (International Finance Corporation – IFC, 2012): Whilst not specifically referencing mine closure, this document states IFC's policy on environmental and social sustainability for activities supported and financed by the IFC. It lists the eight Performance Standards and states that "IFC will only finance investment activities that are expected to meet the requirements of the Performance Standards within a reasonable period of time".
- IFC – Environmental, Health and Safety Guidelines for Mining (IFC, 2007): Closure and post-closure activities should be considered as early in the planning and design stages as possible, the Mine Reclamation and Closure Plan (MRCP) should include physical rehabilitation and socio-economic considerations as part of the project life cycle. The costs associated with mine closure and post-closure activities, including post-closure care, should be included in business feasibility analyses during the planning and design stages. The MRCP should address beneficial future land use be previously approved by the relevant national authorities and be the result of consultation and dialogue with local communities and their government representatives.
- Integrated Mine Closure Good Practice Guide 2nd Edition (ICMM, 2019): Provides mining companies with the guidance needed to effectively integrate closure across the mining life cycle. The guide is not exhaustive but does establish the practices and expectations for closure applicable at a broad variety of sites and can be used as guidance on the standard of practice for sites in the absence of formal regulatory / governmental requirements. It has been designed to be largely compatible with different regulatory regimes and corporate guidelines.
- Tools for Social Performance (ICMM, 2022): General recommendations for a company's engagement to impact stakeholders including incorporating closure in the corporate strategy and decision-making process and developing the closure plan with the relevant authorities and stakeholders to agree on closure commitments to be realised. The guiding principle is that reducing dependence promotes self-reliance, and communities ought to be better off once the mine is gone.
- Mine closure and reclamation planning – Requirements – ISO 21795-1 (International Standard, 2021): Provides the requirements and recommendations for mine closure and reclamation planning applicable to new and operating mines. It incorporates closure into the mining planning design and operations. It also provides a framework for mine closure and reclamation that includes responsibility, integration, design, risk and opportunity assessment and management, evaluations and improvement and knowledge. The standard also details the activities and technical procedures that should be considered during a mine closure and post closure plan.
- Mine closure and reclamation planning – Guidance – ISO 21795-2 (International Standard, 2021): Details the activities required to achieve the closure objectives by component, including tailing storage facilities, waste storage facilities, heap leach facilities, open pits, underground workings, mine infrastructure, and temporary closure. Moreover, the guideline gives special emphasis on land reclamation, water management and stakeholder engagement including a 1000-year return period earthquake as a design criterion for waste rock dumps.

1.3 CLOSURE OBJECTIVES

The closure vision, principles, objectives, and corresponding post mining land use selection, outlined in this section have been developed considering local EPA guidance, ICMM's guidance and site-specific environmental, social, and regulatory context.

1.3.1 CLOSURE VISION

A preliminary closure vision has been proposed and reads as follows:

> *"Closure will strive to leave a positive economic, environmental and social legacy, through the integration of biodiversity enhancement with existing socio-economic activity and create a sustainable future for all stakeholders."*

The closure vision will be further refined in future stages on closure plan development. The vision will be recorded in the form of a succinct statement, will ultimately be developed in consultation with key stakeholders, and will serve as an overarching aspiration for what the closure plan strives to achieve.

1.3.2 CLOSURE PRINCIPALS

Closure principles are guiding statements for reclamation and closure planning and provide the general framework for closure objectives. Suggested principles detailed by ICMM have been adopted for this plan and are listed below:

- Safety – to promote physical safety of the closed mine site over time by the provision of closure activities to make safe (to human and animal) pit left after mining.
- Physical Stability – to promote physical stability or the physical sustainability of the closed mine site over time, creating a physically stable landscape that limits long-term erosion potential and environmental degradation in the long term such that there is little or no safety threat or risk to personnel or the environment due to excessive movement of permanent landforms. The physical stability should be compatible with access and the intended post-mining land use. Although there may be limitations to the practically achievable physical stability of some landforms, the closure design should be developed to manage safety risk over prolonged periods.
- Chemical Stability – to prevent adverse effects on the local environmental quality by chemical contamination arising from Mining Influence Water (MIW). MIW can have degraded quality from rock-water interactions, sediment, or exposure to chemical reagents or vehicle fuel.
- Ecological Stability – to ensure the post closure ecosystem at the closed site is either stable, and remains in a sustainable state, or on a desired trajectory, compatible with the planned post closure land use. This may include goals for biodiversity and for a self-sustaining ecosystem that will be viable in the long term without ongoing mining company support, and compatible with the proposed land use.
- Socio-economic Transition – to promote, to the extent practical, a smooth transition from the socioeconomic conditions that existed during mining activities to the state that will be present after mining. Where practicable, the net socioeconomic impact should be beneficial to the affected region.

Risk Limitation - to control risk to an acceptable level, in several distinct areas (such as safety, environmental, financial, legal compliance, social). Most mining companies will look at closure

through a risk assessment framework, in which controlling risk is commonly an implicit or explicit principle.

- Cost-Effectiveness – to execute the closure activities cost-effectively and efficiently, use the technical, financial and human resources required to implement closure.
- Long-term Care – to design the closure plan to minimise or eliminate the need for long-term post closure care and maintenance. This principle is closely tied with chemical, ecological and physical stability and may be tied with achieving relinquishment of the closed site where that is an objective.

1.3.3 CLOSURE OBJECTIVES

Closure objectives are overarching aims associated with the closure of an operation that expand on components of the vision. Ideally, closure objectives should be informed by an assessment of risks and opportunities, mitigating closure liability, and improving post closure benefits.

Preliminary closure objectives have been proposed as follows:

- Physical Stability: The landscape and any retained infrastructure must remain structurally and geotechnically stable.
- Geochemical Stability: The project area must remain geochemically stable in order to restore and sustain native vegetation and mitigate environmental harm.
- Enhance Biodiversity: The closure plan will aim to enhance the ecosystem services through post-mining land use selection and/or integration with the existing local economic activities in a sustainable way.
- Health and Safety: The closure plan will be designed to assure environmental safety and safety of employees and communities. This will include technical training on economic activities that might continue during the operational and closure phase of the project.
- Water Quality: Surface and groundwater use will be aligned with the PMLU, and water quality and quantity must satisfy legal requirements and remain stable post closure.
- Socio-economic transition: A socio-economic transition plan should be developed to embrace alternative economic activities in the region in accordance with the community's expectations and needs. It will seek to add to the socio-economic value of the area by looking at existing and additional economic land use options.
- Regulatory: Stronghold Guyana will identify and make sure that all their internal and external commitments including national and international legislation and standards will be achieved.

It should be noted that closure principles will remain reasonably static (as they are non-specific), but the closure vision, closure post-mining land-use and closure objectives will evolve throughout the life of mine (LOM). This evolution should be directly informed by the views of key stakeholders, new project information, and the findings of risk and opportunity assessments.

1.3.4 POST-MINING LAND USE (PMLU)

Defining a post-mining land use in an early stage of the project will help define closure activities and avoid efforts that could have a negative effect on closure costs/liabilities and the closure success criteria. However, defining the post mining land use requires many inputs and

several criteria need to be included in the analysis such as permanent alterations, land capabilities, current environmental conditions, international standards, Stronghold Guyana's reputation, stakeholders' needs, stakeholders' acceptance and operational benefits and costs.

1.3.4.1 PRELIMINARY PMLU

For the Closure Plan, it is assumed that the chosen post-mining land use is to return the site to its pre-mining condition to the extent possible. This will involve transitioning the pits into lakes, the importation and rehabilitation of local soil and vegetation, and overall environmental restoration of the site. Future development of this plan will revisit the PMLU selection, conduct PMLU options assessments, and record and update stakeholder inputs. This will be conducted iteratively as the project progresses to ensure the most optimal land use is selected.

1.3.4.2 MONITORING

Physical and chemical stability monitoring is required. While not specific, the COP does mention chemical and physical monitoring. Physical monitoring and management will be conducted for the Project, such as monitoring of erosion control measures and revegetation success. There is no monitoring period defined in the COP, only that:

- A sufficient period of time should have elapsed to demonstrate the stability of the site. For re-vegetated areas, this may require that the vegetation as reached, or is trending towards, a self-sustaining status.
- The monitoring assumes ten years of post-closure monitoring will be needed based on the current project understanding.

1.4 SITE CONDITION

Volume 1: Chapter 2 of the EIA outlines the project details in the Plan of Operations. The site plan has multiple open pits, a waste rock dump, a tailings storage facility, a processing plant, a camp, and ancillary support facilities. Several kilometres of light duty and heavy duty of roads will be present on closure. It is important to note that many of the pit lakes will fill with surface water and groundwater after mining is completed. Waste dumps will be regraded, and the TSF will be graded to drain, with a pond likely to form over most of the TSF surface, in particular on the west side, where the tailings pool and slime-fraction tailings are deposited.

1.5 CLOSURE ASSUMPTIONS

The following conditions drive the closure requirements under the COP:

- The acid rock drainage (ARD) and metal leaching (ML) risk is low for all material site-wide at the current testing level. As a result, chemical stability requires no additional closure effort. This includes pit lakes, which will contain water which is expected to meet discharge quality requirements.
- The TSF contains conventional tailings, and will be closed as a half-pond, half-reclaimed ground feature.
- Each reclaimed streambed must meet both the functional and aesthetic requirements for waterways in the COP.
- Pit walls must be graded for stability. The Project assumes a 2.5:1 slope on the saprolite slopes will be sufficient to retain vegetation and geotechnical stability post-closure.
- The equipment and buildings associated with the processing plant must be removed.

- Some light-duty areas can be reclaimed by relieving compaction with a dozer-based scarifier or tractor-mounted soil disc trailer.
- The area will be revegetated with a local seed mix and with tree saplings to facilitate reforestation.
- The camp buildings will be removed.
- The largest roads will be graded to ensure that there is no disruption to the natural drainage pattern.

1.6 CLOSURE ACTIVITIES

Closure activities are the physical tasks undertaken to close an operation that have been determined will achieve the closure objectives and satisfy the success criteria. These activities can either be undertaken during operations (progressive closure) or after operations (final closure and post-closure).

Rehabilitation measures presented in the following sections have been developed using the stated assumptions for the purpose of presenting the closure plan and preparing a reclamation cost estimate. Further assessment and engineering will be required prior to the implementation of the closure plan to confirm the reported conditions, verify the feasibility of closure plans, and produce design specifications and construction documents. The following sections provide additional detail, where available, for the individual sites' closure tasks.

1.6.1 OPEN PITS

As mentioned previously, there are several open pits within the project which, upon cessation of operations, will be naturally flooded by natural groundwater inflow and surface water run-off. Due to the saprolite being graded to 2.5:1 approaching the water line, and due to the water line mostly within the saprolite horizon, no protective fencing is required. Pit lakes will simply be lakes, with sloped ground down to the water level.

All pit lakes will have an engineered spillway and a trapezoidal berm on the downgradient arc of the lake and are designed as flow-through water features.

1.6.2 TSF

Not all of the TSF is "trafficable", and this feature drives the closure options. In conventional tailings deposition, the tailings are spigot out on the dam face (Figure 1.1).

FIGURE 1.1 EXAMPLE OF CONVENTIONAL TAILINGS SPIGOT

During the process, the coarse-grained tailings fall out of the tailings slurry near the dam, whereas the fine-grained tailings migrate more distally within the facility. For the TSF, the sandy fraction is on the eastern side of the facility near the dam, with the slime fraction deposited on the western side near the natural ground. Because the fine-grained tailings are not conductive, the east side of the TSF will not drain, and a pond will form. It is assumed that ~55% of the TSF will be pond, and ~45% solid surface area. The sand-fraction beach area will be graded to drain, will have reclaimed stream channels, and will be revegetated.

1.6.3 WASTE STORAGE FACILITY

The WSF is designed for closure with an overall design slope of 3:1. However, the inter-bench angles are too high and the bench widths are too wide for final closure. Some regrade is required to make more frequent and smaller benches which will interrupt the slope length and mitigate the kinetic energy of runoff. All surfaces of the WSF will be covered with approximately 0.5 meters of topsoil and will be revegetated. Where necessary, armoured stream channels will be made.

1.6.4 PROCESSING PLANT AND SUPPORTING INFRASTRUCTURE

It is assumed at this level that several pieces of infrastructure will remain available to use as part of the PMLU. Any other building or infrastructure without a PMLU will be demolished down to its foundation level. Table 1.1 proposes a preliminary list of buildings and their post-mining land status, recognising that this status might change as the closure plan evolves. The infrastructure that will remain after closure, will be discussed with the relevant stakeholders and authorities in order to have a clear transfer process.

TABLE 1.1 INFRASTRUCTURE POST-CLOSURE STATUS

Facility	Closure Status
Crushing Facility	Close
Processing Facility	Close
Operations Camp	Retain
Fuel and Chemical Storage	Close
Explosives Magazine	Close
Access Road	Retain
Offices	Retain

It should be noted that as planning progresses, opportunities for integration of PMLU and retention of infrastructure should be consistently explored, in order to both benefit stakeholders and reduce overall liability.

For those buildings that will be demolished, the closure base-case is proposed to consist of:

- Concrete foundations, footings, and curbs will be fully removed, voids will be backfilled with inert material up to grade and covered with topsoil.
- Decontamination of concrete slabs (if required).
- Previously removed overburdened material / onsite soil will be used to cover slabs.
- All surface pipelines will be removed unless required for post closure water management.
- Any salvageable material (i.e., steel, piping, copper, stainless steel, and aluminium) will be removed prior to demolition and be offered for reuse or to benefit local communities. Any remaining material will be disposed of in a recycling facility.
- Any residual non-recyclable waste will be disposed of in an approved disposal facility, either onsite or offsite.
- Any potential hazardous materials identified during the closure process will be removed and disposed of in an approved disposal facility.
- Final grading will be designed to be compatible with the surrounding topography.
- Revegetation will be designed as part of the Biodiversity Management Plan.
- In cases where roads are not part of the post-mining land-use plan, they will be scarified and covered with a layer of soil, and, where needed, appropriate vegetation.

1.6.5 SURFACE WATER MANAGEMENT

As part of the closure process, a comprehensive reassessment of the existing water management structures will be conducted to ensure that closure plans are based on the most up-to-date information, contact water is minimised, and that long term maintenance will not be required based on available geochemical information on local water. The Surface Water Management Plan (SWMP) upon closure will involve the establishment of functioning stream channels protected from erosion by riprap. The current plan considers that the regulations require aesthetic considerations as well as functional considerations.

The final design of the SWMP will be revised based on the results of surface water flow modelling, but assumptions have been made for this preliminary plan as to the depth and width of the channels is required.

1.6.6 TOPSOIL PLACEMENT

Topsoil placement is specifically mentioned in the Code of Practice. The preliminary plan has the placement of 50 cm of topsoil over tailings and mine waste, and the placement of 30 cm of topsoil over the plant area. In the open pit and along the roads, the superficial soil is already saprolite, so the Project proposes discing to relieve compaction followed by revegetation.

1.6.7 REVEGETATION

Revegetation is required under Guyanese law (see Section 2.0), and an appendix in the COP outlines the methods recommended. On-site experience has shown that some impacted areas may revegetate, this is not consistent with the code of practice, and the preliminary plan has active revegetation for some of the disturbed areas.

1.6.8 SITES WITH CHEMICAL USE

Site investigations should be carried out to track potentially contaminated sites for decommissioning and restoration, progressively in operations and in closure, including areas such as:

- Processing plant and reagent mixing areas;
- Cyanide detoxification circuit and supporting infrastructure;
- Power supply and distribution;
- Fuel storage areas;
- Explosives' storage;
- Process plant workshop;
- Process plant warehouse;
- Process plant laboratory; and
- Hazardous waste temporary storage areas.

The preliminary closure plan does not include areas with contamination. It assumes that the mine will operate with pollution prevention in mind, and contamination of soils and water upon closure will be minimal or non-existent.

1.6.9 WASTE MANAGEMENT

Waste management will follow a hierarchy with the emphasis placed on reuse and recycling. A Waste Management Plan (WMP) will be prepared to identify what material can be reused and recycled. Currently, materials identified for reuse include tires (recapping), steel, and wood - if useful to local communities. Materials currently identified for recycling include waste lubricants and filters, broken parts, used air filters etc., out-of-service vehicles, typical household recyclables, batteries, and scrap metals.

1.6.9.1 NON-HAZARDOUS WASTE

As much as possible, waste will be segregated to facilitate recycling. A reputable, licensed contractor will be hired in Guyana to handle the final disposal of recyclable and saleable waste. A non-hazardous waste storage area will be constructed from low-permeability materials.

Waste processing and storage areas will be constructed with curbs to prevent run-off to permeable areas. Run-off and leachate will be collected and treated as needed prior to discharge to the environment.

For non-hazardous materials that cannot be recycled or returned to the suppliers, one or more non-hazardous landfills will have been developed within the Project area to manage the waste. The landfill(s) will be created within the WSF areas and will be constructed and operated to be consistent with best practices. This includes consideration of aspects such as landfill siting, engineering to minimise infiltration and facilitate leachate collection if needed, tracking of waste streams, and monitoring of run-off and leachate generation.

1.6.9.2 HAZARDOUS WASTE

Hazardous waste will not be disposed of in the on-site landfill(s). Hazardous waste generated by the Project will be temporarily stored on site pending off-site shipment for treatment and/or disposal at an approved facility by a licensed contractor.

1.6.10 STAKEHOLDER ENGAGEMENT

As described by ICMM and IFC EHS Guidelines for Mining, effective mine closure planning and implementation considers the views, concerns, aspirations, efforts and knowledge of internal and external stakeholders to identify mutually beneficial closure outcomes for the company and its host communities.

The involvement of stakeholders is key to successful closure and social transition. Engagement on closure should take place throughout the entire mining lifecycle, with an approach that empowers the local community in the decision-making process. Local communities have a central role in planning for mine closure and materialising social transition, as they are the ones who will be impacted, positively or negatively by closure, and will ultimately determine whether it has been successful.

As a general standard, ICMM suggests including the following key stakeholders: local community members, indigenous peoples, workforce, governmental authorities, industry peers, other sectoral contributors, and possibly academics and the media. Input from these groups will allow for the identification of potential impacts, mitigations for mine closure, and for the development and refinement of the closure plan, including final land-use objectives. In the longer term, closure and reclamation that integrate stakeholders' knowledge and interests will support regional development planning and programs beyond the mine's life.

A Project-specific engagement strategy will be designed and implemented during the Project's lifetime, noting that local communities must be involved as early as possible in the development of the closure vision and PMLUs to ensure their ownership of the results, as mentioned in Section 1.3.

Engagement activities might include but are not limited to:

- Virtual and in-person meetings;
- Presentations to national and local authorities including local development planning structures;
- Open houses to engage with local communities;
- Special topics workshops;

- Regular check-in meetings to provide information on the project, related activities, the regulatory process, and preliminary mitigation planning;
- Site tours;
- Community visits;
- Technical advisors' workshops; and
- Socio-economic baseline interviews

As part of the closure strategy, a social transition plan should be developed as early as reasonably possible to identify risks associated with local dependence on the Project and harnessing opportunities to mitigate these risks. This plan should be aligned with the closure vision, objectives, PMLU, and criteria. The plan should be implemented progressively as possible throughout the Project's lifetime.

Engagement will increase in detail, scope and frequency as the project evolves. Social investment should be directed toward building community resilience to the impacts of mine closure through generating post closure socio-economic returns which should be aligned with the shared vision of a post-mining future. Partnerships might also be considered into the social transition to identify and prepare alternative long-term economic opportunities.

1.7 POST-CLOSURE MAINTENANCE AND MONITORING

Closure monitoring and maintenance will encompass physical aspects of the Project such as landforms, water, and biodiversity. The objective of long-term monitoring is to validate the fulfilment of closure success criteria, which include ensuring the safety of landforms, maintaining appropriate water quantity and quality, and establishing self-sustaining ecosystems and habitats. The monitoring and maintenance program will be evaluated further during future study and operation of the mine.

1.7.1 GEOTECHNICAL STABILITY

A geotechnical monitoring program will be developed which will be supported by visual inspections, annual site inspection by a qualified professional, and instrumentations that can include but not be limited to piezometers, inclinometers, radar, prisms, GPS monitors and remote-sensing geotechnical tools.

Closure design will endeavour to minimise the need for long-term monitoring following the eventual closure criteria. Monitoring points and specific instruments will be installed in each area of geotechnical risk as part of closure. The monitoring plan will include the desired frequency of readings, and the action levels for each instrument so that risks can be identified.

If a geotechnical concern is identified, it will need to be investigated by qualified engineers, and appropriate mitigation measures must be implemented to maintain long-term stability.

1.7.2 RECLAMATION MONITORING

Monitoring success of the reclamation during and after closure and ensuring their on-going effectiveness are crucial', including inspection of the establishment and evolution of vegetative cover.

Progressive closure monitoring results will also be incorporated to test rehabilitation techniques and cover systems, so that the monitoring process during closure and post closure can be minimised.

The cover system will be monitored through visual inspections to identify signs of erosion and soil loss; additionally, soil samples can be added to the monitoring program, quarterly inspections of the final cover will be performed to detect and repair any instances of deterioration.

1.7.3 WATER MONITORING

The water monitoring program for closure and post closure will be designed together with the WMP. The program will specify the monitoring points, parameters, and frequency of measurements during closure and post closure. The program will be optimised depending on the results obtained.

The WMP should be designed with a view to reduce the water-related infrastructure to be closed and reduce the monitoring points and frequency. It is expected that the remaining infrastructure will be transferred to the post-mining users as part of PMLUs.

Water quality of the pit lakes will continue to be monitored during the post closure phase prior discharge, to ensure that water has achieved the permit's conditions.

1.7.4 BIODIVERSITY MONITORING

The biodiversity monitoring and maintenance program will be developed as part of a Biodiversity Management Plan, with the program defining monitoring points, parameters and monitoring frequency. The monitoring program will start during progressive closure and will incorporate the results to enhance the closure design and minimise the monitoring program during the post closure phase.

The program can be modified during the closure and post closure phase based on the results obtained and transferred to the post-mining land users if partnerships are built based on the PMLU proposed.

1.8 PROPOSED CLOSURE SCHEDULE

This section aims to summarise the different approaches to closure planning throughout the different phases of the Project's life. The identification of specific actions and allocation of resources at different stages, in alignment with the closure objectives, limits overall liability at cessation of operations and increases the probability of successful closure.

1.8.1 PROGRESSIVE CLOSURE

Progressive closure should be undertaken at the earliest opportunity for those domains (area or areas that have distinct and unique characteristics for the purposes of closure) that will end operational life throughout the LOM and for those components whose configuration allows them to be closed progressively while they are still operating.

Progressive closure will provide a good opportunity to test closure systems, including soil cover systems and vegetation uptake. This information will inform future closure practices, find opportunities to improve the closure process, and help identify additional risks and mitigate them. Additionally, progressive closure is a good opportunity to engage with stakeholders on closure practices and to reaffirm the closure vision and PMLU selection.

1.8.2 FINAL CLOSURE

Final closure will start immediately after the cessation of mining operations and is anticipated to take five years. At the point of final closure, social transition should already be well underway in order to minimise the communities' economic dependence on the Project.

The only infrastructure that currently is considered to be turned over to the community is the camp. All other facilities will be closed.

1.8.3 POST CLOSURE

Post closure refers to the monitoring and maintenance phase after closure has finalised. It is suggested to have a ten-year monitoring and maintenance period; however, this commitment might be transferred to the post-mining responsible parties. In cases where the Project falls short of achieving the desired closure objectives, ongoing maintenance will be necessary to address any deficiencies and work towards meeting the success criteria.

1.8.4 CLOSURE SCHEDULE

For the purposes of scheduling, closure is broken down into four phases, described below:

- Phase 1 – Progressive Closure: Progressive closure of the WSF and implementation of social engagement and transition plans in the preceding five years to final mining activity.
- Phase 2 – Safety Measures and Bulk Earthworks: Closure of the open pit, TSF and WSF in the five years following the cessation of Mining activity.
- Phase 3 – Decommissioning, Decontamination, and Demolition (DD&D), Scarification and Revegetation: Closure of processing infrastructure, accommodation camp and haul in the three years following the cessation of processing activity.
- Phase 4 – Post-closure maintenance and monitoring: Maintenance and monitoring activities carried out for ten years post-closure.

1.9 CLOSURE LIABILITY ESTIMATE

Stronghold Guyana have created a closure liability (closure cost) estimate of all anticipated closure activities. The Project has utilised the best-available unit rates for key reclamation tasks based on the following (in order of preference):

The closure liability estimate was generated from first principles and tabulated into a basis of estimate. A summary of closure costs is shown in Table 1.2, Table 1.3 and Figure 1.2.

TABLE 1.2 CLOSURE COST SUMMARY BY AREA

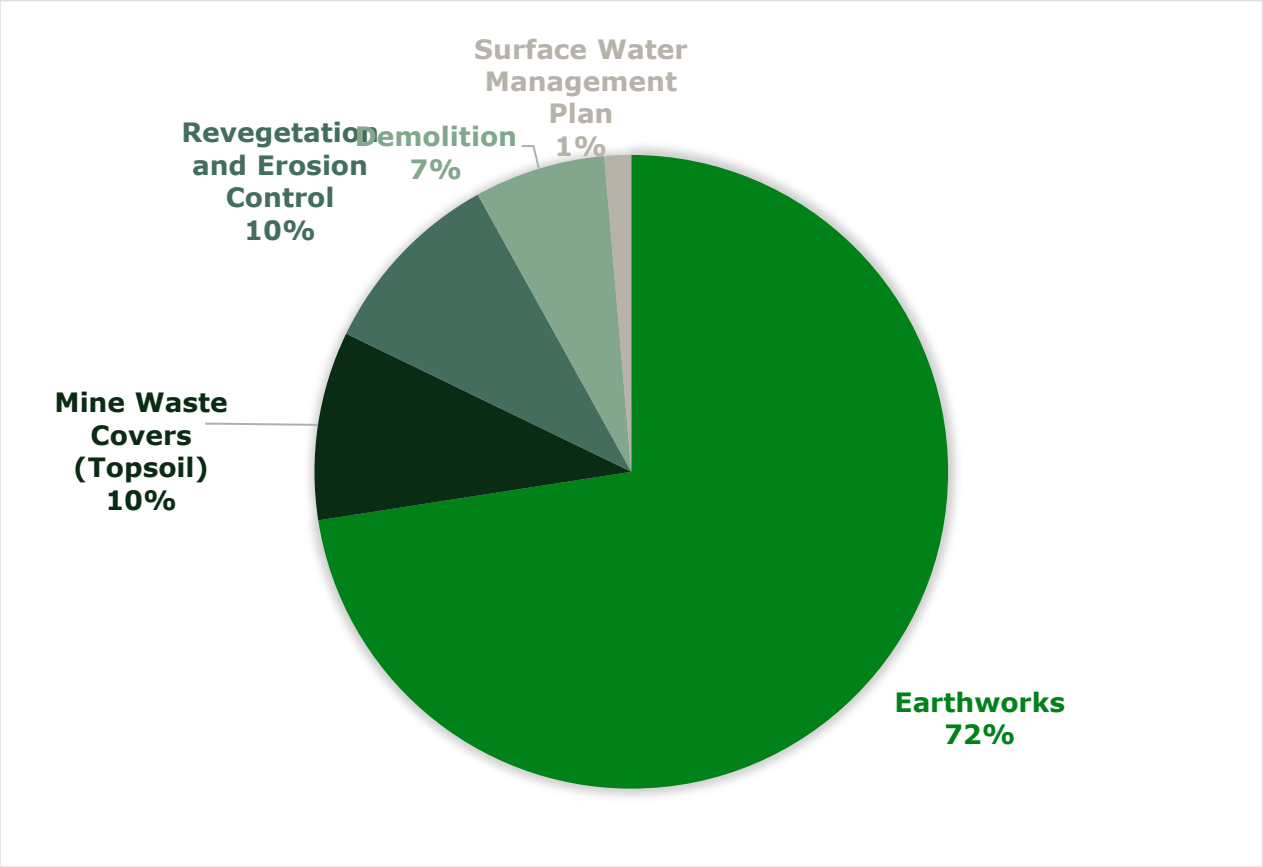
Area of Work	Total Estimated Cost
	(USD)
Tailing Storage Facility	$422,155
Waste Rock Storage Facility 1	$1,688,141
All Pits Inc. Eagle, Salbora, Powis, and North Salbora	$9,412,133
Plant Site and Yards	$1,064,673
Roads	$2,232,841
Surface Water Management Plan	$132,997

Area of Work	Total Estimated Cost
	(USD)
Total Direct Costs	**$14,952,939**
Indirect Costs	**$4,485,882**
Total Final Closure Cost	**$19,438,821**

TABLE 1.3 CLOSURE COST SUMMARY BY ACTIVITY

Direct Costs	
Earthworks	$10,848,545
Mine Waste Covers (Topsoil)	$1,439,715
Revegetation and Erosion Control	$1,460,611
Demolition	$1,000,000
Surface Water Management Plan	$204,068
Subtotal Direct Costs	**$14,952,939**
Indirect Costs	
Engineering Studies	$747,647
Social Programs	$0
Construction QA/QC	$747,647
Contingency	$2,990,588
Total Indirect Costs	**$4,485,882**
Total Final Closure Cost	**$19,438,821**

FIGURE 1.2 DIRECT CLOSURE COSTS BY FACILITY



From this graph, earthworks comprise ~72% of the closure costs. This is typical for a mine which does not have an ARD or ML risk – nearly all of the closure costs are directly related to terraforming the post-mining topography to meet the design criteria.

1.9.1 UNIT RATES

This section presents the actual unit rates taken directly from observed costs at Eagle Mountain. These include the following table, which comprises most of the equipment which will be used in the estimate (Figure 1.3).

FIGURE 1.3 RATES

Description	Units	Estimated Unit Rate (US$)	Comment	Source
General Earthworks				
Dozer Push	$/m3	$ 2.46	For slope regrade	Local earthmoving bid.
Excavator and Trucks, Short Haul	$/m3	$ 2.48	Ex. For pit regrade to other area of pit	San Albino Mine Costs, (Mako project in Nicagragua)
Dozer Regrade for Roads	$/m3	$ 2.46		Local earthmoving bid.
Channel Digging	$/m3	$ 0.75	Using Excavator, but no trucks	San Albino Mine Costs, (Mako project in Nicagragua)
Topsoil Placement	$/m3	$ 1.65	From stockpile, using excavator and shovel	San Albino Mine Costs, (Mako project in Nicagragua)
Topsoil Grading	$/m3	$ 0.03	Road Grader	CAT Handbook
Rip to Relieve Compaction	$/m2	$ 0.02	D6T CAT Dozer Ripping	CAT Handbook
Disc to Releive Compaction	$/m2	$ 0.01	Similar Tractor Rates as D6T CAT Dozer, 25% more efficient Discing	CAT Handbook
Screen Riprap	$/m3	$ 0.44	use EOM waste rock, screened., CAT handbook, Screening Bucket 962	CAT Handbook
Place Riprap	$/m3	$ 0.48	Based on Screen with Loader, 110% cost increase for tramming, hand placing of riprap	CAT Handbook
Close Sediment Ponds	1	$ 25,000.00	Regrade cost to breach ponds	Estimate Based on Prof. Judgement
Revegetation				
Revegetation: Includes scarify Surface and hydroseed with transplants	$/m2	$ 0.10	Matches Oko West, Guayanese project	Oko West Clousre cost estimate, by ERM
Revegetation : Live topsoil	$/m2	$ 0.10	Matches Oko West, Guayanese project	Oko West Clousre cost estimate, by ERM
Erosion control: BMP's such as much, wattles, bales as needed	$/m2	$ 0.50	GRE Estimate, from previous projects. For drainages	
Demolition				
Demolish Plant	LS	$ 1,000,000		Estimate based on professional judgement and experience with similar projects
Camp	LS	zero	Assume camp turned over to community	
Salvage				
Salvage - Plant			Not included, assumed this offsets demolition costs. Safe to assume 10%	
Post-Closure Monitoring and Maintenance (M&M) Per Year				
Water Quality Monitoring	$/year	$ 9,567.92	Labor is estimated. Analytical is direct lab bid.	
Erosion Monitoring, Revegitation Monitoring	$/year	$ 8,255.38	Estimate based on professional judgment.	

This equipment list is assumed to be the available fleet upon closure, and it covers nearly all the required equipment for a major reclamation project.

1.9.2 EARTHWORK EFFICIENCY ASSUMPTIONS

Where necessary, calculated earthwork efficiency rates using CAT manuals were adjusted based on Project design teams on-site experience. Productivity rates in Guyana on muddy ground will likely be below standard productivity rates for equipment (Table 1.4).

TABLE 1.4 EARTHWORK EFFICIENCY ASSUMPTIONS

Equipment	Rate	Unit	Source
Dozer Push and Regrade	95	m^3/hr	CAT Handbook, Adjusted for Site Conditions
Excavator, for Truck and Shovel	140	m^3/hr	

Equipment	Rate	Unit	Source
Excavator, for Diversion Ditches	96.7	m^3/hr	
CAT 735 Trucks	90	m^3/hr	
Grader	6300	m^2/hr	Grader productivity – CAT Handbook 49: page 11-27

These estimated productivity and unit rates are used in some elements of the cost estimate to calculate costs for each earthwork task by volume or area. Where costs were taken directly from San Albino (Stronghold Guyana's active Nicaraguan mine), these assumptions were not used because the costs were already in cost per square meter or cubic meter.

1.9.3 REVEGETATION

Revegetation costs come from several separate tasks: topsoil placement, relieving compaction through discing, erosion control Best Management Practices (BMPs) and re-seeding and revegetation. Topsoil placement costs are calculated from estimated haul distances between stockpiles or excavations and the reclaimed facility using the equipment rates in Section 6.2. Compaction management comes from an internet-based search on discing costs. Erosion control BMP costs come from professional judgement. The Project has utilised a revegetation (reseeding and transplants) estimate taken directly from ERM's Oko West closure cost estimate (ERM, 2024).

1.9.4 DEMOLITION AND SALVAGE VALUE

The preliminary closure plan has not included accurate demolition costs nor salvage value in the cost estimate. The equipment list for the plant has not been finalised at this stage, and therefore salvage value cannot be ascertained at this moment. This preliminary closure plan has put in a $1M placeholder for demolition-salvage, but this may be an underestimate of the final costs.

1.9.5 INDIRECT COSTS

Indirect costs are a significant addition to the mine closure costs. The Project proposes the following indirect costs (as a percentage of the direct costs):

- Contingency: 20% (from PFS-level engineering studies)
- Engineering studies: 5% (from RS Means)
- Construction QA/QC: 5% (from professional judgement)
- Taxes: 0%

The total indirect costs are estimated to be 30% of direct costs.

1.9.6 POST CLOSURE COSTS

Post closure costs are an essential element in the closure costs and a requirement under the COP.

- Operating the sediment ponds and flocculant dosing stations until revegetation is complete.
- Revegetation monitoring

- Erosion control monitoring
- Ongoing site-wide surface and groundwater sampling;

Analytical costs for post-closure water quality monitoring were taken from Kaisen Laboratories in Georgetown, Guyana, or IMEX Incorporated in Guyana, whichever is more favourable. It is unclear how many years of post-closure monitoring will be required. 10 years has been utilised as a conservative upper estimate. The total cost of post-closure monitoring (with the same contingency as above) is ~$1M.

1.9.7 LIMITATIONS

The closure cost estimate is based on the best-available site data and economic estimates at this point in the project. All economic predictions of closure cost are subject to uncertainty and should be interpreted as a best estimate.

It is important to note that this preliminary closure plan has not performed a discounted cash-flow analysis on the closure costs. The final closure costs and the post-closure costs are on a cost timeline.

1.10 RECOMMENDATIONS

The closure cost estimate requires widespread modification after client input and the finalisation of the Plan of Operations.

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APPENDIX C WASTE MANAGEMENT PLAN

Eagle Mountain Gold Mine Project, Guyana

Environmental Impact Assessment Report: Appendix C Waste Management Plan

PREPARED FOR

STRONGHOLD GUYANA INC.

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1. WASTE MANAGEMENT PLAN

1.1 INTRODUCTION

This document is the Waste Management Plan (WMP) for the Eagle Mountain Project. The WMP sets guidelines for the management of hazardous and non-hazardous wastes, and establishes roles and responsibilities for Reunion personnel, contractors, and subcontractors.

The intent of the plan is to afford a high degree of control over the handling of wastes to minimise adverse environmental effects, meet regulatory requirements and ensure sustainable operations. Stronghold Guyana is committed to ensuring that the collection, storage, transportation, and disposal of all wastes generated by all project components will be conducted in a safe, efficient, and environmentally sound manner in full compliance with applicable regulations.

1.1.1 OBJECTIVE

The purpose of this management plan is to:

- Define the regulatory requirements for waste management in Guyana;
- Define roles and responsibilities for implementation of the management plan;
- Define corporate and Project commitments, standard operational procedures and guidance relevant to this management plan;
- Define the waste types, quantities and capacity applicable to the Eagle Mountain Project;
- Define training requirements;
- Define auditing procedures; and
- Define monitoring and reporting procedures;

1.1.2 APPLICATION

The requirements set out in this management plan apply to all Stronghold Guyana's activities throughout the lifecycle of the Eagle Mountain Gold Mine Project, including those carried out by contractors and subcontractors; it does not replace or supplant the terms and conditions set out in individual contracts.

1.2 REGULATORY REQUIREMENTS

The minimum standards of acceptability for this Waste Management Plan are to comply with the following pieces of Guyanese legislation:

- Draft Solid Waste Management Bill 2014;
- Environmental Protection Act 1996; and
- Environmental Protection (Hazardous Wastes Management) Regulations 2000.

1.3 ROLES AND RESPONSIBILITIES

Stronghold Guyana will be responsible for the implementation of waste management practices at the Eagle Mountain mine and will be co-regulated with stakeholders including the GGMC, and the Mining Industry.

GGMC's role as defined by the Mining Act 1989 and the Mining (Amendment) Regulations 2005 is to develop, administer, and enforce the mining regulations. Specific responsibilities include:

- Development and upgrading of the codes of practice;
- Consultations with the stakeholders in the mining industry including mining organisations and miners on the development, and utility of the Codes of Practice;
- Public education, orientation and training; and
- Enforcement of, and monitoring compliance with, the Mining (Amendment) Regulations 2005.

The prime responsibility for the implementation of, and compliance with, the Mining (Amendment) Regulations 2005, and the application of sound environmental management practices rests with Stronghold as the mine owner and operator. Specifically, with the respect to the Waste Management, Stronghold must:

- Manage their operations in compliance with the Mining (Amendment) Regulations 2005, the related Codes of Practices and Guidelines;
- Prepare and implement a waste management and disposal plan; and
- Provide their employees with required training and orientation on the Waste Management and disposal, and the related the regulations, best management OHS practices, codes and guidelines.

Key roles and responsibility for implementation of extractive waste management are outlined in Table 1.1.

TABLE 1.1 ROLES AND RESPONSIBILITIES (WASTE)

Role	Responsibility
Stronghold Management Team	• Approval of management plan • Allocation of resources for implementation
Stronghold General Operations Manager	• Work with site managers to ensure compliance with the environmental and technical terms and conditions and waste management plan. • Work with the Community Relations Manager to address any off-site issues and/or grievances.
Stronghold Environmental Manager	• Ensure that environmental and geotechnical monitoring is undertaken as set out in applicable management plans and procedures. • Overall responsibility for plan scope and implementation. • Ensure incident investigations are undertaken and reported. • Development, monitoring, and revision of this plan.
Environmental Monitoring Officers and Technicians	• Requirement-based monitoring program design • Execution of monitoring program • Maintenance of measuring instruments • Conduct routine work area inspections to ensure relevant activities are in accordance with this Management Plan and related Procedures. • Report all hazards, non-conformances, and incidents.
All employees and contractors	• Report any activities which may pose any impact to the environment. • Avoid performing activities which unnecessarily may pose hazards to other employees or the environment.

1.4 SCHEDULE

The WMP will be implemented during the construction, operation, and closure phases. The Waste Management Manager/ Environmental Manager will disseminate the performance objectives and measures related to waste management to all Project personnel that have a direct or indirect influence on such management during the construction, operation, and closure activities. Communication of the performance objectives and their acceptance as performance indicators by responsible individuals will be recorded. Performance against the indicators will then be tracked and reported annually.

1.5 WASTE MANAGEMENT STRATEGY

The waste management strategy for Eagle Mountain will be determined by the types and volumes of waste generated by the Project. Each category of mine wastes should be tracked from source to disposal.

The types of wastes produced by Eagle Mountain mine will include:

- Overburden during mining
- Tailings from the processing operation
- Solid waste, including food waste from the camp operations
- Septic waste from the camp operations

A hierarchy of waste management practices should be applied to the management of all materials used at the mine. In order of preference, options selected should be:

- Waste avoidance: practices that prevent the generation of waste altogether
- Waste reduction: practices that reduce waste
- Waste reuse: direct reuse of waste materials for the same grade of use
- Waste recycling or reclamation: using valuable components of waste in other processes
- Waste treatment: to reduce hazard or nuisance, preferably at the site of generation
- Waste disposal.

The waste management strategy will be implemented after the commencement of mining operations. Stronghold Guyana will be responsible for implementation.

1.5.1 WASTE CHARACTERISATION

The mine operations are expected to generate the following waste streams during construction:

- Construction waste:
  - Pallets and other wood packaging materials
  - Shipping packaging
  - Discarded dry, non-hazardous materials
  - Scrap metal
  - Scrap lumber
- Discarded office supplies
- Discarded food containers
- Putrescible food waste

- Other "household" waste
- Out-of-service vehicles
- Medical waste
- Solid waste: domestic solid waste or similar industrial waste (non-hazardous and hazardous), including tires, broken and used parts, unused raw concrete, reagent bags, scrap steel
- Liquid waste: unused chemicals, used solvents, used oil, sewage sludge and supernatant water, and wastewater from maintenance shops (non-hazardous and hazardous)
- Paint consumables (paint cans/barrels, brushes, rollers and solvent containers)
- Electronic wastes
- Lead acid batteries
- Lithium Batteries

Mine wastes produced during the life cycle of the Eagle Mountain gold mine which have no economic value include:

- Waste rock
- Tailings: materials rejected from the mill following extraction of recoverable valuable materials
- Overburden materials: dirt, rock, and gravel

However, this plan excludes mine process hazardous wastes, which will instead be covered in the Eagle Mountain Tailings Management Plan.

1.5.2 WASTE REDUCTION, REUSE, AND RECYCLING

Waste management for the Project is governed by the waste management hierarchy with an emphasis placed on waste reduction, reuse and recycling to minimise the volume of non-hazardous wastes that need to be managed. Reducing the amount of material that is consumed is the most effective way of reducing the amount of waste that is generated. Consumption will be assessed by evaluating all procedures, processes, and consumed materials for possible reductions in material usage, as well as possible reductions in generated waste volumes. Examples of waste reduction include:

- product review, selection, and substitution - recyclable/reusable and non-hazardous materials will be used instead of non-recyclable/non-reusable and hazardous materials;
- ordering chemicals or lubricant products in bulk/returnable containers;
- keeping a workable minimum inventory to prevent expiration of products and resulting generation of waste;
- adopting First in first out (FIFO) methodologies for material stores to prevent spoilage
- decreasing the amount of solid waste by reducing the use of disposable items;
- training personnel on waste minimisation and reuse; and
- decreasing the amount of packaging on supplies by requesting that suppliers provide less packaging materials on over-packaged products.

Material which may be reused include tires (recapping), steel, and wood - if useful to local communities. Materials which may be recycled include waste lubricants and filters, broken

parts, used air filters etc., out-of-service vehicles, typical household recyclables, batteries, and scrap metals.

1.5.3 HANDLING OF NON-HAZARDOUS WASTE

Non-hazardous waste generated by the Project is primarily associated with packing and surplus construction materials. The primary material types are wood (pallets), scrap steel, and cardboard. Smaller volumes of other non-hazardous waste, such as paper and organic food waste, will also be generated. As much as possible, waste must be segregated to facilitate recycling. A reputable, licensed contractor will be hired to handle the final disposal of recyclable and saleable waste. A non-hazardous waste storage area will be used to store wastes before they are transferred to the licensed contractor. The storage area will be constructed from low-permeability materials. Any areas used for waste processing and storage areas must be constructed with curbs to prevent run-off to permeable areas. Run-off and leachate must be collected and treated as needed prior to discharge to the environment.

For non-hazardous materials that cannot be recycled or returned to the suppliers, non-hazardous landfills will be used within the Project area to manage the waste. The landfill(s) will be created within the Waste Rock Storage Facility area and will be constructed and operated to be consistent with best practices. This includes consideration of aspects such as landfill siting, engineering to minimise infiltration and facilitate leachate collection if needed, tracking of waste streams, and monitoring of run-off and leachate generation.

1.5.4 HANDLING OF HAZARDOUS WASTE

Hazardous waste will not be disposed of in the on-site landfill(s). Hazardous waste generated by the Project will be temporarily stored on site at a Temporary Hazardous Waste Storage Facility pending off-site shipment for treatment and/or disposal at an approved facility by a licensed contractor.

Designated facilities used for the collection and temporary on-site storage of hazardous waste will include fencing, signage, roofing, lighting, and secondary containment.

Existing management protocols will be maintained for hazardous wastes, including:

- Medical waste
- Used batteries
- Used or residual oil
- Used oil filters
- Hydrocarbon-impregnated materials
- Light bulbs, fluorescent tubes, and vehicle light lamps
- Electronic Wastes
- Reagent/Chemical Wastes (Bags, Jars etc.)

1.5.5 TRANSPORTING WASTE

Reputable certified transportation contractors will be used for the transport of goods and materials to and from the site, including waste. Project personnel will periodically inspect the transporters' performance and compliance with waste transport regulations, contract requirements, and overall performance.

1.6 WASTE CAPACITY ASSESSMENT

The waste capacity assessment for the Eagle Mountain mine considers the following factors:

- Waste classification
- Waste creation, storage, and treatment
- Waste quantity
- Waste disposal
- Environmental impact
- Waste facility closure
- Site-specific conditions
- Sources, pathways, and receptors

Waste generated and managed by the Project will include overburden, tailings, hazardous and non-hazardous wastes. Overburden will be placed in the Waste Rock Storage Facility. All tailings and other process waste will be placed in the tailings pond. Solid waste from the operation of the camp will be segregated according to type. All non-hazardous non-recyclable wastes will be routed to the waste disposal facility located in the TSF, all hazardous waste streams will be stored within the temporary hazardous waste storage facility for offsite shipment to an EPA licensed waste facility. Composting of food and organic wastes will be explored as a means of fertiliser generation for progressive reclamation and revegetation programs. Initially, septic waste will be managed by a series of septic tanks on site, this system will be replaced by a permanent onsite sewage treatment system that will be capable of treating all grey and black waters produced by the project activities. Discharge from the septic tanks will be channelled through a granular filter bed prior to discharge. Septic tanks contents will be emptied as dictated by capacity constraints, by a licensed operator and will be trucked to Georgetown for disposal in accordance with EPA guidelines. The coarse fraction of the tailing waste, recovered from the gravity circuit, will be used as hard capping for access roads.

The waste capacity for the Project will be managed following the GGMC standards of practice.

1.6.1 WASTE STORAGE FACILITY

Stronghold is to ensure that waste dumps are adequately located, designed, managed and reclaimed. The following mitigations are to be applied when selecting appropriate waste dumps:

- Locate waste dumps away from surface waters, springs, seeps and wetlands.
- Take preventive measures to minimise water and wind erosion.
- Enhance the long-term mass stability of a dump by locating and constructing it so that the potential of failure is minimised.
- Characterise the waste material prior to construction of the waste storage facility.
- Create appropriate conditions for rapid revegetation after mining has ceased.

1.6.2 TOP SOIL AND OVERBURDEN PILES

Stronghold Guyana is to ensure that topsoil and overburden piles are adequately located, designed, managed and reutilised for revegetation works. The following practices are to be applied the management of overburden:

- Build separate piles for organic rich material.
- Locate overburden piles as far from surface waters, springs, seeps and wetlands as possible.
- Enhance the long-term mass stability of piles by locating and constructing them so that the potential of failure is minimised.
- Take preventive measures to avoid water and wind erosion.

1.6.3 HAZARDOUS WASTE

Stronghold Guyana is to ensure proper management of hazardous wastes to protect communities and the environment from exposure to, and contamination from hazardous substance in the mining environment by effectively managing their handling, storage, transportation and disposal. The following practices are to be applied the management of hazardous waste:

- Identify materials and prepare hazardous waste inventories
- Describe methods for transport, storage and handling of hazardous waste.
- Identify options for disposal and long-term storage of hazardous waste.
- Prepare an Awareness and Preparedness Emergency plan at Local Level (APELL)
- Provide training on hazardous waste handling and storage for workers
- Conduct required due diligence on waste contractor(s)

1.6.4 NON-HAZARDOUS WASTE

Stronghold Guyana is to ensure the application of waste minimisation principles to reduce the amount of non-hazardous or household wastes that are disposed of and ensure that sound waste disposal practices are implemented. These principles include:

- Promote waste avoidance, reduction, reuse and recycling practices.
- Compost organic waste such as food, leaves, and roots.
- Bury non-recyclable and non-compostable waste in an appropriate landfill complying with corresponding national or local landfill regulations.
- Develop and implement an awareness program on waste minimisation for mine workers.

1.7 WASTE TYPES AND QUANTITIES

Various types of waste will be generated throughout the mining, processing, and operational stages of the Eagle Mountain Project. Understanding the types of waste and their associated quantities is critical for developing effective waste management strategies.

Table 1.2 summarises the general sources and management strategies for mine wastes generated during construction, operation, closure, and post-closure of the Project.

TABLE 1.2 SOURCES AND TYPES OF MINE WASTES

Mining Activity	Source & Types of Wastes	Waste Management Strategies	Notes
Excavation	• Overburden • Top soil	• Segregation, Stockpile, Isolation, Backfilling and Reuse	• Overburden represents the largest portion of mine waste

Mining Activity	Source & Types of Wastes	Waste Management Strategies	Notes
	• Leachate and drainage from stockpiles	• Segregate, temporary covers, diversion and Leachate collection	
Physical Processing, Milling	• Tailings, effluent, Milling Wastes • Petroleum Products	• Settling /Tailing Ponds Disposal, Backfilling • Stockpile • Disposal as Hazardous Waste, or burn	• Workers should be trained in the handling and disposal of waste
Chemical Processing / Extraction	• Contaminated effluents • Hazardous Substances • Petroleum Products • Chemical spills and contamination	• Waste Reduction, Treatment, Disposal • Waste Reduction, treatment, isolation disposal • Disposal as Hazardous Waste, or burn • Segregation, Stabilisation, Isolation, Treatment, Disposal	• Some Chemical and Substances added during Processing • Use approved container and disposal practices • Use Trained Personnel • Disposal of petroleum products of other hazardous material in the river, the marine environment, or on land is an office and prohibited
Housing & Worker Support Services	• Household Wastes	• Waste Minimisation, Segregation and Disposal	• Identify Disposal Sites in Mine Planning

Source: Mining Environmental Management Codes of Practice – Waste Management and Disposal, GGMC, August 2010.

1.8 TRAINING

All direct and contractor employees will undergo induction training that will include company and project policies and procedures. Training will include:

- All employees of Stronghold Guyana and contractors working at the Project site will be provided with general induction, site specific induction and a broad range of health, safety, and environmental awareness training. Appropriate Personal Protective Equipment (PPE) will be available to personnel if required. All relevant personnel will be trained in the use and maintenance of protective equipment.
- Employees of Stronghold Guyana and contractors with specific involvement in areas generating waste will be given additional training in the implementation of the waste management plan.
- Haulers of waste will have appropriate training, and hauling will be undertaken in a manner that prevents the inadvertent or inappropriate release of waste during route.
- Additional, specialist training shall be provided to key personnel involved in activities which involve the use, storage or haulage of mineral waste materials.
- Employees and contractors will attend refresher training once every six months. In case of incidents during waste procedures (handling, disposal, etc.) refresher training will be conducted regularly and as needed.

1.9 AUDITING

Internal compliance auditing will be carried out annually by Stronghold Guyana and controlled by the environmental manager. As may be required by legislation, annual audit reports will be submitted to the relevant authorities.

1.10 MONITORING AND REPORTING

Monitoring and enforcement of the waste management procedures are fundamental in ensuring that the plan is functioning to its optimum efficiency for the life of the Project. Waste will be monitored by each department and key sites with potential for procedural non-compliance will be inspected on a regular basis defined by the level of the risk.

Off-site and on-site disposal will be monitored by tracking waste type, volume, method of disposal, and location. Tracking of the waste streams by each department will show where changes can be made to further improve the waste management system over the life of the Project.

A monitoring program is thus required to alert management when enforcement is necessary to ensure compliance with the plan and procedures. The Environmental Manager will appoint a small audit team whose responsibility will be to:

- inspect Project facilities and waste disposal areas for proper waste segregation, storage and disposal;
- perform periodic reviews of the waste collection areas including procedures, training, equipment, records, and employee awareness; and
- review the inspection findings with area supervisors, operation personnel, transporters, and contractors to correct deficiencies, improve procedures, maintain awareness and communication, and recognise positive or negative performance.

Routine reporting according to a schedule of monitoring inspections will be undertaken in a structured manner such that the management of waste can be accurately tracked. Inspections will cover on-site facilities such as waste collection and storage areas, the landfill(s) as the Waste Rock Storage Facility, as well as related documentation such as inventories, manifests and logbooks. The frequency of scheduled inspections will be dictated by the relevant policies, plans, and procedures but are unlikely to be more than three months apart.

All reports will be reviewed internally by the manager responsible along with the Environmental Manager, in order to identify necessary improvements in the monitoring system. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licenses.

Where emergency or spill incidents occur as a result of upset conditions or non-compliance with the Waste Management Plan, these will be reported per the requirements of the Emergency Preparedness and Response Plan.

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APPENDIX D STAKEHOLDER ENGAGEMENT

Eagle Mountain Gold Mine Project, Guyana

Environmental Impact Assessment Report: Appendix D Stakeholder Engagement

PREPARED FOR

Stronghold Guyana Inc.
(subsidiary of Mako Mining Corp.)

DATE
17 March 2026

REFERENCE
0763224

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1. STAKEHOLDER ENGAGEMENT PLAN

1.1 INTRODUCTION

This document is the Stakeholder Engagement Plan (SEP) for the Project.

1.1.1 STAKEHOLDER ENGAGEMENT PLAN OBJECTIVES

The Eagle Mountain Stakeholder Engagement Plan (SEP) supports an ongoing exchange of information that allows Stronghold Guyana to:

- Identify, understand, and address community/stakeholder priorities and concerns, and;
- Improve decision-making and transparency.

Stakeholder engagement is an ongoing process; as such, this SEP is a living document and will be reviewed and adjusted annually (at a minimum) as the Project progresses.

This SEP has been developed to meet the expectations of Stronghold Guyana, regulators, and communities. It describes the stakeholder identification process and outlines an engagement program to promote meaningful, timely, and effective engagement with stakeholders. It builds on previous engagement efforts, including those conducted in preparation for the Environmental Impact Assessment (EIA).

Engaging stakeholders is an important aspect of managing ongoing social and environmental performance and non-technical risks. The objectives of stakeholder engagement are to:

- Promote the development of respectful and open relationships between stakeholders and Stronghold Guyana;
- Identify stakeholders and understand their interests, concerns, and influence in relation to ongoing activities;
- Provide stakeholders with timely information about Stronghold Guyana activities in ways that are appropriate to their interests and needs;
- Support alignment with Government of Guyana requirements and corporate standards, guidelines, and 'best practices' for stakeholder engagement; and
- Record feedback and close out any grievances that may arise through a formal feedback mechanism.

1.1.2 SEP PRINCIPLES

This SEP has been developed and will be implemented in line with key principles, which include:

- Engagement will be free of external manipulation, interference, coercion, or intimidation.
- Stakeholders will be involved in the consultation process in an ongoing and iterative manner throughout the project cycle.
- Stakeholders will be kept informed of the Project in linguistically accessible and culturally appropriate ways, including Project progress, purpose, duration of activities and any impacts or effects that stakeholders may experience linked to Project development or operation.

- Opportunities for two-way engagement on impacts, risks, or other items of concern to stakeholders will be provided. The input provided by stakeholders through this engagement will be incorporated into the Project decision-making process.
- All engagements will be documented, and any agreements reached recorded. Progress reports on the fulfilment of agreements made will be provided to stakeholders.
- Stakeholders will have access to a grievance mechanism through which they can log concerns, questions and complaints, and receive redress.
- Stakeholders will be involved in and allowed to provide input into the process of impact identification, mitigation development, and monitoring.
- Stakeholder engagement methods and activities are designed to be equitable and non-discriminatory, with regard to vulnerable populations, including women and youth.
- Confidentiality of information and stakeholders will be provided where appropriate.

1.1.3 ADMINISTRATIVE FRAMEWORK

In Guyana, socio-economic and stakeholder engagement components are considered in several laws, including the Environmental Protection Act. Additionally, Guyana is a signatory to several international and regional conventions and protocols aimed at addressing socio-economic and stakeholder concerns. Stronghold Guyana proposes to conduct stakeholder engagement to comply with the spirit and intent of these laws and international agreements, including those outlined in the environmental authorisations for major project developments and other operational activities. In addition, the EPA has published a manual on meaningful stakeholder engagement for projects requiring environmental authorisation (2023), which outlines expectations regarding effective public participation for projects like the Eagle Mountain project in Guyana.

1.1.4 DATA COLLECTION AND METHODOLOGY

Stakeholders are identified at the beginning of new activities and/or Project phases. Once identified, stakeholders are assessed based on their anticipated degree and topics of interest, as well as their role in engagement processes, which may affect Project activities. Stakeholder information is recorded in a stakeholder engagement register, which is an on-going document, and additional stakeholders are added as they are identified.

The SEP includes methods to facilitate stakeholder communication and dissemination of public information. One method is information provision, which offers stakeholders information to support their understanding of proposed Project activities. Another method is consultation, which supports dialogue and active receipt of stakeholder feedback/input based on the information provided, and incorporation of input. These methods capture opinions, concerns, and knowledge on how Project activities may interact with a stakeholder's natural and social environment, allowing Stronghold Guyana to gather information concerning topics that are important to its stakeholders. These activities provide stakeholders with an opportunity to ensure their comments and opinions are heard and concerns addressed.

1.2 CONSULTATION AND ENGAGEMENT APPROACH

1.2.1 AREA OF INFLUENCE

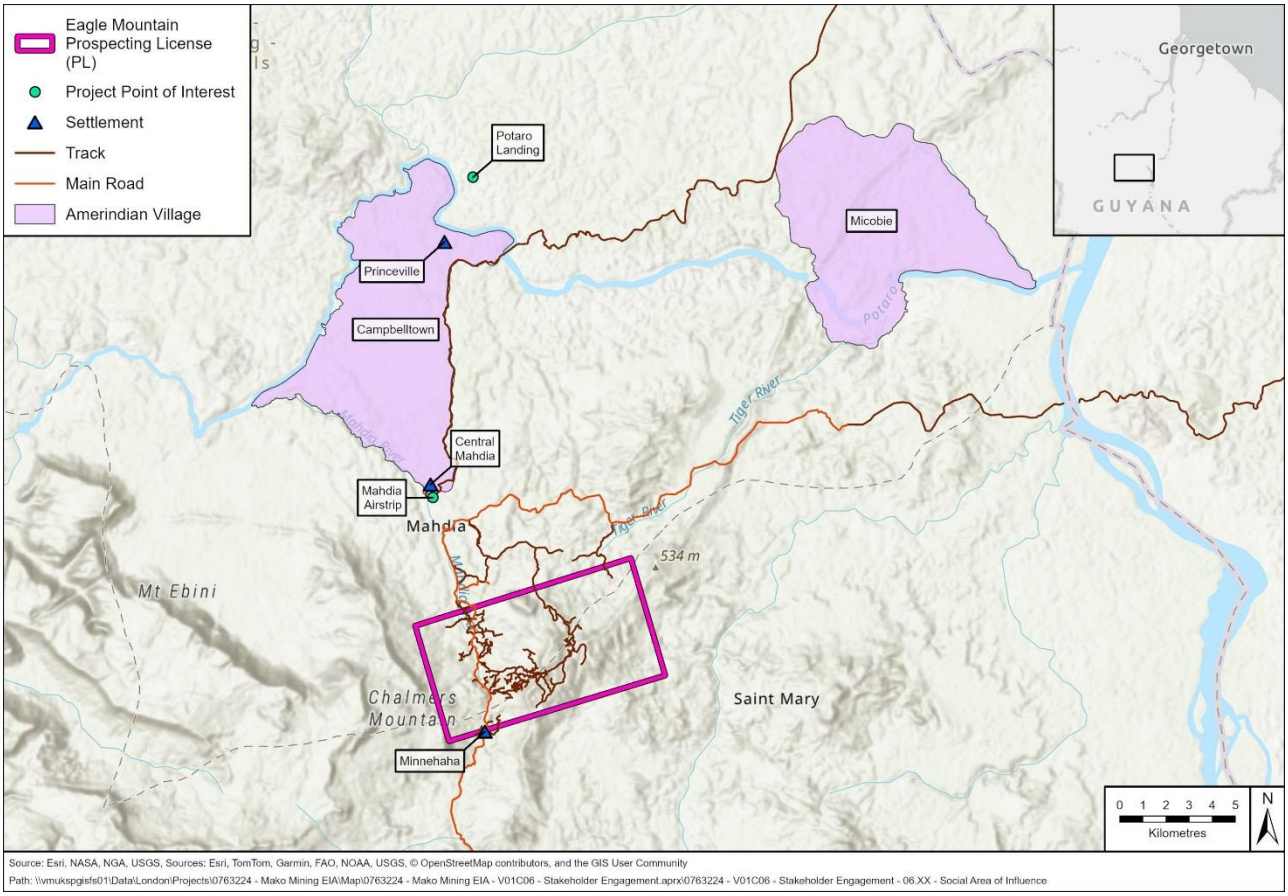
The Social Area of Influence (Social AoI) for the Eagle Mountain Project is divided into areas of Direct Influence and Indirect Influence, depending on the type of impact expected from Project

activities. This is constantly evolving and will be reviewed and updated on an annual basis, or more frequently if there are significant changes to the Project.

1.2.2 STAKEHOLDER IDENTIFICATION

Stronghold Guyana identifies and engages stakeholders and maintains a long list of directly and indirectly affected stakeholders across national, regional, and local levels within government, business, civil society, and local communities. This is a collaborative and iterative process drawn from experienced practitioners with knowledge of international leading practice, national requirements, and local demographics (Table 1.1). Stronghold Guyana maps the physical locations of many of these stakeholders in relation to the Eagle Mountain Project. Some of these locations lie outside the Social AoI but are considered 'sending communities' from which employees originate (Figure 1.1).

FIGURE 1.1 MAP OF COMMUNITIES AROUND EAGLE MOUNTAIN



1.2.3 STAKEHOLDER ANALYSIS

Stronghold Guyana also analyses these stakeholders to assess both their ability to influence the Project, and their interest in (or ability to be impacted by) the Project. This enables Stronghold Guyana to prioritise and tailor engagement to distinct stakeholder groups (Table 1.2).

TABLE 1.1 STAKEHOLDER LONGLIST

Government	Civil Society	Private Sector	Communities

• Guyana Geology & Mines Commission (GGMC)
• Guyana Forestry Association (GFC)
• Guyana Water Authority (GWI)
• Guyana Lands and Surveys Commission (GLSC)
• Ministry of Natural Resources (MNR)
• Environmental Protection Agency (EPA) Guyana
• Guyana Gold Board (GGB)
• Guyana Civil Aviation Authority (GCAA)
• Central Housing and Planning Authority (CHPA)
• Guyana Energy Agency (GEA)
• Maritime Administration Department (MARAD)
• Telecommunications Agency (NFMU)
• Ministry of Health (MOH)
• Guyana Police Force
• Regional Democratic Councils Region 8 (RDC)
• Neighbourhood Democratic Councils Mahdia (NDC)
• Town Councils (Mahdia)
• Council and Village Leaders, including Toshaos
• Guyana Low Carbon Development Strategy
• Government Technical Institute
• President, Vice President, and Prime Minister, and Ministers (Health, Education, etc.)
• National Assembly and Opposition Groups
• Mahdia Post Office
• Mahdia Schools
	• Guyana Gold and Diamond Miners Association (GGDMA)
	• Guyana Women Miner's Association (GWMA)
	• World Wildlife Fund (WWF)
	• Wildlife Conservation Society (WCS)
	• Conservation International (CI)
	• Flora and Fauna International (FFI)
	• Artisanal Gold Council (AGC)
	• University of Guyana
	• Small Miners Association
	• Food for the Poor Guyana Inc.
	• Rain Forest Alliance
	• The Initiative for Responsible Mining Assurance (IRMA)
	• Minamata Conservation on Mercury
		• Internal Stronghold Guyana stakeholders: Board of Directors, leadership, employees
		• Other transport operators, Project suppliers, and/or Stronghold Guyana subcontractors
		• Other project developers
		• Georgetown Chamber of Commerce & Industry
		• Private Sector Commission of Guyana Ltd.
		• Media: local newspapers, radio stations, social media
		• Financial and Strategic Investors
		• International industry initiatives e.g. International Council on Mining and Metals (ICMM), e.g., Mining Association of Canada (MAC), World Gold Council (WGC)
		• Canada – Guyana Chamber of Commerce
			• Amerindian communities:
			  ° Campbelltown (Region 8)
			  ° Micobie (Region 8)
			• Mahdia, Minnehaha
			• Concession and/or title holders
			• Pork-knockers/Artisanal miners, dredging and shaft operators
			• Vulnerable groups, including women, youth, minority communities, Indigenous and Campbelltown peoples, migrant workers, subsistence farmers, and fisher-people
			• Labor-sending communities e.g. Mahdia
			• Informal small-scale miners adjacent to the EMPL.

TABLE 1.2 STAKEHOLDER PRIORITISATION

Level of Influence	Level of Impact	
	Highly Responsive Engage proactively and monitor opinions and level of satisfaction/concern	**Actively Engaged** Engage frequently and look for opportunities to collaborate, partner, and create shared value
	Government • Guyana Gold Board • Guyana Water Authority • Telecommunications Agency • Guyana Civil Aviation Authority • Guyana Energy Agency • Central Housing & Planning Authority	**Government** • Guyana Geology & Mines Commission • Guyana Forestry Commission • Guyana Lands & Surveys Commission • Environmental Protection Agency • Board of Industrial Training **Civil Society** • University of Guyana **Communities** • Council and Village leaders/Toshaos • Surrounding towns and communities • Campbelltown communities **Private Sector** • • Transport operators
	Government • National Toshaos Council • Trade Commissioner Service and Export Development Canada **Civil Society** • World Wildlife Fund • Wildlife Conservation Society • Conservation International • Flora and Fauna International • Artisanal Gold Council **Communities** • Landings • Pork-knockers/Artisanal Miners, dredging & shaft operators **Private Sector** • Digicel • International industry initiatives • Media (print, radio, social) • Other companies	**Government** • Guyana Police Force • Ministry of Health • Ministry of Natural Resources • Ministry of Labour • Regional Democratic Council **Civil Society** • Guyana Gold & Diamond Miners Association • Guyana Women Miners Organisation • Small Miners Association **Communities** • Concession/title holders
	Monitor *Monitor opinions; keep informed on relevant topics*	Keep Informed *Engage regularly; keep involved and consult on topics of interest to each group*

1.2.4 SUMMARY OF ENGAGEMENT UNDERTAKEN

Stakeholder engagement is ongoing throughout Stronghold Guyana's activities in Guyana and will continue through the environmental authorisation application and corresponding EIA development processes.

Stronghold Guyana began proactive communication regarding the company's activities in 2025 to lay the groundwork for establishing and maintaining stakeholder relations. Informational meetings and exchanges of information were conducted between Stronghold Guyana and key external audiences, including government officials, stakeholders within the general public, and representative non-governmental organisations (NGOs).

Stakeholder engagement has been ongoing since then and has included meetings with individual stakeholders, public forums, and local agencies and officials. Public notifications have been published at various points in time throughout the regulatory processes to increase public awareness of Stronghold Guyana's activities.

Continuous engagements with government agencies that have oversight of the Eagle Mountain Project, such as the EPA, Ministry of Natural Resources (MNR), and GGMC, as well as other local decision-making bodies, are taking place throughout Stronghold Guyana's operations.

As part of the environmental authorisation application processes, stakeholders have had the opportunity through a public review period to provide input on the EPA's determination as to whether an EIA was required, as well as input into priority topics to cover in the EIA. For the EIA processes conducted to date, Stronghold Guyana has held face-to-face sector agency and public scoping consultation meetings to provide Project-specific information prior to the finalisation of a Terms of Reference (ToR). Stakeholders have had the opportunity through these meetings to provide input into the issues and concerns they wished to be considered within the EIA. More details can be found in Chapter 6 of the EIA.

1.3 ENGAGEMENT IMPLEMENTATION PLAN

Based on the activities employed and feedback received to-date, Stronghold Guyana will implement the following plan (Table 1.3). This is constantly evolving and will be reviewed and updated on an annual basis, or more frequently if there are significant changes to the Project.

TABLE 1.3 STAKEHOLDER ENGAGEMENT IMPLEMENTATION PLAN

Stakeholders	Engagement Goals	Engagement Activities	Project Phase
Actively Engaged *Engage frequently and look for opportunities to collaborate, partner, and create shared value.*			
• Government • Ministry of Natural Resources • Guyana Geology & Mines Commission • Guyana Forestry Commission • Guyana Lands & Surveys Commission • Environmental Protection Agency • Board of Industrial Training • Guyana Water Authority (GWI)	• Legal, regulatory and permitting compliance • Recruitment and upskilling of local workforce	• Regular formal written communications as part of government engagement processes or in response to queries • Regular formal individual or group meetings with recognised representatives	• Pre-production, Construction, and Operation
• Civil Society • University of Guyana	• Archaeological evaluations • Recruitment and upskilling of local workforce	• Memorandum of Understanding for archaeological project • Scholarships and bursaries	• Pre-production, Construction, and Operation
• Communities • Council and Village leaders / Toshaos • Surrounding towns and communities	• Recruitment and upskilling of local workforce and suppliers • Identification and prioritisation of social investment and support opportunities	• Regular formal and informal written communications as part of ongoing stakeholder engagement activities • Regular formal and informal individual and group meetings with leaders and residents • Regular Multi-Stakeholder Working Group meetings with recognised representatives	• Quarterly visits to communities during Project lifecycle
• Private Sector	• Provision of essential services through subcontracting • Recruitment and upskilling of local workforce and suppliers • Monitoring of relevant permitting, operational and workforce developments	• Regular formal and informal written communications as part of tendering, contracting and managing contractors • Regular formal and informal individual and group meetings with management	• Pre-production, Construction, and Operation
Highly Responsive *Engage proactively and monitor opinions and level of satisfaction/concern*			

Stakeholders	Engagement Goals	Engagement Activities	Project Phase
• Government • Guyana Gold Board • Telecommunications Agency • Guyana Civil Aviation Authority • Guyana Energy Agency • Central Housing & Planning Authority	• Legal, regulatory and permitting compliance • Provision of essential logistics and utilities services	• Formal written communications as part of government engagement processes or in response to queries as needed • Formal individual or group meetings with recognised representatives as needed	• Pre-production, Construction, and Operation
• Civil Society • Campbelltown People's Association/ Village council	• Recruitment and upskilling of local workforce and suppliers • Identification and prioritisation of social investment and support opportunities	• Formal and informal written communications as part of ongoing stakeholder engagement activities as needed • Formal and informal individual and group meetings with leaders and members as needed	• Quarterly visits to communities during Project lifecycle
Keep Informed *Engage regularly; keep involved and consult on topics of interest to each group*			
• Government • Guyana Police Force • Ministry of Health • Ministry of Labour • Regional Democratic Council • Mahdia Town Council • Neighbourhood Democratic Council	• Legal, regulatory and permitting compliance • Identification and prioritisation of opportunities for collaboration • Company and project updates	• Formal written communications as part of government engagement processes or in response to queries as needed • Formal individual or group meetings with recognised representatives as needed	• Pre-production, Construction, and Operation
• Civil Society • Guyana Gold & Diamond Miners Association • Guyana Women Miners Organisation • Small Miners Association	• Monitoring of relevant operational and workforce developments • Identification and prioritisation of opportunities for collaboration	• Informal written communications as part of ongoing stakeholder engagement activities as needed • Informal individual and group meetings with leaders and members as needed	• Pre-production, Construction, and Operation
• Communities • Concession / title holders	• Company and project updates	• Informal individual and group meetings as needed	• Quarterly visits to communities during Project lifecycle
• Private Sector • Transport operators	• Provision of essential services through subcontracting	• Regular formal and informal written communications as part of tendering,	• Pre-production, Construction, and Operation

Stakeholders	Engagement Goals	Engagement Activities	Project Phase
	• Recruitment and upskilling of local workforce and suppliers	contracting and managing contractors • Regular formal and informal individual and group meetings with management	
Monitor *Monitor opinions; keep informed on relevant topics*			
• Government • National Toshaos Council • Trade Commissioner Service and Export Development Canada	• Legal, regulatory and permitting compliance • Identification and prioritisation of opportunities for collaboration • Company and project updates	• Formal written communications as part of government engagement processes or in response to queries as needed • Formal individual or group meetings with recognised representatives as needed	• Pre-production, Construction, and Operation
• Civil Society • World Wildlife Fund • Wildlife Conservation Society • Conservation International • Flora and Fauna International • Artisanal Gold Council	• Monitoring of relevant developments • Identification and prioritisation of opportunities for collaboration	• Informal written communications as part of ongoing stakeholder engagement activities as needed • Informal individual and group meetings with recognised representatives as needed	• Pre-production, Construction, and Operation
• Communities • Landings • Pork-knockers, dredging & shaft operators	• Monitoring of relevant developments	• Informal individual and group meetings as needed	• Quarterly visits to communities during Project lifecycle
• Private Sector • International industry initiatives • Media (print, radio, social) • Other companies	• Monitoring of relevant developments • Identification and prioritisation of opportunities for collaboration	• Regular media monitoring • Formal individual or group meetings with recognised representatives as needed	• Pre-production, Construction, and Operation

1.4 GRIEVANCE PROCEDURE

Stronghold Guyana is developing a Grievance Procedure and associated mechanism for use by external stakeholders. The mechanism will align with the effectiveness criteria from the United Nations Guiding Principles on Business and Human Rights for non-judicial grievance mechanisms and will be properly communicated to all relevant stakeholders on a regular basis.

1.4.1 PURPOSE AND OBJECTIVES

The overall purpose of the Grievance Procedure is to provide an effective and transparent process for community members to raise concerns, complaints, or grievances related to Stronghold Guyana Gold's projects, activities, or impacts. Specific objectives include:

- Ensuring that all grievances are addressed in a timely and fair manner
- Enhancing community trust and engagement
- Identifying and mitigating potential issues early and avoiding conflict

1.4.2 SCOPE

The Grievance Procedure will address issues such as environmental impacts, health and safety concerns, employment practices, and human rights or social or economic impacts, including any other community-related issues.

1.4.3 COMMUNICATION

Stronghold Guyana will periodically review and evaluate the effectiveness of the Grievance Procedure and will solicit feedback from community members to identify areas for improvement and ensure continuous enhancement of the process. The Company will make information about the existence and application of the Grievance Procedure readily accessible to members of surrounding communities through various channels, including community meetings, posters, and digital platforms.

1.5 MONITORING, EVALUATION AND RESOURCING

Stronghold Guyana is conducting ongoing informal and formal engagement with internal and external stakeholders within the AoI. These are resourced and monitored in a variety of ways:

- Quarterly internal **activities reports** are compiled by the Community Relations Officer, reviewed by the Country Manager (or equivalent), and distributed to management. These include data on the quantity and quality of stakeholder meetings.
- Quarterly internal **company newsletters** are developed and distributed to employees and other internal stakeholders.
- The company **Facebook Page** will be officially launched, which will be monitored daily.
- **Media monitoring** reports commenced in 2024 and are compiled daily and shared with management.
- A draft **Communications Strategy** will becompiled by the Community Relations Officer, for review by senior staff and will be submitted to the Board of Directors.
- The inaugural **Sustainability Report** was compiled by the Communications Specialist.

1.5.1 ROLES AND RESPONSIBILITIES

Stronghold Guyana has identified who is Responsible, Accountable, Supportive, Consulted and Informed (RASCI) for all stakeholder engagement activities (Table 1.4). This will be reviewed and updated at least annually, and whenever there are significant changes.

TABLE 1.4 ROLES AND RESPONSIBILITIES

RASCI	Role	Responsibilities
Responsible	Country Manager / Company President	The Country Manager (or equivalent position during the pre-production phase) is responsible for identifying, prioritising, engaging and following up with stakeholders. They will be supported in or delegate responsibilities to other colleagues as the project develops.
Accountable	Chief Operating Officer	The Chief Operating Officer is ultimately accountable for the company's stakeholder engagement approach, reviewing and validating the work of the Country Manager and their team, and directly engaging high priority stakeholders.
Support	Community Relations Officer	Community Relations Officer provides support to the Country Manager in the preparation, implementation, and follow-up of stakeholder engagement and documentation.
Consulted	Senior Management	Senior Management will be consulted on the establishment, review and enhancement of the company's stakeholder engagement approach, with their input and feedback being sought and incorporated, and their direct engagement of high priority stakeholders will be secured as needed.
Informed	Board of Directors	The Board of Directors will be kept regularly informed of ongoing stakeholder engagement approaches, activities and outcomes, and in particular of high priority stakeholders, issues and developments as they arise.

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APPENDIX E PROJECT TEAM CVS

APPENDIX E PROJECT TEAM CV'S

Team Member	Role
Angharad Owen	Project Management Support
Anthea Atkinson	Air and Noise Local Support
Atisha Lyttle	Social Local Specialist
Becky Summons	Project Manager
Brian O'Shea	Air Quality Specialist
Curtis Mashimbye	Groundwater Specialist
David O'Connor	Cultural Heritage Specialist
Deb Bryant	Surface Water and Sediment Quality Specialist
Frank Ocran	Traffic Specialist
George Chatzigiannidis	Noise Specialist
Gillian Gregory	Socio-economic Specialist
Herbert Pirela	Soil Specialist
Indranee Roopsind	Terrestrial Ecology Local Specialist
Irene Bopp	Project Partner
Jason Willey	Aquatic Ecology Specialist
Jessica McIver	Cultural Heritage Lead
Julia Tims	Terrestrial Ecology Specialist
Karishma Misir	Water Resources Local Specialist
Louisa Daggers	Cultural Heritage Local Specialist (UoG)
Mark July	Health and Safety Local Specialist
Mertcan Ozbakir	Hydrogeology Specialist
Niall Olds	Landscape and Visual Specialist
Paul Hesketh	Waste Specialist
Raeburn Jones	Terrestrial Ecology Local Specialist
Shauncy Henry	Social and Environmental Local Support
Yves Verlinden	Air Quality Lead

Angharad Owen, BSc, MSc, PISEP

Senior Consultant (CL2S)

Angharad has over 6 years' experience working in the environmental sector, working in water quality and waste management at Natural Resources Wales before joining ERM as an Environmental Consultant in 2021. At ERM, Angharad has been involved in a variety of projects across teams working on environmental baseline studies, fieldwork management, UK EIAs, international ESIAs, data management, environmental site assessment, corporate sustainability reporting, social performance, stakeholder engagement, permitting and due diligence. Angharad's experience spans the Mining and Oil & Gas sectors, working on projects in the UK, Europe, and Africa. Angharad's professional experience is supported by her knowledge base developed through her academic career including MSc Sustainability, Planning and Environmental Policy, and BSc Geology and Physical Geography.

EXPERIENCE: Over 6 years working in the environmental sector. 4.5 years in environmental consultancy with ERM, and 2 years with Natural Resources Wales, working in water quality data management and waste management.

LINKEDIN: Angharad Owen | LinkedIn

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EDUCATION

- MSc Sustainability, Planning and Environmental Policy - Distinction, Cardiff University, Wales, 2020
- BSc Geology and Physical Geography – First Class Honours, University of Edinburgh, Scotland, 2015

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- ISEP, Practitioner Membership

CERTIFICATIONS

- IAIA Leadership in ESIA, April 2025

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LANGUAGES

- English, native speaker
- Welsh, fluent

FIELDS OF COMPETENCE

- Project management support and coordination
- Proposal writing and costing
- General reporting
- Stakeholder engagement
- Data management and visualisation
- Environmental baseline studies
- Environmental and social impact assessment
- Risk assessments
- Phase 1 desk study investigations
- Health and safety planning
- Welsh language translation

KEY INDUSTRY SECTORS

- Mining
- Oil and Gas
- Renewables

PUBLICATIONS

- A. Owen (ERM), A. Thomas (ERM), R. Sweeney (CL:AIRE), N. Harries (CL:AIRE). (December 2024). *Sustainable Remediation: Identification of sustainable management practices (SMPs) for remediation projects at fuel manufacturing sites*. Report No. 13/24. Concawe. Sustainable Remediation: Identification of sustainable management practices (SMPs) for remediation projects at fuel manufacturing sites - Concawe

KEY PROJECTS

Eagle Mountain Gold Mine, Mako Mining, EIA, Mining, Guyana, (2024 – Present)

ERM is currently supporting Mako Mining with the development and submission of a local EIA report to the Guyana EPA for the Eagle Mountain Gold Mine Project. Angharad is a Project Coordinator providing project management support to technical SMEs, coordinating technical inputs, and preparation of the EIA reporting.

Kassinga ESIA, Tosyali Iron and Steel S.A. (TISA), ESIA, Mining, Angola, (2024 – Present)

ERM is supporting TISA with the Kassinga Gold Mine Project for completion of an international ESIA that aligns with IFC PS and EP4 standards. Angharad is a Project Coordinator providing project management support to technical SMEs, supporting with in field surveys for baseline data collection, and preparation of ESIA reporting.

Zinnwald Lithium, Scoping Report, Mining, Germany (2024 – 2025)

ERM is supporting Zinnwald Lithium with the ESIA scoping for their Mine Project in the Erzgebirge region of Germany. As Project Coordinator, Angharad is providing project management support to technical SMEs, coordination of technical inputs, data management, and preparation of the ESIA Scoping Report.

Oko West Gold Project, Reunion Gold, Local EIA and ESIA, Mining, Guyana (2023 - 2025)

ERM has been supporting Reunion Gold with the Oko West Gold Mine Project for completion of a local EIA submission to Guyana EPA and international ESIA to IFC PS and EP4 standards. Angharad is a Project Coordinator providing project management support to technical SMEs, including preparation of the environmental and social baseline data collection and preparation of EIA and ESIA reporting. Previous projects include environmental baseline study and scoping report which Angharad also provided support with.

Project Gaia, Anglo American, Social Performance, Mining, Africa (2023 - 2024)

ERM is supporting Anglo American with the development of their Social Performance Plan for multiple renewable energy projects under development across several AA sites globally as part of their commitment to carbon neutrality by 2040. Angharad is supporting the project through updating AAs Contractor Social Management Plans for multiple sites in alignment with the specific renewable project plans. This includes reviewing AA's Social Plans and details of the site-specific renewables project and ensuring the document aligns with AAs Social Way 3.0 procedure, also developed by ERM. In addition, Angharad also supported the completion of SHIRA assessments in relation to risks associated with contractor activities.

GISTM Tailings Storage Facility Implementation, Rio Tinto Closure, Mining, Global (2023)

ERM is supporting Rio Tinto Closure in the implementation of the Global Industry Standard for Tailings Management (GISTM) for new and existing (operating and closed) tailings storage facilities (TSFs). Angharad has supported with the environmental document review and data gathering of several closed sites for input into the Integrated Knowledge Base used to develop an understanding of the environmental and socio-economic conditions at each site. She also supported the risk assessment phase of the project, consolidating the site risk registers and developing the multi-disciplinary risk assessment (MDRA) in preparation for client workshops.

Phase 2 Social Stabilisation, Anglo American Platinum, Social Performance, Mining, South Africa (2023)

Anglo American launched the updated Social Way 3.0, which defines an integrated social management system that sets out the approach to social performance. ERM is supporting Anglo American Platinum with Phase 2 Social Stabilisation to implement the SW3.0 requirements. Angharad supported the SME lead for Contractor Social Management with the alignment of Contractor Social Management with the requirements of Anglo American's Social Way 3.0 policy. This involved developing and updating the Contractor Social Management Plans for multiple sites, defining clear roles and responsibilities for implementation.

Jadar ESIA, Rio Sava Exploration, Mining, Serbia (2021 – 2023)

Angharad has supported the Jadar lithium mine ESIA project as Data Manager through its various stages, managing vast amounts of documents in both the Clients' and ERMs SharePoint databases. She has built a comprehensive database, summarising 1,500+ documents with detailed descriptions and relevance to ERM subject teams, utilising Microsoft Excel to provide a simple and efficient method to instantly search and review Client-provided documents. The creation of the data directory has supported the project SMEs with document review and identification of data gaps, contributing to the successful delivery of the Preliminary ESIA (2021) and the most recent update to the ESIA.

Corporate Sustainability Report, Confidential Client, Mining, Global (2021 – 2022)

ERM assisted the client in creating a Sustainability Report that outlines the social, environmental, and economic contributions of its members, establishing a baseline for common goals. Angharad played a key role in developing the sustainability reporting framework, data collection, and report writing. She helped create a KPI questionnaire to align member contributions with the client's sustainability goals and global frameworks. Angharad also analysed member data, conducted interviews, identified data gaps, and researched industry trends to enhance the report. Additionally, she provided project management support and collaborated with the team on client updates.

Social Way 3.0, Anglo American, Mining, Global (2021 – 2022)

ERM are supporting Anglo American with the roll-out of training regarding their new Social Way 3.0 policy. Angharad's role in the project was to support the analysis of feedback data received from trainers and participants. Data was collated across several sites and AA departments, extracting the key themes and inputs to produce clear, concise, and visual report deliverables for AA.

Project Logan, Tailings Risk and Consequence Assessment, Confidential Client, Mining, Global (2021)

ERM was contracted to conduct a tailings risk screening assessment and consequence analysis for the Client's global tailings storage facilities. Angharad supported the project through research, cost-risk analysis, data analysis, and reporting. She reviewed Closure Plans, assessed data on endangered species, land use, population, and housing prices for the Cost Risk Analysis model. This led to an assessment of consequences from potential TSF failures, including socio-economic and environmental costs. She ensured effective communication across teams, maintaining workflows in impact modeling, risk analysis, and GIS tasks, while supporting timely report delivery.

Water Stewardship Reporting, Anglo American, Mining (2021)

Angharad assisted with the data management team, looking at water usage and stewardship projects across the global Anglo American mining sites. Tasks involved monthly data collation and analysis of water usage data and updating the dashboards and reports for each site.

Anthea Atkinson

Consulting Associate

Motivated and proactive environmental scientist with a strong desire to gain practical experience in environmental consultancy. Demonstrated ability to quickly grasp new concepts and apply them effectively in real-world scenarios. Excellent interpersonal and communication skills, allowing for seamless collaboration with colleagues and clients. Adept at multitasking and managing time efficiently to meet project deadlines.

LINKEDIN: https://www.linkedin.com/in/anthea-atkinson-1621172a3/

EMAIL: anthea.atkinson@erm.com

EDUCATION

- Bachelor of Science (BSc) in Environmental Science, University of Guyana, 2024

LANGUAGES

- English, native speaker
- Portuguese, B2

FIELDS OF COMPETENCE

- Environmental monitoring and research methods
- Knowledge and practice with data analysis.
- Noise monitoring

KEY INDUSTRY SECTORS

- Biodiversity and Conservation
- Air and Noise Quality Surveys

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KEY PROJECTS

Environmental, Social, Community Health and Cultural Heritage Baseline (Oko West Project)- Mining Sector (July 2023 – July 2024)

Participated in the equipment mobilization and data collection for the wet and dry seasons Air Quality assessment surveys and, carried out noise monitoring activities during the dry season period.

Whiptail Environmental Impact Assessment, Guyana- Oil and Gas Sector (August 2023)

Conducted stakeholder engagement with fisherfolks and local residents in Region 6.

Coastal Birds Survey (EEPGL) (September 2024)

Supported the data collection (auditory and visual recording) of bird species along the coast of Guyana (Region 1).

Dewatering Sampling Survey (EMGL) – 2024

Supported data collection of water samples for the Gas to Energy Project.

Atisha Lyttle, BSc.

Consultant, Social Performance

As a Social Performance Consultant with three years of experience, I specialize in conducting social baseline studies and developing high-quality social baseline chapters for Environmental Impact Assessment (EIA) reports, aligned with IFC Performance Standards. I have successfully led fieldwork and stakeholder engagement activities in both the oil and gas and gold mining sectors, with a particular focus on projects in Guyana. My work ensures that social risks and community dynamics are accurately captured and integrated into project planning and compliance frameworks, supporting responsible resource development and sustainable outcomes.

EXPERIENCE: Three years' experience in social performance and stakeholder engagement.

LINKEDIN: Atisha Lyttle, LinkedIn

EMAIL: atisha.lyttle@erm.com

EDUCATION

- Bachelor's Degree. International Relations, University of Guyana, Guyana, 2019

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Director, Shades of the Sky Inc. (NGO)
- Harvard Model United Nations – Latin America, 2019
- 5th Annual Youth Parliament - Guyana, 2019
- Member/Secretary, University of Guyana International Affairs Association, 2015-2019
- Mentor/Counsellor, Camp GLOW Guyana, 2015-2018

LANGUAGES

- English, Native speaker
- Spanish, Basic

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- Chinese (Mandarin), HSK L1

FIELDS OF COMPETENCE

- Community and Stakeholder Engagement
- Key Informant Interviews
- Socioeconomic Surveys
- Socioeconomic Research and Report Writing

35 MultiWell Environmental Impact Assessment of Cumulative Effects

Conducted Stakeholder and Community Engagement activities within the Project's area of influence.

Conducted distribution of CIAs to the Regions and EPA.

Whiptail Development Project, Environmental Impact Assessment

Conducted Stakeholder and Community Engagement activities within the Project's area of influence.

Contributed to the research and updating of the Socioeconomic Chapters of the EIA.

Conducted disclosure of EIAs to the Regions and EPA.

Presented on the Socioeconomic aspect of the Project during the Disclosure Meetings; assisted with the coordination and logistics for the Whiptail Disclosure Meetings.

Reunion Gold, Environmental Baseline Studies, Oko West Project, Cuyuni-Mazaruni

Participated in the Social Surveys with Communities and other stakeholders to support the baseline studies. Also contributing to the socio-economic baseline write up of the local EIA and international ESIA.

Assisted with the Air Quality Monitoring, Hydrology Monitoring, and Soil Sampling at the Oko West Camp; also served as the teams' Field Safety Officer.

Presented the socioeconomic aspect of the Project to the public during disclosure meetings.

Hammerhead Development Project, Environmental Impact Assessment

Conducted Stakeholder and Community Engagement activities within the Project's area of influence; and led the initial drafting and updating of the Socioeconomic Baseline and Impact Assessment chapters.

Conducted disclosure of EIAs to the Regions and EPA.

Presented on the Socioeconomic aspect of the Project during the Disclosure Meetings; assisted with the coordination and logistics for the Hammerhead Disclosure Meetings.

Becky Summons

Consulting Director

Becky Summons is a Consulting Director with ERM based in the Cardiff, UK Office. Miss Summons has over 15 years' experience in Environmental and Social Impact Assessments (ESIAs) in the Americas, Africa, Europe, and Southeast Asia. Becky has been Project Manager for over 50 large scale international lender Projects covering the mining, power, renewables, oil and gas, agribusiness, tourism, and infrastructure sectors. She specialises in conducting ESIAs to lender requirements (e.g., IFC, ADB, EBRD, and Equator Principles) and ensuring projects obtain their social and environmental license to operate. She is currently project manager of three large mining projects in South America and Africa for national and international standards.

EXPERIENCE: 15 years' experience in Sustainable Finance for International Environmental and Social Impact Assessments

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EMAIL: becky.summons@erm.com

EDUCATION

- MSc, Marine Environmental Protection, Bangor University, Wales, United Kingdom, 2009
- BSc (Hons), Marine Biology, University of Swansea, Wales, United Kingdom, 2003

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Member of the Institute of Environmental Management and Assessment (IEMA)
- DECC Level 2 Corporate Manager (Oil Spill Response); Oil Spill Response (2011)
- Member of the IFC Hydropower Working Group in Asia (2018-2021)

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Environmental Impact Assessment (EIA)
- Environmental Planning and Regulations
- Renewables, Oil and Gas, & Power Specialist
- Environmental Monitoring
- Marine Biology and Ecology
- Stakeholder Engagement

KEY INDUSTRY SECTORS

- Mining
- Renewables
- Power
- Oil and Gas
- Infrastructure and Industry

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KEY PROJECTS

MINING

ESIA for Gold Mine, Guyana, 2025.

Project Manager, and oversees the environmental and social baseline data collection, stakeholder engagement, and preparation of the ESIA and ESMP to Guyanese EPA standards.

ESIA for Iron Ore Mine, Angola, 2024.

Lead ESIA Advisor, and oversees the environmental and social baseline data collection, stakeholder engagement, and preparation of the ESIA and ESMP to IFC PS and EP4 standards.

ESIA for Gold Mine, Guyana, 2024.

Project Manager, and oversees the environmental and social baseline data collection, stakeholder engagement, and preparation of the ESIA and ESMP to IFC PS and EP4 standards.

ESIA for Gold Mine, Guinea, 2023.

Project Manager, and oversees the environmental and social baseline data collection, stakeholder engagement, and preparation of the ESIA and ESMP to IFC PS and EP4 standards.

Scoping Report for Iron Ore Mine, Angola, 2023.

Environmental specialist for the Project and includes a gap analysis against IFC PSs as well as preparation of the environmental baseline and scoping assessment.

RENEWABLES

ESDD for Wind Farm in Poland, Confidential, 2023.

Project Manager for a wind farm ESDD/Red Flags study in Poland to IFC Standards. The work includes ad hoc support for the company's ESMS system, ESDD preparation, and input to monitoring programs.

IFC EHS Guidelines for Hydropower in Myanmar, 2020.

Project Manager and lead author of the IFC EHS guidelines for hydropower projects in Myanmar. Worked closely with IFC to prepare the guidelines for Myanmar developers and Ministry of Environment.

ESIA for IEAD Wind Farm 2GW, Laos, 2022.

Project Manager for a 2GW wind farm ESIA study in Laos to ADB and IFC Standards. The work includes sub-contractor management, desk top research and conducting ESIA review.

Red Flags for Wind Farm, Thailand, Confidential, 2022.

Project Manager for a 1GW wind farm ESDD/Red Flags study in Thailand to IFC Standards. The work includes sub-contractor management, desk top research and conducting red flag review.

ESIA for MEDCO Geothermal Project, Indonesia, MEDCO, 2022.

Project Manager for a 3000 MW geothermal project in Indonesia to IFC Standards. The work includes sub-contractor management, baseline survey planning, engagement, and conducting impact assessment to international standards.

ESIA for Phamong and Saravan HPP, EA, Laos, 2021.

Project Manager for two large HPP in Laos on the Mekong to ADB and IFC standards. The work includes sub-contractor management, baseline survey planning, engagement, and conducting impact assessment to international standards.

ESIA for the Shweli-3 HPP, EDF/ Marubeni/ Ayeyar Thinthar, Myanmar, 2020.

Becky is Project Manager for the 300 MW HPP in Northern Shan State. The work involves conducting an updated ESIA study to

international (IFC) standards including environmental baseline surveys and engagement. The work also includes producing national permitting documentation including reviewing and input to all chapters including legal, project description, baseline, impacts, and EMP.

INFRASTRUCTURE & INDUSTRY

ESDD for Airport Project in Tanzania, 2023.

Project Manager for an ESDD to IFC standards for an airport in Zanzibar. The scope also included due diligence and gap analysis against IFC including key resettlement and land acquisition and biodiversity issues.

ESDD for Roads Project in Tanzania, 2023.

Project Manager for an ESDD to IFC standards for a road in Zanzibar. The scope also included due diligence and gap analysis against IFC including key resettlement and land acquisition and biodiversity issues.

ESIA for Water Treatment Plant in Indonesia, Karian Water, 2020-2021.

Becky was the Project Manager for an ESIA to IFC standards for a water treatment plant in Jakarta. The scope also included public consultation and environmental baseline surveys as well as a review of resettlement and land acquisition plans.

SEA and EIA for New Yangon City Development, Myanmar, 2019.

Becky was the Project Manager for a Strategic Environmental Assessment and six EIA reports for Phase 1 of the new Yangon city development in western Yangon. This involves EIAs on power, water, wastewater, bridges, roads and industrial zones. The scope also include public consultation and environmental baseline surveys as well as a review of land acquisition plans.

OIL AND GAS

Scoping and IFC Strategic Plan, BP, Oman, 2024.

Project Manager for an IFC scoping and strategic plan for green hydrogen and renewables project in Oman. Oversees the baseline data collection, stakeholder engagement, and preparation of the ESIA scoping report and strategic plan for permitting to IFC PS and EP4 standards.

ESIA for Block A6 Development, TEPM, Myanmar, 2020.

Project Manager for an ESIA for field development (including platform and export pipeline) in Block A6. The work involves submission of EIA to National permitting requirements, stakeholder engagement and baseline data collection.

POWER

ESIA for Waste to Energy plant in Northern Thailand, 2022.

Becky is the Project Manager for two WTE plants in Northern Thailand to conduct Gap Analysis against IFC and ESIA scoping studies. The work includes baseline survey planning, engagement, and conducting impact assessment.

ESIA for Oil Terminal, Yangon, Myanmar, Brighter Energy, 2019.

Becky is supporting the ESIA for an oil terminal in Yangon including attending the public consultation meetings and reviewing documentation to ensure it meets Myanmar national EIA Procedure standards.

Environmental Survey for Coal Fired Power Plant, Myanmar, 2018.

Becky conducted offshore environmental surveys for a coal fired power plant project in Southern Myanmar. This included site visit and sediment surveys for river and jetty for coal barge access.

Brian O'Shea

Managing Technical Consultant

Brian has over seven years of experience in environmental consulting. His emphasis is directed toward environmental project management, logistics, and site planning. With a background in atmospheric sciences, he is an expert at air monitoring system development, operation and maintenance. Brian has been involved in numerous projects in the oil and gas, power generation, and manufacturing industries for upstream, midstream, and downstream facilities. He has maintained air monitoring networks to develop quality-assured data for projects throughout the US and internationally in South America and Africa.

EXPERIENCE: 7 years' experience in oil and gas, power generation, and manufacturing

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EDUCATION

- B.S. Atmospheric Sciences, University of Illinois – Urbana Champaign, USA, 2016

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Air & Waste Management Association

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Ambient air monitoring compliance
- Data analysis
- Field technician

KEY INDUSTRY SECTORS

- Oil & Gas

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- Manufacturing
- Power

HONOURS AND AWARDS

- Global Recognition Award 2021 – ERM: Demonstrated outstanding contribution for work done in Angola regarding safety, behaviors, actions & results.

KEY PROJECTS

Environmental Management Program, LNG, Angola, Africa

Designed and built an ambient air monitoring shelter for an LNG plant. Successfully managed the international logistics of transportation of equipment to site. Integrated gaseous analyzers monitoring NO2, SO2, H2S, and VOC's, as well as particulate matter with meteorological instruments. Guided the field team in installation and start-up of air monitoring equipment and trained client technicians to properly support and maintain the monitoring network for the duration of the 3 years of monitoring.

Ambient Air Monitoring, EEPGL, Guyana

Designed and built an ambient air monitoring shelter for EEPGL. Supported international logistics of transportation of equipment to site. Performed multiple trips to Guyana to support maintaining the integrity of the monitoring system by successfully performing maintenance and calibrations of instrumentation to develop quality assured air monitoring data. Lead integration of gas chromatography instrumentation to analyze BTEX concentrations.

ESHIA Development, Reunion Gold, Guyana

Designed an ambient air monitoring network to monitor baseline ambient air concentrations in support of developing an ESHIA for Reunion Gold. Successfully procured, shipped and installed instrumentation in the rainforest in Guyana. Trained local staff to properly maintain the air monitoring network. Coordinated efficient logistic methods for collecting air samples and transporting them out of the rainforest to be shipped to the US for laboratory analysis.

Perimeter Dust Monitoring, Armada Hoffler, Maryland

Supported design of an ambient air monitoring network to monitor real-time dust impacts of site activities on an active construction site. Successfully installed dust monitoring network and trained local staff to successfully perform daily calibrations and site selection of monitors to accurately assess daily activities.

Curtis Mashimbye, Pr.Sci.Nat., GWD

Senior Consultant

Hydrogeologist with over eight years of experience in contaminated land and risk-based monitoring in oil and gas, energy, chemical industries, and water stewardship. He has experience in site assessments, exploration of groundwater resources and holistic water resources management.

He also has experience in hydrogeological-related site work, drilling, pump test design, monitoring, and supervision. He has experience in large-scale technical hydrogeological studies to quantify risks inherent to significant potential pollution sources and remediation.

EXPERIENCE: 8 years experience in geosciences

LINKEDIN: https://www.linkedin.com/in/nhlamulo-curtis-mashimbye-pr-sci-nat-41521257/

EMAIL: curtis.mashimbye@erm.com

EDUCATION

- M.Sc. Hydrogeology, Institute for Groundwater Studies (IGS), University of the Free State, South Africa, in progress
- M.Sc. Geography (GIS), University of the Free State, South Africa, 2018
- B.Sc. Honours Geology, University of the Free State, South Africa, 2015
- B.Sc. Honours Geography, University of the Free State, South Africa, 2014
- B.Sc. Geology, University of the Free State, South Africa, 2012

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Professional Natural Scientist (Pr. Sci. Nat.), South African Council for Natural Scientific Professions (SACNASP) Member no: 127573
- Geological Society of South Africa (GSSA) Member no: 971378
- Groundwater Division (GWD) Member no: 1078/21

LANGUAGES

- English (Native), Xitsonga (Native), Sesotho (Intermediate), isiZulu (Intermediate), and Afrikaans (Intermediate)

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FIELDS OF COMPETENCE

- Geoscience (Geology, Hydrogeology, Geomorphology, Geospatial)
- Mining, Oil and Gas, Energy, and Water Resource Development and Water Stewardship
- Groundwater Resource Management (quantity and quality)
- Environmental Impact Assessments
- Technical Due Diligence, Lender Support and Guidance

KEY INDUSTRY SECTORS

- Chemical, Contaminated Land and Remediation
- Oil and Gas, and Water Resource Development and Management

HONOURS AND AWARDS

- Best Presentation at IAH 2023 by a Young Professional

KEY PROJECTS

Contaminated Land Monitoring Reporting and Project Management – South Africa

Multiple monitoring events at Fuel Depot (Refinery), involving gauging and sampling of groundwater monitoring wells. Reporting on identifying historical LNAPL plume migration across several sites. Conducting LNAPL bail tests and subsequently analysing potential LNAPL transmissivity rates.

Shell Downstream Water Risk and Supply, Reporting and Project Management

A study of water supply to selected retail sites in South Africa, which included the analysis of water demand and process flow on-site, an assessment of water-related risks (quantity, quality and regulatory considerations of water supply and discharge), and recommendations towards water conservation, sustainability and compliance.

Key Projects Before Joining ERM

Sample of Key Projects Before Joining ERM (more than 50 projects successfully delivered)

BASF Chemetall, Reporting and Project Management – South Africa

Hydrogeological fieldwork (hydrocensus, groundwater sampling, drilling). Groundwater resource baseline risk assessment and monitoring.

SASOL, Reporting and Project Management – South Africa

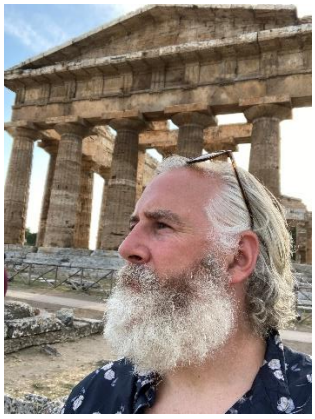
Hydrogeological fieldwork (hydrocensus, groundwater sampling, drilling). Groundwater resource baseline risk assessment and monitoring.

Dikwena Chrome, Reporting and Project Management – South Africa

Hydrogeological fieldwork (hydrocensus, groundwater sampling, drilling). Impact assessments, remediation, monitoring and groundwater management.

David J O'Connor, MA MIAI

EMEA Lead Consultant, Cultural Heritage & Archaeology Associate Partner



David is an environmental project manager and technical specialist, with over 25 years' professional experience. He has extensive and varied experience delivering major mining, transport, power and other infrastructure and development schemes on projects across the Ireland, UK, Europe, Africa, Asia and South America, delivering a wide range of services from desk-based ESIA / HIA reports and Cultural heritage Management Plans, to remote surveying, archaeological site investigations, built heritage assessments, underwater & marine environment studies and compliance auditing, especially to International Lender standards and UNESCO WHC Cultural Heritage requirements for World Heritage Sites. He has authored and project managed environmental and Cultural Heritage elements of ESIAs on projects of all sizes, including large-scale linear infrastructural (transport & pipeline). He deals directly with regulators, stakeholders and clients as well as other heritage contractors. He provides advice and direction at every stage of the project lifecycle, from feasibility, managing design change, input into emerging construction and environmental design to the production of assessment reports, environmental statements, international lender standard compliance and construction. Much of David's work involves advising around International Financial Lender standards for Cultural Heritage on projects across the globe, advising on compliance, eliminating gaps and developing Management Plans - at all times advocating best international practice. David has a strong background in contracting, having project managed numerous large-scale construction stage heritage contracts with ultimate responsibility for Strategic oversight, Contract Management, Health & Safety, Logistics, Financial control, Human Resources, Environmental Specialists, Client Liaison, Plant, Reporting etc. to project teams of up to 150 people. Before joining ERM he successfully ran his own environmental consultancy.

EXPERIENCE: Over 25 years' in Environmental and Cultural Heritage consultancy

LINKEDIN: https://www.linkedin.com/in/david-j-o-connor-9a8b2224/

EMAIL: david.oconnor@erm.com

EDUCATION

- Master of Arts Degree. Archaeology, University College Dublin, Ireland, 1997
- Bachelor of Arts Degree. Archaeology, Greek & Roman Civilisation, University College Dublin, Ireland, 1996

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Institute of Archaeologists of Ireland (IAI)

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- Licensed to direct archaeological excavations in Ireland (since 2002)

LANGUAGES

- English, native speaker
- Italian, Level C1 (CEFR) – proficient
- German, Level B1 (CEFR) – good understanding
- Irish, Level B1 (CEFR) – good understanding

FIELDS OF COMPETENCE

- Archaeology
- Architectural Heritage
- Cultural Heritage
- Historical Research
- Environmental Project Management

KEY INDUSTRY SECTORS

- Transportation (Rail & Road)
- Government
- Oil & Gas / Power
- Mining & Metals

HONOURS AND AWARDS

- Special Award, School of Archaeology, University College Dublin, Ireland 1997

PUBLICATIONS

- Heritage Assessment Reports, 1998-2017 200+ unpublished reports
- Archaeological Investigation Reports, 2002-2017 100+ unpublished reports
- Archaeological Features at Risk Project, 2001
- Saintonge Polychrome from Ireland, 1998
- Archaeology from Georgian Dublin, 1996

KEY PROJECTS

Luang Prabang HPP, Laos, 2023 - present

New Nydro-power plant along the Mekong river – Special Cultural Heritage advisor to lender banks on UNESCO World Heritage Sites.

High Speed Rail, Egypt, 2021 - present

New high speed rail network crossing Egypt, including assessment of impacts on UNESCO World Heritage Sites. Cultural Heritage lead consultant for the EISA.

EBRD PR8 Guidance Note, 2021-2022

Development of new Guidance Notes for the EBRD to accompany revised Performance Requirements for Cultural Heritage (PR8).

Jadar Underground Mine, Serbia, 2017 - present

Large underground Lithium Borate mine. Environmental Project Manager and Cultural Heritage consultant for the ESIA.

Pallas Green Mine, Ireland, 2019 - present

Large underground Lead-Zinc mine development. Environmental project manager and Cultural Heritage consultant for the ESIA.

Bankan Gold Mine, Guinea, 2022 - present

Large opencast mine development. Cultural Heritage lead consultant for Scoping.

Realt na Mara, Ireland, 2022

Offshore Windfarm, Cultural Heritage lead for EIA & Consenting

Celtic Horizons, Ireland, 2022

Offshore Windfarm, Cultural Heritage lead for EIA & Consenting

Mainstream RP, Ireland, 2022

Offshore Windfarm, Cultural Heritage lead for EIA & Consenting

Iberdrola Canary Islands, Spain, 2022

Offshore Windfarm, Cultural Heritage lead for ESIA

Equinor Baltyk 1, Poland, 2021-2022

Offshore Windfarm in the Baltic Sea. Cultural Heritage lead for ESDD and ESIA Gap closure

Shymanivske Iron Ore Mine, Ukraine, 2021

Environmental and Social Due Diligence on existing gold mine in Greece. Lead Cultural Heritage consultant.

Rovina Mine, Romania, 2021 - ongoing

Large underground mine development. Cultural Heritage lead consultant for ESIA to international Lender standards.

Perama Hill Mine, Greece, 2019

Environmental and Social Due Diligence on existing gold mine in Greece. Lead Cultural Heritage consultant.

Agua Rica Mine, Argentina, 2021 - ongoing

Large underground mine development. Cultural Heritage lead consultant for ESIA to international Lender standards.

Cornish Lithium Mine, United Kingdom, 2021 - ongoing

Large opencast Lithium mine. Cultural Heritage consultant for the ES.

Olympias, Skouries & Stratoni Mines, Greece, 2019

Environmental and Social Due Diligence on three existing gold mines in Greece. Lead Cultural Heritage consultant.

High Speed 2, Phase 2a, United Kingdom, 2017 – 2022

New high speed rail line. Deputy Historic Environment Lead (2017-2019) and Historic Environment lead (2019-2022) for the ES, APs, Hybrid Bill, Parliamentary Select Committee and Post Hybrid Bill phases. Designing and Managing route-wide non-intrusive Geophysical Field Surveys from 2017 to 2022. Author of the Phase 2a Historic Environment Research and Delivery Strategy (HERDS) for the construction phase of the project.

High Speed 2, Phase 2b, United Kingdom, 2017-2018

New high speed rail line. Historic Environment lead (acting) for EIAR and Hybrid Bill Environmental Overarching Contract (EOC).

East West Rail, United Kingdom, 2020 - 2021

New high speed rail line. Historic Environment lead (acting) for preliminary design.

Egypt High Speed Rail, Egypt, 2021-present

New high speed rail line. Historic Environment lead for ESIA to International lender standards.

Cairo Metro, Egypt, 2019

New metro rail line. Cultural Heritage support for ESIA to International lender standards.

NO-UK Telecoms Cable, United Kingdom, 2021

Telecoms cable from UK to Norway. Cultural Heritage consultant for scoping, regulator engagement and planning compliance.

Çanakkale 1915 Bridge and Kınalı-Tekirdağ-Çanakkale-Savaştepe Motorway, Turkey, 2017

354km motorway including world's longest suspension bridge. Lead Cultural Heritage consultant for the ESIA.

TAP Pipeline, Greece, Albania, Italy 2017

New large-scale Trans Adriatic Pipeline Project. Cultural Heritage reviewer for ESIA.

Forthwind Windfarm, United Kingdom, 2021

Windfarm across a sensitive landscape. Cultural Heritage consultant for ES review and update.

Greenlink Interconnector, Ireland, 2021-present

Electricity interconnector between Ireland and Wales. Cultural Heritage compliance manager for construction stage of the 23km onshore underground cable in Ireland.

EastMed Pipeline, Greece, Cyprus 2021-present

New large-scale trans-boundary Pipeline Project. Cultural Heritage reviewer and adviser for ESIA.

Kekava Bypass, Riga, Latvia, 2019

New 15km motorway. Compliance audit of Cultural Heritage section of ESIA to EBRD standards.

Mersinli Windfarm, Ismir, Turkey 2018

New large-scale 15 turbine windfarm across sensitive landscape. Cultural Heritage consultant for ESDD.

Tiguil Windfarm, Ukraine, 2020

New large-scale windfarm across sensitive landscape. Cultural Heritage consultant for ESDD.

N2 Dual Carriageway, Ghana, 2020 - ongoing

Upgrade of primary national route. Cultural Heritage lead consultant for ESIA to International lender standards.

N1 Road Upgrade, Togo, 2022

Upgrade of primary national route. Cultural Heritage lead consultant for ESIA to International lender standards.

RdP & RdS Road Upgrades, Benin, 2021

Upgrade of primary national route and ancillary route. Cultural Heritage lead consultant for ESIA to International lender standards.

Textile Parks, Ghana, Togo, Benin, Ivory Coast 2020 - ongoing

Cultural Heritage lead consultant for ESIAs at the various locations.

Solar 21 Solar Farm, United Kingdom, 2022

Large Solar Farm development across a sensitive landscape. Cultural Heritage consultant for ES.

Desal Desalinization Plant, Djibouti, 2021

New desalinization plant and pipelines. Lead Cultural Heritage consultant for ESIA.

GGU Utilities, Georgia, 2020

Environmental and Social Gap Analysis Report for multiple sites and Corporate Environmental and Social Management System of Georgia Global Utilities JSC.

KRPP Power plant & Mine, Kosovo, 2018

Major power generation station, Pristina, Kosovo. Lead Cultural Heritage consultant for the ESIA.

Papua LNG, Papua New Guinea, 2019

New large-scale LNG extraction and c.100km Pipeline to coast Project. Cultural Heritage ESIA gap analysis to IFC standards.

Sohar LNG Bunkering Project, Oman, 2019

Development of Sohar port area. Lead Cultural Heritage consultant for the Social Baseline Study.

Bapco Modernization Program, Bahrain, 2019

Petro-chemical refinery. Author of Cultural Heritage Chance Finds Procedure.

Ruwais Diyab, Abu Dhabi, UAE, 2019

Ruwais Diyab Social Baseline Study. Initial Cultural Heritage screening for the ESIA.

Lake Albert Solar, Uganda, 2019

Development of large Solar energy farm, Uganda. Initial Cultural Heritage screening for the ESIA.

Cuambra Solar, Mozambique, 2019

Development of large solar energy farm. Initial Cultural Heritage screening for the ESIA.

Solheimer Wind Farm, Iceland, 2019

New large-scale 16 turbine windfarm. Lead Cultural Heritage consultant for ESIA.

Nhkotakota Solar Power Plant, Malawi 2019

New large-scale Solar Power Plant. Cultural Heritage author of Chance Finds Procedure.

Various Large Infrastructure Projects, Dublin Port Company, Ireland, 2010-2017

Cultural Heritage consultant to major infrastructure projects within Dublin Port, including Alexandra Basin, Great South Wall, Berth 50, Graving Dock No.1 and other projects.

Olancito Irrigation Project, Honduras, 2018 – 2019

Regional Irrigation project involving over 400 new wells within the Olancito valley. Lead Cultural Heritage consultant for the ESIA.

Tamale Airport, Ghana, 2018

Major phased expansion of airport facilities at Tamale, Ghana. Lead Cultural Heritage consultant for the ESIA.

Ghobbert Windfarm, Djibouti, 2018

New large-scale 27 turbine windfarm. Lead Cultural Heritage consultant for ESIA.

Algabas Refinery, Kazakhstan 2018

New large oil refinery in western Kazakhstan. Cultural Heritage consultant for the ESIA.

The Reserve Development, Gibraltar 2017

Large private residential development in Gibraltar. Cultural Heritage consultant for desk based assessment.

Lamego Solar, Mozambique, 2018

Development of large solar energy farm. Initial Cultural Heritage screening for the ESIA.

KEY PROJECTS BEFORE JOINING ERM

UNESCO World Heritage Site Management Plan, Ireland, 2013-2014

Undertook a Compliance Audit of the existing Management Plan in relation to UNESCO Cultural Heritage regulations and authored a new Draft World Heritage Site Management Plan.

Heritage Impact Assessments for Schools & Primary Care Centres, Ireland, 2012-2017

Heritage Impact Assessments for over 50 new government funded school developments In Ireland.

Dublin Metro North Underground Railway, Railway Procurement Agency (RPA), Ireland, 2006-2010

17km Metro Light Rail Line for Dublin. Lead Cultural Heritage consultant for the EIA.

National Shipwreck Inventory, Ireland, 2012-2016

GIS Heritage Database Application being developed by the Irish Government. Undertook Research and Developed the Inventory.

Various Large Infrastructure Projects, Dublin Port Company, Ireland, 2010-2017

Cultural Heritage consultant to a number of major infrastructure projects within Dublin Port

N4 Dromod Roosky Bypass, Ireland, 2005-2007

Archaeological Testing & Excavation of 10km of new road. Project Manager, Senior Archaeologist & Project Supervisor Construction Stage (PSCS).

Pallas Green Mine, Ireland, 2010-2012

Large underground Lead-Zinc mine development. Cultural Heritage consultant for the EIA.

Lansdowne Road Stadium, Ireland, 2004-2006.

New 50,000-seat stadium for Rugby & Football. Cultural Heritage consultant for the EIA and planning enquiry.

N25 New Ross Bypass, Ireland, 2005-2007

14km of new National Primary road development. Cultural Heritage consultant for the EIA and planning enquiry.

Dublin LUAS Light Rail BX, Ireland, 2004-2006.

New Light Rail line extension through Dublin centre. Cultural Heritage consultant for route-options and scoping phase.

Deb Bryant, MSc, PAg

Associate Partner, Freshwater Sciences

Deb is a freshwater scientist with a Master's degree in Biology and expertise in a range of freshwater and marine services. Deb has conducted work at greenfield and developed industrial sites, across numerous sectors over the past 20 years. She is an effective project and discipline manager and believes in value-based leadership. She works closely with project teams to deliver successful projects and concurrently maintains productive and open relationships with clients.

EXPERIENCE: 20 years' experience in environmental consulting.

LINKEDIN: linkedin.com/in/deb-bryant-018aa98

EMAIL: Deb.Bryant@erm.com

EDUCATION

- MSc. Biogeochemistry, University of Victoria, Canada, 2007
- H.BSc. Physical Geography/Environmental Science, 1997

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Institute of Professional Agrologists
- Canadian Association on Water Quality
- BC Water and Waste Association

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Aquatic, sediment, and water quality assessments
- Environmental assessment and permitting
- Project and team management

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KEY INDUSTRY SECTORS

- Infrastructure
- Mining

KEY PROJECTS

Associate Partner for Permitting and Baseline scopes for Skeena Resources (Eskay Creek)
Deb manages the permitting (Technical Sample and Ancillary) scope, oversees all baseline components, and contributes to overseeing the project as part of the partner team.

Discipline Lead – Water Management at IAMGold Rosebel (Saramacca)
Provided input to ongoing water management issues at Saramacca and focused on the development of an arsenic management plan including the use of passive and active treatment of site water prior to entering treatment ponds.

Senior Reviewer and Manager- Projects in Northwest BC
Senior reviewer for freshwater baseline program (water quality, sediment quality, periphyton and benthic invertebrates) for Galore Creek, Brucejack Gold Mine, Iskut project (Johnny Mountain), and Tenas project.

Water Lead - International Projects
Discipline lead for water scopes; baseline collection, water quality/water balance modelling, facilitation of passive treatment options, and on-site water management at IAMGold Rosebel (Saramacca) and Yamana Gold Agua Rica sites.

KEY PROJECTS PRIOR TO JOINING ERM

Water Lead – Due Diligence at Minto Mine
Debbie reviewed the water management strategy and execution at the Minto Mine with regard to water quality and passive treatment planning. The due diligence team participated in a multi-day site visit and conducted interviews of the Operations team.

Project Manager – Mission Creek Spill Recovery
Senior scientist and project manager leading the coal derailment project through new regulation (Spill Preparedness, response, and Recovery Regulation B.C. Reg.185/2017) of the *Environmental Management Act*. The team was guided through stream restoration, aquatic sampling, and coordination of stakeholder engagement.

Project Manager – Metro Vancouver – Boundary Bay Ambient Monitoring Program Assessment
Managed the review of Metro Vancouver's Ambient Monitoring Program (2009-2015). Subject matter focused on changes in biophysical health of Boundary Bay in the context of Metro Vancouver's waste and stormwater discharges. The media included water column chemistry, sediment chemistry, and mussel tissue chemistry and was examined in temporal and spatial statistical framework.

Project Manager – BC Ministry of Forests, Lands and Natural Resource Operations. Modified Stage 1 / Limited Stage 2 Preliminary Site Investigation 2016-2019
Managed three site investigations through the province. Complete participation in the project, development of workplan, field due diligence and sampling program, client communication, report

writing and subcontractor coordination. Data was subject to British Columbia Water Quality Guidelines and Contaminated Sites Regulation (CSR) water standards, sediment and soil standards. Data was then applied to the Risk Ranking Tool developed for risk identification of abandoned mines.

Project Manager - Kivalliq, Angilak Project, Nunavut
Managed the initial environmental program for this site in Nunavut, Developed the surface water program for four years and executed climate station maintenance, wildlife observation program, hydrologic and water chemistry program.

Project Manager - Kaminak Coffee Proposed Mine Site, Yukon
Preparation of baseline studies and an environmental assessment under the Yukon Environmental and Socio-Economic Assessment Act, 2015. Assisted in managing baseline studies and an effect.

assessment for the proposed Kaminak Coffee copper/gold mine near the Yukon River, south of Dawson City, Yukon. Assisted in the preparation of water use licensing and other permitting materials.

Project Manager – Public Works and Government Service Canada: Fort Nelson Remediation Sampling Program
Managed the Fort Nelson Sampling program from 2015-2019. Subject matter concentrated on variation in salt and metals impacts identified in groundwater and surface water at periods of high flow at and in the vicinity of the site. Historical data review, workplan generation, coordination, budget control, and client and internal team communication were implemented.

Project Manager – Teck Coal
Managed the development and/or updates of multiple flocculant management plans for permit requirements.

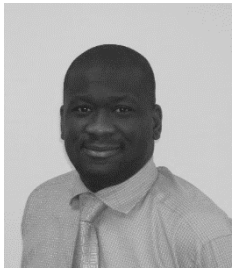
Discipline Lead – George Massey Tunnel Replacement Project
Designed the aquatics program for this environmental assessment. Collected all sediment and water samples and analyzed for all chemical and physical conditions in the South Arm of the Fraser River. The environmental assessment was completed, and support given to design engineers for environmental monitoring best practices.

Discipline Lead – Port Metro Vancouver Roberts Bank Container Capacity Improvement Project (CCIP)
Designed the sediment and water quality program for this environmental assessment. Collected sediment and water samples and analyzed for all chemical and physical conditions in the proposed project footprint. Additionally, Debbie established the database in preparation of the extensive chemical and physical data collected for this environmental assessment.

Discipline Lead – Taseko (Gibraltor Mine) Human Health and Ecological Risk Assessment
Gibraltar was required to complete a Human Health and Ecological Risk Assessment (HHERA) to assess the potential effects of parameters of concern for the area of influence by the mine site activities. Gap analysis was performed, followed by supplemental water and sediment quality data collection in all receiving surface water bodies on site. Data was prepared for HHERA analyses.

Frank Ocran, MSc

Principal Transport Planner



Frank is a Principal Transport Planner with over 12 years' experience working on transport planning projects and has gained a breath of experience on a wide range of topics including development planning and management, transport appraisal, travel planning and traffic engineering. He has gained experience in the various stages of the development planning process from policy reviews, stakeholder engagement, access strategies through to detailed transport assessments.

He uses modelling techniques to develop future ready solutions to mitigate the impact of developments for a wide range of projects including wind farms, mixed-use developments, and government & local authority projects.

EXPERIENCE: 12 years' experience in Transport

EMAIL: frank.ocran@erm.com

EDUCATION

- MSc Transport Planning & Engineering, Edinburgh Napier University (2007)

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Member, Chartered Institute of Highways and Transportation (2009)
- Member, Transport Planning Society (2014)

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Transport Assessments & Statements
- Construction Traffic Management Plans
- DMRB and Local Design Standards

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- Access Strategies
- Network Modelling

KEY INDUSTRY SECTORS

- Renewables

KEY PROJECTS

Tattymoyle Wind Farm, Northern Ireland (2023- Ongoing)

Lead Transport Consultant managing the transport inputs for the Environmental Impact Assessment submission.

Ceislein Wind Farm, Section 36 EIA (2023- Ongoing)

Lead Transport Consultant managing the transport inputs for the Environmental Impact Assessment submission.

Hurworth Moor Solar Farm (2023- Ongoing)

Lead Transport Consultant managing the transport inputs for the Transport Assessment for the planning submission.

Owenreagh Wind Farm Repowering, Northern Ireland (2023)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Cloud Hill Wind Farm, Section 36 EIA (2023)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Ladyfield Wind Farm, Section 36 EIA (2023)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Torrance Wind Farm Extension II, Section 36 EIA (2022)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Armadale Wind Farm, North Sutherland, Section 36 EIA (2022)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Grayside Wind Farm, Section 36 EIA (2022)

Project Manager responsible for managing the transport inputs of the EIAR for the Environmental Impact Assessment (EIA) Submission.

Baillie Greener Grid Park, Thurso (2021)

Project Manager responsible for managing the transport inputs of the Transport Assessment for the planning submission.

Cloich Forest Wind Farm, Section 36 EIA (2021)

Senior Engineer responsible for the preparation of the Transport and Traffic Chapter of the EIAR

Tormsdale Wind Farm, Section 36 EIA (2021)

Senior Engineer responsible for the preparation of the Transport and Traffic Chapter of the EIAR

Heathland Wind Farm Section 36 Application (2021)

Senior Engineer responsible for the preparation of the Transport and Traffic Chapter of the EIAR

George Chatzigiannidis

Principal Technical Consultant

George Chatzigiannidis is a principal environmental noise consultant. He has over 12 years of experience in the field of noise and vibration assessment.

George is based in ERM's Barcelona office focusing on environmental air and underwater noise assessments. His core focus is in measurements and data analysis, air and underwater noise modelling and assessment, providing technical reports and managing projects.

George has experience across a number of sectors (roads, renewables, O&G, power plants, mines) in Africa, EU, UK, Asia, North and South America.

EXPERIENCE: 12 years' experience in Acoustics and Vibration

LINKEDIN: www.linkedin.com/in/georgechatzigiannidis

EMAIL: george.chatzigiannidis@erm.com

EDUCATION

- MSc. Acoustical Engineering, University of Southampton, United Kingdom, 2011.
- University degree, School of Biology, Department of Ecology, Aristotle University of Thessaloniki, Greece, 2008

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Member of Institute of Acoustics

LANGUAGES

- Greek, native speaker
- English, fluent
- Spanish, fluent

FIELDS OF COMPETENCE

- Underwater noise assessment
- Environmental noise assessment and modelling

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- Construction noise and vibration assessment
- Environmental noise monitoring techniques and noise management plans
- Road and rail noise measurement and assessment

KEY INDUSTRY SECTORS

- Power
- Renewables
- Windfarms
- Oil and Gas
- Construction
- Mines Transport

HONOURS AND AWARDS

- MSc Honors

KEY PROJECTS

Datacentre in Johannesburg South Africa , SDD, Arup & Microsoft, ongoing

George is attending meetings with engineers, assisting with mitigation design, and supervising the noise modelling team for the SDD.

Windfarms and Solar plant in Oman, EIA, Total Energies, 2024

George lead the noise impact assessment, reviewed the relevant work undertaken by local subcontractor and prepare the inputs for the noise impact assessment sections for IFC criteria.

Datacentre in Madrid Spain, SDD, Ethos & Microsoft, 2024

George supervised the modelling team, and review the noise inputs on the SDD report.

Greenbreeze onshore windfarm in Rumania, OX2, 2024

George led the modelling team. George reviewed and finalized the noise impact assessment report.

Coastal Virginia Offshore Wind Commercial Project, ESDD, Dominion, 2024

George reviewed the underwater noise impact technical report and environmental statement to identify potential gaps between national and international standards and assess environmental risks of the project.

ADDA, Underwater noise assessment in Denmark for piling and drilling activities, TEPDK, 2023 - 2024

George was leading the modelling team. George was responsible for the underwater noise impact assessment report.

Green Hawk, Support for offshore wind tender in Germany, Equinor, 2023

George reviewed the German standards for underwater noise and help Equinor to understand the requirements for their future applications.

Adaro Windfarm, Indonesia, 2023.

George led the modelling team. George reviewed and finalized the noise impact assessment report.

Green Breeze Windfarm, Romania 2023.

George reviewed and finalised the technical report for the preliminary noise model of a windfarm in Romania.

Bankan, Gold Mine, Predictive Discovery, Guinea, 2022-2023.

George's role is to supervise the noise baseline and the construction and operation model of a gold mine. George prepared the EIA report and a technical report.

Highspeed Train Egypt, Siemens, 2022- 2023

George was leading the noise team. George reviewing the noise and vibration impact assessment report for the construction and operation of a high speed train in Egypt.

5 Flyovers, Inzag, Angola, 2022 – 2023.

George's role is to supervise the noise baseline and the model the construction and operation of the improvement of a road in Angola.

Koforidua Road Scheme, PROPAV, Ghana, 2022 – 2023

George's role is to supervise the noise baseline and the model the construction and operation of the improvement of a road in Ghana.

Thermopower plant, Gabon, Wärtsilä, 2021- 2023

George's role was to model the construction and operation related to the project. Finally, George prepared the EIA report and a Technical report.

Underwater Noise Assessment of Drilling in Malaysia, Total, 2021

George led the team in modelling and assessment of underwater noise impacts due to drilling offshore Malaysia. George prepared the Technical report and he contributed to the EIA.

Ronesans, Highway, Turkey, 2021

Project Manager. George's role was to supervise the noise baseline and to model the construction and operation of a new highway between Nakkaş and Başakşehir. Finally, George will prepare the EIA report and a Technical report.

Bonikro Mine Expansion, Afrique Gold, Ivory Coast, 2021

George's role was to model the mining operations related to the expansion of the project. Finally, George prepared the EIA report and a Technical report.

Rovina Mine, Samax, Rumania, 2020 - 2021

George's role was to model the mining operations related to the expansion of the project. Finally, George prepared the EIA report and a Technical report.

Due diligence for two windfarms in Poland, EBRD, 2020

George reviewed the technical report and modelling details to ensure the project will comply with the national and international noise standards.

Due diligence for windfarm in Kazakhstan, EBRD, 2020

George reviewed the technical report and modelling details to ensure the project will comply with the national and international noise standards.

Underwater Noise Assessment of Piling Noise, Total, Denmark, August 2020

George led the team in modelling and assessment of underwater noise impacts due to piling noise for Halfdan North and Valdemar platforms off shore Denmark. George prepared the Technical report and he contributed to the EIA.

HS2 Phase 2b – UK, 2017-2019

George is the Sound and Vibration Noise Manager. His role ranges from to attending meetings with design and engineers (Arup and Costain), reviewing the noise inputs to managing the noise modelling team and preparing reports for the ES.

HS2 Phase 2a – UK, 2016-2018

George's role ranged from attending meetings with design and construction engineers (Arup and Costain) and reviewing the noise inputs to managing the noise modelling team.

KRPP, Coal Power Station, Kosovo, 2018

Project Manager. Site field survey and modelling. George's role was to complete the noise baseline for this project and to model the operation. Finally, George prepared the EIA report and a Technical report.

Bechtel, Highway, Kenya, 2017-2018

Project Manager. George's role was to supervise the noise baseline and to model the construction and operation of a new highway connecting Nairobi with Mombasa. Finally, George prepared the EIA report and a Technical report.

Rakita, Timok Mine, Serbia, 2016 – 2017

Project Manager. Site field survey and modelling. George's role is to complete the noise baseline for this project and to model the operation. Finally, George prepared the EIA report and a Technical report.

Rio Saba (Rio Tinto), Jadar Mine, Serbia, 2016

George's role was to complete the noise baseline for this project and to support the model the operation.

Corbetti Thermo Power Station, Ethiopia, 2015

Project Manager. Site field survey and modelling. George's role was to complete the noise baseline for this project and to model the operation. Finally, George prepared the EIA report and a Technical report.

Hipolito Windfarm – Mexico 2015

George's role was to organize and analyze the meteorological data and model the operation of the windfarm. Finally, George prepared the EIA report and a Technical report.

Underwater Noise Assessment of Pipelaying development Adriatic Sea, Confidential Client, 2016

George led the team in modelling and assessment of underwater noise impacts from the FLNG development project including drilling and operational phases.

Gillian Gregory, PhD

Principal Consultant

Gillian Gregory is a mine closure and social performance practitioner based in British Columbia, Canada. She has 14 years' experience leading and working on major mining, oil and gas, alternative energy projects, including impact assessments, engagement programs, due diligence assessments, and socioeconomic and Indigenous programming. She specializes in incorporating socioeconomic and cultural considerations in mine closure, transition, and reclamation planning, and in stakeholder engagement and capacity-building. She is fluent in English and Spanish.

EXPERIENCE: 14 years' experience in the mining sector

LINKEDIN: https://www.linkedin.com/in/gillian-h-gregory

EMAIL: gillian.gregory@erm.com

EDUCATION

- Research Fellow. Mine Closure, University of Melbourne/Sustainable Minerals Institute, Australia, 2022
- PhD. Geography. McGill University, Canada, 2016
- MA. Anthropology. McGill University, Canada, 2009
- BA (hon). Anthropology & Creative Writing, University of Alberta, 2007
- List most recent first

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- International Association of Impact Assessment
- American Association of Geographers
- Australian Centre for Geomechanics
- Sustainable Minerals Institute

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LANGUAGES

- English, native speaker
- Spanish, fluent
- French, working knowledge

FIELDS OF COMPETENCE

- Mine closure and mine transition planning
- Impact assessment
- Stakeholder and Indigenous/rightsholder engagement
- Government, community, and Indigenous relations
- Due diligence and international performance standards
- Project management

KEY INDUSTRY SECTORS

- Mining and mine closure
- Oil and gas
- Power
- Renewables
- International and community development

PUBLICATIONS

- Gregory, G. 2021. "Rendering mine closure governable and constraints to inclusive development in the Andean region." Resources Policy 72: 102053.
- Gregory, G. 2021. "Las consecuencias del COVID-19 en la gobernanza de las industrias extractivas en Colombia." CIDER Boletín, Universidad de los Andes, May 3.
- Bebbington, A., A. Carballo, G. Gregory, and T. Werner. 2021 "Negotiating the Mine: Commitments, Engagements, Contradictions." In The Routledge Handbook of Critical Resource Geography, edited by Matthew Himley, Elizabeth Havice, and Gabriela Valdivia, 248–59. Oxon and New York: Routledge.
- Werner, T., A. Bebbington, and G. Gregory. 2019. "Assessing the impacts of mining: Recent contributions from GIS and remote sensing." The Extractive Industries and Society 6(3): 993-1012.
- Gregory, G. and I. Vaccaro. 2015. "Islands of governmentality: Rainforest conservation, cultural preservation, and the alternative modernization of Guyana's interior territory." Territory, Politics, Governance 3(3): 344-363.

KEY PROJECTS

Social transition planning Confidential client, Asia-Pacific 2024

Senior social lead for workshop and associated deliverables to support social transition planning for asset based in Asia-Pacific.

Legacy asset Indigenous and stakeholder engagement strategy North American Tungsten Corporation, Canada2024

Senior social lead for the development of an Indigenous and stakeholder engagement strategy for a legacy asset in the Northwest Territories, Canada.

Due diligence report Confidential client, Canada 2024

Senior lead for due diligence report for potential asset purchase in western Canada, focused on potential risks associated with Indigenous and stakeholder relations.

Closure-specific Indigenous engagement planning Burgundy Diamond Mines, Canada 2023-ongoing

Senior social lead supporting implementation of planning associated with closure criteria for Ekati's Integrated Reclamation and Closure Plan, and corresponding lead on Closure-Specific Engagement Execution Plan to guide engagement and integration of Traditional/Indigenous Knowledge in closure activities.

Social performance and mine closure support Glencore Kidd, Canada 2023-ongoing

Senior social lead supporting external stakeholder and Indigenous engagement planning, transition and community investment planning, social impact assessment, and strategic advisory support specific to mine closure.

Environmental and Social Impact Assessment and stakeholder engagement planning support Reunion Gold/G Mining Ventures, Guyana 2023-ongoing

Senior social lead for EIA for Oko West project in Guyana, and lead for stakeholder engagement planning, including scoping, consultations, and strategic planning.

Sustainability audits Pan American Silver, Peru 2023

Senior lead in execution of sustainability audits at 3 mine sites in Peru, including audit work and IsoMetrix reporting.

Social performance and engagement planning, Teck Coal/Elk Valley Resources, Canada 2022-ongoing

Senior lead to support ongoing external stakeholder and Indigenous engagement strategy and tracking for the Fording River Extension (FRX) project, including providing ongoing support in managing and reporting on all external stakeholder engagement and communications.

Closure regional development strategic and social support DeBeers, Canada 2022

Provided technical expertise and planning for social closure and transition planning for a large diamond mine in northern Canada, focusing on regional collaborations and post-closure land use opportunities and development.

North American Mine Closure Working Group Northwest Territories, Canada 2022

Supported planning, content development, and facilitation for annual workshop attended by major mining leaders and juniors. Focus on new trends in mine closure across North America, with key focus in 2022 on 'the north.'

Indigenous engagement and strategic negotiations support Confidential client, Canada 2022

Senior social support for miner-led initiative to re-engage with Indigenous host community of a potential mine project, with particular focus on Indigenous consultation and engagement, as part of project feasibility and strategic planning.

Reclamation and Closure Plan Teck Coal, Canada 2022

Project manager and social performance SME on draft Reclamation and Closure Plan for the Fording River Extension (FRX) project.

Social performance and stakeholder engagement strategy support Yamana Gold/Glencore, Argentina 2022

Senior social lead supporting stakeholder and government relations communications strategic planning for brownfield project in Argentina.

Environmental and social due diligence Confidential client, Mexico 2022

Senior support and input to IFC and Equator Principles lender's reporting for proposed LNG project in northern Mexico.

Stakeholder engagement planning Inter Pipeline, Canada 2022

Senior lead for the development of a regulatory-compliant Indigenous and stakeholder engagement strategy for a proposed "blue hydrogen" project and associated infrastructure spanning two provinces and involving more than 30 Indigenous Nations.

Social closure and stakeholder engagement planning, Pan American Silver, Argentina, Peru, Mexico 2022

Senior lead in the development of social closure plans, including social investment initiatives, for mines approaching or currently undergoing closure, in compliance with Pan American Silver's social closure standard and with distinct national/provincial jurisdictions.

KEY PROJECTS PRIOR TO JOINING ERM

Social closure planning Confidential client, Colombia 2018-2022

Provided technical expertise in amended closure plan timelines following early operational closure and determined social criteria for closure 'success'.

Mine closure policy support Multiple parties, Colombia 2018-2022

Organized and led a multi-party working policy group (government, civil society, private sector) to incorporate socioeconomic dimensions into mine closure planning, based on early projected coal mine closures in northern Colombia.

Socioeconomic baseline assessment Lithium projects, Argentina and Chile 2020-2021

Led socioeconomic baseline assessment for two lithium projects in northern Argentina and Chile.

Land reclamation and use planning Legacy Mine, Saskatchewan 2017

Provided technical expertise in land reclamation and use planning on behalf of First Nations in northern Saskatchewan in area surrounding legacy mining works, as part of federal government compensation planning. Acted as expert witness in legal proceedings.

Social impact assessment BC Hydro and Lake Babine Nation, Canada

Led social impact assessment for hydropower extension projects in northwest British Columbia.

Traditional Knowledge and Use Studies SAGD Operations, Canada 2015-2016

Led traditional knowledge and use studies for proposed SAGD operations in northern Alberta in areas potentially affecting First Nations.

Community-Based Resource Management SERNANP and TNC, Peru 2013-2014

Provided technical expertise as part partnership with Peruvian parks (SERNANP) and TNC to determine the impacts of urbanization on community-based fisheries management in in Loreto region.

Technical advisory support LCDS, Guyana 2008-2009

Acted as technical advisor during drafting of the Low Carbon Development Strategy (associated with Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) planning) to determine terms for inclusion of illegal and/or informal gold mining in carbon offset planning for Indigenous-titled lands.

Herbert Pirela

Senior Project Manager

Herbert is a soil scientist with wide experience in designing, conducting, and managing major environmental investigations and permitting projects. The major focus of his work has been on impact analyses for soils, reclamation, and geology, and includes environmental assessments under the National Environmental Act (NEPA) and other United States and international regulations. Herbert has extensive experience with international standards and best practices, especially with the IFC Performance Standards and WBG EHS Guidelines, having lead and conducted multiple environmental and social and environmental and social impact assessments (ESIA) for power, oil gas, mining clients.

EXPERIENCE: 20 years' experience in power, mining, oil & gas, renewables

LINKEDIN: https://www.linkedin.com/in/herbert-pirela-9449a41b/

EMAIL: herbert.pirela@erm.com

EDUCATION

- Ph.D. Soil Chemistry/Fertility (soil scientist), Iowa State University, USA, 1987

LIST OF EIS/MEPA/NEPA PROJECTS

- Newmont Merian TSF2 Project ESIA Addendum – Soils SME
- Saramacca Satellite Mine Project ESIA – DPM, soils SME
- Gold Mine Tailings Storage Facility Expansion ESIA – PM, Soils SME
- Atlantic Coastal Pipeline West Virginia, Virginia, and North Carolina – Soils and Restoration SME

LANGUAGES

- English, native speaker
- Spanish, native speaker

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FIELDS OF COMPETENCE

- National Environmental Policy Act (NEPA) and state-equivalent NEPA compliance
- Project planning and design to address soils and geological issues
- Soil restoration/revegetation
- Cumulative Impact Assessment

KEY INDUSTRY SECTORS

- Mining / Metals
- Oil & Gas
- Power / Renewables

KEY PROJECTS

Merian TSF2 Project ESIA Addendum; NIMOS; Newmont; 2022-2024

Subject Matter Expert (SME) soils, for ESIA Addendum of a tailings storage facility expansion in Suriname, South America. Responsible for the collection of soil samples for physical and chemical quality characterization and preparation of baseline and impacts chapters of the ESIA.

Contact: Hedy Feen-Hoeseni, Environmental Superintendent, Newmont

hedy.feen@newmont.com, +597 427707 x28365

Saramacca Satellite Mine Project ESA, Rosebel Gold Mines (RGM) – IAMGOLD Corporation, Suriname; 2017-2018

The Project consisted of two main components: an open pit mine and a private road for hauling mined mineralized material to the existing RGM mill for processing. Herbert served as the assistance Project Manager and the soils SME lead in the development of the ESIA to satisfy contractual obligations, national guidelines, and draft regulations as well as international and corporate standards for project development.

Rachel Pollack@iamgold.com, + 597 325115 x204431

Gold Mine Tailings Storage Facility Expansion ESIA, Rosebel Gold Mines (RGM) – IAMGOLD Corporation, Suriname; 2021-2022

To maintain gold production levels, Rosebel Gold Mines investigated the feasibility of expanding its mines tailings storage facility. The expansion included the expansion of the existing tailings facility to the east by constructing seven additional dams, which raised total vertical containment by 43 meters when the Project was completed. Dr. Pirela served as project manager and soils lead to conduct an environmental and impact assessment for the expansion of the gold mines existing tailings storage facilities in according to local and international guidelines.

Rachel Pollack@iamgold.com , + 597 325115 x204431

Atlantic Coastal Pipeline West Virginia, Virginia, and North Carolina; 2019

For a 600 miles long interstate natural gas transmission pipeline that crosses West Virginia, Virginia, and North Carolina, and would serve multiple public utilities and their growing energy

needs in Virginia and North Carolina. Dr. Pirela was the lead soil scientist in charge of the development comprehensive Rehabilitation and Restoration Plan for the project, including detailed plans to include pollinator plant and warm season grasses species in the restoration of the right-of-way in piedmont and coastal plain areas in Virginia and North Carolina.

Contact: Ross Vellacott Partner, ERM

ross.vellacott@erm.com, (612) 347-7158

Merian Gold Mine Project ESHIA, Newmont Mining Corporation, Suriname

Suriname Gold Company, LLC (Surgold) owns and operates the Merian Gold Project 30 Km to the north of the Nassau Mountains in eastern Suriname. Dr. Pirela led the soils impact assessment for the Environmental and Social Impact Assessment of a new gold mine in Suriname.

Nassau Plateau Bauxite Mine ESHIA, Suriname Aluminum Company, Suriname

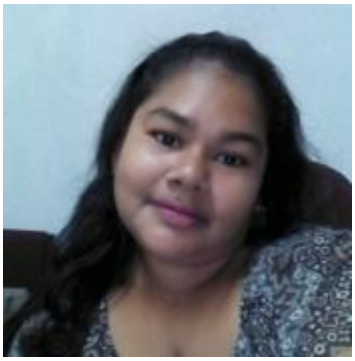
Manager and soil lead for the development of an ESHIA for new bauxite mine on the Nassau Plateau that evaluated the environmental and social impacts of the proposed new mine.

Keystone Pipeline, Alberta and Saskatchewan Canada, and Montana, South Dakota and Nebraska

TransCanada Keystone Pipeline, LP (TransCanada) construction of a new pipeline approximately 1,980-mile, 36-inch and related facilities to transport crude oil from the Western Canadian Sedimentary Basin to the Texas Gulf Coast. Herbert was the lead geologist/soil scientist that evaluated the impacts of the project on the geological and soil resources along the pipeline route.

Indranee Roopsind, BSc, MSC

Biological Resources Specialist



Indranee is a field biologist who has conducted field expeditions all over Guyana, studying large and small mammals with special focus on riverine and semi-aquatic species, reptiles and amphibians, birds, and fishes. She has worked on developing and implementing monitoring systems for wildlife management, and wetland systems within the Iwokrama Forest and the North Rupununi Wetlands. She has a keen interest in understanding the population and behavioral ecology of the Giant River Otter Pteronura brasiliensis in Guyana. She has also worked extensively with indigenous peoples on strategies that link the science of traditional knowledge with strategies for natural resources management.

EXPERIENCE: 21 years' experience in environmental education, biodiversity assessments and working with indigenous communities on natural resource management planning

EMAIL: Indranee.Roopsind@erm.com

EDUCATION

- Master of Science, Forest Biology, University of Guyana
- Bachelors of Science, Biology Major, Chemistry Minor, 2002, University of Guyana

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- IUCN SSC Otter Specialist Group (Giant Otter Species Group)
- Women in Nature Network (WiNN) Guyana

LANGUAGES

- English

FIELDS OF COMPETENCE

- Field biology (Mammalogy, Herpetology and Ichthyology)
- Community engagement

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- Environmental education

KEY INDUSTRY SECTORS

- Biodiversity
- Wetland ecology
- Ecosystem services and sustainable development

HONOURS AND AWARDS

- Cleveland Metro Parks Zoo Scotts Neotropical Fund.
- Tom Dolan IV Conservation Fellowship. 2003. Philadelphia Zoo, USA
- UNDP Volunteer Award.
- Grant from the Smithsonian National Zoo. 2001
- Grant from the Jacksonville Zoo. 2001

PUBLICATIONS

- Sustainable Development of the Rupununi-Linking People, Biodiversity and the Environment. 2006.
- Giant Otters – Linking People, Forests and Businesses .2004.
- Epiphytic Diversity in Lowland Tropical Forest. 2002
- A proposed study of the fish consumption by the Giant Otter *Pteronura brasiliensis* in the North Rupununi Wetlands, Guyana. 2001
- Capacity building for adaptive management: a problem-based learning approach. Development in Practice, Vol. 21, No. 2, 2011, p. 190-204
- Ecosystem services education modules. GSI Project, United Nations Development Programme, Guyana. 42p.
- 2006. The ECOSENSUS Approach and application for the NRAMP in the North Rupununi as a component of the participatory research.
- A new species of Colostethus (Anura: Dendrobatidae) with maternal care from Kaieteur National Park, Guyana. Zootaxa, 1238: 35-61.
- Surveying and Monitoring Distribution and Population trends of the Giant Otter (Pteronura brasiliensis) – Guidelines for a Standardisation of Survey Methods as Recommended by the Giant Otter Section of the IUCN/SSC Otter Specialist Group.

KEY PROJECTS

Terrestrial Ecology Local Specialist, Giant Otter Surveys, Oko West Project, Reunion Gold (2024)

As part of the Oko West Gold Project, giant otter surveys were conducted to monitor the endangered species and establish their populations and habitat distribution and quality within the Project area of influence. Main duties included assisting in the development of survey methodology, implementation of survey and compilation of survey reports**.**

Terrestrial Ecology Local Specialist, Environmental Baseline Study and ESIA, Oko West Project, Reunion Gold (2022-2024)

ERM was engaged by Reunion Gold to conduct environmental baseline studies and ESIA for the Oko West Gold Project in Guyana. Main duties included assisting in the development of survey methodology, implementation of survey and compilation of baseline reports**.**

Riverine Mammal Biodiversity Lead, Gas to Energy ESIA, Biological Baseline, ExxonMobil Guyana – EEPGL (2021-2023)

ERM was engaged by ExxonMobil to elaborate the ESIA for Gas to Energy Project in Guyana. Main duties included assisting in the development of survey methodology, implementation of survey and compilation of final report**.**

Riverine Mammal Biodiversity Lead, Payara ESIA, Biological Baseline, ExxonMobil Guyana – EEPGL (2019 – 2020)

ERM was engaged by ExxonMobil to elaborate the ESIA for Payara Development Project in Guyana. Main duties included assisting in the development of survey methodology, implementation of survey and compilation of final report**.**

Biologist, Demerara River Mammal Survey, Liza Phase II ESIA, ExxonMobil Guyana – EEPGL (2019-2020)

ERM was engaged by ExxonMobil to elaborate the ESIA for Liza Phase II Development Project in Guyana Demerara River Mammal Survey.

Main Duties: Assist in the development of survey methodology, implementation of survey and compilation of final report**.**

Community Engagement Specialist/Field Manager, WWF Guianas (2016 – 2018)

Main Duties: Facilitate training and development sessions for indigenous villages in Region 9 on the development of 10 year village improvement plans, and coordinate field activities in the Rupununi.

Research Assistant, PANTHERA (April 2015 – 2016)

Assessing sustainable hunting yields and hunter awareness as a foundation for managing wildlife populations in Guyana.

Rapid Assessment Programme Researcher, Conservation International (June 2014 – September 2014)

Responsible for the documentation of the levels of ecosystem services use by communities and potential impacts on the savanna/forest/wetland systems for the baseline assessment for the expansion of the pre- investment Georgetown-Lethem Road.

Biodiversity specialist (August 2012 – October 2012)

Responsibilities included the design, implementation and compilation of an assessment of the biodiversity along the Cove and John Mangrove Reserve for applications to the Guyana Mangrove Restoration Project.

Researcher/Lecturer (August 2009 – October 2011)

IUCN funded project working with indigenous communities in southern Guyana (Rupununi) on capacity enhancement and natural resources management planning associated with wetland resources, including community fisheries management, and natural sites management. Work

included facilitating courses to youths from Amerindian communities in the Rupununi, aimed at wildlife and natural resources management.

Research Assistant/Wetlands Researcher (January 2004 – December 2008)

Darwin Initiative sponsored project; Sustainable Management of the Rupununi Wetlands – Linking People, Environment and Biodiversity; Phase 1 and Phase 2.

Research Assistant

Development and implementation of distribution and habitat use studies of *P. brasiliensis* in the Iwokrama Forest and North Rupununi Wetlands. Additional responsibilities included extensive faunal field surveys, river patrols, data entry, and community outreach.

Environmental Educator

Responsibilities include the preparation of a bi-annual newsletter, instructing classes at the Guyana Zoo to primary level.

Irene Bopp

Partner, Mining Impact Assessment

A Chartered Environmentalist specialising in the management and compilation of ESIA's for mining and infrastructure projects internationally. She has managed environmental contributions from screening and pre-feasibility study phases through to meeting operational objectives, whilst ensuring compliance with international standards and local regulations.

Mineral experience includes coal, iron, gold, and platinum mining operations, and further experience in associated infrastructure such as roads, railways, ports, water treatment facilities, wind power generation and hydropower generation. Irene has worked in the Guyana, Guinea, Angola, Republic of Liberia, Cameroon, Democratic Republic of Congo, South Africa, Guyana, Argentina as well as Germany, Serbia, Armenia, Poland, and Turkey.

In addition, operational excellence, business optimisation and business strategic growth has complemented her quality assurance, project, and team management expertise.

EXPERIENCE: 18 years' experience in large scale environmental and general project management, regulatory compliance, operational excellence and optimisation.

LINKEDIN: https://www.linkedin.com/in/irene-bopp-24440539/

EMAIL: irene.bopp@erm.com

EDUCATION

- MSc Aquatic Health, Two-year research project (University of Johannesburg, 2008).
- BSc Honours – Aquatic Health (University of Johannesburg, 2005)
- BSc Environmental Science (Rand Afrikaans University, 2004)

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Chartered Environmentalist: Institution of Environmental Sciences (CEnv)
- Member of the Institution of Environmental Sciences (MIEnvSc)

LANGUAGES

- English, native speaker
- Greek (proficient)

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FIELDS OF COMPETENCE

- ESIA
- Regulatory Compliance
- IFC
- Equator Principles
- Stakeholder Interaction
- Project Management

KEY INDUSTRY SECTORS

- Mining
- Renewables
- Infrastructure

KEY PROJECTS

Zinnwald Lithium (Germany)

ERM are carrying out the ESIA Scoping study for a proposed Lithium Mine in Saxony, Germany. This is the pre-requisite to the ESIA study. ERM are also providing water advisory services during the PFS stage of the project.

Nurcan Kassing Mine (Angola)

ERM have completed a scoping study for a proposed iron ore mine in Angola. ERM is now carrying out the ESIA for the mine. This includes all baseline studies and co-ordination with local subcontractors to deliver the ESIA to lenders requirements and local legislation.

PDI Bankan Mine (Guinea)

Senior advisor to the ERM team compiling a scoping report and ESIA to Guinea regulations and International Standards. A further ERM team was working on the design of the mine.

Confidential Client (Republic of Liberia)

Environmental lead for advisory on ESG aspects of operations in Liberia. This is an operation iron ore mine with associated infrastructure (railway and port) and they are expanding the onsite operations. This project includes a ESIA gap analysis, CSRD environmental gap analysis and environmental aspect monitoring and regulatory compliance advisory.

Rio Tinto Rincon (Argentina)

Strategic Advisory and workstream lead for an IFC gap analysis consideration and ESIA upgrade to meet IFC Standards for a Lithium deposit in Argentina. This project includes interaction with IFC.

Dundee Precious Metals (Serbia)

Partner-in-charge for PEA, MRE and Environmental and Social support for the exploration and permitting of a Gold deposit in Serbia, in support of their PFS. The following phases will include baseline collection, social surveys, FS support and ESIA, all to local and international standards.

Reunion Gold (Guyana)

Partner-in-charge of scoping, baseline studies and ESIA for a proposed Gold Mine in the Guiana Shield. The studies span across all specialties and compilation of the ESIA guided by the IFC and in compliance with the Environmental Protection Agency of Guyana. In addition, this includes critical habitat assessment and cultural heritage specialized assessments.

Oksut Gold Mine (Turkey)

Ongoing closure and rehabilitation support as they enter their final decade of mining. This project includes heap leach pad covering options and waste rock dump design advice. In addition, closure water modelling water balance form part of the advisory role.

KEY PROJECTS PRIOR TO JOINING ERM

Putu Iron Ore Mine (Republic of Liberia)

Preparation and coordination of a major ESIA for the development of a 50 Mtpa iron ore mine in the Republic of Liberia in compliance with the Equator Principles and the IFC Performance Standards. The ESHIA also considered the impact of the 185km road upgrade, rail route development and a new port facility. This project included all authority, stakeholder and community relations.

Ntem Mining (Cameroon)

Project Director for the scoping phases of the ESIA for the Ntem Mine in the Republic of Cameroon, an Affero Mining owned iron ore mine. The role involves regulatory compliance (local and international) as well as project management and report compilation for the scoping phase of the project. All legislative and client communication was carried out and scoping studies concluded.

Western Cluster (Republic of Liberia)

Compilation and management of the WCL screening study. The mine can yield 30 million tons of iron ore annually — comprising quartz, hematite, and magnetite, and other minerals.

Randgold Resources (DRC)

Project management and report compilation of the ESIA for the Nzoro Hydro Power Station and transmission line environmental studies (Democratic Republic of Congo (DRC)) in line with IFC Environmental Standards and Equator Principles. This infrastructure is to support the Kibali Gold mining operations.

Randgold Resources (DRC)

Project management and report compilation for the Kibali Gold mining operations environmental and social studies (DRC) in line with IFC Environmental Standards and Equator Principles.

Bokoni Platinum Ltd (South Africa)

All aspects of environmental compliance for their platinum mine. This resource is the second largest PGM resource in South Africa.

Exxaro Resources (Pty) Ltd (South Africa)

Project management and report compilation for Arnot Coal colliery EIA and EMP in support of an environmental authorisation.

BHP Billiton (South Africa)

Project management and report compilation for Klipspruit South Coal colliery EIA and EMP in support of an environmental authorisation.

PD Co Mining ESIA (Poland)

IFI Regulations, principle implementation and quality assurance for an underground coal mine ESIA in Lublin, Poland.

Guris Geothermal Power Plant (Turkey)

Geothermal Power plant due diligence in Turkey on behalf of the EBRD. Compiler and project manager.

Continental Wind (Serbia)

Project management and compilation of an updated ESIS for the wind farm in order to comply with IFC and Equator Principles.

Jason Willey

EIA and Fisheries Specialist

Mr. Willey has over 18 years' experience in ecology, with specific expertise in aquatic and estuarine ecology and fisheries. Most of his ecological work has supported environmental impact assessments and permitting projects for industrial projects, particularly in the oil and gas and mining sectors. He has assessed environmental impacts of various oil and gas projects in the United States, the Guianas, and Australia for onshore and offshore components of upstream and downstream developments. Since 2015 Mr. Willey has worked almost exclusively on offshore oil and gas exploration and production projects in Guyanese territorial waters. Prior to 2015, Mr. Willey managed and/or provided senior technical input for several ESIAs for mining and energy projects in Suriname.

[Double click to add pic]

EXPERIENCE: 18 years' experience in ecology for onshore and offshore components of upstream and downstream developments

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EMAIL: name.surname@erm.com

EDUCATION

- B.S., Biology, University of Richmond, Richmond, VA, May 1997
- M.S., Environmental Science and Policy, Johns Hopkins University, MD, May 2007

FIELDS OF COMPETENCE

- Environmental Impact Assessment
- Aquatic and estuarine ecology, including quantitative and qualitative fish community survey methods (EPA rapid bioassessment protocol), aquatic macroinvertebrate ecology, water quality sampling, and in-stream macrohabitat assessment
- Essential Fish Habitat (EFH) assessment
- Fish entrainment studies

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- International EIA Best Practice Compliance (IFC Performance Standards; World Bank EHS Guidelines)
- Stakeholder Engagement and management

KEY INDUSTRY SECTORS

- Oil & Gas
- Mining
- Power

KEY PROJECTS

Environmental and Social Impact Assessment, Merian Gold Mine.

Led the biological resources and impact assessment portion of an ESIA for a gold mine and transport road in northwestern Suriname. Supervised the biological field surveys, which documented the presence of several species of rare and potentially new-to-science fishes as well as several rare mammals in the project area. Prepared a detailed biological management plan which provided for a net gain in habitat quality by restoring legacy unlicensed mines within the concession as per IFC requirements.

Lelydorp I ESIA.

Project manager for a re-mining project targeting legacy mine pits surrounding the Paranam refinery in Suriname. Project objective was to further excavate mine pits that were abandoned in the 1980s due to technological limitations at the time related to water management capacity. Critical issues included maintenance of pit slope stability, public safety, dust management, and water quality management. Encorachment by host communities into the legacy mine area since the 1980s made socioeconomic and cultural issues much more prevalent than when the pits were first excavated, and a robust stakeholder engagement process was required.

Environmental Impact Assessments, Liza Phase 1 and Phase 2, Payara, and Yellowtail Offshore Developments, ExxonMobil.

Managed Environmental Impact Assessments of all four offshore oilfield development in the Stabroek Block, a deepwater petroleum license area offshore of Guyana, by EEEPGL to date. Key environmental issues have included potential for oil spills to impact Shell Beach (an internationally recognized nesting habitat for several species of endangered sea turtles), greenhouse gas emissions, marine water quality, and cumulative socioeconomic issues related to the oil and gas industry. Due to the location of the project in relation to environmentally sensitive areas to the north and west, ERM mapped coastal sensitivities in Venezuela, Trinidad & Tobago, and the southern Lesser Antilles. ERM also delivered the associated management plans and various environmental approvals for the proposed activities. Assisted ExxonMobil staff with an audit of potential service providers in Guyana and Trinidad as part of the tender evaluation process for waste management services.

Strategic Environmental Assessment, Exploration Activities, ExxonMobil.

Project manager for a Strategic Environmental Assessment of exploration activities in the Stabroek Block, a deepwater exploration block offshore of Guyana. Was also responsible for delivering the associated management plans and various environmental approvals for the

proposed activities including exploratory drilling, seismic surveys, geotechnical and geophysical investigations, and metocean surveys. Assisted ExxonMobil staff with an audit of potential service providers in Guyana and Trinidad as part of the tender evaluation process for waste management services. Worked closely with the local Exxon affiliate in Guyana to help navigate a poorly defined regulatory structure in Guyana and deliver the necessary approvals on an accelerated schedule.

Millenium Challenge Corporation.

Developed a Watershed Management Legacy document that consolidated information and lessons learned over MCC's five-year development compact with the government of Liberia. The document evaluated the potential issues related to unregulated or under-regulated mining activity on watershed health in the St. Paul River. Issues identified included lack of buffer zones, uncontrolled releases of contaminants, conflicts between entrenched mining interests and the nascent hydropower industry in the county, and lack of technical capacity within the Government of Liberia's regulatory agencies. The study also cited negative effects on government funding for social and environmental programs related to rampant smuggling of gold out of the country to avoid payment of royalties to the government.

Environmental Impact Assessment, GuyanaSPAN Seismic Survey, GX Technology.

Regulatory advisory and senior marine ecology lead on an addendum to a prior EIA prepared for a proposed seismic survey covering most of the Suriname EEZ. The survey acquisition area covered 1.5 million km2 within portions of six blocks adjacent to the boundary of the Suriname/Guyana EEZs. GX Technology had previously completed a similar survey in 2013 in an adjacent area offshore Suriname, and ERM negotiated an agreement with NIMOS that allowed GX Technology to submit an abbreviated assessment and submit an addendum to the original EIA to permit the additional offshore work.

Environmental and Social Impact Assessment, Wageningen Sugarcane-to-Ethanol Project, Staatsolie.

Managed the aquatic biodiversity component of the ESIA for Staatsolie's sugarcane-based bioethanol project in Wageningen in the Nickerie District, Suriname. The Wageningen project would require clearing large amounts of coastal swamp forest and would have the potential to affect the salinity of the lower Nickerie River, although the ESIA concluded that with proactive management of discharges from the Project as well as withdrawals from the Nickerie River to supply irrigation water, the project was feasible.

Environmental and Social Impact Assessment, Nassau Bauxite Mine, Suralco.

Lead aquatic ecologist on a feasibility assessment for a bauxite mine at a greenfield site in central Suriname. Supervised a multi-year aquatic survey and biomonitoring program of high altitude streams on the Nassau plateau, a remote cloud forest plateau in the undeveloped interior. Responsible for training Surinamese HSE staff in low-impact ecological sampling and monitoring protocols. Replaced rotenone-based collection protocols with a combination of modern low-impact and traditional methods. Trained local field teams, which include scientists and native assistants in new survey protocols. ERM's survey methodologies were highly effective; work in 2009 documented seven rare species of loricariid catfish on the plateau, including one species that is new to science.

Environmental, Social, and Health Impact Assessment, Kabata Refinery, Guinea.

Aquatic biodiversity lead for the ESIA for Alcoa and RioTinto's proposed Kabata refinery and related port, railway, and related infrastructure located in Boka Prefecture Guinea. Collaborated with an expert local biodiversity field team to execute a rapid assessment of aquatic biodiversity at the site and surrounding region, including an assessment of the IUCN-listed critically endangered marsh crab Afrithelphusa monodosa. The project would have unavoidable direct and indirect impacts on the habitats for this species as well as sensitive coastal mangroves, local fishing grounds, and nursery habitat for commercially valuable marine species. Led the project team in application of the mitigation hierarchy and assessment of design and layout alternatives to reduce impacts on biodiversity and ecosystem services.

Jess Mc Iver,

Managing Technical Consultant, Cultural Heritage

Jess is a Managing Technical Consultant for cultural heritage with 12+ years' experience delivering on requirements for green and renewable energy, mining, transport, linear infrastructure and rail within Europe, Middle East and Africa. Jess can provide a wide range of skills and service offerings for cultural heritage including environmental and social due diligence for international lender standards, screening, scoping through to full ESIA and post ESIA commitments in the form of Cultural Heritage Management Plans during construction and operation stage.

Bespoke offerings include cultural heritage training to international lender standards and auditing of management processes, remote sensing and developing fit for purpose cultural heritage guidance for project specific needs.

EXPERIENCE: 13 years

EMAIL: jessica.mciver@erm.com
LINKEDIN: https://www.linkedin.com/in/jessmciver/

EDUCATION

- Post Grad Hon's Archaeology, University of Cape Town 2012.
- BA, Environmental and Geographic Science, Social Anthropology, Archaeology. 2011.

PROFESSIONAL AFFILIATIONS

- Association for South African Professional Archaeologists (ASAPA)
- ACIfA (Chartered institute for Archaeologists

FIELDS OF COMPETENCE

- Cultural Heritage
- Archaeology
- Due Diligence IFC PS8
- Intangible cultural Heritage

KEY INDUSTRY SECTORS

- Mining
- Renewable Energy
- Sustainable Infrastructure

HONORS AND AWARDS

- ERM Service Excellence Award

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KEY PROJECTS

Baringo geothermal ESIA, Kenya August 2024- present
Cultural heritage lead for PESIA, Outline of Indigenous Peoples Plan and ESMP.

Green Ammonia ESIA, Kenya Oct 2023- present
Cultural heritage lead for international ESIA

Green Hydrogen ESIA, Morocco, May 2022- present
Cultural heritage lead for screening and scoping study

Baynes Hydroelectric ESIA, Namibia Mar 2023
Cultural heritage support for a hydroelectric plant

Ammonia Port ESIA, Nigeria Oct 2023
Cultural heritage lead for international ESIA

Ammonia Plant Expansion, Nigeria December 2022
Cultural heritage lead for international ESIA

Project Gaia Feasibility study, South Africa Oct 2022- present
Cultural heritage lead in advisory role on renewable developments in existing mining locations.

High speed rail ESIA, Egypt, October 2022- present
Cultural heritage lead for international ESIA

Arad Wind Farm Romania 2023
Cultural Heritage chapter in an Environmental Impact Assessment for a windfarm in Romania to international lender standards

Adamdel and VisVisa Wind Farm, Serbia 2023
Cultural Heritage chapter in an Environmental Impact Assessment for a windfarm in Romania to international lender standard

Mahenge Transmission Line Tanzania (Dec 2022 to March 2023)
Cultural Heritage ESIA review and CHMP development for a transmission line and mine in Tanzania to international lender standards

Cabinda Airport Expansion, Angola, Oct 2023- March 2024
Cultural Heritage ESDD screening and report for an airport development in Angola
QGMI Ghana road upgrade January- December 2022
Scoping, baseline and ESIA phase, and development of a Cultural Heritage Management Plan for a road scheme in Ghana to international lender standards

Baltyk III and Baltyk III ESDD, Poland, January 2024
Cultural Heritage ESDD screening and report for an offshore windfarm in Poland

Baltic Eagle ESDD, Germany, September 2023
Cultural Heritage ESDD screening and report for an offshore windfarm in Germany

Anchoise Gas ESDD Morocco March 2023
Cultural Heritage ESDD screening and report for a gas development in Morocco

Rio Tinto Global Cultural Heritage audit April 2022- November 2022
Conducted an audit on the management of cultural heritage for Rio Tinto's EMEA assets in line with their in-company standards, national legislation and international lender standards

TTE Oman ESIA June 2024
Two windfarm ESIAs in Oman, cultural heritage chapters for baseline and impact assessment

Iraq Degassing expansion plant, January 2024
Baseline and Impact Assessment for cultural heritage

Anchoise Gas ESDD Morocco March 2023
Cultural Heritage ESDD screening and report for a gas development in Morocco

Oman ESDD Rakiza Kilo, March 2023
Cultural Heritage ESDD screening and report for a development in Oman

GSEZ Liberville Airport, Gabon March 2021
Cultural Heritage input into the Scoping Report for the environmental and Social Impact Assessment of the proposed rehabilitation of the Liberville International Airport Access and Junction road, Gabon

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Julia L. Tims, M.Sc.

Technical Director Biodiversity and Ecosystem Services

Julia provides project management and technical leadership for domestic (US) and international Environmental and Social Impact Assessment (ESIA) projects within a broad range of sectors including renewable energy, agricultural, mining, oil and gas, and transportation. She specializes in managing complex projects and coordinating diverse specialist teams in conducting baseline and impact studies, leading stakeholder and agency consultations, and developing mitigation and management plans. Julia has particular expertise in projects that combine technical biodiversity issues with project design, land management, conservation planning for sensitive species and habitat, and stakeholder engagement related to biodiversity and the interactions between biological and social issues.

EXPERIENCE: 25 years' experience in terrestrial ecology, natural resource management, project permitting, and environmental and social impact assessment.

EMAIL: Julia.Tims@erm.com

EDUCATION

- M.Sc., Natural Resources Management/Ecology, Cornell University, 1999, With Distinction
- B.Sc., Entomology and Applied Ecology/Wildlife Conservation, University of Delaware, 1990

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- International Environmental and Social Impact Assessment
- International standards, including Equator Principles, IFC Performance Standards
- Domestic (US National Environmental Policy Act) Environmental Assessments and Environmental Impact Statements
- Environmental and Social Management and Monitoring Plans (ESMMP)

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- Environmental and social due diligence
- Application of mitigation hierarchy
- Biodiversity offsets
- Ecosystem services assessment
- Project permitting and documentation
- Endangered species conservation and management
- Biodiversity Action Plans
- Critical Habitat Assessment
- High Conservation Value (HCV) Assessment
- Stakeholder engagement related to biodiversity and biological/social interactions
- Interaction with environmental NGOs
- Alternatives analysis
- Cumulative impact assessment

KEY INDUSTRY SECTORS

- Energy
- Oil and Gas
- Mining
- Agriculture
- Transportation

PUBLICATIONS

- Tims, J.L., I.C.T Nisbet, J. Hatch, and C. Mostello. 2004. Characteristics and performance of
- Common Terns in Old and Newly-established colonies: implications for long term conservation. Waterbirds. 27(2):134-143.
- Tims, J.L. and K.M. Brown. 2001. Food Items Obtained by Gulls at and Around JFK International Airport: Relevance to Airport Management. Waterbirds. 24(1): 44-52.
- Tims. J.L. and K.M. Brown. 2001. Changes in the Nesting Populations of Colonial Waterbirds in Jamaica Bay Wildlife Refuge, New York, 1974-1998. Northeastern Naturalist. 45:17-28.
- If this list is extensive, relocate this entire sub-section to the end (after Key Projects)

KEY PROJECTS

Environmental and Social Impact Assessment, Nicaragua

Led the biodiversity component of the Environmental and Social Impact Assessment (ESIA) and preliminary offset strategy for the world's largest infrastructure project. The project consists of the canal and related infrastructure including two ports, a transmission line, roads, and reservoirs.

Developed specialist team of over 100 Nicaraguan and international experts to conduct marine, terrestrial, and freshwater biodiversity studies across the country and led wet and dry season field surveys. Led the data analysis and terrestrial biodiversity impact assessment, prepared

detailed biodiversity and protected areas management plans and offsetting proposals, and developed the environmental and biodiversity components of the Environmental and Social Management System (ESMS). Key issues included loss of primary rainforest, impacts to sea turtles, impacts to over 80 rare species, habitat fragmentation, impacts to protected areas and the Mesoamerican Biological Corridor, and impacts to critical habitat. All work on the project was conducted in alignment with IFC Performance Standards. The ESIA was approved by the Government of Nicaragua and was subject to intense national and international scrutiny due to the high profile nature of the project.

Environmental and Social Impact Assessment, Offshore Oil Exploration Project, Guyana

Led the biodiversity components of two EIAs for offshore oil exploration projects in Guyana. Conducted baseline assessment focusing on seabirds and coastal birds and assessed the potential impacts of the proposed projects, including unplanned events such as oil spills, on bird populations in the Caribbean region, including rare species.

Environmental and Social Impact Assessment, Indonesia

Lead biodiversity specialist for biodiversity baseline preparation and impact assessment for a nickel and cobalt mine and hydrometallurgical processing plant in Central Halmahera and East Halmahera Regencies, North Maluku Province, Indonesia. The island contains numerous endemic and red list flora and fauna and lies within the Northern Maluku Endemic Bird Area, which has the highest levels of bird endemism for its size anywhere in the world. Because of this high level of bird endemism, Halmehara and its neighboring isands rank number ten out of a total of 218 designated biological diversity hotspots in the world. Extensive baseline biodiversity studies were conducted over a ten year period and results were collated into a biodiversity baseline report. Julia conducted an ecosystem services review, IFC PS6 critical habitat assessment, and impact assessment and developed a robust Biodiversity Action Plan (BAP) and Biodiversity Management Strategy that focused on minimizing unavoidable impacts to critical habitats, endemic birds and other rare species, and important ecosystem services. Evaluated the feasibility of biodiversity offset options in accordance with Buisiness and Biodiversity Offet Program (BBOP) Principals.

Environmental and Social Due Diligence, Belize

Currently leading the biodiversity and water aspects of an Environmental and Social Due Diligence (ESDD) of a sugarcane cultivation and processing mill for CIFI. The project is located in Belmopan District, Belize where rapid agricultural expansion is occurring. The greenfield site contained primary and secondary forest prior to clearing for project development and lies adjacent to a national protected area that was designated for the protection of jaguar and several sensitive water and wetland resources. Key issues facing the project include habitat loss, impacts to rare species, water quality, impacts of water abstraction on salinity and downstream water availability, maintenance of ecosystem services, cultural resources, resettlement, occupational health and safety, and induced and cumulative impacts from other sugarcane growers in the region that are growing sugarcane to supply the mill.

Environmental and Social Impact Assessment, Ghana

Led the biodiversity and ecosystem services portions of the ESIA for in western Ghana. The project was highly controversial amongst Ghanaians and national and international NGOs for

biodiversity and social reasons: the project area was located within a portion of Bui National Park, which has high biodiversity value. The area also contains roughly 2,000 villagers that would require resettlement if the project were to proceed. The ESIA was conducted in accordance with World Bank/IFC policies and guidelines. ERM conducted extensive stakeholder consultation throughout the ESIA process, a major focus of which was the effect of the project on the National Park and management options to balance project and park needs.

Environmental, Social, and Health Impact Assessment, Guinea

Project manager and biodiversity and ecosystem services lead for the ESIA for refinery and related port, railway, and related infrastructure located in Boka Prefecture Guinea. Collaborated with an expert local biodiversity field team to execute a rapid assessment, conducted in three seasonal survey missions, of terrestrial and aquatic biodiversity at the site and surrounding region. Two key species of concern identified were the IUCN-listed critically endangered marsh crab Afrithelphusa monodosa and the West African chimpanzee Pan troglodytes verus. The project would have unavoidable direct and indirect impacts on the habitats for these species as well as sensitive coastal mangroves, local fishing grounds, and nursery habitat for commercially valuable marine species. Led the project team in application of the mitigation hierarchy and assessment of design and layout alternatives to reduce impacts on biodiversity and ecosystem services.

Coordinated with the government of Guinea and local and international NGOs and other stakeholders regarding potential biodiversity offsets focused on chimpanzees. Supported Alcoa and Rio Tinto in consultations with Wildlife Chimpanzee Foundation regarding offsetting options and feasibility of offset implementation.

Environmental and Social Impact Assessment, Cameroon

Provided technical oversight on the biodiversity and ecosystem services aspects of an ESIA for a proposed 116 km, 225kV transmission line between Bekoko and Nkongsamba in western Cameroon. The proposed transmission line follows an existing line for much of its route; however, part of the line required clearing of relatively undisturbed rainforest habitat that is adjacent to the Mouyouka – Kombé Kompina Forest Reserve. Ecological issues addressed included habitat loss and fragmentation, endemic plant and wildlife species, loss of biodiversity, anthropogenic effects on wildlife populations, and erosion and associated increases in sediment loads to rivers and streams. The project involved extensive stakeholder consultation, including assessment of natural resource livelihoods and the interactions of social and ecological issues regarding the project.

Environmental and Social Impact Assessment, Angola

Led the biodiversity and ecosystem services portions of an located on the lower stretches of Kunene River, at the Angola-Namibia border. The project is located in a desert and mountainous region with high biodiversity and high species endemism. Provided technical oversight of five specialist studies (vegetation, avifauna, mammals, insects, and herptiles) that were conducted by local and international experts. Incorporated specialist input into the ESIA for the project and developed management recommendations in partnership with the specialists and the project proponent in order to minimize adverse biodiversity impacts and to maximize potential benefits of the project (e.g., access to stable water source, etc.).

Environmental and Social Impact Assessment, Suriname

Led the biodiversity aspects of the ESIA related to a proposed expansion of Alcoa's aluminium refinery in northeastern Suriname. Led an international team of biodiversity experts to conduct a rapid assessment biodiversity survey of the undeveloped area surrounding the refinery. The survey assessed the biological condition and value of the site based on: 1) habitat heterogeneity; 2) a preliminary survey of the organisms that characterize each of the habitats; and 3) the intactness of the habitats, and their capacity to support important biological resources and ecological processes. The results of the survey were used to evaluate the impact of the proposed refinery expansion on the local ecology and to recommend ways to minimize adverse effects on sensitive habitats and species.

Geothermal Project, St. Vincent and the Grenadines

Led the biodiversity and stakeholder engagement components of the ESIA for a geothermal energy project on the island of St. Vincent. Cooperated with local experts to conduct terrestrial and aquatic biodiversity baseline studies and water resource assessments. Led the stakeholder engagement aspects of the ESIA, including government communication and coordination and execution of the public meetings and focus group discussions in relation to the ESIA. The ESIA was conducted on budget, under an expedited 4-month timeframe, and was unanimously approved by the Government of St. Vincent and the Grenadines.

Environmental and Social Impact Assessment, Trinidad and Tobago

Led the environmental portion of the ESIA for a proposed aluminum smelter in southwestern Trinidad. The key environmental issues with the project included potential impacts to groundwater, habitat fragmentation, and changes in land use from agricultural to industrial. The project involved significant stakeholder consultation, including consultation with Trinidad's Environmental Management Authority regarding the scope of the ESIA and related public consultations. The project was highly controversial and put on hold before the publication of the ESIA. Based on the history of the project, ERM developed a lessons learned document that outlined recommendations for strategic approaches to the project if it is reactivated.

Environmental and Social Impact Assessment, Suriname

Project manager and lead biodiversity specialist for the ESIA for proposed sugarcane to ethanol project located in Wageningen, northwestern Suriname. The 15,000 hectare site is bordered to the north, east, and south by nature reserves and undeveloped land, and to the west by rice fields.

The project contains agricultural (sugarcane plantation) and industrial (ethanol and sugar processing and production facility) components. A combined raw sugar/ethanol plant and power exportation plant is planned to allow for flexibility to vary ethanol versus sugar production depending on market demands and to export power to the national grid. ERM developed the ESIA to conform with Suriname National Institute for Environmental and Development Standards (NIMOS) standards. Key issues addressed in the ESIA included impacts to biodiversity, forest loss, water quality, water use/demands from the project and other users, impacts to nationally registered historic sites, impacts to protected areas, maintenance of ecosystem services, land use management and ownership, and greenhouse gas (GHG) production. ERM developed a GHG emissions inventory and assessed GHG impacts based on minimum GHG savings in terms of the project's GHG intensity against a fossil fuel comparator using the methodology and rules defined in the European Union Renewable Energy

Directive (EU RED). ERM was able to predict GHG savings of 60 to 85 percent depending on the amount of electricity sold to the national grid.

Environmental and Social Impact Assessment, West Greenland

Project manager and biodiversity lead for the ESIA for Aluminium and Hydroelectric Project, which consisted of an aluminium smelter, marine port, two hydroelectric projects, and electric transmission lines. This project constituted the largest industrial development in Greenlandic history. Issues identified during ESIA scoping included smelter air and water emissions and waste management; effects of the hydroelectric development on caribou migration, birds and internationally recognized Important Bird Areas, Arctic char, and cultural resources; and social and health effects related to immigration of foreign workers, housing, infrastructure, and social and health services. Collaborated with local and international experts to conduct baseline environmental, human health, and social studies. The impact assessment is currently on hold pending government negotiations relative to project development.

Biodiversity Baseline Studies and Impact Assessment, Argentina and Chile

Led the analysis and reporting for a Rapid Biodiversity Assessment and Ecosystem Services Review to fill baseline data gaps for a gold mine and related infrastructure located on the border of Chile and Argentina. The project has been under construction for over a decade and is now operational. Used the Valued Environmental Components (VEC) approach to assess the project's historic construction-related impacts and predicted future operational impacts on biodiversity.

VEC's included rare flora, several rare terrestrial fauna species, migratory ungulates, vegas (i.e., wetlands), aquatic and riparian habitats, species known to provide important ecosystem services to local communities, and an internationally recognized Biosphere Reserve that is located just outside the Project's area of influence. Julia used the information generated during the baseline and impact assessment to update the project's Biodiversity Management Plan to define measures that will minimize and manage ongoing impacts to VECs during project operation and closure. Also prepared a Critical Habitat Assessment relative to IFC Performance Standard 6 and advised client on PS6 conformance.

Cumulative Impact, Peru

As part of the ESIA for the Gas Project in Peru, Julia conducted a comprehensive cumulative impacts assessment on biological resources that could result from the planned oil and gas developments and expansion of the Gas Separation Plant, combined with other past and reasonably foreseeable future activities within the lower Urubamba watershed. The assessment identified the probability and magnitude of cumulative effects on biodiversity, habitat quality, rare species, ecosystem services, and indigenous communities that rely on biological resources for sustenance fishing and hunting.

Business and Biodiversity Offsets Program (BBOP)

Providing biodiversity expertise in an advisory group that is developing a standardized approach for identifying, developing, and implementing biodiversity offsets for projects with unavoidable adverse impacts on biodiversity. Advisory group members include corporate representatives, academic scientists, representatives of environmental NGOs, US state and federal regulators, and international government representatives. The group is currently developing a protocol and a set of tools for determining when an offset is appropriate and

defining the scope and nature of appropriate offsets. Efforts are also focused on implementation and long term management and protection strategies for biodiversity offsets and the possibility of aggregating offsets into national or global protected areas management system aimed at specific conservation priorities.

Environmental Impact Statement for an HCP and ITP for a Wind Power Project, OH

Project Manager and avian/threatened and endangered species lead on an EIS for the United States Fish and Wildlife Service (USFWS) to assess the potential effects of the proposed 250 MW Wind Power Project in west-central Ohio. The Project required an Incidental Take Permit (ITP) pursuant to the Endangered Species Act (ESA) to authorize the incidental take of Indiana bats, listed as federally endangered under the ESA, that would likely occur as a result of the Project.

The EIS assessed the effects of issuance of the ITP on Indiana bats and other resources as required by the National Environmental Policy Act (NEPA) including migratory birds and compliance with the Migratory Bird Treaty Act and other applicable federal regulations and Executive Orders. The EIS included a robust cumulative impact assessment of numerous wind projects proposed for the region and their cumulative impact on Indiana bats and migratory birds. This high-profile and precedent-setting project was the first ITP issued for Indiana bat related to a wind project in the US. ERM assisted the USFWS in preparing a robust EIS that withstood extensive public, NGO, and legal scrutiny on an expedited schedule. The final EIS was published in April 2013, and the USFWS approved the HCP in July 2013. The EIS was challenged in US Federal court and ultimately upheld, with the ITP issued in 2015.

Supplemental Environmental Impact Statement for an HCP and ITP for a Wind Power Project, OH

Project Manager and avian/threatened and endangered species lead on a supplemental EIS (SEIS) for the USFWS to assess the potential effects of the proposed 250 MW Wind Power Project in west-central Ohio. This high-profile and precedent-setting project was the first ITP issued for Indiana bat related to a wind project in the US. ERM assisted the USFWS in preparing a robust EIS that withstood extensive public, NGO, and legal scrutiny on an expedited schedule. The final EIS was published in April 2013, and the USFWS approved the HCP in July 2013 and issued the ITP in 2015. The EIS was successfully challenged in US Federal court in 2017 on the basis of too few alternatives evaluated so ERM is now preparing an SEIS to address three additional operational alternatives.

Environmental Impact Statement for a Hydroelectric Project Relicensing, Portland, OR

Project manager for the EIS and technical leader for terrestrial ecological issues for relicensing the hydroelectric project. Managed the NEPA process for the project, including preparation of the Draft and Final EIS as third-party contractor to the Federal Energy Regulatory Commission and facilitated interactions with PGE and the FERC regarding relicensing issues. Led the interaction among cooperating agencies in the NEPA process including US Forest Service and BLM. Provided technical expertise within working groups and facilitated coordination among natural resource trustees on ecological issues. Key issues included the effects of the project on wildlife and habitat, threatened and endangered plant and animal species, habitat loss, habitat connectivity/ fragmentation and wildlife movement, and establishment and spread of exotic

species. Collaborated on preparation of a Vegetation Management Plan, Invasive and Exotic Species Management Plan, and Threatened and Endangered Species Management Plan.

Environmental Impact Statement Power Project. Massena, NY

Technical leader for terrestrial vegetation and wildlife sections of the EIS related to the proposed relicensing of the hydroelectric power project. The EIS was prepared to meet federal NEPA and New York SEQRA standards and requirements. During the five year relicensing process, Julia provided technical expertise within working groups and facilitated coordination among natural resource trustees on ecological issues. Key issues includes the effects of the project on wildlife and habitat, threatened and endangered plant and animal species, habitat loss, habitat connectivity/ fragmentation and wildlife movement, and establishment and spread of exotic species. Facilitated interactions with NYPA, NYSDEC, and USACE.

Wind Power Project, PA

Project manager for a proposed 100 megawatt (MW) wind energy facility, located north of Scranton, PA. Currently supporting the project's feasibility assessment/due diligence review, early stakeholder outreach, and leading biological, environmental, and cultural resources pre-construction surveys for the project.

Wind Power Project, WV

Project manager for a proposed 150 megawatt (MW) wind energy facility located approximately 30 miles north of Elkins and in the immediate vicinity of the town of Bayard, West Virginia. The project site encompasses almost 24,000 acres of previously or currently mined land and the current land use on the site is a mix of forest, agriculture, and actively disturbed and regenerating lands. The project was subject to NEPA because the Navy will be purchasing the power generated by the project. Managed all pre-construction biological, environmental, and cultural resources surveys and supported state and federal agency consultation and public outreach for the project.

Solar Siting Support, VA

Leading environmental due diligence assessments and surveys for potential solar project developments throughout Virginia. Currently developing permitting matrices and streamlining the developer's due diligence processes to meet corporate and local requirements. Due diligence focuses on identifying regulatory constraints and potential issues of concern for sites including wetlands, floodplains, endangered species, cultural resources, site access, proximity to grid, among others. Developing a standardized assessment and ranking system to assist in identifying no-go projects and ranking the potential projects according to level of regulatory constraints and environmental issues.

Environmental Assessment, NM

Lead biodiversity and endangered species specialist for an EA that evaluated the effects of creating low-level military aircraft training exercises in New Mexico for the Air National Guard with the Federal Aviation Administration as a cooperating agency. Assessed the effects of low-level flight missions on the endangered Mexican spotted owl and on recreational use in two National Forests and successfully led the consultation with USFWS regarding impacts to Mexican spotted owl and other federally listed species.

Environment Impact Statement, ME

Responsible for preparing the biological portions of an EIS evaluating the effects of modifying the Condor 1 and 2 MOAs for the ANG 102nd Fighter Wing based at Otis AFB with the FAA as a cooperating agency. The proposed action involved lowering the floor to 500 feet AGL to improve air-to-ground training. The biological work focused on determining the impacts to migratory birds and bald eagles and involved extensive federal and state agency consultation.

Environmental Assessment, AZ

Lead biodiversity and endangered species specialist for an EA evaluating the environmental effects of the proposed beddown of eighteen F-16 aircraft at 162 FW base at Tucson International Airport (TIA) for Air National Guard. Key issues involved noise impacts at TIA and effects of increased noise and use of inert and live munitions during training operations on the federally endangered Sonoran Pronghorn antelope at Barry M. Goldwater Range, an active military flight training range. Work included preparation of a Biological Assessment and Section 7 consultation with USFWS, both of which were concluded successfully and on schedule.

Environmental Impact Statement for Hydroelectric Project Relicensing, Portland, OR

Project manager for the EIS and technical leader for terrestrial ecological issues for relicensing the hydroelectric project. Managed the NEPA process and the biological aspects of the project, including preparation of the Draft and Final EIS as third-party contractor to the Federal Energy Regulatory Commission and facilitated interactions with PGE and the FERC regarding relicensing issues. Led the interaction among cooperating agencies in the NEPA process including US Forest Service and BLM. Provided technical expertise within working groups and facilitated coordination among natural resource trustees on ecological issues. Key issues included the effects of the project on wildlife and habitat, threatened and endangered plant and animal species, habitat loss, habitat connectivity/ fragmentation and wildlife movement, and establishment and spread of exotic species. Collaborated on preparation of a Vegetation Management Plan, Invasive and Exotic Species Management Plan, and Threatened and Endangered Species Management Plan.

Runway Safety Area Improvements and Terminal Construction/Expansion, Niagara

Falls, NY Project manager and technical lead for wetlands and endangered species components of two Environmental Assessments (EAs) for Runway Safety Area Improvements and a Terminal Expansion. The EAs were prepared for the Niagara Frontier Transportation Authority (NFTA) to meet both federal NEPA and New York SEQRA standards for impact assessments. Facilitated consultation with state and federal agencies regarding potential archaeologically and biologically significant areas within and adjacent to the site. Conducted wetland delineation and stream habitat assessment of Cayuga Creek, which runs through the airport property and will be impacted by the proposed runway extension. Evaluated several alternatives to minimize the effects of the runway expansion on wetlands and aquatic habitats. Coordinated with NYSDEC and USACE Buffalo District to address issues related to stream relocation and mitigation design.

Crown Landing Liquefied Natural Gas Environmental Studies and Permitting. Logan Township, NJ.

Technical lead for endangered species and terrestrial ecological issues associated with a proposed liquefied natural gas (LNG) import terminal located on the Delaware River in New Jersey.

Conducted terrestrial investigations at the site including wetland delineation, vegetation community characterization, wildlife habitat assessment, and threatened and endangered species investigations. Prepared Federal Energy Regulatory Commission (FERC) resource reports and worked closely with client to address ecological issues associated with the project and provided guidance for potential avoidance and mitigation measures to offset potential impacts of the project. Primary ecological issues with the project included impacts to wetlands, bald eagles, and other listed species. Addressed ecological issues with the regulatory agencies and prepared state and federal permit applications for the project.

Natural Gas Pipeline Third Party EA, ME

Technical lead for biological issues related a pipeline expansion (looping) project, including construction of five new compressor stations in Maine and Massachusetts. Natural resource issues included wetlands, wildlife, vegetation, and threatened and endangered species. Conducted project scoping and interagency consultation as part of FERC's pre-filing process. Conducted Section 7 Endangered Species Act consultations for bald eagle, Atlantic salmon, and shortnose sturgeon and resolved agency issues, which eliminated the need for formal consultation and a Biological Assessment.

Biological Assessment, Texas LNG, Brownsville, TX

Prepared the Biological Assessment pursuant to the Endangered Species Act for the Federal Energy Regulatory Commission to assess the potential impacts of the proposed Texas LNG project on 16 federally listed species. The assessment covered marine and terrestrial species, with particular emphasis on wintering shorebirds that concentrate in coastal Texas during winter, northern Aplomado falcon, ocelot, and gulf coast jaguarundi. The project was precedent setting in that is was one of the first in Texas to consider compensatory mitigation (i.e., offset or conservation bank) for wetlands and listed species (red knot, piping plover, ocelot, and jaguarondi) in one integrated offset/conservation bank.

Karishma Misir

Senior Environmental Consultant

Passionate & driven environmental professional and researcher with experience managing and working with natural resources projects in Guyana and other countries in the Caribbean region, including Trinidad and Tobago and Belize. In addition, possesses experience in working with various international development organizations and regulatory agencies in Guyana such as the Environmental Protection Agency (EPA) and the Guyana Forestry Commission (GFC). Areas of focus include support drafting of ESIAs/ EMPs, project coordination, field Surveys in hinterland regions, conducting environmental compliance/audits, community development and stakeholder engagement.

EXPERIENCE: 12 years' experience in Environmental services

LINKEDIN: https://www.linkedin.com/in/karishma-misir-2b484722a/

EMAIL: karishma.misir@erm.com

EDUCATION

- BSc. Geography / Economics, University of Guyana, Guyana, 2014
- Queens College, 12 CSEC, Guyana, 2009

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Guyana Toastmasters Club

LANGUAGES

- English, native speaker | fluent

FIELDS OF COMPETENCE

- Support drafting of ESIA/ESMPs
- Socio- Economic Surveys
- Environmental Compliance Audits
- Drafting of proposals, concept notes and terms and scope (T&S) for projects

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- Climate Change, Sustainability and Environmental Research
- Stakeholder and Community Engagement
- Logistics, Planning and Coordination for Site Surveys and Field Visits, Scoping and Disclosure Meetings for ESIA projects
- Collecting physical and biological samples from environment – Groundwater, Surface Water, Soil, eDNA samples etc.
- Conducting and Reporting on Phase 1 Environmental Assessment (ASTM Standard).

KEY INDUSTRY SECTORS

- Oil & Gas
- Forestry
- Environmental Regulation
- Mining

KEY PROJECTS

KEY PROJECTS PRIOR TO JOINING ERM:

Guyana REDD+ Project - Guyana Forestry Commission (GFC)

During my tenure as Project office I focused on; planning and conducting stakeholder consultation sessions with Forest dependent communities and a broader spectrum of stakeholders, collating and compiling stakeholder reports, providing guidance on the development of materials for capacity building, maintaining the Information System from field data and laboratory test results which forms the basis of Guyana's Forest Carbon Monitoring System (FCMS), collection of field data from forest survey plots to assess carbon emissions.

Forestry and Mining Projects – Guyana Environmental Protection Agency (EPA)

As an Environmental officer I was involved in drafting environmental authorizations/permits for large-scale forestry and mining projects, conducting site field visits and environmental compliance audits, reviewing of Terms of Reference for EIAs, EMPs, reviewing of EIAs, EMPs, and ESIAs for large-scale logging and mining operations, environmental Research for formulating of Environmental and Operating permit conditions.

Belize REDD+ Readiness Project - World Bank Forest Carbon Partnership Facility (FCPF)

The objective of the REDD+ Readiness Preparation Project was to assist Belize in carrying out Readiness Preparation through a participatory and inclusive process in order to strengthen their capacity to participate in future REDD+ carbon payment transactions. Provided support in my capacity as consultant to the development proposals and project concept notes as is required by donors, consolidate and prepare work plans, prepare annual progress reports for World Bank, liaison with Government Agencies, NGOs and other relevant stakeholders, formulate Project Summary Information Reports, coordinate Field teams, prepare Presentations on project progress and updates, monitoring and evaluation of key indicators and subcontractors.

KEY PROJECTS AT ERM

Yellowtail Environmental Impact Assessment (ExxonMobil Guyana Limited)

- Coordination the assembly and distribution of the EIAs to the EPA and the Regions.

Gas to Energy Environmental Impact Assessment (ExxonMobil Guyana Limited) and Post Permit Monitoring/ ESSMP

- Coordination the assembly and distribution of the EIAs to the EPA and the regions.
- Conduct socio economic surveys in communities along the pipeline route
- Logistics and coordination for public scoping meetings, stakeholder engagements, and technical meetings with EPA.
- Logistical support for teams conducting various physical and biodiversity surveys along Gas to Energy pipeline route
- Conduct vegetation surveys for post permit monitoring.
- Support Mobilization of teams for the ESMMP
- Coordinate teams to conduct social, cultural, vegetation and biodiversity surveys along the transmission corridor to support supplemental assessment conducted by GoG to support funding by EXIM bank.

Social Impact Assessment – Shell (Manatee) Trinidad and Tobago

- Compile and disseminate project progress via meeting minutes.
- Conduct research for drafting of the social baseline report.
- Summarize and consolidate stakeholder concerns and feedback from stakeholder engagement sessions.

Guyana Grove to Timehri Public Infrastructure Project (IDB)

- Conduct reconnaissance visits along project pathway
- Conduct stakeholder interviews in communities
- Coordinate and present the ESMS and EMPs for stakeholder consultation sessions
- Prepare reports for summary of stakeholder feedback from consultation sessions

Environmental Baseline Studies and ESIA (Reunion Gold / G-Mining)

- Coordination and logistics for Local & International teams during the wet and dry season surveys in Oko – Region 7 (Cuyuni Mazaruni).
- Collection of surface water, groundwater, and soil samples and sampling of Aquatic Biodiversity
- Assist in preparation of sections of the baseline report
- Planning and coordination for public scoping meetings across various regions in Guyana.
- Support drafting terms and scope for the Environmental and Social Impact Assessment.
- Support otter reporting.

Environmental Phase 1 Assessment (ExxonMobil Guyana Limited)

- Coordination and logistics for site visit
- Conduct Phase 1 assessment in region 6 Guyana

- Drafting of environmental phase 1 report
- Collate and present summary of main findings and recommendations to the client

Whiptail Environmental Impact Assessment (ExxonMobil Guyana Limited)

- Coordination, planning and logistics for scoping & disclosure Meetings across regions in Guyana.
- Support drafting of physical baseline chapters
- Present a portion of the physical baseline studies during the disclosure meetings
- Compiling of comments, feedback and concerns from the disclosure meetings

Environmental and Social Management System (ESMS) – Muneshwers Guyana Limited.

- Conduct site visit on project site to assess gaps in Environmental and social systems in accordance with IDB guidelines
- Preparation of Transportation Management Plan and Labour Conditions Policy documents.

ESIA Addendum Nevis (IDB/CDB and NEVLEC)

Support drafting of Addendum for plugging and abandonment of geothermal wells in Nevis

Desktop ESIA for 3-D Seismic Drilling Offshore (CCG)

Preparation of two (2) desktop ESIAs for 3-D seismic survey within shallow and deep- water blocks offshore of Guyana.

Environmental Audit (Mcquarie)

- Conduct virtual environmental audit for a facility in Trinidad and Tobago.
- Preparation of audit report.

Hammerhead Environmental Impact Assessment

- Support drafting of chapters
- Coordinate and plan disclosure meeting sessions in regions 1-6

Other

- Drafting and Preparation of Local Content Reports for the Guyana Office according to guidelines provided by the Local Content Secretariat.
- Provide data for Ecometrica platform for Guyana office.
- Support development of Proposals for various local projects.
- Functions as Field Safety Officer (FSO) for various surveys across projects.

Curriculum Vitae Ms. Louisa Bhavita Daggers, 207- Mon Repos South, East Coast Demerara, Guyana Tel#: 592- 220-6885, 649-1113 E-mail louisadaggers@gmail.com or louisadaggers@u.boisestate.edu or louisa.daggers@uog.edu.gy

Nationality: Guyanese
Date of Birth: July-10-1987

EDUCATION

PhD Candidate **(Present)**
University of Guyana
Major**: Biodiversity Conservation (Archaeology)**
Topic: A stable isotope Investigation of Holocene human environmental interplay and land use patterns along Guyana's Coastal littoral. This research relies on archaeological human and faunal data to reconstruct coastal population mobility, diet and environment using a multi proxy approach encompassing Carbon Isotope ^{13}C, Carbon ^{14}C, and Oxygen Isotope ^{18}O.

MASTER DEGREE **(2012)**
Boise State University IDAHO U.S.A
Major: **Applied Anthropology**
Concentration: Archaeology
Major Research: Development of a Cultural Resource Management Legislation for Developing Countries (Case Study Guyana). Development of a draft policy framework geared towards the protection and conservation of Guyana's archaeological and historical cultural heritage, in response to a subject of global contentiousness and to combat the impacts of economic growth a development on cultural heritage.

BACHELOR OF ARTS DEGREE **(2010)**
UNIVERSITY OF GUYANA GEORGETOWN, GUYANA
Major: TOURISM STUDIES
Major Research: Exploring the viability of the Guyana Natural History Museum (The Guyana National Museum) as a component of the Guyana Tourism Industry. Evaluating the tourism potential of the museum and the impact of the tourist dollar on sustainability, marketing and development of a tourist friendly museum. Identifying the current museum threats and opportunities for improvement in an evolving museum industry globally.

Human Subjects Training CITI Program
University of Miami U.S.A

Miller School of Medicine (Certification for working and conducting research with human subjects). Training to meet international IRB ethical standards in data collection (scientific and ethnographic, cultural) in person data collection.

DIPLOMA PROJECT MANAGEMENT **(2011)**
EDEX U.K. UNITED KINGDOM
Project management, with an emphasis in managing human resources and project activities through data and time management and reporting

CERTIFICATE IN GIS (ARC 10 & Q GIS) **(2013)**
GEOTECH VISION GEORGETOWN /JAMAICA

CERTIFICATE **(2012)**
UNDERWATER CULTURAL HERITAGE MANAGEMENT
Program included the assessment of a project site and the drafting of site management management plans, assessing impacts of activities including the engagement of local communities and museums.
UNESCO PORT ROYAL, JAMAICA

NAS INTERNATIONAL TRAINING **(2012)**
NAUTICAL ARCHAEOLOGY SOCIETY PORT ROYAL, JAMAICA
Introduction to Foreshore and Underwater Archaeology course (Part 1) geared towards the assessment of underwater archaeological sites for conservation and management

CERTIFICATE
UNESCO UNDERWATER CULTURAL HERITAGE CERTIFICATION
Strengthening UCH in Latin America and the Caribbean **(2021)**

CERTIFICATE
PADI - Open Water **(2012)**

POSITIONS

Earth Archive Country Coordinator- Amazon Chapter 1 (2021-2024) responsible for the identification of cultural and ecological areas of interest for the purpose of mapping and conservation, including stakeholder engagement and data sharing.

Researcher and Coordinator, Amerindian Research Unit, University of Guyana. Responsible for the coordination of the Associate degree in Anthropology, coordinate and co-supervise the Archaeology Field school, Archaeological research, networking on a regional and international level and deliver courses in Anthropology and Archaeology
(2014 – Present)

Research Affiliate, British museum, Santa Domingo Latin America Center of excellence: provide support and collaborate in regional research on cultural heritage, policies and areas of conservation issues **(2019- Present)**

Co-Editor, Archaeology and Anthropology Journal of the Walter Roth Museum. The only English-speaking anthropology journal in south America, the journal is published in honor of the Walter Roth Museum, by Boise State University and the University of Guyana, ARU. My responsibilities include networking, issuing calls for papers, reviewing and identification of reviewers for journal submissions and dissemination of information. (**2016- Present)**

Research Affiliate, Walter Roth Museum of Anthropology. Involved in research with the archaeological collection of the Walter Roth Museum including providing voluntary training, collection management and data exchange (**2013- Present)**

Co-Supervisor, Denis Williams School of Archaeology, a capacity building program initiated by the University of Guyana and the Walter Roth Museum over a decade ago, which focuses on public awareness, training of local and international participants in the area of archaeology field techniques. This program was under the WRMA until its return in 2018 to the university. Responsibilities include, proposal writing, identification of sites, management of resources in and out of field, supervising of students in field and class room, teaching and reporting finds to local authorities and public**. (2011- Present)**

Member- Guyana Heritage Society (**Present**)
Member- American Rock Art Research Association (**Present**)

PREVIOUS POSITIONS

- **Teaching Assistant (TA):** Boise State University, Idaho, U.S.A **(2012)**
- **Anthropological Officer**/ Administrative manager/ Curator: Walter Roth Museum of Anthropology **(2012 -2013)**
- **Anthropological Assistant** at the Walter Roth Museum of Anthropology; Ministry of Culture Youth and Sport **(2009 to 2011)**
- **Anthropological Assistant** at the Guyana National Museum **(2008-2009)**

GRANTS

2024- Rock art Conservation of the Upper Mazaruni Awarded by Ministry of Amerindian Affairs) Guy$ 5,000,000 (**USD$ 25,000.00**)

2022- Archaeological Investigation of South Rupununi Savanah (Funded by Boise State University and University of Guyana) **USD $ 6,000.00**

2020- Ethnographic Case study of Rupununi savannah fire Management practices (Funded by UNESCO)

2019- Archaeological assessment of Dubulay Ranch, Berbice River, Denis William Archaeology Field School (funded by: University of Guyana and Boise State University) **UDS $ 5,000.00**

2019- Archaeological Survey of Karasabai Petroglyphs, (funded by: Boise State University and University of Guyana) **USD$ 5,000.00**

2018- Archaeological investigation of the North Central Rupununi, Denis William Field School (funded by: Department of Culture, Boise State University, University of Guyana) **USD $ 5,000.00**

2017- Archaeological Survey of Shea and Rupunau Archaeological sites (funded by: Falcon Inc. and Walter Roth Museum Anthropology) **USD $ 3,000.00**

2016- Archaeological Survey of the Aishalton Petroglyph complex South Rupununi (funded by: Department of Culture and Walter Roth Museum of Anthropology) **USD $ 3,000.00**

2015- 2017 (18 Month Project) Assessing prehistoric diet breadth to model a low carbon life way, (funded by the World Bank) **USD $ 33,000.00**

HONOURS/ AWARDS

2017- **Exemplary Research Achievement** (Guyana Cultural Association of New York)
2011-2012 **Gem Grad Award**
2011-2012- **Graduate Scholars Award**
2011. **Fellowship Boise State University Graduate School**

SELECTED SOCIAL AND CULTURAL CONSULTANCY:

Cultural Expert and Archaeologist: Cultural Resource Management project (Client: Reunion Gold) **(ERM 2023- current)**

Responsibilities: Project Implementation, training of students and Cave site Data recovery, materials analysis and reporting in collaboration with Boise State University and ERM

Resident Archaeologist/Cultural and Social Expert: Archaeological Assessment : Gas to Energy Transmission Line Client : GOG **(ERM 2023-2024)**

Responsibilities included: Site Assessment and CRM Impact Assessment Report

Social Specialist : Lead researcher: Local Works Listening Tours **(client** USAID) **: Consultant: (TCG 2023/2024)**

Responsibilities included: Public consultation, community stakeholder engagement, Lead focus Group Discussions with PWD, Youths, Women , Mixed groups, NGO's and Local Government , including key informant interviews and reporting.

Resident Archaeologist: Archaeological Assessment: Reunion Gold **(ERM 2023)**
Responsibilities included: Site Assessment and CRM Impact Assessment Report

Resident Archaeologist: Archaeological Assessment: EEPGL GuySuCo Training Facility Port Mourant Berbice **(ERM 2022-2024)**
Responsibilities included: Site Assessment and CRM Impact Assessment Report

Resident Archaeologist: Archaeological Assessment: EEPGL Gas to Energy Project **(ERM 2022).**
Responsibilities included: Site Assessment and CRM Impact Assessment Report

Anthropologist and Cultural Expert- Ethno-ecological and Archaeological Assessment within the vicinity of Karawaimaine Taawa, Aishalton , South Rupununi Client: CIFOR, SWM & SRDC (**2022**)

Social Specialist: Stakeholder engagement: Green Climate fund full funding proposal **(client** FAO**: Consultant: ECO ltd. (2020-2021)**
Responsibilities included: Public consultation, community stakeholder engagement, development of stakeholder engagement methodology, development of stakeholder Engagement Plan for project implementation and stakeholder engagement report

Social Specialist: GMI Manganese Mine, Social Impact assessment, Focus on Resettlement, CRM and Land use Guyana **(**Consultant: **EMC**) **(2020-2021)**
Responsibilities included: stakeholder engagement, community profiling, evaluation of resettlement initiative, development of the grievance redress mechanism and characterization of social impacts

Social Specialist: Stakeholder engagement, Climate Smart Agriculture in Region # 9, Ministry of Agriculture **(**Consultant: **CIAT) (2019)**
Responsibilities included: Community stakeholder engagement, stakeholder engagement report and recommendations

Social Specialist/Anthropologist : Design and Implementation of REDD+ Pilot Project In Guyana: GoG project, IDB funded, (consultant: **FCGI**) **(2019)**
Responsibilities included: Stakeholder Consultation, Reporting, project concept development and refining, Identification of project implementation sites, Monitoring of Implementation, Budgeting and financial management

Social Specialist: Comprehensive Study of Citizen Security in Indigenous Communities: GOG project, IDB funded (consultant: **TCG**) **(2019)**
Responsibilities included: stakeholder engagement, community sensitization, key informant interview and focus group discussion

Social Specialist: Stakeholder Engagement: The Enhancement of Sheriff Street Mandela Avenu Roadway improvement Project (IDB funded) MoPI: Egis international and SRKN **(2018-2019)**
Responsibilities included: stakeholder engagement, monitoring and conflict resolution and reporting

Indigenous and Social Specialist: Sustainable Agricultural Development Project; GFC Readiness project: FAO **(** consultant: CITA**)** **(2018)**
Responsibilities included: Public consultation, community stakeholder engagement, development of stakeholder engagement methodology, stakeholder engagement report. Evaluation of indigenous and vulnerable groups within the project area of influence

Social Impact Assessment: Pirara Researh Center and Resevoir Region#9; Ministry of Agriculture and SRKN **(2017-2018)**
Responsibilities included: socio-ecomomic impact assessment, development of impact matrix development of social management plan, designing of the grievance redress mechanism and IPP (Indigenous peoples plan)

Social Expert: East Pedestrian Overpass: Consultant RM Engineering (Client:Ministry of Public Infrastructure (**2017)**
Responsibilities included: Stakeholder engagement, the implementation of grievance redress mechanism and reporting and

Social Expert: Social Impact Assessment**;** Sea Defence project: Consultant (SRKN) Client :Ministry of Public Infrastructure **(2016)**

Responsibilities included: Socio-ecomomic impact assessment, development of impact matrix development of social management plan, and the designing of the project grievance redress mechanism.

Social & Cultural Heritage Consultant: The Guyana Gold Fields Inc **(January 2014)**
Responsibilities included: Site Assessment and CRM Impact Assessment Report

Resettlement plan and Social Survey Consultant: Conducted a social impact assessment and Re-settlement survey for the Sophia Block X & F to the Amila Falls Hydro Project transmission line project**, contracted by Sight global (Miami) and Re plan (Canada) (May- June 2013)**

Social & Cultural Assessment Consultant: Conducted archaeological assessment for the

Bonasika mining site for GINMINE bauxite company **(February-April 2013)**
Responsibilities included: Site Assessment and CRM Impact Assessment Report

Archaeologist/Anthropologist: Social and Cultural Assessment: Port Royal UCH Site Jamaica (collaboration with JNHT and UNESCO) **(November 2012)**

Current Research Projects

1. Stable Isotope assessment of Archaeological human and Faunal Remains of Guyanas North Western Coast (Collaboration Boise State University)
2. The Assessment of the Upper Mazaruni Rock art Panel and pigment Characterization (University of Guyana, in collaboration with the GoG)
3. Aishalton Petroglyph Conservation and community engagement

Publications

- UNESCO. 2024. Indigenous Peoples' Traditional Knowledge of Fire: Observing, Understanding, and Coping with Climate Change and the vulnerabilities of Socio-Environmental Systems - Case studies from the Guiana Shield (Guyana, Suriname, Venezuela). UNESCO. Paris. 92 Pp. (Guyana Chapter) : https://unesdoc.unesco.org/query?q=Corporate:%20%22UNESCO%20Office%20in%20Kingston%22&sf=sf:*

- Daggers, L. 2023**.** The Value of the Karaawaimin Taawa for the Wapishan People (Book Chapter) CIFOR, FAO, WCS & CIRAD. 2023. The Karaawaimin Taawa – Insights from a biocultural assessment led by the *Wapichan people in Guyana*. Rome, FAO. https://doi.org/10.4060/cc5251en

- Richards, A., C. White, L. Daggers, Soke-Fonkel. T, Edwards. A, Sutherland. A, Aguiste. I, 2023**.** Archaeology, Indigenous and Local Knowledge, and Climate Change in the Caribbean:Select Case Studies among the Kalinago, Macushi and Maroon communities in the Windward Islands and the Guianas. Archaeology and the Publics,Vol 38.2. Cambridge Press

- Plew, M.G, and. Daggers, L.B. 2022. Archaeology of Guyana (Text Book), University of Guyana Press 2022.

- Daggers, L.B and Plew, M.G. Using New Methods to Assess Holocene Environmental Change in Northwestern Guyana (Book Chapter) University of Florida Press 2022.

- Christopher Fishera, Stephen Leisza, Louisa Daggers et al., 2022. Creating an Earth Archive**.** PNAS, Vol 19. No. 11

- Daggers, L.B. Pereira, G. Browne, P. H, . 2022. Archaeological Survey within the Vicinity of Karaawaimin Taawa, South Rupununi, Guyana. Anthropology & Archaeology Journal Vol. 25

- Daggers, L.B. Pereira, G. Plew.M.G. 2022. A Report on Archaeological Survey near Rupunau and Shulinab Anthropology & Archaeology Journal Vol. 25

- Daggers, L.B. 2021. Assessing Holocene Coastal Environmental Dynamics in North Western Guyana, In Sunnucks, L.O and Cooper, J. 2021 *Mapping a New Museum, Politics and Practices of Latin American Research with the British Museum*. Routledge

- Carolina Navarrete-Frías[1], Miguel Lizarazo[1], Anton Eitzinger [1], Caroline Mwongera [1], Judith Rosales[2] Louisa B. Daggers[2], Pauline Bullen[2], Dina Benn[2], Satesh Nanlall[3], Danny Sandoval[1], Andres Jines[1] 2021. Climate Smart Agriculture Investment Profiles in Guyana: A way forward

- Mwongera C; Eitzinger A; Bullen P; Daggers L; Kinyua I; Rosales J. 2020. Climate-Smart Agriculture Rapid Appraisal Report for Guyana. CIAT Publication No. 503. International Center for Tropical Agriculture (CIAT). Cali, Colombia. 30 p.

- Daggers, L.B, Pereira, G. and Plew M.G 2019. Archaeological Survey of in the vicinity of Karasabai North Rupununi, Anthropology & Archaeology Journal Vol. 23

- Daggers, L.B and Plew, M.G. et al., 2018. Assessing the Holocene Environment of Northwestern Guyana: An Isotopic Analysis of Human and Faunal Remains, Latin American Antiquity

- Hastings, R.D., Daggers, B.L., Stoll, A.A.M. 2018. Ethno-Meteorology in Upper Mazaruni: Uncovering Indigenous Knowledge of the Kapon Akawaio People. Anthropology & Archaeology Journal Vol. 22

- Pereira, G., Daggers B.L. 2017 A Short Note on Petroglyphs of Rupunau Village, South Rupununi Guyana. Anthropology & Archaeology Journal Vol. 21

- Daggers, L.B, Pereira, Gand, Pitamber. M. 2016. Archaeological Survey of the Aishalton Complex South Rupununi Guyana. Anthropology & Archaeology Journal Paper Vol. 20

- Daggers, L. B. 2015. CRM Archaeological Infrastructure for Guyana and Developing countries. Anthropology & Archaeology Journal Paper Vol. 19 #2

- Plew, M.G, & Daggers, L.B. 2015. Recent Excavation of the Siriki Mound North West Guyana. Antiquity Gallery

- Plew, M. G, &. Daggers, L.B, 2015 and Notes on Archaeological Survey and Testing at Warapana Shell Mound, North West Guyana. Anthropology & Archaeology Journal Paper Vol.19 #1

- Daggers, L. B. 2015. Underwater Cultural Heritage paper: Guyana protects it's Underwater Heritage. UNESCO Culture and Development Magazine Issue #13.

- Report: Archaeological Assessment of Prehistoric sites within the Vicinity of Chateu Marot and Abary, East Coast Demerara Guyana: Louisa Daggers, 2014.

- Plew, M. G, Periara, G. and Daggers, L.B. 2014. Archaeological Survey at Karanambu, Northern Rupununi, Guyana Anthropology & Archaeology Journal Paper Vol.18

- Plew M. G., Willson, C. A and Daggers, L.B. 2012. Archaeological Excavations at Siriki Shell Mound, Northwest Guyana. *Monographs in Archaeology* No. 4, University of Guyana.

- **Conference presentations:** co-authored a poster covering the pathology of the Siriki man (A prehistoric skeleton that was excavated by myself and Dr. M. Plew in Guyana) this poster was presented at the American Association Physical Anthropology (AAPA) annual Conference in Portland Oregon and the American Association for the Advancement of Science (AAAS) conference Boise Idaho **(Portland U.S.A 2012)**

Curriculum Vitae Ms. Louisa Bhavita Daggers, 207- Mon Repos South, East Coast Demerara, Guyana Tel#: 592- 220-6885, 649-1113 E-mail louisadaggers@gmail.com or louisadaggers@u.boisestate.edu or louisa.daggers@uog.edu.gy

CONFERENCES/SEMINARS/TRAINING COURSES/WORKSHOPS ATTENDED

Island at the Helm Conference: presentation: Breaking Barriers : Linking Scientific Understandings with Traditional Knowledge As a Means to Build Climate Change Resilience (**Aruba 2022**)

Impact Justice Conference: Presentation: Communication Constrains and barriers within indigenous communities (**Dominica 2022)**

Workshop: UNESCO- Post Disaster Needs Assessment Workshop (**Guyana 2021**)

University of Guyana CSA Symposium: Presentation: Tribute to the George Simon; Archaeological contributions of George Simon **(2021)**

Earth Archive Congress: Presentation on the vulnerability of Guyana's archaeological sites to Climate change and development and the important of Lidar scanning for future research **(2021)**

Webinar UNESCO: International Decade of Indigenous languages (moderator and representation of Guyana/ and the Amerindian Research Unit) **(2021)**

Organization of American States: Inter-American Commission on Human Rights (**IACHR**) Regional Meeting: Presentation: Indigenous Rights to self-determination in Guyana and local policy issues **(2021)**

Iwokrama: Emerging Science Webinar Series: Presentation: Petroglyphs of Guyana **(2020)**

International Association of Caribbean Archaeology: Presentation: Isotopic analysis of Human and faunal Remains of North Western Guyana (**Barbados 2019**)

Society of American Archaeology: Presentation: Moving Beyond: Using New Methods of Assessing Holocene Environmental Change in Northwestern Guyana **(New Mexico 2019)**

Guyana Cultural Association NYC: Presentation: Excavations of the Siriki Shell Mound **(**New **York 2017)**

Guyana Cultural Association NYC Presentation: Cultural Heritage and the Absence of Policy Infrastructure **(New York 2017)**

World Monument Fund: Presentation: Archaeology Within the community Landscape **(Aurthor Chung Convention Center 2016)**

Workshop: OAS: Heritage Elicitation **(Georgetown 2019)**

Workshop: FAO: Green Climate Fund, proposal development **(Georgetown 2018)**

Workshop: WWF: Protected Area Systems (shell Beach) **(Georgetown 2018)**

Workshop: Princeton University: Paleoclimatology, Dendrochronology for pre modernist (**U.S.A 2015**)

United Nations & OECS Expert Meeting: Science Policy Interface, and the possible contribution of Indigenous Research and Knowledge to SIDS and Sustainable Development **(St. Lucia 2015)**

UNESCO ICH Workshop: Safeguarding our Intangible Cultural Heritage stakeholder awareness workshop. (**Guyana, 2013**)

UNESCO UCH Workshop: Underwater Cultural Heritage Management capacity building Workshop for Caribbean Nations. (**Jamaica, 2012**)

Department of Anthropology Lecture Series: "before the Argonauts: Early Metallurgy and interactions in Bronze age Eurasia and Beyond" by David Peterson (**Idaho**, **2012**)

WWF Project Proposal Writing Work Shop: A three days workshop providing guidance for the preparation of writing international grant proposals (**Guyana 2012**)

Idaho thirty eight annual conferences: The Idaho archaeological society **(Idaho, U.S.A 2011)**

REFERENCES

Dr. Mark G. Plew (Professor Emeritus) - Department of Anthropology, Boise State University, Boise Idaho **E-mail address:** mplew@boisestate.edu

Elford Liverpool (Lecturer)- Department of Biology, University of Guyana
E-mail address: elford.liverpool@uog.edu.gy

Mark July

HSE Coordinator

Mr. Mark July has a wide range of experience within the Health and Safety space having worked on/in numerous varying environments both onshore and offshore, with a background in Environmental Studies he has overseen and participated in environmental surveys at various points ranging from the planning stages to the implementation stage. Mr. July is also a certified Aquatic Experienced Person (AEP). Further he has experience in implementing safety systems and plans both in the field and office spaces, managing emergency situations in the field and with medevac situations both on and offshore. To add to his credit, he possesses working knowledge of both local and international safety standards and regulations which are essential to his role at ERM.

EXPERIENCE: Collectively possesses 7 years' experience serving in various roles within the Oil & gas, Mining, construction, Tourism and multimedia sectors.

LINKEDIN: Mark July - HSSE Coordinator/ Consultant - ERM: Environmental Resources Management | LinkedIn

EMAIL: mark.july@erm.com

EDUCATION

- B.Sc.. Environmental Studies, University of Guyana, Guyana, 2021
- Diploma in Tourism, St. Rose's High School, CAPE,2017
- Caribbean Secondary Education Certificate, CSEC 2015

LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Health & Safety
- Environmental

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- Multimedia

KEY INDUSTRY SECTORS

- Tourism
- Multimedia
- Oil & Gas
- Mining
- Construction

KEY PROJECTS

Ambient Air Quality (EEPGL 2024)

Functioned as Field safety Officer (FSO) and ERM onsite manager for subcontractor overseeing work which required subsurface clearance planning while on an active construction site. Additionally implemented lifting plan and transportation of MAML in the field from region 4 to region 3.

Coastal Birds Survey (EEPGL 2022 and 2023)

Functioned as Field Safety Officer, conducting daily safety briefings as well as ensuring the health and safety plan is followed also assisted with Observing and recording bird species along the coast of Guyana (Region 2-6).

Sea Water Sampling (EEPGL 2022 and 2024)

Organizing logistics for the mobilization of teams, procuring equipment and sample preservation in the field functioning as a Sampling Technician/ Sampling lead on the team sample collection, preparation and packing samples. Conducting daily safety briefings and debriefs were also duties performed.

Environmental Phase I and CRM Survey (EEPGL 2022)

Prepared health and safety documentation performed vehicle inspection and assisted with planning and logistics to facilitate mobilization of the team.

In the field the field functioned as the field safety officer ensuring the team was

equipped as was necessary to be on site and worked according to the safety plan.

Assisted the experts on the ground with measurements and environmental observations, documentation via audio and visual recording devices.

Oko Mining Project (Reunion Gold 2022 and 2024)

Functioned as FSO, conducting daily safety briefings as well as ensuring the health and safety plan is followed. Additionally provided aid to the various teams with observations and recording of mammals, birds and herps. Worked closely with the aquatic biodiversity team in conducting drag seine exercises, sampling aquatic species and eDNA collection and storage. Trained in the setup and function of hydrology stations with the objective to retrieve data and perform in field levelling surveys, also functioned as a sampling personnel collecting and preserving water, sediments and air in the field.

Gas to Shore (EMGL 2022 AND 2023)

Functioned as Field Safety Officer, conducting daily safety briefings as well as ensuring the health and safety plan is followed in the field and aiding with the archaeology team to survey and cordon off areas with suspected historical structures. Scouting Potential sites for the relocation of Mobile Air Monitoring Lab and providing feedback in accordance with set criteria.

KEY PROJECTS PRIOR TO JOINING ERM

2018: Demerara Associates-Multimedia Technician

Setting up, using, and maintaining audio-visual and computer media equipment; set up sound and lighting equipment; responsible for audio recordings, and broadcast, edit recordings and deal with signals to broadcast content on internet; provides

training in equipment operations to staff and clients; schedules and maintains various audio-visual equipment.

JANUARY 2019: GUYANA LANDS AND SURVEY COMMISSION-COMMITTEE FOR THE REVIEW OF THE IMPLEMENTATION OF THE CONVENTION (CRIC17) OF THE UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD):

Facilitated arrival and departure arrangements for dignitaries, responded to queries from dignitaries and assisted with production of conference documents and related correspondence.

2018: SOLOMON GROUP (USAID JUVENILE JUSTICE PROJECT GUYANA)

Schedule and execute visits to government offices to retrieve information concerning the juvenile Justice system, recorded them and update web-based platforms. Collated confidential documents with the purpose of encrypting documentation for transport.

2021: E&A CONSULTANT'S GAS TO ENERGY/ GAS TO SHORE SOCIOECONOMIC SURVEY

Conduct interviews with households and businesses deemed to be in the Area of influence to obtain baseline data to evaluate potential direct impacts of the Gas to Shore project.

2021: SMALL BUSINESS BUREAU, MINISTRY OF TOURISM, INDUSTRY & COMMERCE

Physically check and organize client information to update digital records using checklists. Flag discrepancies with internal databases and highlight elements necessary for clients to achieve compliance.

Mertcan Ozbakir, MSc, MAIG

Principal Technical Consultant – Hydrogeology

Mertcan Ozbakir's experience encompasses multiple aspects of water-related issues including hydrogeology, aqueous geochemistry, water quality, water resources and groundwater management studies. He has over 17 years of experience through which he has worked as a research and teaching assistant, field engineer and consultant hydrogeologist for global clients. He has so far involved in large-scale projects focusing on mine water hydrogeology, numerical groundwater flow modeling, mine dewatering and slope depressurization, mining waste geochemistry, mine water management and mine closure. His experience involves a diverse range of technical studies, spanning from the early prefeasibility stage through to post-closure, demonstrating proficiency across the entire project lifecycle of mining projects. Mertcan Özbakır fulfills the requirements of a Qualified Person and is a Member of the Australian Institute of Geoscientists (AIG).

EXPERIENCE: 17 years' experience in mining, oil & gas and environmental sectors

LINKEDIN: https://www.linkedin.com/in/mertcan-ozbakir/

EMAIL: mertcan.ozbakir@erm.com

EDUCATION

- MSc. Hydrogeology, Hacettepe University, Turkey, 2010
- BSc (Hons). Hydrogeology, Hacettepe University, Turkey, 2007

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- International Association of Hydrogeologists (IAH)
- International Mine Water Association (IMWA)
- Australian Association of Geoscientists (AIG)

LANGUAGES

- Turkish, native speaker
- English

FIELDS OF COMPETENCE

- Mine water management

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- Development of mine dewatering and slope depressurization strategies
- Water resources impact assessment
- Hydrogeological site characterization
- Numerical groundwater flow modelling
- Acid rock drainage and metal leaching at mining sites
- Mine closure
- Technical due diligence for mining

KEY INDUSTRY SECTORS

- Mining & Minerals
- Environmental
- Oli & Gas

PUBLICATIONS

- Reconstruction of the Late Quaternary Paleoclimate in the Central-North Taurids from the Records of Cave Stalagmites (Turkey).

HYDROGEOLOGY & GEOCHEMISTRY

Development of Mine Closure Plan and Closure Cover Designs for the Oksut Gold Mine, Centerra Gold, Turkey (April 2024 - present)

- Development of geochemical characterization program for waste rock dump, heap leach facility and open pit.
- Sourcing alternatives assessment for closure covers
- Closure cover design
- Heap rinsing simulations and assessment of closure water treatment requirements

Hydrogeological Characterization and Numerical Groundwater Flow Modelling or the Oko West Gold Mine, Guyana (April 2024 – present)

- Development of hydrogeological field testing program
- Hydrogeological site characterization
- 3D numerical modelling to estimate pit dewatering requirements
- NI43-101 PFS reporting for Project's hydrogeological characteristics and requirements.

Hydrogeological Monitoring and Periodic Review of Pit Dewatering / Depressurization Requirements for the Gediktepe Gold Mine, Balıkesir, Turkey (April 2022)

- Periodic site visits to monitor open pit slope performance and hydrogeological conditions
- Review of pit designs to provide consultancy on dewatering well plans and well locations
- Development of hydrogeological scoping and future strategy for pit dewatering and slope depressurization

Hydrogeological Characterization and Groundwater Impact Assessment for the Bakırtepe Gold Mine Naldoken Capacity Extension Project, Sivas, Turkey (December 2021 – December 2022)

Project Manager for hydrogeological characterization and impact assessment studies including:

- Hydrogeological characterization of mining lithologies to develop strategies for mine water management.
- Numerical groundwater flow modeling
- Supervision of hydrogeological field operations including aquifer tests, sampling and measurement of physical and chemical parameters.

Geochemical Characterization and Predictive Water Quality Modeling for the Bakırtepe Gold Mine Naldoken Capacity Extension Project, Sivas, Turkey (December 2021 – December 2022)

Project Manager for acid rock drainage and environmental geochemistry studies including:

- Geochemical sample selection from drill cores
- Geochemical characterization of mining lithologies through static testing
- Mass balance calculations and conceptual site model development
- Predictive water quality modeling for potential waste rock seepages, potential leakages from tailings storage facility and open pit lake formation
- Geochemical impact assessment

Hydrogeological Site Characterization for Tailings Storage Facility Design Project, Kef Mine Site, Elazığ, Turkey (July 2021 – present)

Project Manager for hydrogeological characterization studies including:

- Hydrogeological characterization of mining lithologies to develop strategies for mine water management.
- Liaison with state officials regarding hydrogeological scope and reporting.
- Supervision of hydrogeological field operations including pumping tests, packer tests sampling and measurement of physical and chemical parameters.
- Supervision of drilling operations including casing installation and well development.

Open Pit Closure Plan and Water Management Plan for the Himmetdede Gold Mine, Kayseri, Turkey (November 2021 – July 2022)

Project manager for the development of closure pit lake modeling and water management plan including:

- Development of 3D numerical groundwater flow model for the open pit closure phase,
- Development of numerical predictive water quality model for the pit lake through closure phase,
- Development of detailed closure plan for the open pit,
- Development of water management plan for the closure phase of the project

Hydrogeological Scoping Study for the Kevitsa Cu-Ni-PGE Mine, New Boliden, Lapland, Finland (November 2021)

Key technical expert for the review of hydrogeologic studies and development of future mine water management strategy including:

- Review of previous studies regarding hydrogeology and mine water management
- Review of hydrogeological monitoring data (including groundwater level measurements and recordings obtained from vibrating wire piezometers)
- Development of a road map for water management and pit dewatering

Hydrogeological Scoping Study for the AquaVia (Sam Mills SRL) Groundwater Production Factory, Bologa-Cluj, Romania (September 2021)

Key technical expert for hydrogeologic studies and water resources management strategy including:

- Review of previous studies and update the field data on water points
- Assessment of groundwater utilization alternatives
- Hydrogeological site characterization and 3D numerical groundwater flow modeling
- Assessment of groundwater sustainability for water supply operations

Water Resources Investigation and Hydrogeologic Appraisal for DANONE Burdur Project, DANONE Waters, Turkey (December 2020 – July 2021)

Project Manager for hydrogeologic studies and water resources management strategy including:

- Review of previous studies and update the field data on water points
- Assessment of groundwater utilization alternatives
- Assessment of groundwater sustainability in terms of its use as a drinking water source
- Identification of groundwater monitoring requirements

Hydrogeological Site Characterization and Hydrogeological Impact Assessment Study for the Karlık Metallic Mine Project, Limak, Balıkesir, Turkey (May 2021 – present)

Project Manager for hydrogeologic studies and water resources management strategy including:

- Hydrogeological characterization of mining lithologies to develop strategies for mine water management.
- Numerical modeling of groundwater inflow rates to underground mining zones.
- Supervision of hydrogeological field operations including pumping tests, packer tests sampling and measurement of physical and chemical parameters.
- Supervision of drilling operations including casing installation and well development.

Geochemical Characterization and ARD Impact Assessment Study for the Karlık Metallic Mine Project, Limak, Balıkesir, Turkey (May 2021 – present)

Project Manager for geochemical studies and water quality management strategy including:

- Geochemical sample selection from drill cores
- Geochemical characterization of mining lithologies through static testing

- Assessment of kinetic tests and estimation of loading rates
- Mass balance calculations and conceptual site model development
- Predictive water quality modeling for potential waste rock seepages, potential leakages from tailings storage facility and open pit lake formation
- Geochemical impact assessment

Hydrogeological Site Characterization and 3D Numerical Modeling for Bizmisen Iron Mine Project Tailings Storage Facility, BILFER, Erzincan, Turkey (May 2021 – present)

Project Manager for hydrogeologic framework and modeling studies including:

- Water points identification and development of technical framework for the TSF hydrogeological investigations

Hydrogeological Site Characterization and 3D Numerical Modeling for Ayazmant Iron Mine Project Tailings Storage Facility, BILFER, Balıkesir, Turkey (May 2021 – present)

Project Manager for hydrogeologic framework and modeling studies including:

- Hydrogeological characterization of mining lithologies to understand baseline hydrogeological characteristics
- Numerical Modeling to assess potential seepages from the TSF
- Groundwater Impact Assessment

Hydrogeological Site Characterization and Groundwater Sustainability Assessment for the BOTAŞ Tuzgölü Underground Natural Gas Storage Expansion Project, BOTAŞ – IÇTAŞ, Aksaray, Turkey (January 2021 – July 2021)

Key technical expert for hydrogeologic studies and water resources management strategy including:

- Review of previous studies and update the field data on water points
- Assessment of groundwater utilization alternatives
- Hydrogeological site characterization and 3D numerical groundwater flow modeling
- Assessment of groundwater sustainability for water supply operations

Geochemical Characterization and Predictive Water Quality Modeling for the Uyuzhamam Gold Mine Project, Taşzemin Inc., Eskişehir, Turkey, (February 2020 – January 2021)

Project Manager for acid rock drainage and environmental geochemistry studies including:

- Geochemical sample selection from drill cores
- Geochemical characterization of mining lithologies through static testing
- Assessment of kinetic tests and estimation of loading rates
- Mass balance calculations and conceptual site model development
- Predictive water quality modeling for potential waste rock seepages, potential leakages from tailings storage facility and open pit lake formation
- Geochemical impact assessment

Long Term Assessment of Water Resources Monitoring Data for the Ispir Copper-Zinc Mine, Demir Export Inc., Erzurum, Turkey (April 2020 – October 2020)

Expert hydrogeologist for evaluation and assessment of water resources data including;

- Characterization of Project Area water points
- Identification of water types
- Assessment of water quality analysis results
- Establishment of long-term monitoring requirements

Development of Water Resources Management Plan for the Yenipazar Gold Mine Project, Aldridge Minerals Inc., Yozgat, Turkey (July 2019 – September 2019)

Expert hydrogeologist for technical due diligence on site and preparation of water resources management plan.

- Review of previous studies and update the field data on water points
- Review of alternatives for process water supply and drinking water supply for nearby communities
- Identification of project's potential impacts on communities and water resources
- Establishment of an updated mine water monitoring program

Development of Mine Dewatering/Depressurization Design Strategy and Mine Water Management Plan for the Gökırmak Copper Project, Acacia Mining Operations Inc., Kastamonu, Turkey (November 2017 – March 2019)

Project Manager for Mine Dewatering and Mine Water Management studies including the following tasks:

- Hydrogeological characterization of mining lithologies to develop strategies for mine water management.
- Numerical simulations of groundwater flow to optimize dewatering/depressurization strategy.
- Development of surface water management plan.
- Development of contact waters strategy through water quality assessments.

Hydrogeological Site Characterization and Numerical Groundwater Modeling for the Çayırhan-II Coal Field, Çayırhan Elektrik Üretim ve Madencilik A.Ş., Beypazarı, Turkey (August 2017 – October 2018)

Project Manager for hydrogeological characterization and numerical modeling study focusing on:

- Hydrogeological characterization of mining lithologies to develop strategies for mine water management.
- Numerical modeling of groundwater inflow rates to underground mining zones.
- Supervision of hydrogeological field operations including pumping tests, packer tests sampling and measurement of physical and chemical parameters.
- Supervision of drilling operations including casing installation and well development.

Water Resources Impact Assessment for the Gökırmak Copper Project, Acacia Mining Operations Inc., Kastamonu, Turkey (June 2016 – September 2017) (prepared for EBRD, available at http://www.ebrd.com/work-with-us/projects/esia/acacia-.html);

Project Manager for hydrogeological site characterization and numerical groundwater modeling study with regard to assessment of environmental impacts originates from pit dewatering and potential seepages from mining waste facilities.

Water Supply Project for the Gökırmak Copper Mine, Kastamonu, Acacia Mining Operations Inc., Turkey, (January 2016 – October 2016)

Project Manager for the investigation of groundwater resources regarding mine water supply, drilling and pumping test supervision of the water supply wells.

Geochemical Assessment and Waste Characterization of the Proposed Ispir Copper Mine, DEMİREXPORT AS, Erzurum, Turkey (June 2015 – January 2016)

Geochemical sample selection, Evaluation of the potential acid rock drainage and metal leaching behavior of waste material through geochemical characterization and water quality assessment methods.

Mining Waste Geochemical Characterization and Predictive Water Quality Modeling for the Ovacık Gold Mine, KOZA Gold, Bergama (Turkey, April 2014 – April 2015)

Geochemical sample selection, Evaluation of the potential acid rock drainage and metal leaching behavior of waste material through geochemical characterization, predictive water quality modeling.

Geochemical Assessment and Waste Characterization of the Muratdere Gold-Copper Mine, PRAGMA Finance, Bozüyük, Turkey (August 2014 – May 2015)

Geochemical sample selection, Evaluation of the potential acid rock drainage and metal leaching behavior of waste material through geochemical characterization and water quality assessment methods.

Geochemical Assessment and Waste Characterization of the Proposed Gediktepe Gold-Copper Mine, Polimetal Mining, Inc., Balıkesir, Turkey (August 2014 – May 2015)

Geochemical sample selection, Evaluation of the potential acid rock drainage and metal leaching behavior of waste material through geochemical characterization and water quality assessment methods.

Phase-II Environmental Site Assessments for BP Turkey, BP RM, Turkey (June 2015 – April 2019)

Project Manager for Phase-II environmental site assessment studies including the following tasks:

- Hydrogeological field operations such as aquifer tests, sampling and measurement of physical and chemical parameters.
- Periodic evaluations of water quality data
- LNAPL characterization and transmissivity estimations

- Monitoring natural attenuation parameters along the flow direction.

Phase-II Environmental Site Assessment for the GE Gebze Site, GE Grid Solutions, Gebze, Turkey (February 2019 – February 2019)

Project Manager for Phase-II environmental site assessment studies including the following tasks:

- LNAPL characterization and transmissivity estimations
- Development of LNAPL conceptual site model
- Water quality evaluations
- Monitoring natural attenuation parameters along the flow direction.

Phase II Groundwater and Soil Investigation in Bekaert Turkey Facility Site, BEAKERT NV, İzmit, Turkey, (June 2015 – September 2015)

Project Manager for the subsoil and groundwater contamination investigation in the Facility Site. The project included desktop studies, installation of soil boreholes, collecting soil and groundwater samples, chemical analyses of these samples for the contamination assessment.
Key Projects

MINE CLOSURE AND REHABILITATION

Open Pit Closure Plan and Water Management Plan for the Himmetdede Gold Mine, Kayseri, Turkey (November 2021 – July 2022)

Project manager for the development of closure pit lake modeling and water management plan including:

- Development of 3D numerical groundwater flow model for the open pit closure phase,
- Development of numerical predictive water quality model for the pit lake through closure phase,
- Development of detailed closure plan for the open pit,
- Development of water management plan for the closure phase of the project

Mine Closure Plan for the Gökırmak Copper Project, Acacia Mining Operations Inc., Kastamonu, Turkey, 2018

Project Manager for Development of a Mine Closure Plan providing additional studies to those carried out in the preliminary version including updates on mine water hydrogeology, mining waste geochemistry, biodiversity and critical habitat assessment, identification of social impacts and stakeholder engagement, closure objectives, post-closure monitoring and updated financial provision for closure.

Preliminary Mine Closure Plan for the Ispir Copper-Zinc Project, Demir Export Inc., Erzurum, Turkey, 2018

Project Manager for the preliminary mine closure study for early identification of how closure issues will be managed with specific emphasis on mine water hydrogeology, mining waste geochemistry, closure objectives, post-closure monitoring and financial provision for closure.

Preliminary Mine Closure Plan for the Gökırmak Copper Project, Acacia Mining Operations Inc., Kastamonu, Turkey, 2017

Project Manager for the preliminary mine closure study for early identification of how closure issues will be managed with specific emphasis on mine water hydrogeology, mining waste geochemistry, closure objectives, post-closure monitoring and financial provision for closure.

Mine Closure Plan for Mastra Gold Mine Open Pits and Waste Rock Dump, KOZA Gold, Gümüşhane, Turkey, 2017;

Specific Mine Closure Plan focusing on different closure alternatives for two open pits and one WRD which are in final stage of operation. Closure studies consisting optimization of closure cover for WRD, waste rock backfilling strategy in the open pit, assessment of Acid Rock Drainage and Metal Leaching (ARD-ML) issues on mine waters, closure cost estimation, analysis for different closure alternatives and assessment of regulatory issues for mine closure.

HYDROGEOLOGICAL STUDIES AS PART OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROJECTS

Environmental and Social Impact Assessment for the Gökırmak Copper Mine, Acacia Mining Operations, Inc., Kastamonu, Turkey, 2017 (prepared for EBRD, available at http://www.ebrd.com/work-with-us/projects/esia/acacia-.html);

Revision and improvements to the previous EIA and ESIA reports for hydrogeology, water supply and mine closure sections.

Environmental Impact Assessment for the Kapıkaya Gold-Copper-Silver Mine, KOZA Gold, İzmir, Turkey, 2016;

Tracking the full procedure to complete EIA process, evaluation of relevant baseline data and impact assessment.

Environmental Impact Assessment for the Ovacık Gold Mine 3rd Tailings Storage Facility, KOZA Gold, İzmir, Turkey, 2015;

Field sampling and processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

Environmental and Social Impact Assessment for the İspir Copper Mine, DEMIREXPORT AS, Erzurum, Turkey, 2015;

Field data processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

Environmental Impact Assessment for the Muratdere Gold-Copper Mine, PRAGMA Finance, Bilecik, Turkey, 2015;

Field sampling and processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

Environmental Impact Assessment for the Oksut Gold Mine, Centerra Gold, Kayseri, Turkey, 2014;

Field sampling and processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

Environmental Impact Assessment for the Çöpler Gold Mine, Alacer Gold, Erzincan, Turkey, 2014;

Field sampling and processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

Environmental and Social Impact Assessment for the Yenipazar Gold Mine, Aldridge Minerals Inc., Yozgat, Turkey, 2013;

Field sampling and processing, evaluation and reporting of detailed water quality studies using relevant aqueous geochemistry software.

ENGINEERING, PROCUREMENT AND CONSTRUCTION PROJECTS

DISI: Mudawarra to Amman Water Conveyance System Project, GAMA Power Systems, Jordan, 2011;

Project Engineer for a water supply study aiming to complete a total of 64 production wells to provide 100 million cubic meters of drinking water per year to Amman, via a 320 km length pipeline.

ACADEMIA & RESEARCH

- Field sampling and chemical analyses using ICP-MS Instrument under the supervision of Prof. Serdar Bayari of Hacettepe University (2007 – 2010).
- Stable isotope studies for reconstructing past climates of central Anatolia using ^{18}O and ^{13}C isotope data of cave stalagmites (2007 – 2010).

Niall Olds, CMLI

Technical Consulting Director

Niall joined ERM in August 2023 bringing over 25 years' landscape and environmental consultancy experience to the company. He is a Chartered Member of the Landscape Institute and specialises in Landscape Architectural services but has proven experience in the management and delivery of Environmental Impact Assessments.

In the initial stages of Niall's career he specialised in masterplanning and planning services for residential, mixed-use and industrial developments. Subsequent to this, Niall has gained considerable experience at national and international levels in landscape planning matters related to major infrastructure projects, energy production projects and energy transmission, taking an active role in the provision of guidance and advice to clients on Landscape and Visual matters. Niall has acted as an expert witness at Public Inquiry.

EXPERIENCE: 25 years' experience in Environmental Consultancy and Landscape Architecture

LINKEDIN: https://www.linkedin.com/in/niall-olds-1b6a7042/

EMAIL: niall.olds@erm.com

EDUCATION

- Diploma Landscape Architecture (DipLA), Edinburgh College of Art, UK 1998
- BSc (Dual Hons) Landscape Design and Plant Sciences, University of Sheffield, 1992

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- Chartered Member of the Landscape Institute
- Construction Skills Certification Scheme

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LANGUAGES

- English, native speaker

FIELDS OF COMPETENCE

- Landscape and visual impact assessment
- Landscape design
- Masterplanning
- Stakeholder engagement
- Project management and delivery
- Environmental impact assessment
- Feasibility studies
- 3d development conceptualisation/visualisations
- AutoCAD/Autodesk products

KEY INDUSTRY SECTORS

- Onshore and offshore renewables
- Transport infrastructure
- Energy infrastructure
- Urban Realm

KEY PROJECTS

Kintradwell Grid Connection, Caithness, Scotland (September 2023 – present)

Niall is currently leading the Landscape and Visual inputs to the Overhead Line Connection serving the recently consented Kintradwell Wind Farm.

Key Projects Prior to Joining ERM

Lower Thames Crossing, Kent & Essex, England

In his role as Associate Director of Landscape Architecture Niall was responsible for the preparation of the assessment of impacts on landscape and visual receptors resulting from changes to the overhead line equipment, where existing lines were either de-commissioned, re-strung or where new routes were proposed.

Combined Solar and Battery Energy Storage, Italy

As Lead Landscape Advisor Niall was part of the environmental team supporting the identification and feasibility of solar and BES sites across mainland Italy and Sicily. Working remotely Niall was able to support the identification of prospective sites and potential environmental constraints using his skills in landscape and utilising 3d modelling software at the feasibility and conceptual design stages.

Beinn an Tuirc Wind Farm (Phase III), Scotland

As Lead Landscape Architect Niall was responsible for leading the design of the wind farm layout and leading the team in the delivery of the Landscape and Visual Impact Assessment. In addition, Niall led on consultations with Argyll & Bute Council and Scottish Natural Heritage,

obtaining a consent without objection from key consultees and PLI. Niall was also responsible for engagement with the public and the provision of exhibition materials.

Craignagapple Wind Farm, Northern Ireland

In his role as Lead Landscape Architect Niall was responsible for leading the design of the wind farm layout and leading the landscape team in the delivery of the Landscape and Visual Impact Assessment to the nine turbine wind farm sited in the Sperrins Mountains. As part of the post application work, Niall provided landscape evidence at the planning sessions.

Inch Cape Offshore Wind Farm, Firth of Forth, Scotland

In his role as Associate Director of Landscape Architecture Niall was responsible for undertaking the peer review, on behalf of Marine Scotland/Scottish Government, of the Seascape, Landscape and Visual Impact Assessment (SLVIA) to the 1GW offshore wind farm. The wind farm was indicated as being widely visible from coastal settlements in the East of Scotland and in this regard Niall's review was to confirm that the SLVIA would sustain scrutiny in the event of any legal challenge and addressed all pertinent issues including consideration of weather conditions and effects resulting from night-time aviation/maritime lighting.

Wylfa Newydd, Anglesey, Wales

In his role as Principal Landscape Architect for the project Niall was responsible for the preparation of the inter and intra cumulative landscape and visual impact assessments and assisting the project management in developing the approach to the cumulative assessments of other technical disciplines.

A9/A96 Smithton Link, Inverness, Scotland

In his role as Senior Landscape Specialist on the project Niall was part of the multi-disciplinary team progressing the contract document package and detailed desigson having taken the project through both the DMRB Stage 2 and Stage 3 assessments.

A9 Dualling Programme, Luncarty to Glen Garry, Scotland

In his role as Senior Landscape Specialist on the project Niall was part of the team providing landscape and visual technical advice as part of the DMRB Stage 2 and DMRB Stage 3 assessments to five of the proposed sections of dualling. Niall's remit also included the undertaking of the Landscape and Visual Assessments and preparation of the landscape and ecological mitigation proposals. On three of the projects Niall went on to provide input to the tender stages and draft the contract documentation.

Paul Hesketh

Technical Director

Paul is Technical Director with over 30 years' experience in dealing with complex site management issues. He is a focussed solution provider working around problems on behalf of his clients and provides insightful high-level advice. His principal focus is dealing with the complex legacy issues relating to the management of sites including soil and groundwater pollution stemming from historic industrial and waste management operations, infrastructure removal and transition of sites to new owners. He brings practical knowledge to provide transition support through his involvement in the closure and subsequent sale / regeneration of numerous sites, including steel plants (including large integrated works), metals refining, chemical plants, and multiple manufacturing sites (papermills, automotive plants, can manufacturing, aircraft maintenance / deep servicing).

Experience: 30 years experience in environmental consulting

LinkedIn: https://www.linkedin.com/in/paul-hesketh-0319583b/

Email: paul.hesketh@erm.com

Education

- BSc (Hons) Applied & Environmental Geology, Birmingham University, UK, 1991

Professional Affiliations and Registrations

- Fellow of the Geological Society
- Specialist in Land Condition (SiLC)

Languages

- English, native speaker

Fields of Competence

- Complex Project Management
- Closure Planning / Regeneration & Just Transition
- Site Investigation and Remediation / Earthworks
- Waste Management
- Environmental Permitting
- Due Diligence

Key Industry Sectors

- Metals & mining
- Chemicals
- Manufacturing

Publications

- Risk Based Management of Mercury-Impacted Sites, Network for Industrially Contaminated Land in Europe (NICOLE), 2015
- Initiating a just transition in response to a low-carbon energy transition in coalfield communities, Western Ukraine (ACGM Mine Closure 2022), 2022

Key Projects

Closure and Decommissioning: Confidential Client, SA. Pre-closure advisory support in relation to the closure of an oil refinery in South Africa. Briefing in relation to development and planning needs to facilitate sale of the site / exit.

Closure, Decommissioning and Regeneration: Project Melbourne. Delivery of closure support services for an integrated automotive manufacturing facility. Regulatory support, permit surrender and investigations to determine if any liability arising from manufacturing operations.

Closure, Decommissioning and Regeneration: Precious Metals Refinery.
Advisory support in relation to closure and decommissioning of a precious metals refinery on behalf of the freehold landowner who intended to redevelop the facility and needed to ensure that all works were completed to a satisfactory standard.

Due Diligence: Global Mining Company
Review of closure liabilities associated with the potential purchase of a global mining company. Assessment of compliance with standards and potential impact on future liabilities.

Closure and Decommissioning: Global Miner.
Advisory support to the global closure team on issues relating to studies approach and scope, definition of costs, site repurposing approaches and lessons learnt.

Due Diligence: UK Integrated Steel plant.
Assessment of environmental liabilities, on behalf of purchaser, relating to historic and current operations of an integrated steel plant including landfill operations. Development of cost model detailing liability envelope, and scope of works post-purchase to allow quantification and carve out of liabilities.

Liability Management: Staveley Chemical Works, UK.
Development of a strategic approach to site assessment and monitoring programmes to allow sequenced remediation of a large derelict chemical platform.

Due Diligence: European Integrated Steel Manufacturer. Assessment of environmental issues related to a Europe wide portfolio of steel plants. Cost model relating to on-going obligations for landfill management, soil and groundwater impact and liability post closure.

Closure and Decommissioning: Crown Cork & Seal, Neath, UK. Permit surrender and regulatory support in relation to metal shaping facility. Investigation of soil and groundwater impact, development of a remediation strategy and implementation of the strategy.

Liability Management: Remediation of Former Waste Disposal Lagoon, UK. Turn-key remediation of a lagoon that was used for the disposal of waste phosphorus materials. Directed assessment programme and bid. This led to a nine-month construction project which involved the installation of mineral cap which was installed underwater and suspended on a single 3ha sheet of geotextile, which had to be floated on the lagoon and sunk as a single operation.

Regeneration Planning, 2012 London Olympics, UK.
Formulated relevant planning conditions for remedial activities for this multi-tiered development and produced a protocol for discharge of conditions, and interaction with the Planning Delivery Team (PDT) of the Olympic Delivery Authority by the applicant. Paul leads a team of consultants providing advice, to the PDT, relating to the quality of investigation reports, and remediation strategies submitted by the applicant.

Brownfield Development, UK, Merebank. During this project Paul provided advice to the end tenant team and sign-off of third-party works which related to brown-field issues for the development of Europe's largest winery. This is a 1,000,000sq ft building constructed in an area with extensive deposits of zinc smelter residues, and manufacturing of mustard gas during WW1.

Liability Management / Regeneration Planning: Remediation Strategy, Panteg Steelworks, UK. Project was undertaken on behalf of the Local Planning Authority and involved a review of site investigation and remediation

strategy to determine the level of Section 106 contribution required from the developer. The risks associated with development of a school/tertiary college land for which was being used as the developers Section 106 obligation, were also assessed.

Liability Management: Former Ethylbenzene Manufacturing Plant, Barry, UK. Assessment of contaminant distribution, potential risks and regulatory requirements for a former ethylbenzene manufacturing plant.

Brownfield Development / Regeneration Planning: Beryllium Pad, Avonmouth, UK, Merebank. Advice in relation to the possible exhumation of beryllium contaminated materials, which were encapsulated in pits beneath a concrete slab in the early 1970s. Given the high perceived levels of risk a tiered investigation approach was utilised starting with non-invasive techniques and subsequently sampling materials from within the pits. A detailed quantitative risk assessment was undertaken which generated a safe concentration form long term use of the site.

Two of the five burial pits were subsequently exhumed with materials recovered for safe disposal off-site.

Key Projects Prior to Joining ERM

Closure and Decommissioning / Remedial Review, Rogerstone, Newport, UK, Alcan. The project involved a process of determining environmental liabilities and management options for reducing these liabilities at an active aluminium rolling mill. Paul was involved in this work since its inception, the study started with an audit of the existing facility and the development of a conceptual model. Site investigations refined the conceptual model, and quantitative risk assessments were undertaken. Unacceptable risks were determined as being present from organic contaminants due to the likely impacts upon surface water. The remediation strategy was focussed on the treatment of organic contaminants within groundwater through a large pump and treat abstraction system. This system was located within an active area of the plant, which required a high degree of liaison and planning during installation**.**

Closure and Decommissioning, Falkirk, UK. Provision of advice relating to the closure, decommissioning of an aluminium rolling mill in Falkirk, Scotland and subsequent sale of the land.

Project involved a review of existing information, gap analysis and scoping of site investigations in order to develop a risk based assessment to allow operator to safely withdraw from the site.

Closure and Decommissioning: Irish Ispat, Cork, Ireland. Paul was responsible for undertaking an audit of the Irish Ispat electric arc furnace in Cork on behalf of the Irish government. The Irish government are the free-hold owners of the site, and as the steel works had gone into liquidation, the Irish government were concerned regarding potential environmental liabilities that they may face when the site is returned to them. It was estimated that the Irish government had a liability of approximately €30m relating to the site due to the sites proximity to environmental receptors and the nature of the closure.

Closure, Decommissioning and Regeneration: All Wales Strategy & Spent Pickle Liquor Lagoons assessment, UK, Corus. Providing strategic assistance to Corus with regard to environmental liabilities associated with the Welsh closure sites, principally Bryngwyn works Swansea, Ebbw Vale and Llanwern Newport, and the transfer of the Whitehead works to the 'New' Llanwern.

Work involved Phase 1 auditing of the Llanwern, Bryngwyn and Ebbw Vale plants. Scoping of Phase 2 site investigations for all three of these plants, and direction of the Whitehead site investigations. Development of remediation costs and support in relation to site divestment strategies.

The Spent Pickle Liquor project involves an assessment of liabilities for an area of the Llanwern works not included with the closure area, and development of an appropriate strategy for remediation of this area. The applicability of over 50 remedial; techniques were assessed. A strategy was developed which provided management options

ranging from £4.5M to £25M. On site trials were undertaken and one of the lagoons has been relocated (to make way for the new Whitehead works within the Llanwern plant) by de-solidification and pumping.

Liability Management: Multiple Site Assessments, UK Wide, Defence Estates. Responsible for delivery of various projects involving Phase 1 and Phase 2 investigations on active military bases including engineering depots, supply centres, aircraft maintenance sites and the manufacture of chemical weapons and explosives production. A variety of ground investigation techniques have been employed at these sites to provide appropriate levels of information.

Closure & Regeneration: RAF St Athan Determination of soil and groundwater impacts through 50 years of maintenance activity. Understanding consequences, risk mitigation strategies and support during sale of the base to allow owner to achieve a clean exit.

Liability Management: Project Dragon, Caerphilly, UK. Project involved the development of construction guidance for deep basement excavations, within a factory extension. Groundwater beneath the factory had been contaminated with chlorinated solvents, excavations penetrated groundwater by some 2m.

Work involved liaison, with regulators to gain necessary consents and approvals, and management of environmental monitoring programme during construction phase.

Liability Management: Abandoned Metal Mine Programme, Wales, UK
Management of environmental and ecological studies to assess pollution arising from historic pb-zn mines in mid-Wales, UK, and public safety, historic value and nature conservation needs.

Raeburn Anthony Jones

599 Arcadia Village, East Bank Demerara, Guyana. Tel: (592) 685 3271, (592) 611 2748. Email: mocha72gy@gmail.com

EXPERIENCE

2019- Present Independent Consultant- Environmental Assessment and Management Planning (EAMP)

- Reunion Gold Corporation – Oko West Project Environmental Baseline Survey
- Kumu Hydropower Project
- Moco Moco Hydropower Project
- Mahdia Solar Farm Project
- Stronghold Gold Inc. – Kilroy Resources Project
- Rapid Biodiversity Assessment North Eastern Dam of the East Demerara Water Conservancy
- Friendship Industrial Site

Environmental and Social Management Planning

- Black Jaguar Quarry ESMP

Special Projects

- Coastal Zone Sensitivity Mapping Project
- MOF, Pipeline and Vegetation Survey - Guyana Gas to Shore Project
- Georeferencing and vegetation clearing NGL Site and Pipe Line route- Guyana Gas to Shore Project
- Preparation and vegetation clearance - landing of Exxon Mobile Fiber Optic Cable Ogle
- Lidar survey for Guyana Gas to Shore Project

2016 – 2019 Ground Strurctures Engineering Company. Liliendaal, Georgetown.
Head of Department – Enviromental Unit.

- Planning , scheduling and implementing work programs and for unit(field and office).
- Analyzing data and Preparation of reports.
- Coordinate the development of Environmental and Social Impact Assessment for clients.
- Coordinate and conduct bio – physical and social baseline surveys for ESIAs.

2009 - 2016 Forestry Consultant, Logger and Miner.

- Preparation of Forest Management and Annual Plans.
- Conducting training in Reduce Impact Logging (RIL).
- Conducting training in GPS, compass and mapping.
- Mananging small scale mining and logging operation.

- Designing and implementing forest inventories (Per -Harvest & Post – Harvest).
- Designing, aligning and constructing forest and mining road network.
- Identifying and demarcation of concession boundaries (forest and gold mining).
- Designing, planning and directing construction projects.
- Supervising daily activities of construction site, determining workforce and material demands.
- Procuring materials and ensuring these are efficiently utilized.
- Ensuring that project is completed within the budgetary requirements and on schedule.

2008 – 2009 Guyana School of Agriculture. Mon Repos, E. C. D.
Lecturer – Forestry and Agriculture

- Planning , implementing programs and schedules for students.
- Assisting in student welfare and counselling.
- Supervising subordinate technical staff and students.
- Revising the forestry syllabus to meet the needs of the forest sector.
- Serving as a panel member in both academic and admission committee.
- Lecturing courses as determined by the principal.
- Organizing field trips, laboratory and other relevant training activities.
- Assist in organizing extra curriculum activities for students and staff.
- Performing other duties as determined by the principal.

2007 - 2008 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Assistant Commissioner of Forests – Inventory

- Preparation of work plans and budgets for the Inventory Unit.
- Supervising state forest inventories (Per -Harvest & Post – Harvest).
- Advising communities on Participatory Forest Management.
- Implementing and supervising the Sustainable Forestry Management Program for forest dependent communities (World Wildlife Fund Project).
- Maintaining registers of all inventories on forest resources conducted in Guyana.
- Conducting field audits to verify information provided in Annual Plan of operation of all forest concessions.
- Verifying information on the log tracking database.
- Supervising state forest concession boundary demarcations.
- Supporting the allocation of forest areas for productive uses.
- Designing and implementing national forest resources management databases.
- Conducting training programs in the use of GPS, Compass & Mapping technology for the forest sector and Guyana Forestry Commission.
- Evaluating Forest Management & Annual Operation Plans.

- Working in collaboration with other natural resources agencies.
- Evaluating staff performance, ensuring the maintenance of discipline & the efficient use of resources.

2005 - 2007 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Assistant Commissioner of Forests – Forest Resource Planning

- Managing large concession administration database.
- The preparation of work plans and budgets for the Forest Resource Management Division.
- Advising the forest sector on matters relating to forest resource and forest management planning.
- Evaluating Forest Management & Annual Operation Plans.
- Working in collaboration with other natural resources agencies.
- Advising communities on Participatory Forest Management.
- Supervising state forest inventories (Per -Harvest & Post – Harvest).
- Supervising state forest concession boundary demarcations.
- Conducting training programs in Reduce Impact Logging (RIL) technology for the forest sector.
- Collecting information on communities, monitoring social impacts of forest operations and reporting on social issues.
- Supporting the allocation of forest areas for productive uses.
- Ensuring the participation of communities & stakeholders in forest area management planning and preparing area management plans.
- Supervising the updating of forestry concession maps.
- Compiling the Permanent Sample Plot Guidelines for Guyana.
- Conducting training programs in the use of GPS, Compass & Mapping technology for the forest sector and Guyana Forestry Commission.
- Evaluating staff performance, ensuring the maintenance of discipline & the efficient use of resources.

2003-2005 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Assistant Commissioner of Forests – Forest Resources Information

- Consulting with agencies responsible for natural resources information & assisting with the preparation of forest resource information.
- Supervising data analysis, evaluating resource information & preparing reports.
- Providing mapping services to the Guyana Forestry Commission and the forest sector.
- Research & advise the Guyana Forestry Commission on forest resource information & GIS/GPS & Mapping practices.

- Assisting with the preparation of work plans & budgets for the Division.
- Supporting the allocation of forest resources for productive uses.
- Conducting training programs in the use of GIS/GPS & Mapping technology for the forest sector and the Guyana Forestry Commission.
- Monitoring & evaluating staff performance, ensuring the maintenance of discipline & the efficient use of resources.

2002-2003 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Resource Planning Officer

- Planning forest surveys & inventory programmes.
- Assisting in establishing, training & equipping the survey & inventory field teams.
- Assisting in the procurement & management of approved materials & equipment.
- Preparing & implementing work plans for related field surveys & inventories.
- Drafting of the Code of Practice for the Harvesting of Nibi & Kufa (NTFP).
- Drafting of the Code of Practice for the Harvesting of Manicole (NTFP).
- Monitoring data collection & data processing for non timber forest products.
- Supervising the establishment of Permanent Sample Plots for Nibi & Kufa (NTFP).
- Supervising the maintenance of forest & plantation reserves.

1998-2002 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Senior Field Assistant

- Implementing work plans provided by the Assistant Commissioner Forests & Resource Planning Officers.
- Supervising the provision of equipment, transport & supplies for field operations.
- Managing costs to ensure field exercise objectives are achieved & executed to a high standard according to plans & procedures.
- Providing information, liaising with government agencies, communities & other stakeholders.

1994-1998 Guyana Forestry Commission. 1, Water Street Kingston, Georgetown.
Field Assistant III

- Conducting concession boundary demarcations & verifications.
- Conducting forest inventories.
- Establishing Permanent Sample Plots & assisting in research work.

- Assisting in the preparation of maps for concessionaires & field work.
- Providing training for internal & external stakeholders.

EDUCATION

BSc. Forestry (Credit) **2002**
University of Guyana

Dip. Forestry **1994**
Univesity of Guyana

REFERENCES

1. Elroy Charles, PhD, MSc, BSc.
   Senior Lecturer
   Faculty of Agriculture & Forestry
   University of Guyana
   Turkeyen Campus
   Tel: 592 222-3599
   Email: elroy.charles@uog.edu.gy

2. Godfrey Marshall, MSc. BSc.
   Consultant
   Tel. 642 1910 (mobile)
   Email: gemar@guyana.net.gy

3. Seon Hamer, MSc, BSc.
   Lecture 1/ Coordinator of Undergraduate Programmes
   School of Earth and Environmental Science
   University of Guyana
   Turkeyen Campus
   Tel: 222 4180 or 222 2463 (mobile 692 3809)
   Email: seon.hamer@uog.edu.gy

4. Janice Bollers, BSc, MSc, CAPM.
   Consultant
   Tel. 621 0387 (mobile)
   Email: karamaro@yahoo.com

5. Owen Bovell, MSc, BSc.

Lecturer
Faculty of Agriculture and Forestry
University of Guyana
Turkeyen Campus
Tel. 222-3599 (mobile) 657-9863
Email: ugfacagri@yahoo.com

Shauncy Henry, BSc. Biology

Consulting Associate

Shauncy is a passionate natural resource professional with a background in biological sciences. Through extensive fieldwork and hands-on research, Shauncy has honed her expertise in biological surveys, working with multiple national and international stakeholders to develop solutions to national environmental management issues through inclusive, environmental approaches. Shauncy has contributed to Guyana National Entomological Plan as a Microbiologist for three years engaging in several management plans for Guyana. Areas of focus include biological conservation and environmental conservation, sustainable practices, and stakeholder engagement. Further, non-biological experience includes air quality, groundwater, and socioeconomic surveys. In addition, with exceptional interpersonal skills, Shauncy has collaborated with many clients and colleagues for Key Projects at ERM Guyana.

EXPERIENCE: [6] years of experience (Ministry of Health – Microbiologist, ERM Guyana Inc – Environmental Consulting Associate): conducting biological baseline surveys.

LINKEDIN: https://www.linkedin.com/in/shauncy-henry-885a98258/

EMAIL: shauncy.henry@erm.com

EDUCATION

- Master of Science Degree (MSc.) Student – Pending Graduand, 2025
- Bachelor of Science Degree (BSc.) Biology - University of Guyana, Georgetown, Guyana, 2019

LANGUAGES

- English, native speaker
- Spanish (Basic)

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FIELDS OF COMPETENCE

- Biodiversity assessment
- Knowledge and practices with data analysis
- Map Reading and Navigation Using GPS
- AES/ VES for birds
- Camera trapping for wildlife research
- Laboratory skills (organic, inorganic, physical and biochemistry)
- Mathematical and numerical skills
- Groundwater and Hydrology research
- Forensic Engineering
- Socioeconomic Assessment
- Map Reading and Navigation (GPS) – Basic
- Project Management
- Air Quality Monitoring

KEY INDUSTRY SECTORS

- Biodiversity and conservation
- Mining
- Health (Vector Control/National Infectious Diseases)

KEY PROJECTS

Environmental, Social, Community Health and Cultural Heritage Baseline (Oko West Project) - Mining Sector (July 2023- December 2024)

Participated in the data collection for the aquatic (fish and macroinvertebrate) dry season survey and the wet season terrestrial (mammals, birds and herpetofauna) surveys. Supported the camera trapping for wildlife installation and (led) retrieval activities. In addition to biological surveys, assisted with socioeconomic assessment and reporting.

Hydrogeological Baseline Surveys (Oko West Project) – Mining Sector (September 2023 – November 2023)

Participated in the data collection for the hydrology and groundwater sampling surveys.

Whiptail Environmental Impact Assessment, Guyana- Oil and Gas Sector (August 2023)

Conducted stakeholder engagement with fisherfolks and residents in regions 5 and 6 and the Regional Democratic Council (RDC), Region 6.

Coastal Birds Survey (EEPGL) (September 2023, September 2024)

Supported the data collection (auditory and visual recording) of bird species along the coast of Guyana (Region 1-6).

Gas to Energy Terrestrial Surveys (Riverine Otters and Vegetation) (March & April 2025): participated in data collection for riverine otters and vegetation post pipeline construction.

Seawater Sampling Campaign (May 2025): data collection around the FPSOs (Liza Destiny, Liza Unity and Payara Prosperity).

KEY PROJECTS PRIOR TO JOINING ERM

National Action Plan - Entomology Unit (Microbiologist – Ministry of Health, Guyana)

Supported the laboratory services for health departments, community environmental health programs and for physicians needing information for diagnosis and treatment. Also conducted environmental services using integrated vector management throughout various communities in the country.

Yves Verlinden, MIEnvSc, MIAQM

Principal Technical Consultant

Yves is a principal consultant air quality specialist with ERM. He is currently leading the air quality impact assessment for a hydrogen storage facility in the UK and has previously undertaken project work investigating the use of hydrogen in combustion systems in relation to emissions to air. Yves has experience with power plants, refineries, chemicals production, mining, iron and steel plants, and a range of other types of industry.

EXPERIENCE: 20 years' experience in Air Quality

LINKEDIN: https://www.linkedin.com/in/yves-verlinden-44481567/

EMAIL: yves.verlinden@erm.com

EDUCATION

- MSc Applied Biological Sciences. Environmental Technology, University of Ghent, Belgium, 2002

PROFESSIONAL AFFILIATIONS AND REGISTRATIONS

- EIA-expert 'air', Flanders
- EIA-expert 'water', Flanders
- Full Member IES
- Full Member IAQM

LANGUAGES

- Dutch: mother tongue
- English: good
- French: fair
- German: limited

FIELDS OF COMPETENCE

- Detailed dispersion modelling utilising IMPACT and IFDM, ADMS, AERMOD and CalPuff
- Mitigation of impacts on air quality, both end-of-pipe as process integrated
- Preparing and undertaking ambient air quality monitoring surveys

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- Undertaking assessments of traffic emissions on air quality
- Preparation of water balance, linear impact assessment of water discharge
- Input into the PPC process for industrial clients

KEY INDUSTRY SECTORS

- Infrastructure
- Power and New Energy
- Oil & Gas
- Mining
- Iron & Steel
- Non-ferrous metals
- (Petro)Chemical
- Manufacturing

KEY PROJECTS

Confidential Client – Air Quality Impact Assessment for a new Gold mine in Guinea, 2023

Open-pit mine project in early design phase was conceptualised by Yves based on early design data for air quality impact assessment using AERMOD dispersion modelling. With sensitive receptors in close proximity to activities, extra attention was given to embedded mitigation and design input.

Operational monitoring program for 3 mine sites, Ivory Coast, (2022 - ...)

Yves is developing/updating an air quality monitoring program for the sites to undertake baseline and operational air quality monitoring. This involves site works in support of the project to initiate the site monitoring. Yves is also delivering on-site and remote training for the mine's EHS teams.

Expansion impact assessments for existing gold mine, Ivory Coast, 2020 - 2022

Client operates a gold mine in Ivory Coast. The mine operates pits in close proximity to residential receptors in a nearby town. The client was seeking to expand mine pits towards the town. An impact assessment was required for the expansion works. Yves was PM and air quality modelling lead for this project.

Gangra DSO Mining Project - ESIA for a proposed expansion of an iron ore mine, Liberia, 2015-2016

The Project was proposed by ArcelorMittal Liberia Limited (AML) as an interim measure in response to changing regional and global financial circumstances. Yves prepared the Air Quality Impact Assessment which considered impacts from the mining activities, the handling of ore and waste and from the transport of ore by road to the processing and loading facilities. The impact assessment utilised dispersion modelling (AERMOD) to identify critical issues and facilitate the development of mitigation programmes for the reduction of impacts to air quality. The project was undertaken in line with the requirements of the IFC.

Allana Potash, Yara potash and G&B Minerals – EIAs and baseline air quality monitoring programmes for three proposed Potash mines, Ethiopia, 2012-2016

Yves worked on three separate, adjacent project sites to support the development of solution potash mines in the Danakil depression in Ethiopia. The projects required the development and in country deployment of baseline air quality monitoring surveys. Yves undertook baseline site works in support of one of the projects, prepared the air quality impact assessment and management plans for two of the projects and technically reviewed the baseline evaluation and impact assessment of one of the projects.

In addition to identifying the baseline conditions, the surveys also informed the clients regarding the potential for contamination of the potash product due to deposition of contaminant dusts to evaporation ponds. The EIAs considered impacts associated with the proposed developments, these primarily being associated with road traffic arising from shipping of product in terms of both exhaust emissions and emissions from unpaved roads, power generation and the operations of the proposed processing plants. The EIAs required particular consideration of the extreme nature of the environment and were undertaken in line with the requirements of IFC guidance.

China Union – EIA and baseline air quality monitoring for a proposed iron ore mine, Liberia, 2012

Yves developed and implemented a baseline air quality monitoring survey which considered the construction and operation of the mine, rail line and dedicated port facility for a proposed iron ore mine in Liberia. Yves undertook baseline site works in support of the project.

London Mining and African Minerals – EIA and baseline air quality monitoring for two proposed iron ore mines, Sierra Leone, 2012

ERM was commissioned to support the expansion of two operational iron ore mines in Sierra Leone. Baseline air quality monitoring surveys were developed and implemented, with due consideration of the existing operations.

Multi-element EIAs were undertaken in line with IFC requirements for the projects considering the construction and operation of the mines, including transport routes and ship loading. The impact assessments utilised dispersion modeling to identify critical issues and facilitate the development of mitigation programmes for the management of impacts at sensitive receptors.

APPENDIX F TOPIC APPENDICES

AIR

DUSTDISC DEPOSITION REPORT

Client:	Mako Mining Corp	**Site:**	Georgetown, Guyana

DUSTDISC SETTLEMENT AAC% & EAC% DATA

Our reference:	Date Out:	Date In:	Interval* (days)	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Dust Impact Risk
158391 / 1D mine / ZMMCGTG	15-Oct-25	12-Nov-25	28	99.4	5.2	3.5	0.2	N/A

Sampling interval exceeded 14 days - Dust Impact Risk not calculated

*We recommend 1-14 day sampling intervals

Please see our 'Quick Guide to DustDisc Reporting' for more information on our assessment matrix and criteria

DustScanAQ is a registered trademark and the trading name of DustScan Ltd

GRAVIMETRIC ANALYSIS REPORT

Client:	Mako Mining Corp	**Site:**	Georgetown, Guyana

DUSTDISC DEPOSITIONAL DATA

Our Reference	Date Out:	Date In:	Interval (days)	Mass of dust (mg) as released solids	Inferred deposition rate as released solids (mg/m^2/day)
158391 / 1D mine / ZMMCGTG	15-Oct-25	12-Nov-25	28	21.9	185.5

Some sites use 'Frisbee-type' deposition gauges and apply a 'custom and practice' threshold of 200 mg/m^2/day as a means of assessing performance, in the absence of any recognised limit values for visible / nuisance dust (see Environment Agency M17).

Dust mass of less than 2.37 mg is below our detection limit and is therefore reported as BDL.

The table above shows that the calculated deposition rates of the above DustDisc samples collected from the Georgetown, Guyana did not exceed 200mg/m^2/day.

If you have any questions regarding the above results or any other matters please don't hesitate to get in touch.

Analyst's comments

158391 / 1D mine / ZMMCGTG: Calculation has been manually adjusted to account for double quantities of glue from two sticky pads

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2187

LABORATORY ANALYSIS REPORT

NITROGEN DIOXIDE IN DIFFUSION TUBES BY U.V.SPECTROPHOTOMETRY

REPORT NUMBER U00068R
BOOKING IN REFERENCE U00068
DESPATCH NOTE 119503
CUSTOMER Ormantine Attn: MICHAEL WILLMONT
1740 Convair Street
Palm Bay
Florida
FL32909
USA
DATE SAMPLES RECEIVED 19/12/2025
JOB NUMBER 61959

Location	Sample Number	Exposure Data Date On*	Date Off*	Time* (hr.)	µg/m³ *	ppb *	µg NO_2 on tube
Eagle Mountain 1	1977367	15/10/2025	12/11/2025	666.55	5.08	2.65	0.25
Eagle Mountain 2	1977368	15/10/2025	12/11/2025	666.57	4.19	2.19	0.20
Eagle Mountain 3	1977369	15/10/2025	12/11/2025	666.58	4.11	2.14	0.20
Blank 1	1977370			666.58	2.93	1.53	0.14
Blank 2	1977371			666.58	2.97	1.55	0.14
Blank 3	1977372			666.58	1.03	0.54	0.05
Blank 4	1977373			666.58	1.78	0.93	0.09
Blank 5	1977374			666.58	2.04	1.07	0.10
Blank 6	1977375			666.58	2.48	1.29	0.12
Blank 7	1977376			666.58	1.88	0.98	0.09
Laboratory Blank				666.58	<0.62	<0.32	<0.030

Comment: Results are not blank subtracted
Result reported as <0.030 µg is below the reporting limit.
Results have been corrected to a temperature of 293 K (20°)
Overall M.U. ±9.7% **Limit of Detection** 0.030µgNO_2
The reported expanded uncertainty is based on a standard uncertainty multiplied by a factor of *k*=2, providing a level of confidence of approximately 95%. Uncertainty of measurement has not been applied to the reported results.

Tube Preparation : 20% TEA / Water Analysed on UV CARY3

Analyst Name Mihnea Marmara **Report Checked By** Andy Poole

Date of Analysis 09/01/2026 **Date of Report** 09/01/2026

Analysis carried out in accordance with documented in-house Laboratory Method GLM7

Samples have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures. Results within this report relate only to samples as received. Data provided by the client and any subsequent calculations shall be indicated by an asterisk (*), these calculations and results are not within the scope of our UKAS accreditation. Any queries concerning data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

REPORT OFFICIALLY CHECKED

Gradko International Ltd
This signature confirms the authenticity of these results
Signed.....
L. Gates, Laboratory Manager

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF SULPHUR DIOXIDE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER U00067R
BOOKING IN REFERENCE No U00067
DESPATCH NOTE No 119503

CUSTOMER Ormantine Attn: MICHAEL WILLMONT
1740 Convair Street
Palm Bay
Florida
FL32909
USA

DATE SAMPLES RECEIVED 19/12/2025
JOB NUMBER 61959

Location	Sample Number	Date Exposed*	Date Finished*	Exposure Hours*	SO_4^{2-} µg on tube	SO_2 µg/m³*	SO_2 ppb*
Eagle Mountain 1	1977377	15/10/2025	12/11/2025	666.50	0.25	4.61	1.73
Eagle Mountain 2	1977378	15/10/2025	12/11/2025	666.45	1.06	19.38	7.27
Eagle Mountain 3	1977379	15/10/2025	12/11/2025	666.42	2.61	47.66	17.87
Blank 1	1977380			24.00	0.74	377.16	141.44
Blank 2	1977381			24.00	0.40	201.90	75.71
Blank 3	1977382			24.00	0.38	190.33	71.37
Blank 4	1977383			24.00	0.26	133.81	50.18
Blank 5	1977384			24.00	1.53	775.43	290.79
Blank 6	1977385			24.00	0.39	197.59	74.10
Blank 7	1977386			24.00	0.29	149.43	56.04
Laboratory Blank				666.50	<0.09	<1.59	<0.60

Comment: Results are not blank subtracted
Tubes have exceeded shelf-life. Results may be compromised.

Overall M.U. ±11% **Reporting Limit** 0.09µg SO_4^{2-}

The reported expanded uncertainty is based on a standard uncertainty multiplied by a factor of *k*=2, providing a level of confidence of approximately 95%. Uncertainty of measurement has not been applied to the reported results.

Analysed on Inuvion ICU12

Analyst Name Gordon Clemenson **Report Checked By** Amandeep Kaur

Date of Analysis 08/01/2026 **Date of Report** 09/01/2026

Analysis has been carried out in accordance with in-house method GLM1

Samples have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures. Results within this report relate only to samples as received. Data provided by the client and any subsequent calculations shall be indicated by an asterisk (*), these calculations and results are not within the scope of our UKAS accreditation. Any queries concerning data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

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L. Gates, Laboratory Manager

DUSTDISC DEPOSITION REPORT

Client:	Environmental Resources Management (ERM)	**Site:**	Rolling Meadows, USA

DUSTDISC SETTLEMENT AAC% & EAC% DATA

Our reference:	Date Out:	Date In:	Interval* (days)	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Dust Impact Risk
153380 / MINE / ZERMRMUSA	10-Apr-25	07-May-25	27	99.9	12.0	3.7	0.4	N/A

Sampling interval exceeded 14 days - Dust Impact Risk not calculated

*We recommend 1-14 day sampling intervals

Please see our 'Quick Guide to DustDisc Reporting' for more information on our assessment matrix and criteria

DustScanAQ is a registered trademark and the trading name of DustScan Ltd

GRAVIMETRIC ANALYSIS REPORT

Client:	Environmental Resources Management (ERM)	**Site:**	Rolling Meadows, USA

DUSTDISC DEPOSITIONAL DATA

Our Reference	Date Out:	Date In:	Interval (days)	Mass of dust (mg) as released solids	Inferred deposition rate as released solids (mg/m^2/day)
153380 / MINE / ZERMRMUSA	10-Apr-25	07-May-25	27	32.64	286.1

Some sites use 'Frisbee-type' deposition gauges and apply a 'custom and practice' threshold of 200 mg/m^2/day as a means of assessing performance, in the absence of any recognised limit values for visible / nuisance dust (see Environment Agency M17).

Dust mass of less than 0.80 mg is below our detection limit and is therefore reported as BDL.

The table above shows that the calculated deposition rates of the above DustDisc samples collected from the Rolling Meadows, USA exceeded 200mg/m^2/day at MINE.

If you have any questions regarding the above results or any other matters please don't hesitate to get in touch.

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tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

NITROGEN DIOXIDE IN DIFFUSION TUBES BY U.V.SPECTROPHOTOMETRY

REPORT NUMBER T03414R
BOOKING IN REFERENCE T03414
DESPATCH NOTE 116040
CUSTOMER Ormantine Attn: MICHAEL WILLMONT
1740 Convair Street
Palm Bay
Florida
FL32909
USA
DATE SAMPLES RECEIVED 22/05/2025
JOB REFERENCE 58351 (012633-1366)

Location	Sample Number	Exposure Data Date On*	Date Off*	Time* (hr.)	µg/m³ *	ppb *	µg NO_2 on tube
Mine Site 1	1976903	10/04/2025	07/05/2025	644.43	3.01	1.57	0.14
Mine Site 2	1976904	10/04/2025	07/05/2025	644.43	8.33	4.35	0.39
Mine Site 3	1976905	10/04/2025	07/05/2025	644.43	4.65	2.43	0.22
TBS1	1976906			644.43	0.64	0.33	0.03
TB1	1976907			644.43	0.68	0.36	0.03
BS1	1976908			644.43	0.77	0.40	0.04
B1	1976909			644.43	4.23	2.21	0.20
No barcode on arrival	2238017			644.43	1.13	0.59	0.05
No barcode on arrival	2238018			644.43	0.64	0.33	0.03
No barcode on arrival	2238019			644.43	0.92	0.48	0.04
	Laboratory Blank			644.43	0.00	0.00	0.000

Comment: Results are not blank subtracted.
Unlabelled tubes not listed on exposure sheet were received.
Numbers 2238018, 2238017 & 2238019 were allocated & maximum exposure time used.
Results have been corrected to a temperature of 293 K (20°).

Overall M.U. ±9.7% **Limit of Detection** 0.028µgNO_2

The reported expanded uncertainty is based on a standard uncertainty multiplied by a factor of *k*=2, providing a level of confidence of approximately 95%. Uncertainty of measurement has not been applied to the reported results.

Tube Preparation: 20% TEA / Water Analysed on UV CARY1

Analyst Name Ivelina Paldamova **Report Checked By** Marek Bianga

Date of Analysis 03/06/2025 **Date of Report** 03/06/2025

Analysis carried out in accordance with documented in-house Laboratory Method GLM7.

Samples have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures. Results within this report relate only to samples as received. Data provided by the client and any subsequent calculations shall be indicated by an asterisk (*), these calculations and results are not within the scope of our UKAS accreditation. Any queries concerning data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

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LABORATORY ANALYSIS REPORT

DETERMINATION OF SULPHUR DIOXIDE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER T03413R

BOOKING IN REFERENCE No T03413

DESPATCH NOTE No 116040

CUSTOMER Ormantine Attn: MICHAEL WILLMONT
1740 Convair Street
Palm Bay
Florida
FL32909
USA

DATE SAMPLES RECEIVED 22/05/2025

Location	Sample Number	Date Exposed*	Date Finished*	Exposure Hours*	SO_4^{2-} µg on tube	SO_2 µg/m³*	SO_2 ppb*
Mine Site 1	1976913	10/04/2025	07/05/2025	644.43	0.13	2.53	0.95
Mine Site 2	1976914	10/04/2025	07/05/2025	644.43	0.74	13.95	5.23
Mine Site 3	1976915	10/04/2025	07/05/2025	644.40	0.31	5.81	2.18
TBS1	1976916			644.43	0.34	6.37	2.39
TBS1	1976917			644.43	0.12	2.36	0.88
BS1	1976918			644.43	1.38	26.14	9.80
B1	1976919			644.43	0.29	5.46	2.05
No barcode on arrival	2238014			644.43	0.43	8.17	3.07
No barcode on arrival	2238015			644.43	0.12	2.35	0.88
No barcode on arrival	2238016			644.43	0.36	6.71	2.52
Laboratory Blank				644.43	0.01	0.15	0.05

Comment: Results are not blank subtracted
Unlabelled tubes not listed on exposure sheet was received. Numbers 2238014-16 were allocated & maximum exposure time used.
No exposure details were given for tubes 1976916-19. Maximum exposure time was used.

Overall M.U. ±11% **Reporting Limit** 0.09µg SO_4^{2-}

The reported expanded uncertainty is based on a standard uncertainty multiplied by a factor of *k*=2, providing a level of confidence of approximately 95%. Uncertainty of measurement has not been applied to the reported results.

Analysed on Dionex Inuvion ICU12

Analyst Name Gordon Clemenson **Report Checked By** Linda Gates

Date of Analysis 04/06/2025 **Date of Report** 06/06/2025

Analysis has been carried out in accordance with in-house method GLM1

Samples have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures. Results within this report relate only to samples as received. Data provided by the client and any subsequent calculations shall be indicated by an asterisk (*), these calculations and results are not within the scope of our UKAS accreditation. Any queries concerning data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

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NOISE

ERM

Noise Survey Data Sheet

R1 Day 1

Location:	5.186297°N, 59.130679°W
Investigator Name:	A. Atkinson & S. Henry
Date:	10/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.8 dB, deviation of -0.2 dB)

Meteorological Conditions

Wind Speed:	6km/h
Direction:	E
Temperature:	25ºC
RH %:	97%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	Music from a nearby shop
Other noise source(s):	Dogs barking, residents chatting, chickens, generator in distance, motorcycles, ATVs
Time start:	10:06
Time end:	11:06
Comments:	# of motorcycles - 4
	# ATVs - 1

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Noise Survey Data Sheet

R1 Day 2

Location:	5.186297°N, 59.130679°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB

Meteorological Conditions

Wind Speed:	10km/h
Direction:	E
Temperature:	28^0C
RH %:	77%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	Birds, residents chatting, music from shops nearby
Other noise source(s):	Motorcycles, generators in distance, ATVs, cars and pickup trucks
Time start:	16:26
Time end:	17:26
Comments:	# of ATVs – 1
	# of pickup trucks – 2
	# of cars – 1
	# of motorcycles - 2
	This area saw minimal vehicular traffic from residents

ERM

Noise Survey Data Sheet

R1 Night 1

Location:	5.186297°N, 59.130679°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	NNE
Temperature:	23°C
RH %:	99%
Barometric Pressure in mmHg:	763
Predominant noise source(s):	Birds
Other noise source(s):	dogs barking, roosters crowing, motorcycles, pickup trucks, residents chatting, chickens, generator in distance, motorcycles, ATVs
Time start:	06:10
Time end:	07:10
Comments:	# of motorcycles - 1
	# of pickup trucks - 2

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Noise Survey Data Sheet

R2 Day 1

Location:	5.185396°N 59.128159°W
Investigator Name:	A. Atkinson & S. Henry
Date:	10/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.8 dB, deviation of -0.2 dB)

Meteorological Conditions

Wind Speed:	6km/h
Direction:	E
Temperature:	25^0C
RH %:	97%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	birds, cicadas
Other noise source(s):	ATVs passing, music from nearby settlement, residents singing, motorcycles and cars.
Time start:	08:40
Time end:	09:40
Comments:	# of cars - 1
	# of motorcycles - 1

ERM

Noise Survey Data Sheet

R2 Day 2

Location:	5.185396°N 59.128159°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB

Meteorological Conditions

Wind Speed:	10km/h
Direction:	E
Temperature:	28^0C
RH %:	77%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	birds
Other noise source(s):	Music from residents' homes, motorcycles, cars
Time start:	15:16
Time end:	16:16
Comments:	# of motorcycles - 1
	# of cars - 1

ERM

Noise Survey Data Sheet

R2 Night 1

Location:	5.185396°N 59.128159°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/04/2024
Meter Manufacturer and Model Number:	Casella, CEL-63X
Serial Number:	2425358
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB/94dB at 1kHz
Calibrator Serial Number:	0966247
Initial Calibration:	114 dB
Final Calibration:	114 dB (ended at 113.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	NNE
Temperature:	23^0C
RH %:	98%
Barometric Pressure in mmHg:	763
Predominant noise source(s):	Insects, frogs, birds
Other noise source(s):	Residents arguing in distance, howler monkeys in distance, dog barking in distance, motorcycles, cicadas
Time start:	05:01
Time end:	06:01
Comments:	# of ATVs - 1
	# of motorcycles - 1

ERM

Noise Survey Data Sheet

R3 Day 1

Location:	5.232950°N 59.139367°W
Investigator Name:	A. Atkinson & S. Henry
Date:	10/4/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114 dB (ended at 113.8 dB, deviation of -0.2 dB)

Meteorological Conditions

Wind Speed:	10km/h
Direction:	ENE
Temperature:	28°C
RH %:	82%
Barometric Pressure in mmHg:	757
Predominant noise source(s):	Birds, stream nearby about 50m away
Other noise source(s):	Dredging activities, residents chatting nearby
Time start:	11:34
Time end:	12:34
Comments:	

ERM

Noise Survey Data Sheet

R3 Day 2

Location:	5.232950°N 59.139367°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/4/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114 dB (ended at 113.8 dB, deviation -0.2 dB)

Meteorological Conditions

Wind Speed:	10km/h
Direction:	NE
Temperature:	23°C
RH %:	82%
Barometric Pressure in mmHg:	758
Predominant noise source(s):	Insects (especially cicadas), stream flowing about 50m away, birds
Other noise source(s):	Residents chatting, music in distance, generator, pickup truck
Time start:	17:52
Time end:	18:52
Comments:	

ERM

Noise Survey Data Sheet

R3 Night 1

Location:	5.232950°N 59.139367°W
Investigator Name:	A.Atkinson & S.Henry
Date:	9/4/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.8dB, deviation of -0.2dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	ENE
Temperature:	24°C
RH %:	71%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	birds, cicadas, stream flowing about 50m away
Other noise source(s):	dogs barking in the distance, dredging activities from small scale miner, residents chatting in distance
Time start:	05:56
Time end:	06:56
Comments:	

ERM

Noise Survey Data Sheet

R4 Day 1

Location:	5.267342°N 59.139735°W
Investigator Name:	A. Atkinson & S. Henry
Date:	8/4/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	10km/h
Direction:	E
Temperature:	28°C
RH %:	72%
Barometric Pressure in mmHg:	758
Predominant noise source(s):	Chickens, birds, generation
Other noise source(s):	Music in the distance, aircrafts flying overhead, pickup trucks
Time start:	14:00
Time end:	15:00
Comments:	# of aircrafts – 2
	# of pickup trucks - 1

ERM

Noise Survey Data Sheet

R4 Day 2

Location:	5.232950°N 59.139367°W
Investigator Name:	A.Atkinson & S.Henry
Date:	9/4/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 113.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	ENE
Temperature:	24ºC
RH %:	98%
Barometric Pressure in mmHg:	762
Predominant noise source(s):	birds
Other noise source(s):	chicken, dogs barking, motorcycles, residents, generators from homes in surrounding area
Time start:	07:29
Time end:	08:29
Comments:	# of motorcycles - 1

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Noise Survey Data Sheet

R 5 Day 1

Location:	5.204431°N 59.116831°W
Investigator Name:	A. Atkinson & S. Henry
Date:	09/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB

Meteorological Conditions

Wind Speed:	11km/h
Direction:	E
Temperature:	23^0C
RH %:	88%
Barometric Pressure in mmHg:	760
Predominant noise source(s):	Birds, cicadas
Other noise source(s):	howler monkey in distance, ATVs passing on road, generator
Time start:	12:07
Time end:	13:07
Comments:	# of ATVs – 3 Generator is located approximately 1200m from monitoring location

ERM

Noise Survey Data Sheet

R5 Day 2

Location:	5.204431°N 59.116831°W
Investigator Name:	A. Atkinson & S. Henry
Date:	10/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 139.8 dB, deviation of -0.2 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	NE
Temperature:	24^0C
RH %:	92%
Barometric Pressure in mmHg:	759
Predominant noise source(s):	birds, insects
Other noise source(s):	generator, howler monkeys
Time start:	13:17
Time end:	14:17
Comments:	generator is located approximately 1200m from monitoring location

ERM

Noise Survey Data Sheet

R5 Night 1

Location:	5.204431°N 59.116831°W
Investigator Name:	A. Atkinson & S. Henry
Date:	10/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 139.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	NNE
Temperature:	23^0C
RH %:	89%
Barometric Pressure in mmHg:	760
Predominant noise source(s):	insects, frogs, crested owl
Other noise source(s):	generator
Time start:	22:01
Time end:	23:01
Comments:	generator is located approximately 1200m from monitoring location

ERM

Noise Survey Data Sheet

R5 Night 2

Location:	5.204431°N 59.116831°W
Investigator Name:	A. Atkinson & S. Henry
Date:	11/04/2025
Meter Manufacturer and Model Number:	Casella, CEL-633C
Serial Number:	1239532
Calibrator Manufacturer, Model, and dB:	Casella, CEL-120/1, 114dB at 1kHz
Calibrator Serial Number:	4723380
Initial Calibration:	114dB
Final Calibration:	114dB (ended at 139.9 dB, deviation of -0.1 dB)

Meteorological Conditions

Wind Speed:	5km/h
Direction:	NNE
Temperature:	22^0C
RH %:	99%
Barometric Pressure in mmHg:	759
Predominant noise source(s):	insects, frogs
Other noise source(s):	generator
Time start:	22:00
Time end:	23:00
Comments:	generator is located approximately 1200m from monitoring location

SOILS

Workorder: A25-15869
Client: Stronghold Guyana Inc.
Analysis: BTEX
Units: ppb or µg/Kg

Actlabs ID	Client ID	Benzene	Toluene	Ethylbenzene	(m,p) Xylene	o-xylene	Surrogate Standard % Recovery
A25-15869-1	C2	< 10	< 10	< 10	< 10	< 10	100
A25-15869-2	C3	< 10	< 10	< 10	< 10	< 10	90
A25-15869-3	C4	< 10	< 10	< 10	< 10	< 10	90
A25-15869-4	C5	< 10	< 10	< 10	< 10	< 10	85
A25-15869-5	C6	< 10	< 10	< 10	< 10	< 10	95
A25-15869-6	C7	< 10	< 10	< 10	< 10	< 10	110
A25-15869-7	C8	< 10	< 10	< 10	< 10	< 10	100
A25-15869-8	C9	< 10	< 10	< 10	< 10	< 10	110
A25-15869-9	C10	< 10	< 10	< 10	< 10	< 10	97
A25-15869-10	C11	< 10	< 10	< 10	< 10	< 10	87
A25-15869-11	C12	< 10	< 10	< 10	< 10	< 10	110
A25-15869-12	C13	< 10	< 10	< 10	< 10	< 10	120
A25-15869-13	C14	< 10	< 10	< 10	< 10	< 10	100
A25-15869-14	C15	< 10	< 10	< 10	< 10	< 10	120
A25-15869-14 Matrix Spike Dup	% Recovery	94	100	90	89	96	94
A25-15869-14 Matrix Spike Dup	% Recovery	110	110	100	100	110	100
A25-15869-15	C16	< 10	< 10	< 10	< 10	< 10	88
A25-15869-16	C17	< 10	< 10	< 10	< 10	< 10	99
A25-15869-17	C18	< 10	< 10	< 10	< 10	< 10	98
A25-15869-18	C19	< 10	< 10	< 10	< 10	< 10	83
A25-15869-19	C20	< 10	< 10	< 10	< 10	< 10	120
A25-15869-20	S1	< 10	< 10	< 10	< 10	< 10	77
A25-15869-21	S2	< 10	< 10	< 10	< 10	< 10	100
A25-15869-22	S3	< 10	< 10	< 10	< 10	< 10	92
A25-15869-23	S4	< 10	< 10	< 10	< 10	< 10	110
A25-15869-24	S5	< 10	< 10	< 10	< 10	< 10	90
A25-15869-25	S6	< 10	< 10	< 10	< 10	< 10	82
A25-15869-26	S7	< 10	< 10	< 10	< 10	< 10	85
A25-15869-27	S8	< 10	< 10	< 10	< 10	< 10	84
A25-15869-28	S9	< 10	< 10	< 10	< 10	< 10	92
A25-15869-29	S10	< 10	< 10	< 10	< 10	< 10	84
A25-15869-30	S11	< 10	< 10	< 10	< 10	< 10	100
A25-15869-31	DP1	< 10	< 10	< 10	< 10	< 10	80
A25-15869-32	DP2	< 10	< 10	< 10	< 10	< 10	97
A25-15869-33	DP3	< 10	< 10	< 10	< 10	< 10	77
A25-15869-33 Matrix Spike	% Recovery	100	75	51	46	76	76
A25-15869-33 Matrix Spike Dup	% Recovery	110	80	57	52	83	82

Method Blank	-	< 10	< 10	< 10	< 10	< 10	110

Workorder: A25-15869
Client: Stronghold Guyana Inc.
Analysis: PAH
Units: ppb or µg/Kg

	Actlabs ID	A25-15869-1	A25-15869-2	A25-15869-3	A25-15869-4	A25-15869-5	A25-15869-6	A25-15869-6 Duplicate	A25-15869-7	A25-15869-8	A25-15869-9	A25-15869-10	A25-15869-11
	Client ID	C2	C3	C4	C5	C6	C7	C7	C8	C9	C10	C11	C12
Napthalene		< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.6	1.4
Acenaphthylene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acenaphthene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluorene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenanthrene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Anthracene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoranthene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Pyrene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chrysene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzo(a)anthracene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzo(b)fluoranthene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzo(k)fluoranthene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzo(a)pyrene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dibenzo(a,h)anthracene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Indeno(1,2,3-cd) pyrene		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Benzo(ghi)perylene		< 1.0	< 1.0	< 1.0	3.2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	6.8	< 1.0

A25-15869-12	A25-15869-13	A25-15869-14	A25-15869-15	A25-15869-16	A25-15869-17	A25-15689-18	A25-15869-19	A25-15869-20	A25-15869-21	A25-15869-22	A25-15869-23	A25-15869-23 Duplicate	A25-15869-24	A25-15869-25
C13	C14	C15	C16	C17	C18	C19	C20	S1	S2	S3	S4	S4	S5	S6
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	13.0	< 1.0	1.3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.1	< 1.0

A25-15689-26	A25-15869-27	A25-15869-28	A25-15869-29	A25-15869-30	A25-15869-31	A25-15869-32	A25-15869-33	Method Blank
S7	S8	S9	S10	S11	DP1	DP2	DP3	-
< 1.0	< 1.0	< 1.0	1.3	< 1.0	< 1.0	< 1.0	2	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
< 1.0	< 1.0	< 1.0	2.9	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Workorder: A25-15869
Client: Stronghold Guyana Inc.
Analysis: TPH
Units: ppm or mg/Kg

Actlabs I.D	Client I.D	TPH (ppm or mg/L)
A25-15869-1	C2	< 1.0
A25-15869-2	C3	< 1.0
A25-15869-3	C4	< 1.0
A25-15869-4	C5	3.2
A25-15869-5	C6	< 1.0
A25-15869-6	C7	< 1.0
A25-15869-6 Duplicate	C7	2.2
A25-15869-7	C8	< 1.0
A25-15869-8	C9	1.9
A25-15869-9	C10	< 1.0
A25-15869-10	C11	7
A25-15869-11	C12	< 1.0
A25-15869-12	C13	< 1.0
A25-15869-13	C14	< 1.0
A25-15869-14	C15	< 1.0
A25-15869-15	C16	< 1.0
A25-15869-16	C17	1.8
A25-15869-17	C18	< 1.0
A25-15869-18	C19	1.9
A25-15869-19	C20	< 1.0
A25-15869-20	S1	1.8
A25-15869-21	S2	1.1
A25-15869-22	S3	< 1.0
A25-15869-23	S4	< 1.0
A25-15869-23 Duplicate	S4	< 1.0
A25-15869-24	S5	2.2
A25-15869-25	S6	4.8
A25-15869-26	S7	< 1.0
A25-15869-27	S8	1.4
A25-15869-28	S9	< 1.0
A25-15869-29	S10	16.6
A25-15869-30	S11	< 1.0
A25-15869-31	DP1	5.9
A25-15869-32	DP2	< 1.0
A25-15869-33	DP3	< 1.0
Laboratory Method Blank	--	< 1.0

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Report Date: 8/12/2025

Activation Laboratories

Analyte Symbol	Hg	H20-	Li	Na	Mg	Al	K	Ca	Cd	V	Cr	Mn	Fe	Hf
Unit Symbol	ppb	%	ppm	%	%	%	%	%	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	5	0.1	0.5	0.01	0.01	0.01	0.01	0.01	0.1	1	1	1	0.01	0.1
Upper Limit	100000		400	3	50	10	5	50	1000	10000	5000	10000	50	500
Method Code		1G GRAV-Moisture	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
c2	400	13.4	3.8	0.02	0.03	5.74	0.17	0.02	< 0.1	433	144	192	13.8	2.3
c3	260	14	6.8	0.02	0.08	> 10.0	0.19	0.04	< 0.1	398	261	1280	14.9	2.8
c4	209	24.1	5.9	0.04	0.07	5.33	0.2	0.1	< 0.1	188	64	224	5.04	2.9
c5	276	19.6	5.7	0.02	0.07	> 10.0	0.05	0.05	< 0.1	590	210	316	17.8	6
c6	363	24.6	17.4	0.09	0.22	> 10.0	0.88	0.08	< 0.1	271	122	494	10.4	7.1
c7	429	16.2	14.5	0.06	0.16	> 10.0	0.49	0.12	< 0.1	291	153	967	11.6	6.9
c8	194	25.3	7	0.02	0.11	> 10.0	0.04	0.05	< 0.1	465	519	1770	22.5	2.3
c9	337	24.8	8.9	0.01	0.05	> 10.0	0.14	0.02	< 0.1	525	106	249	21	8.6
c10	281	16.2	4.9	0.01	0.05	> 10.0	0.08	0.01	< 0.1	644	122	631	23.2	13.8
c11	695	24.9	8.8	0.03	0.1	> 10.0	0.4	0.04	< 0.1	449	99	361	16.1	8.5
c12	422	16.2	8.6	0.03	0.08	> 10.0	0.26	0.04	< 0.1	422	77	381	14.6	8.2
c13	630	16.4	6.7	0.04	0.1	9.82	0.63	0.03	< 0.1	459	125	651	16.2	6.2
c14	91	23.9	14.1	1.71	0.03	> 10.0	0.62	0.01	< 0.1	510	84	284	15.5	1.5
c15	67	17.8	6	0.02	0.14	> 10.0	0.82	0.01	< 0.1	400	210	123	19.1	2.3
c16	301	19.4	9.4	0.03	0.1	9.81	0.17	0.07	< 0.1	440	98	784	15.2	9.6
c17	237	12.4	6.8	0.01	0.06	9.13	0.05	0.05	< 0.1	476	170	896	17.5	10.1
c18	77	24.1	10.8	0.02	0.18	> 10.0	0.27	0.06	< 0.1	383	168	385	15	2.1
c19	263	19.4	7.2	0.01	0.05	> 10.0	0.05	0.02	< 0.1	429	82	476	14.6	8.7
c20	143	11.1	9.7	0.02	0.09	> 10.0	0.48	0.03	< 0.1	546	239	673	19.1	3.3
s1	273	12.5	4	0.05	0.05	8.79	0.38	0.02	< 0.1	86	162	117	12	3.7
s2	788	12.1	11.6	0.06	0.16	7.85	2.22	0.05	< 0.1	159	105	396	5.55	5.5
s3	207	16.2	6.4	0.03	0.06	> 10.0	0.16	0.03	< 0.1	332	221	233	15.1	4.9
s4	171	14.4	10.7	0.02	0.19	> 10.0	0.94	0.02	< 0.1	170	52	158	6.71	8.9
s5	266	11.5	9.3	0.02	0.08	> 10.0	0.13	0.04	< 0.1	634	115	452	18.3	9
s6	348	14.1	7.2	0.04	0.07	> 10.0	0.1	0.07	< 0.1	427	82	540	14.7	9.8
s7	233	11.7	8.7	0.71	0.04	> 10.0	0.33	0.04	< 0.1	563	79	123	20	1.1
s8	177	20.3	18.4	0.04	0.26	> 10.0	0.56	0.03	< 0.1	257	244	334	13	5.3
s9	169	19.4	14.7	0.02	0.08	> 10.0	0.35	0.03	< 0.1	340	72	310	14.1	8.4
s10	273	13.8	16.4	0.03	0.13	> 10.0	1.16	0.02	< 0.1	147	60	329	8.46	10.3
s11	156	12.3	5.3	0.05	0.08	8.46	0.59	0.01	< 0.1	226	149	1440	11	4.7

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Activation Laboratories

Analyte Symbol	Hg	H20-	Li	Na	Mg	Al	K	Ca	Cd	V	Cr	Mn	Fe	Hf
Unit Symbol	ppb	%	ppm	%	%	%	%	%	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	5	0.1	0.5	0.01	0.01	0.01	0.01	0.01	0.1	1	1	1	0.01	0.1
Upper Limit	100000		400	3	50	10	5	50	1000	10000	5000	10000	50	500
Method Code	1G	GRAV-Moisture	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
DP1	357	13.9	7	0.05	0.08	9.52	0.11	0.09	< 0.1	404	73	629	13.9	10.1
DP2	979	10.3	10.7	0.05	0.14	6.74	2.13	0.06	< 0.1	146	71	340	4.91	4.3
DP3	357	24	18.6	0.1	0.21	> 10.0	0.89	0.09	< 0.1	272	104	509	10.7	7.3

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Activation Laboratories

Analyte Symbol	Hg	Ni	Er	Be	Ho	Ag	Cs	Co	Eu	Bi	Se	Zn	Ga	As	Rb	Y
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	0.5	0.1	0.1	0.1	0.05	0.05	0.1	0.05	0.02	0.1	0.2	0.1	0.1	0.2	0.1
Upper Limit	100000	5000	1000	1000	1000	100	100	500	100	2000	1000	10000	500	10000	5000	10000
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
c2	400	31.9	0.6	0.2	0.2	< 0.05	0.4	3.8	0.19	0.2	6.1	25.6	23.1	9.1	5.2	3.6
c3	260	63.4	1.6	0.7	0.6	< 0.05	0.67	65.2	0.7	0.12	4.9	49.4	25.2	9.4	7.6	12.3
c4	209	20.7	1.2	0.2	0.3	< 0.05	0.67	4.2	0.36	0.13	3.4	28.9	15.7	3.3	8.7	6.6
c5	276	20.2	0.5	0.3	0.2	0.26	0.37	6.4	0.21	0.16	11	31.2	41.2	3.2	2.3	3.8
c6	363	65.4	1.1	0.6	0.4	0.09	3.03	13.3	0.57	0.47	3.3	81.9	38.1	3.9	53.9	6.9
c7	429	53.9	1.2	0.6	0.5	0.06	1.64	51	0.7	0.31	3.8	67.8	32.9	5.5	31.8	10.1
c8	194	133	1.1	0.5	0.3	< 0.05	0.38	73	0.31	0.22	5.3	68.7	36.2	5.2	2.3	6
c9	337	28.9	0.7	0.4	0.2	< 0.05	1.06	9.5	0.29	0.47	7	44.6	56.6	9.8	11.6	3.8
c10	281	13.6	1	0.4	0.3	< 0.05	0.8	12.8	0.49	0.34	13.3	74.7	57.9	13.5	4.5	6.6
c11	695	30.1	0.8	0.6	0.3	0.13	1.27	7.7	0.43	0.66	10.1	63.2	49.2	8.1	21.6	6
c12	422	22.2	0.7	0.4	0.2	< 0.05	1	10.9	0.35	0.53	7.3	48.8	40.8	6.7	16.5	4.6
c13	630	28.1	1.4	1	0.4	0.18	1.43	24.3	0.55	5.49	3.3	74.1	30.9	12.7	30.4	8.8
c14	91	88.1	1	0.7	0.3	< 0.05	0.58	7.6	0.39	0.11	3	35.5	33.7	3.7	18.4	6.9
c15	67	87.2	1.3	0.8	0.4	0.32	1.74	7.6	0.44	0.53	2.4	20.6	39.6	32.3	34.1	7.2
c16	301	24.8	0.7	0.2	0.2	0.06	1.16	19.4	0.3	0.27	7.4	56.4	32.2	4.9	10.6	4.7
c17	237	18.2	0.6	0.2	0.1	< 0.05	0.35	20.1	0.2	0.23	6.9	74.8	28.6	6.6	2.5	3.5
c18	77	80	1.1	0.3	0.3	< 0.05	1.66	14.8	0.39	0.28	2.3	56.4	31.8	7.5	16.6	6.7
c19	263	24.4	0.7	0.4	0.2	< 0.05	0.4	9.8	0.25	0.22	7.3	60.9	42.5	5.3	3.5	4.7
c20	143	48.5	1.2	0.5	0.4	0.07	1.72	24.5	0.71	1.56	3.3	56.1	38.6	37	17.8	8.2
s1	273	33.8	2.1	0.4	0.8	< 0.05	1.06	2.1	1.61	0.17	6.2	34.3	35.6	7.2	12.8	15
s2	788	29.2	3.5	1.5	1.1	0.06	2.65	16.2	1.28	0.71	0.6	60.4	19	4.1	99.6	29.4
s3	207	54.3	1	0.3	0.4	< 0.05	1.13	4.1	0.48	0.29	12.8	31.9	35.9	13.9	7.1	7.7
s4	171	18.3	1.5	0.8	0.4	< 0.05	3.52	3.4	0.58	0.64	4.4	25.8	36.1	6.6	66.3	11
s5	266	20	0.7	0.3	0.3	0.05	1.19	11.9	0.32	0.35	13.4	51.7	35.6	9.3	8.4	5.1
s6	348	18.3	0.7	0.4	0.2	0.06	0.53	15.1	0.28	0.36	8.9	71.4	33.9	5.5	5.9	4.4
s7	233	60.8	0.7	0.5	0.3	< 0.05	0.78	5.5	0.33	0.14	8.1	42.8	29.9	6.7	11.8	5.8
s8	177	126	0.9	0.6	0.3	< 0.05	2.35	16.9	0.6	0.28	3.2	77	33.2	5.5	33.2	7
s9	169	27.5	0.7	0.7	0.2	< 0.05	1.81	8.1	0.33	0.41	4.4	51.1	46.9	6.4	26.2	4.4
s10	273	16.1	0.9	0.8	0.3	< 0.05	3.36	4	0.78	1.19	8	36	64.4	6.6	78.7	5.6
s11	156	42.4	0.7	0.3	0.2	0.13	1.21	18.9	0.37	0.17	4.9	35.2	22.7	7.5	23.2	4.8

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Activation Laboratories

Analyte Symbol	Hg	Ni	Er	Be	Ho	Ag	Cs	Co	Eu	Bi	Se	Zn	Ga	As	Rb	Y
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	0.5	0.1	0.1	0.1	0.05	0.05	0.1	0.05	0.02	0.1	0.2	0.1	0.1	0.2	0.1
Upper Limit	100000	5000	1000	1000	1000	100	100	500	100	2000	1000	10000	500	10000	5000	10000
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
DP1	357	16	0.6	0.3	0.2	< 0.05	0.55	17.2	0.25	0.32	7.3	70.4	29.8	4.5	6.1	4.9
DP2	979	23.3	3.2	1.2	1.1	0.05	2.46	13.3	1.17	0.6	0.4	51.3	15.7	3.5	90.4	26
DP3	357	64.6	1.1	0.7	0.3	0.09	2.82	14.4	0.65	0.49	4.2	82.3	41.1	4.2	57.2	7.4

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Activation Laboratories

Analyte Symbol	Hg	Zr	Nb	Mo	In	Sn	Sb	Te	Ba	La	Ce	Pr	Nd	Sm	Gd	Tb
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	1	0.1	0.05	0.1	1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Upper Limit	100000	5000	500	10000	100	200	500	500	5000	10000	10000	1000	10000	100	5000	100
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
c2	400	82	12	1.52	< 0.1	2	0.6	< 0.1	29	6.3	11.7	1.4	4.7	0.9	0.8	0.1
c3	260	97	9.1	0.94	0.1	2	5.1	< 0.1	69	6.1	13.1	1.6	6.3	1.5	2.2	0.5
c4	209	120	9.7	0.71	< 0.1	1	0.8	< 0.1	67	8.4	15.9	1.9	7.3	1.8	1.3	0.2
c5	276	251	21.4	1.34	0.1	2	0.6	< 0.1	16	5.3	11.7	1.2	4.2	1	0.8	0.1
c6	363	268	24	2.95	0.1	3	0.3	< 0.1	256	21.2	56.8	4.2	14.8	3.2	1.9	0.4
c7	429	254	23.3	2.77	0.1	2	0.4	< 0.1	162	21.3	86	4.8	15.7	3.2	2.2	0.4
c8	194	68	5.6	1.98	0.2	2	0.6	< 0.1	33	3.7	11.6	1.1	4.4	1	1.4	0.2
c9	337	281	22.5	2.96	0.2	4	0.4	< 0.1	36	12	20.9	2.3	8.5	1.4	1	0.2
c10	281	515	49.9	3.67	0.2	5	0.5	0.2	31	18.1	31.3	3.6	11.4	2.1	1.6	0.3
c11	695	289	23	2.88	0.2	4	0.7	0.1	104	19.7	30	3.6	11.3	1.8	1.7	0.2
c12	422	308	27.1	2.79	0.1	3	0.4	< 0.1	67	12.3	21.3	2.4	8.7	1.7	1.2	0.2
c13	630	232	24.2	59.9	0.1	3	0.7	0.3	189	15	38.3	3.3	11.4	2.2	1.9	0.3
c14	91	62	2.4	0.81	< 0.1	1	0.4	< 0.1	148	2.3	6.2	0.7	3.1	0.9	1.1	0.2
c15	67	68	6.2	3.79	0.2	2	1.4	0.3	157	9.3	23.7	2.3	7	1.8	1.4	0.3
c16	301	391	46.8	2.29	0.1	3	0.4	< 0.1	52	8.3	15	1.8	6.3	1.2	1	0.2
c17	237	433	43.5	2.62	0.2	3	0.8	< 0.1	14	5.8	10.9	1.2	4.7	0.6	0.6	0.1
c18	77	66	6	0.82	0.1	1	0.8	0.1	66	4.6	11.5	1.2	5.2	1.3	1.4	0.2
c19	263	364	32.2	2.29	0.1	3	0.4	0.1	42	9.6	17.4	1.7	5.2	1.2	0.9	0.2
c20	143	116	11.7	54.6	0.2	2	2.5	0.4	119	10.3	22	2.5	9.5	2.3	2.1	0.4
s1	273	141	11.5	1.46	0.2	2	1.1	< 0.1	82	23	45.9	7.5	30.2	6.7	4.8	0.6
s2	788	203	18	3.69	< 0.1	2	0.9	0.1	643	34.2	72.9	8.2	31.3	6.1	5.3	0.9
s3	207	180	22.9	2.11	0.1	3	0.8	< 0.1	57	17.4	29.4	3.6	12.4	2	1.8	0.3
s4	171	331	30.1	2.49	< 0.1	4	0.7	< 0.1	198	30.7	45.2	6.1	20.2	3.5	2.5	0.4
s5	266	358	31.8	2.47	0.1	3	0.4	0.1	43	11.1	18.9	2.4	8.8	1.3	1.1	0.2
s6	348	378	34.8	2.3	0.2	2	0.3	< 0.1	35	8.6	13.5	1.7	6.3	0.9	0.9	0.2
s7	233	47	4.2	1.22	0.1	1	1.7	0.2	72	4.5	8.6	1.3	4.9	1.4	1.3	0.2
s8	177	181	17.3	3.43	0.1	2	0.6	< 0.1	183	17.3	30.6	3.4	12.8	2.8	1.9	0.3
s9	169	301	23.7	2.16	0.2	3	0.6	< 0.1	83	13.8	23.1	2.8	8.8	1.6	1.4	0.2
s10	273	339	31.3	4.18	0.1	4	0.7	< 0.1	220	31.4	60.4	6.4	21.4	3.9	2.1	0.3
s11	156	193	8.2	1.17	< 0.1	1	0.8	0.1	214	10.5	20.6	2.1	7.3	1.4	1.2	0.2

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Activation Laboratories

Analyte Symbol	Hg	Zr	Nb	Mo	In	Sn	Sb	Te	Ba	La	Ce	Pr	Nd	Sm	Gd	Tb
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	1	0.1	0.05	0.1	1	0.1	0.1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Upper Limit	100000	5000	500	10000	100	200	500	500	5000	10000	10000	1000	10000	100	5000	100
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
DP1	357	389	40.5	2.22	0.1	3	0.4	< 0.1	35	7.7	12.8	1.5	6.2	1.1	0.9	0.1
DP2	979	187	16.8	3.07	< 0.1	2	0.8	< 0.1	593	31.3	64.8	7.5	29.1	5.5	4.4	0.8
DP3	357	262	22.1	3.14	< 0.1	3	0.4	< 0.1	263	21.5	59.7	4.3	14.6	2.8	2	0.3

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Activation Laboratories

Analyte Symbol	Hg	Dy	Cu	Ge	Tm	Yb	Lu	Ta	Sr	W	Re	Tl	Pb	Th	U
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.001	0.05	0.5	0.1	0.1
Upper Limit	100000	5000	10000	500	1000	5000	100	1000	10000	200	100	500	5000	500	10000
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
c2	400	0.8	35.3	0.4	< 0.1	0.6	0.1	0.7	11.4	0.8	< 0.001	< 0.05	7	3.3	0.8
c3	260	2.5	89.3	0.2	0.2	1.8	0.2	0.6	6.9	0.7	< 0.001	0.06	7	2.8	0.7
c4	209	1.4	42.8	0.2	0.1	1	0.2	0.6	18.3	1	< 0.001	0.06	5.6	3.1	0.9
c5	276	0.8	89.3	0.2	< 0.1	0.7	< 0.1	1.4	18.3	1	0.001	0.08	8.6	5.9	1.5
c6	363	1.8	70.6	0.2	0.1	1	0.2	2.2	29.3	8.3	0.001	0.31	20.5	16.2	4.8
c7	429	2.2	72.5	0.2	0.2	1.4	0.3	1.9	23.9	5.8	< 0.001	0.19	14.9	11.2	3.6
c8	194	1.7	156	0.3	0.1	1.2	0.2	0.4	6	0.5	< 0.001	0.05	6.2	1.8	0.4
c9	337	1.1	130	0.2	< 0.1	0.6	0.1	1.9	16.6	2.9	0.002	0.09	13.8	19.9	4.3
c10	281	1.4	68.3	0.2	0.1	1.2	0.2	3.1	29.3	1.9	0.001	< 0.05	10.8	14.6	2.8
c11	695	1.4	81.8	0.3	0.1	1.1	0.1	1.8	19.1	12.3	0.001	0.15	14.2	16.4	3.4
c12	422	1.2	74.3	0.2	0.1	0.9	0.1	2	16	9.3	< 0.001	0.1	12.8	12.5	3.2
c13	630	1.8	118	0.2	0.2	1.5	0.3	1.7	12.4	16.7	0.002	0.2	17.9	11.9	3.1
c14	91	1.4	166	0.3	0.1	1	0.1	0.2	153	0.2	< 0.001	0.11	4.5	1.1	0.4
c15	67	1.9	96.1	0.3	0.2	1.5	0.3	0.5	8.6	15.2	< 0.001	0.19	23.3	3.6	2
c16	301	1.2	92.6	0.1	0.1	1	0.2	2.7	17	2.5	0.001	0.08	8.8	7.4	2
c17	237	0.6	99.4	0.2	< 0.1	0.7	0.1	2.5	11.6	2.9	0.002	< 0.05	7.2	4.6	1.4
c18	77	1.8	122	0.3	0.2	1.1	0.2	0.4	6.4	5.8	< 0.001	0.1	6.5	1.9	0.9
c19	263	1	87.8	0.2	0.5	0.9	0.1	2.1	14.3	5.4	< 0.001	0.07	17.6	15.8	3.4
c20	143	2	132	0.3	0.2	1.2	0.2	0.8	13.2	16.4	< 0.001	0.12	9.3	4.3	2.2
s1	273	3.4	32.6	0.3	0.4	2.5	0.4	0.8	23.8	1.3	< 0.001	0.12	8	3	1.7
s2	788	5	47.4	0.2	0.5	3.6	0.5	1.5	22	5.2	< 0.001	0.46	19.6	12	3.6
s3	207	1.6	34.9	0.4	0.2	1.1	0.2	1.4	30	2.1	< 0.001	0.08	10.2	7.7	1.9
s4	171	2.2	25.9	0.2	0.2	1.6	0.3	2.3	23.6	5.6	< 0.001	0.26	25.2	24.8	5.1
s5	266	1.3	84.2	0.2	0.1	1.2	0.1	2	20.1	2.2	0.001	0.07	10.4	9.5	2.4
s6	348	1.1	111	0.2	0.1	0.9	< 0.1	2.2	14.5	3.8	0.002	< 0.05	7.8	8.5	2
s7	233	1.3	93.1	0.3	< 0.1	0.7	0.1	0.3	71.6	0.8	0.001	0.11	5.6	1.7	0.6
s8	177	1.6	95.9	0.2	0.2	1	0.2	1.4	18.9	5	< 0.001	0.21	19.5	14.6	4.1
s9	169	1.8	86.8	0.1	0.1	0.8	0.1	2.1	15.8	6.1	0.001	0.16	14.7	20.2	5.4
s10	273	1.9	24.3	0.2	0.1	1	0.2	3.4	30.6	28.6	0.001	0.36	29.2	44.2	12.6
s11	156	1.1	33.1	0.3	< 0.1	0.7	0.1	0.6	26.6	0.7	0.001	0.32	18.6	4.9	1.2

Report Number: A25-15869

Report Date: 8/12/2025

Activation Laboratories

Analyte Symbol	Hg	Dy	Cu	Ge	Tm	Yb	Lu	Ta	Sr	W	Re	Tl	Pb	Th	U
Unit Symbol	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	5	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.001	0.05	0.5	0.1	0.1
Upper Limit	100000	5000	10000	500	1000	5000	100	1000	10000	200	100	500	5000	500	10000
Method Code	1G	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS	TD-MS
DP1	357	1	114	0.1	0.1	0.8	0.1	2.4	13.5	3.9	< 0.001	< 0.05	8	7.5	1.8
DP2	979	5	40.8	0.2	0.4	3	0.5	1.3	19.4	4.4	< 0.001	0.44	17.4	11.1	3.4
DP3	357	2	73.3	0.2	0.2	1.1	0.2	2	32	8.3	< 0.001	0.33	21.1	15.7	5.1

Report Number: A25-15869

Report Date: 8/12/2025

Activation Laboratories

Analyte Symbol	Hg	Unashed Weight	Ash Weight	% Ash
Unit Symbol	ppb	g	g	%
Lower Limit	5			
Upper Limit	100000			
Method Code	1G	none	none	none
c2	400	200	183	91.4
c3	260	202	176	87.1
c4	209	209	184	88
c5	276	193	150	77.9
c6	363	141	122	86.1
c7	429	152	136	89.5
c8	194	195	163	83.7
c9	337	196	163	82.9
c10	281	184	148	80.4
c11	695	106	85.5	81
c12	422	192	166	86.1
c13	630	204	183	89.8
c14	91	201	185	91.6
c15	67	202	174	86
c16	301	205	171	83.3
c17	237	203	176	86.6
c18	77	202	178	87.8
c19	263	198	155	78.2
c20	143	202	180	89.1
s1	273	205	178	87
s2	788	161	154	95.9
s3	207	204	171	83.8
s4	171	202	173	85.4
s5	266	202	169	83.9
s6	348	206	173	83.7
s7	233	215	193	89.8
s8	177	189	170	89.8
s9	169	197	153	77.5
s10	273	147	123	83.7
s11	156	253	225	89

Report Number: A25-15869

Report Date: 8/12/2025

Activation Laboratories

Analyte Symbol	Hg	Unashed Weight	Ash Weight	% Ash
Unit Symbol	ppb	g	g	%
Lower Limit	5			
Upper Limit	100000			
Method Code	1G	none	none	none
DP1	357	199	168	84.1
DP2	979	191	182	95.1
DP3	357	118	102	86.3

WATER

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Suite # 400
Golden, CO 80401
www.global-resource-eng.com

Technical Memorandum

DATE:	14 January, 2026		
ATTENTION:	Steve Parsons, CEO	**PROJECT NO.:**	24-1450
CC:	Kevin Pickett	**COMPANY:**	Mako Mining Corp
PREPARED BY:	Yuliya Subotskaya	**REVIEWED BY:**	Larry Breckenridge
SUBJECT:	Update Geochemical Report on Eagle Mountain Waste Rock Kinetic Cells		

1.0 INTRODUCTION

Mining developments must manage risks of Acid Rock Drainage (ARD) and Metal Leaching (ML) associated with development and operations. A geochemical assessment of the ARD and ML risk for the Eagle Mountain project was delivered to Mako Mining Corp (Mako) in August 2025 in support of the ESIA (Global Resource Engineering, 2025). The 2025 report presented all static testing results, as well as the results of the onsite waste rock kinetic testing through August 2025.

The objective of this geochemical report is to provide an update on the leachate chemistry of the kinetic cells through the end of 2025, and to access the continuation of the kinetic cell testing program in 2026. This update report should be interpreted as a supplement to the 2025 geochemical report, and will reference the static results presented there.

2.0 TESTING PERFORMED

2.1 Waste Rock

In summary, 50 waste rock samples, varying in location, lithology and oxidation, have been collected and tested at the site. All samples were tested at the SGS lab in Lakefield, Canada for the following constituents:

- Acid Base Accounting (ABA) by modified Sobek (Lawerence & Wang, 1996)
- Metals by *aqua regia* digestion and Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- Synthetic Precipitation Leaching Procedure (SPLP) (US EPA, 1994).

Detailed results of this testing are presented in GRE's Geochemical Analysis of Eagle Mountain Waste Rock and Tailings (Global Resource Engineering, 2025).

2.2 Kinetic Cells

Ten onsite kinetic tests commenced in January 2025. The material in the kinetic cell were splits of the following samples submitted to SGS:

Table 2-1 Kinetic Cell Samples

Sample ID	Hole ID	From (M)	To (M)	Lithology	Oxidation	Pit
GC25-18	Pit-Geotech-11	67	75.6	Volcanic	Fresh	Salbora
GC25-19	Pit-Geotech-12	36.21	41.52	Microgabbro	Fresh	Salbora
GC25-20	Pit-Geotech-12	25.5	30.76	Volcanic	Transition	Salbora
GC25-22	Pit-Geotech-04	50.65	56.24	Granodiorite	Fresh	Toucan
GC25-24	Pit-Geotech-15	28.13	30.75	Granodiorite	Fresh	Eagle
GC25-26	Pit-Geotech-05	26.1	30.6	Volcanic	Transition	Powis
GC25-27	Pit-Geotech-05	36.6	38.69	Volcanic	Fresh	Toucan
GC25-28	Pit-Geotech-10	5.67	11.28	Saprolite	Saprolite	Eagle
GC25-31	Pit-Geotech-14	21.74	24.47	Old Dolerite	Fresh	Eagle
GC25-37	EMM21-20	30.76	36.44	Granodiorite	Fresh	Eagle

As of the writing of this report, the cells have been running for 50 weeks. This section will present the results of 50 weeks of on-site measurements and 10 months of leachate quality data.

Overall, the kinetic cells have been running smoothly with minimal disturbance. There have been a few notable instances where the collected data may have been affected, and those are detailed below:

- There was a leaky outlet in cell GC25-22 that was noted and fixed 14/03/2025.
- On 07/3/2025, due to low rain, field crew added distilled water directly to the leachate rather than allowing it to percolate through the rock bucket.
- On 28/2/2025, 04/10/2025, 10/10/2025, some parameters were not measured due to low overall water collected. Recorded results from these days have been removed from the analysis.
- Dissolved oxygen measurements commenced on 14/3/2025 due to the delay in transporting a dissolved oxygen meter to the site.
- pH was not measured onsite from 24/11/2025 to the end of the year due to a broken pH probe.
- ORP measurements were begun on 08/08/2025 when an ORP probe was able to be delivered to site.
- The saprolite sample, cell GC25-28, periodically caked up and became impervious to water percolation, with the first instance on 19/9/2025. It was stirred manually to allow water to continue to flow through the sample.

- Because of a lack of effluent in October, 2025, the monthly analysis sample was collected in early November.

Weekly Measurements

Figure 2-1 presents the leachate pH results for the 50 weeks of measurements.

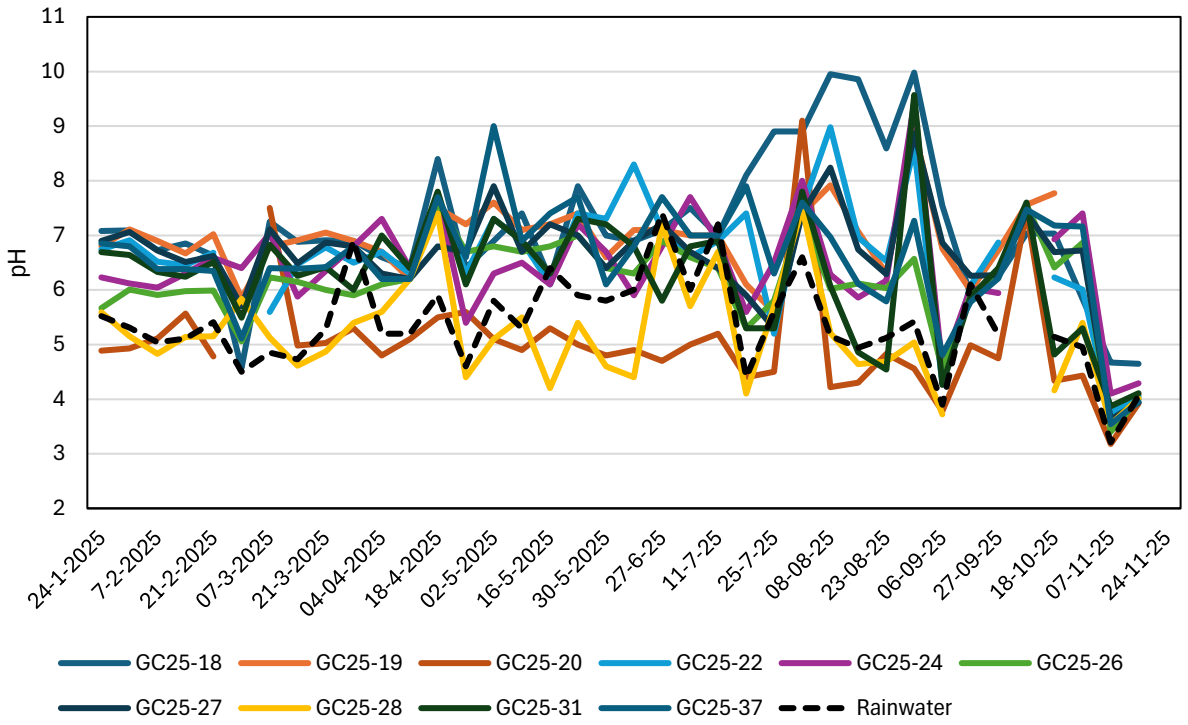


Figure 2-1 Kinetic Cell pH

Results from 28-2-2025 and 07-3-2025 are excluded from the graph due to measurement procedure and low water content affecting measurement accuracy.

Most cells test consistently above rainwater pH. The exception is cell GC25-20 and GC25-28, (volcanic transition material from Salbora and saprolite from Eagle) which periodically test at or below rainwater pH. This is an indication that acid neutralizing minerals are not readily dissolved into leachate upon contact with naturally acidic rainwater, not present, or that acid generation occurring. GC25-20 has a sulfur content of 0.685%, an AP of 21.1, and an NP of 3.3, so it is likely that the low pHs seen are a result of sulfide mineral oxidation. On several instances, the leachate from GC25-20 was noted to be green, indicating the presence of ferrous sulfate, the product of sulfate mineral oxidation, in solution. However, this cell still shows mild ARD behavior.

The pH results are better interpreted in the context of electrical conductivity, dissolved oxygen, and measurement of liters of leachate collected, presented in Figures 2-2, 2-3, and 2-4 respectively.

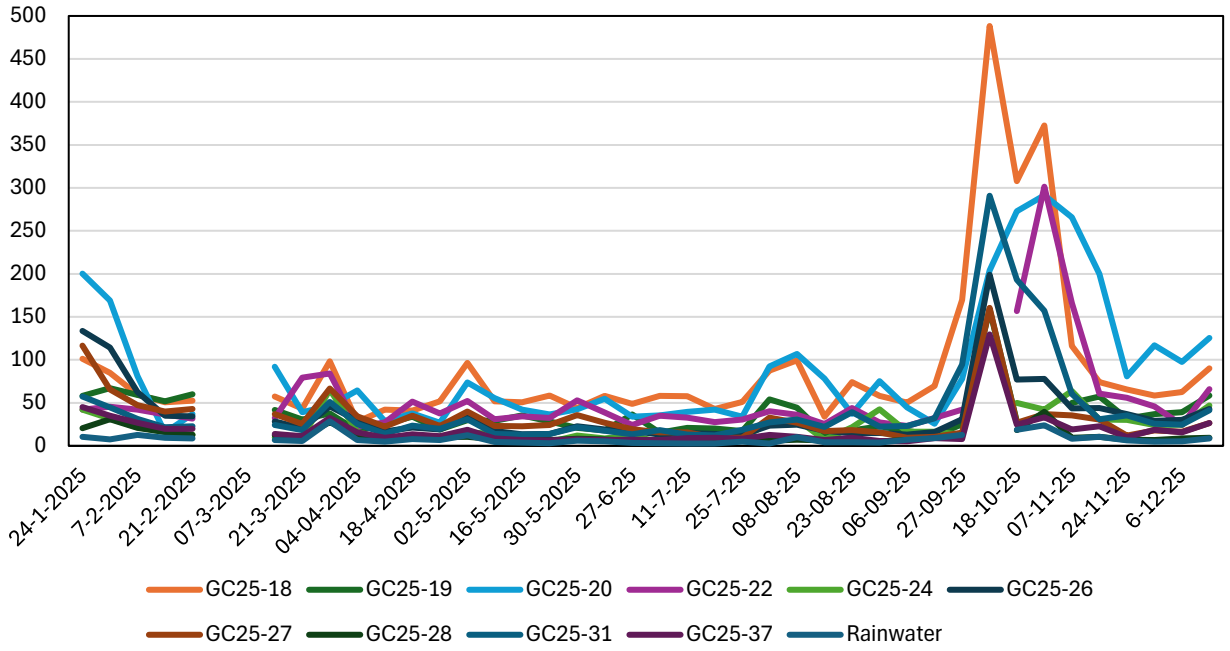


Figure 2-2 Kinetic Cell Electrical Conductivity

Results from 28-2-2025 and 07-3-2025 are excluded from the graph due to measurement procedure and low water content affecting measurement accuracy.

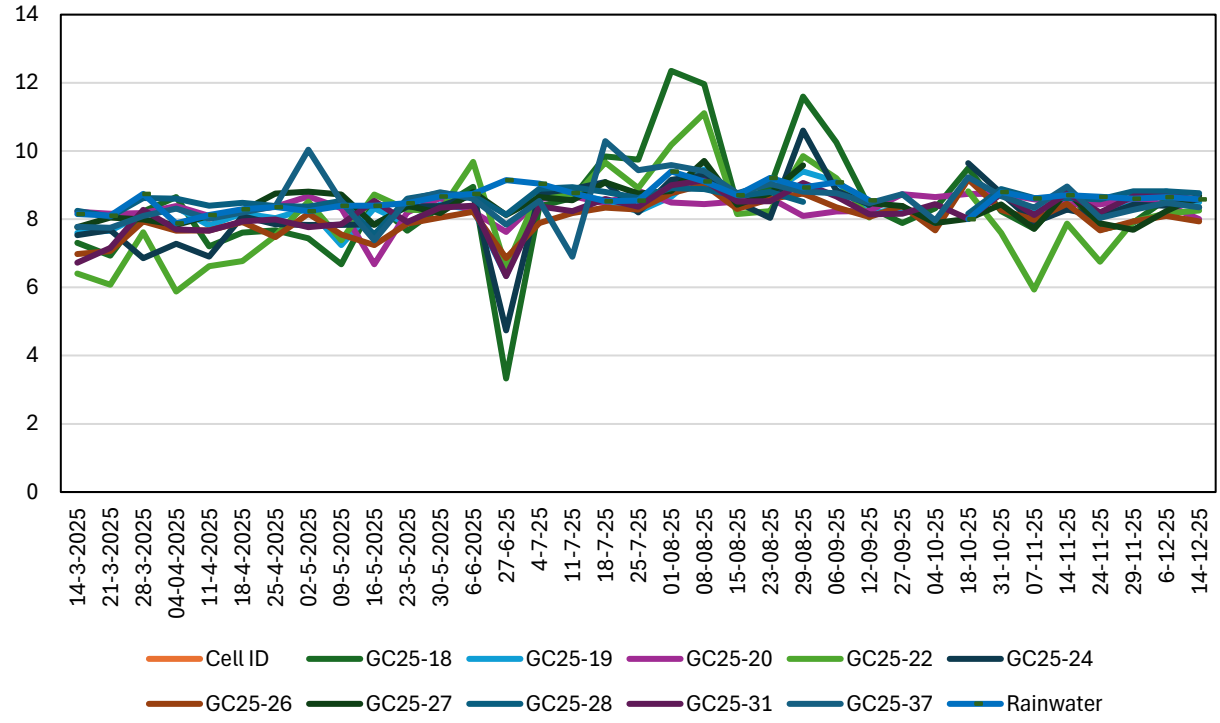


Figure 2-3 Kinetic Cell Dissolved Oxygen

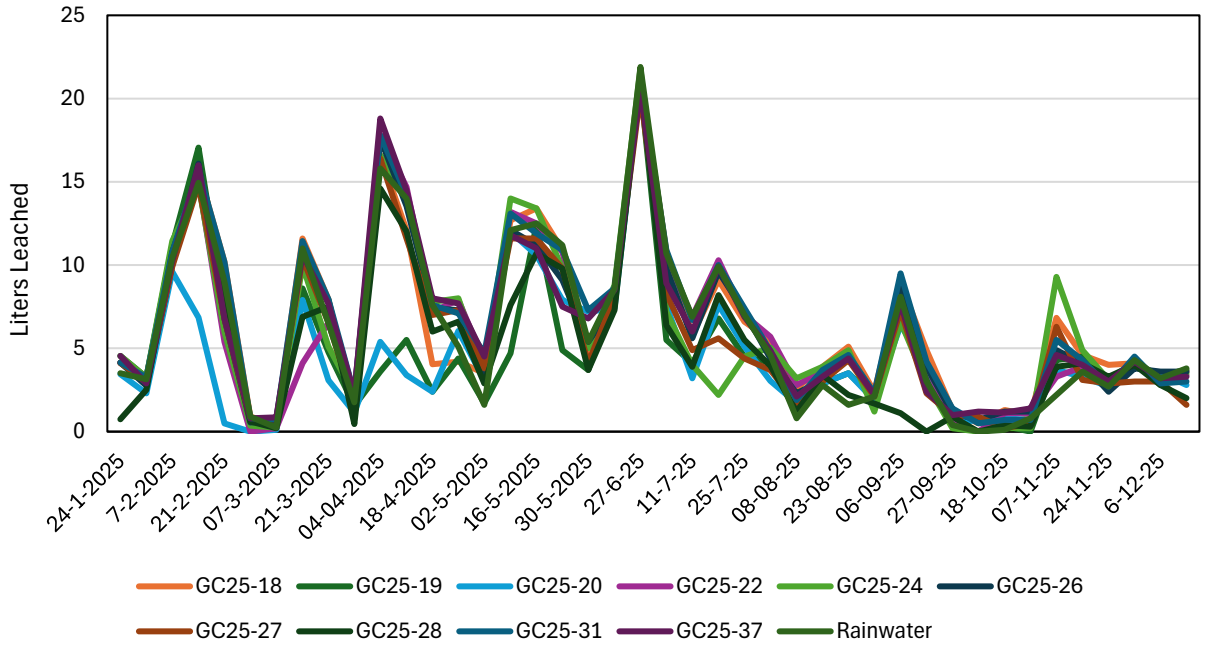


Figure 2-4 Kinetic Cell Liters Leachate Collected

The electrical conductivity measures the ability of a solution to conduct electricity, which is directly proportional to the concentration of dissolved ions present in solution. Electrical conductivity results show that all leachate is consistently above rainwater conductivity and releasing ions into solution. Lowest conductivity is seen in leachate from GC25-28 (saprolite from Eagle). This is consistent with what is expected of saprolite, as due to its oxidized nature, saprolite is typically barren of acid generating and acid neutralizing minerals, as well as most dissolvable salts. GC25-20 and GC25-18 (transition material from Salbora and fresh rock from Salbora) have consistently higher conductivities than other cells. There is a notable spike in electrical conductivity of the leachate solutions from all the kinetic cells in October of 2025. This spike corresponds with the dry period where minimal, if any, leachate was collected from the cells (Figure 2-4). The observed increase in electrical conductivity of the solution during this dry period is a natural result of the same amount of ions being washed from the rock in a smaller volume of water. The electrical conductivity values return to near pre-dry period levels in November and early December when rain again begins to fall on the site.

Dissolved oxygen measures the amount of oxygen present in the leachate. Less dissolved oxygen in solution indicates that oxygen is being used to oxidize other material in solution. Most dissolved oxygen readings are close to full saturation and show that all leachate is acceptable for supporting aquatic life. This implies that oxygen consumption due to mineral reactions is overtaken by the continuous replenishment of oxygen by the abundance of gaseous phase and the fast gaseous diffusion mechanisms. On several occasions, particularly in the dry season,

leachate from kinetic cell GC25-22 (fresh granodiorite from Toucan) has particularly low (5.9 – 7 mg/L) DO measurements relative to other kinetic cells. However, even these lower levels of DO are above the minimum necessary for sustaining aquatic life (USEPA, 2021).

Monthly Laboratory Results

Ten months of data have been received thus far. Samples were taken on 2/14/2025, 3/14/2025, 4/18/2025, 5/16/2025, 6/27/2025, 7/25/2025, 8/23/2025, 10/31/2025, 11/24,2025, 12/14,2025. All samples were sent for metals analysis to Kaizen Laboratory in East Bank Demerara, Guyana, except for the first sample (2/14/2025) which was analyzed at IMEX Laboratory in East Coast Demera, Guyana. The concentration of metals in kinetic cell leachate was compared to U.S. EPA freshwater and drinking water standards (US EPA). The metal concentrations in leachate over time for notable metals are presented below. Exceedances of EPA freshwater standards are labeled in the graphs.

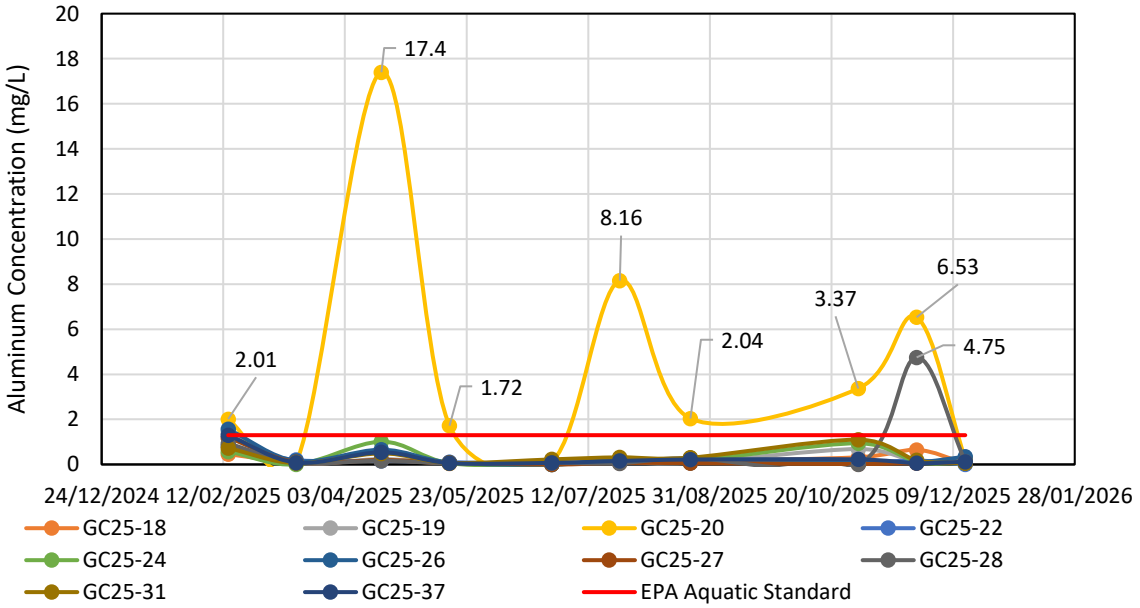


Figure 2-5 Kinetic Cell Leachate Aluminum Concentration

The aluminum concentration in kinetic cell leachate has, for most kinetic cells, remained below the EPA aquatic standard for aluminum (1.3 mg/L). However, leachate from GC25-20 showed periodic exceedances of the standard, both in the wet and dry seasons. The magnitude of the exceedance appears to increase in the dry seasons. Additionally, leachate from GC25-28 showed one instance of exceedance on 11/24/25.

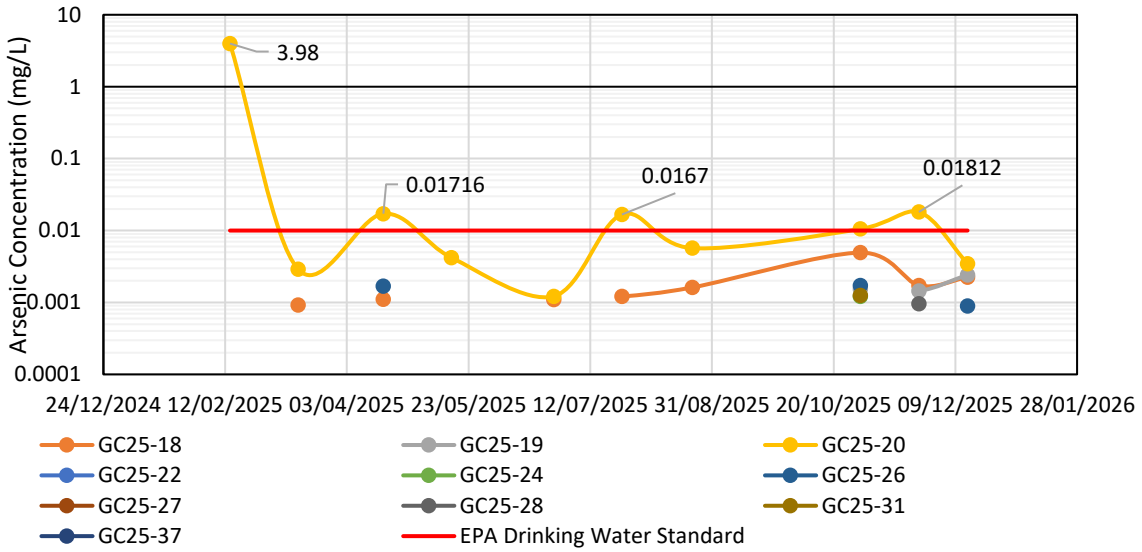


Figure 2-6 Kinetic Cell Leachate Arsenic Concentration

The arsenic concentration in kinetic cell leachate has, for most kinetic cells, remained below the EPA aquatic standard for arsenic (0.01 mg/L). However, leachate from GC25-20 showed periodic exceedances of the standard, particularly in the dry seasons.

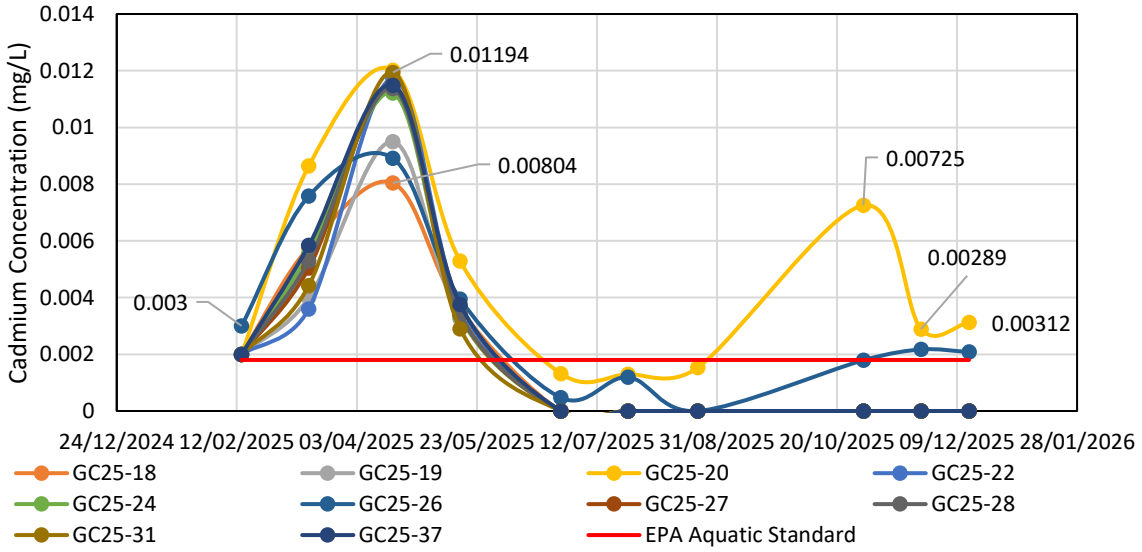


Figure 2-7 Kinetic Cell Leachate Cadmium Concentration

The cadmium concentration in kinetic cell leachate showed exceedance of the EPA aquatic standard for cadmium (0.002 mg/L) at the beginning of the kinetic cell life (Feb – June). However, the concentration of cadmium in most kinetic cells has since dropped to below detection limit

(0.0004 mg/L). Leachate from GC25-20 and from GC25-37 continues to show periodic exceedances of the standard.

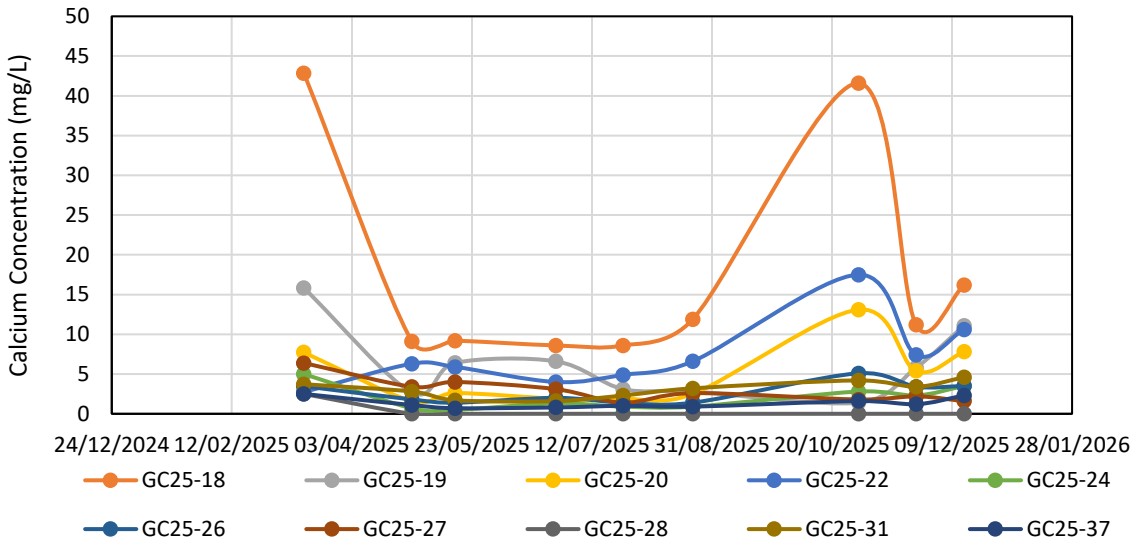


Figure 2-8 Kinetic Cell Leachate Calcium Concentration

Calcium was not analyzed in the first testing round (2/14/2025). Leachate from most kinetic cells has levels of calcium between 0 and 5 mg/L. The leachate from GC25-18 shows consistently elevated levels of calcium relative to the other kinetic cells in the range of 8 to 45 mg/L. This is consistent with the high neutralization potential present in this sample, and likely indicates that the calcium-containing, acid-neutralizing minerals in the rock of GC25-18 are dissolving into solution upon contact with rainwater.

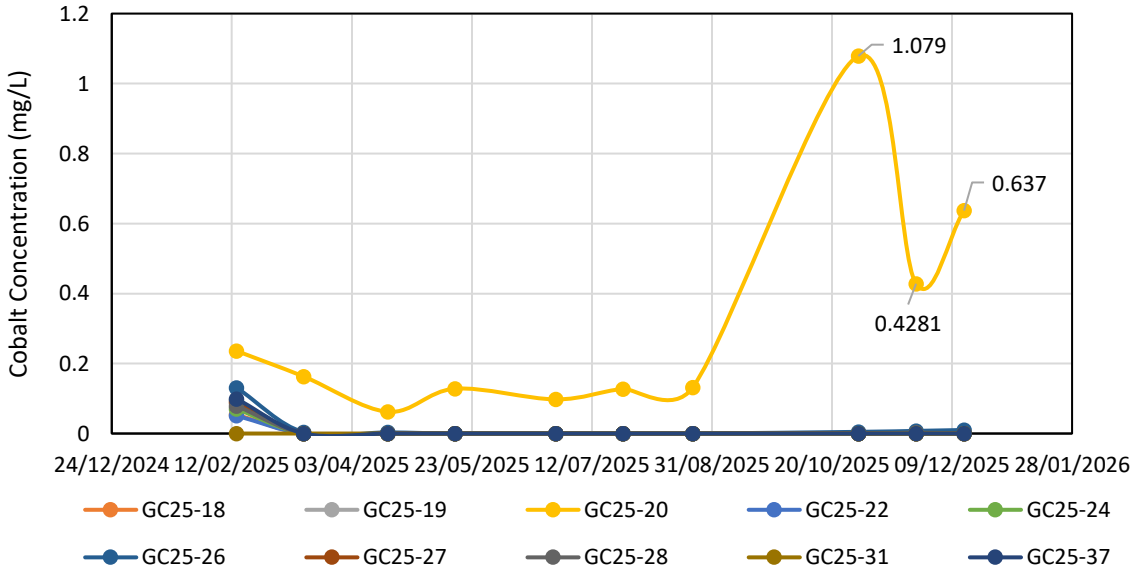


Figure 2-9 Kinetic Cell Leachate Cobalt Concentration

The cobalt concentration in kinetic cell leachate has, for most kinetic cells, remained below 0.1 mg/L. However, leachate from GC25-20 shows consistent cobalt leaching in the range of 0.1 to 0.2 mg/L, as well as periodic increases in cobalt, especially during the dry season, up to 1.079mg/L.

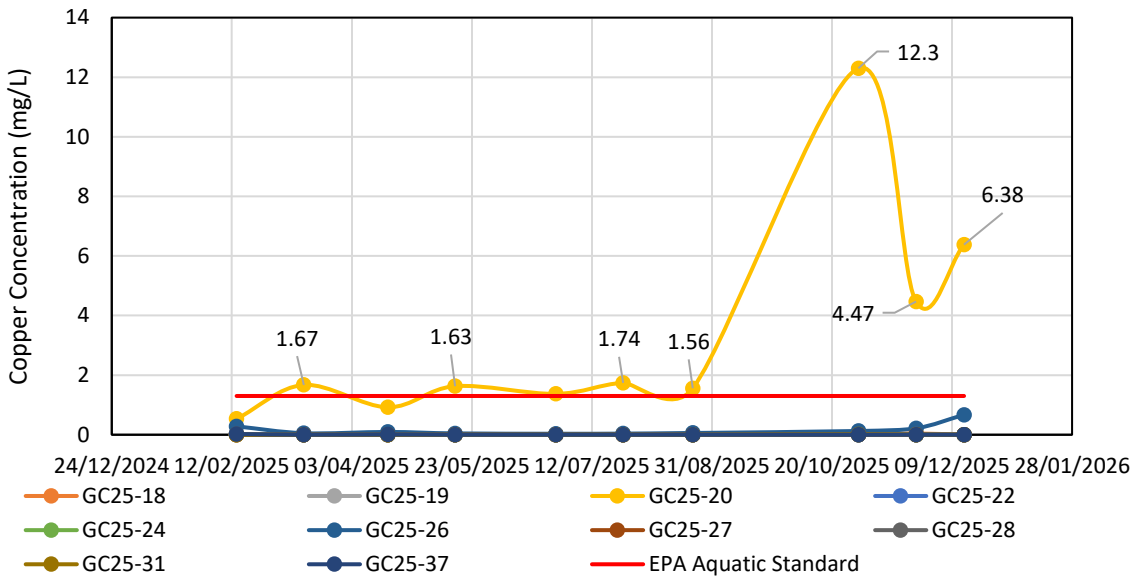


Figure 2-10 Kinetic Cell Leachate Copper Concentration

The copper concentration in kinetic cell leachate has, for most kinetic cells, remained below the EPA aquatic standard for copper (1.3 mg/L). However, leachate from GC25-20 showed periodic exceedances of the standard, up to a high of 12.3 mg/L on 10/31/2025.

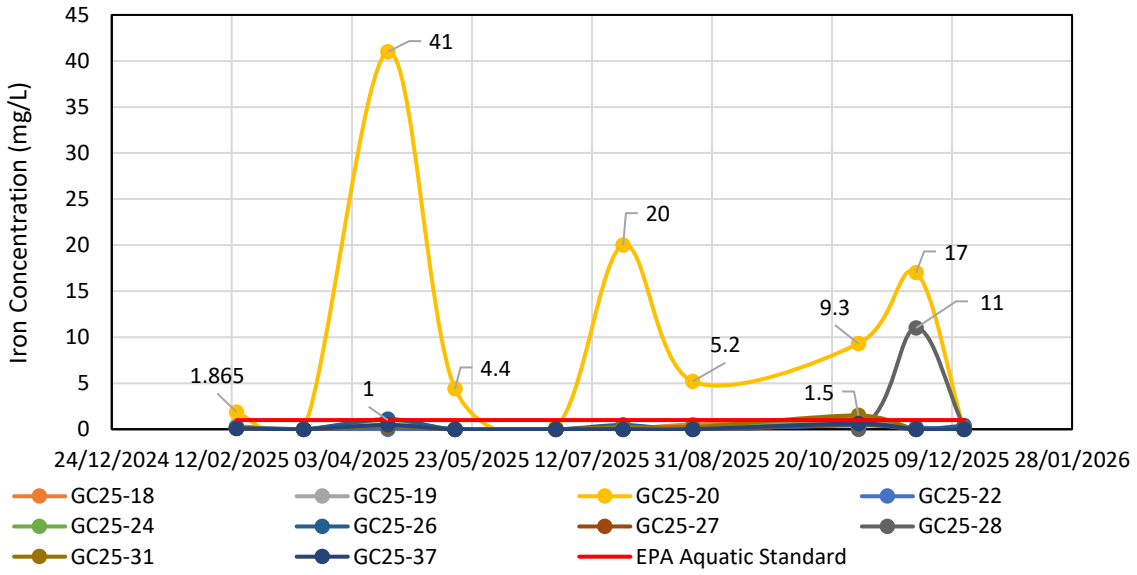


Figure 2-11 Kinetic Cell Leachate Iron Concentration

The iron concentration in kinetic cell leachate has, for most kinetic cells, remained below the EPA aquatic standard for iron (1 mg/L). However, leachate from GC25-20 showed periodic exceedances of the standard, up to a high of 41 mg/L on 4/25/2025. The magnitude of the exceedance appears to increase in the dry seasons, and closely follows the same exceedance pattern observed in GC25-20 aluminum concentrations (Figure 2-5). Additionally cell GC25-27 shows an exceedance of the iron standard on 10/31/2025 and GC25-28 shows an exceedance of the iron standard on 11/24/2025.

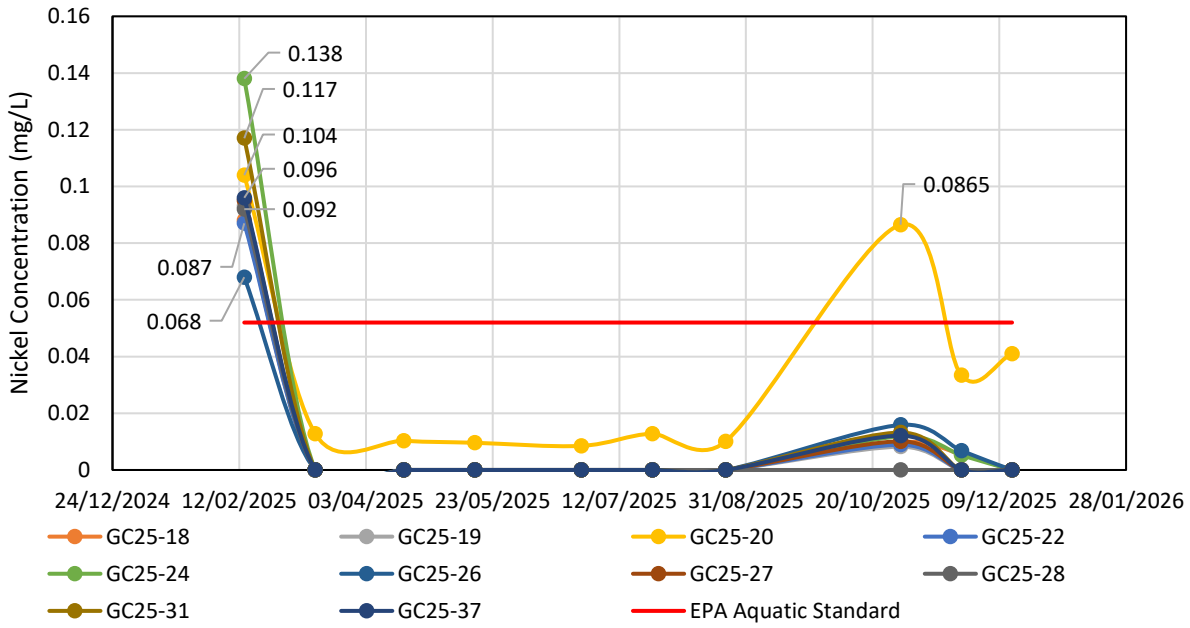


Figure 2-12 Kinetic Cell Leachate Nickel Concentration

The nickel concentration in kinetic cell leachate showed exceedance of the EPA aquatic standard for nickel (0.052 mg/L) in the first testing cycle for all kinetic cells. However, the concentration of nickel in most kinetic cells has since dropped to below detection limit (0.005 mg/L), with the exception of GC25-20, which has been testing below the EPA standard except for on 10/31/2025.

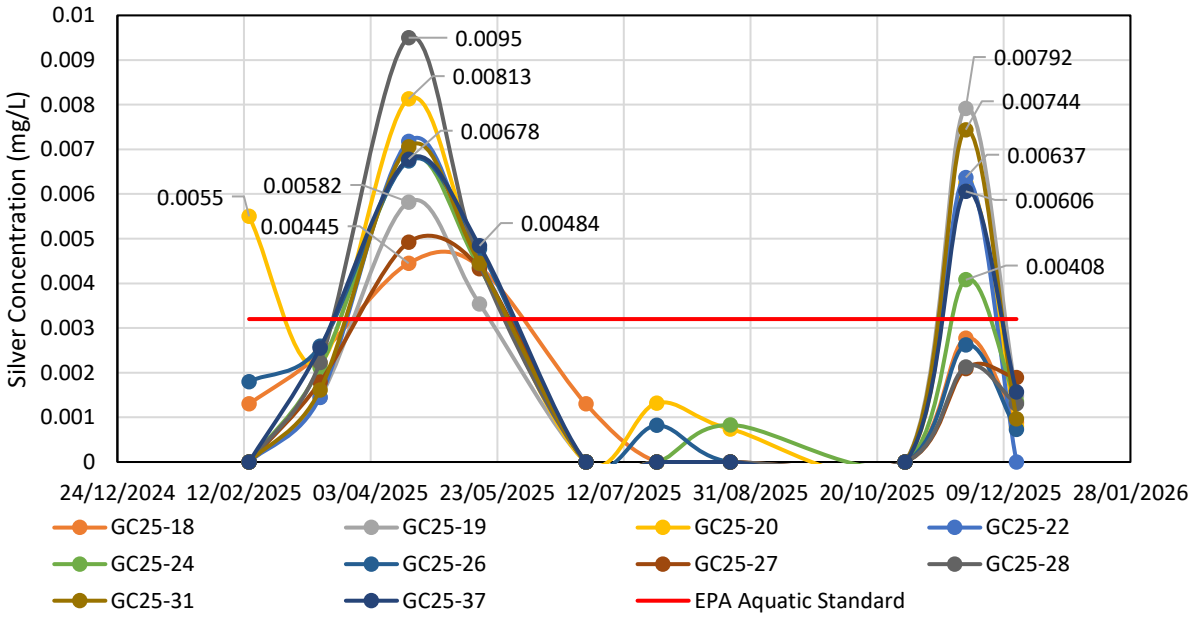


Figure 2-13 Kinetic Cell Leachate Silver Concentration

The silver concentration in kinetic cell leachate showed exceedance of the EPA aquatic standard for silver (0.0032 mg/L) for all cells at the beginning of the first wet season (April and June) up to 0.0095mg/L and again for some at the beginning of the second wet season (November) up to 0.0079mg/L. In the time before, between, and after, the concentration of silver in most kinetic cells was near or below detection limit (0.001 mg/L).

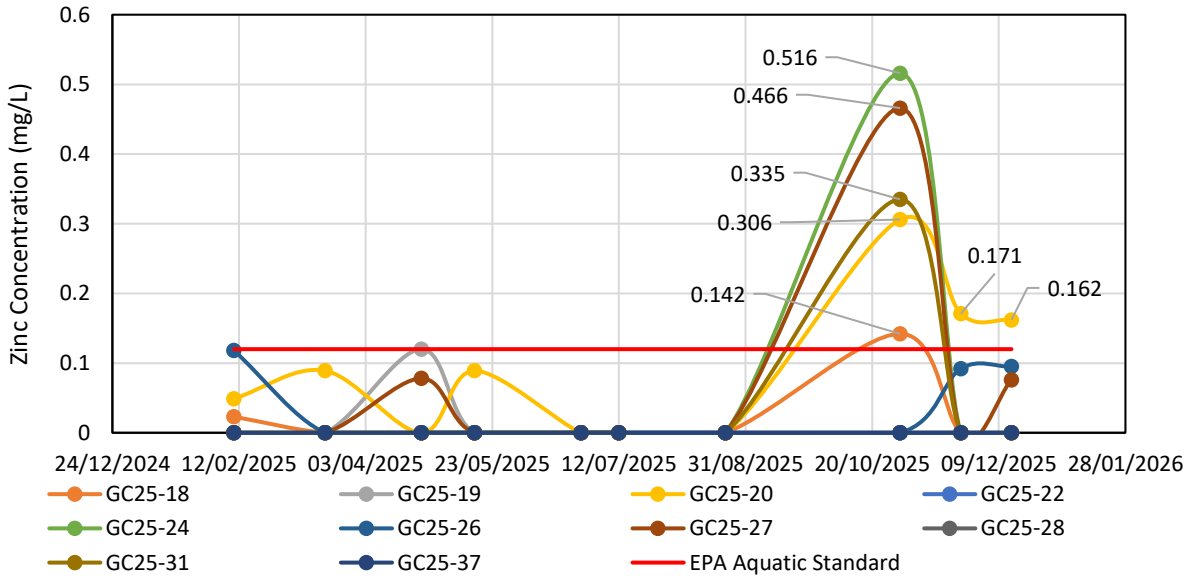


Figure 2-14 Kinetic Cell Leachate Zinc Concentration

Zinc concentrations in the kinetic cell leachate have been below the EPA aquatic standard for zinc (0.12 mg/L) for the entirety of the testing time until 10/31/2025, when leachate from 5 cells (GC25-18, GC25-20, GC25-24, GC25-27, and GC25-31) tested above the standard up to

0.516 mg/L. Although the zinc leachate concentration was back down to below standards for four of the cells in November, the leachate from GC25-20 continued to concentrations of zinc above the EPA standard in both November and December.

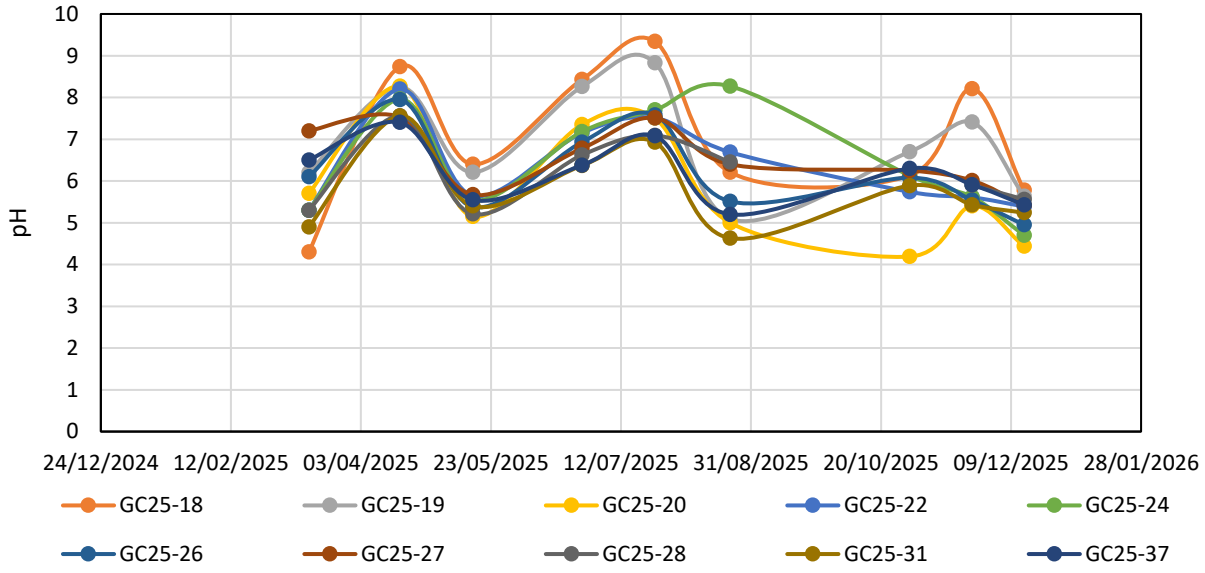
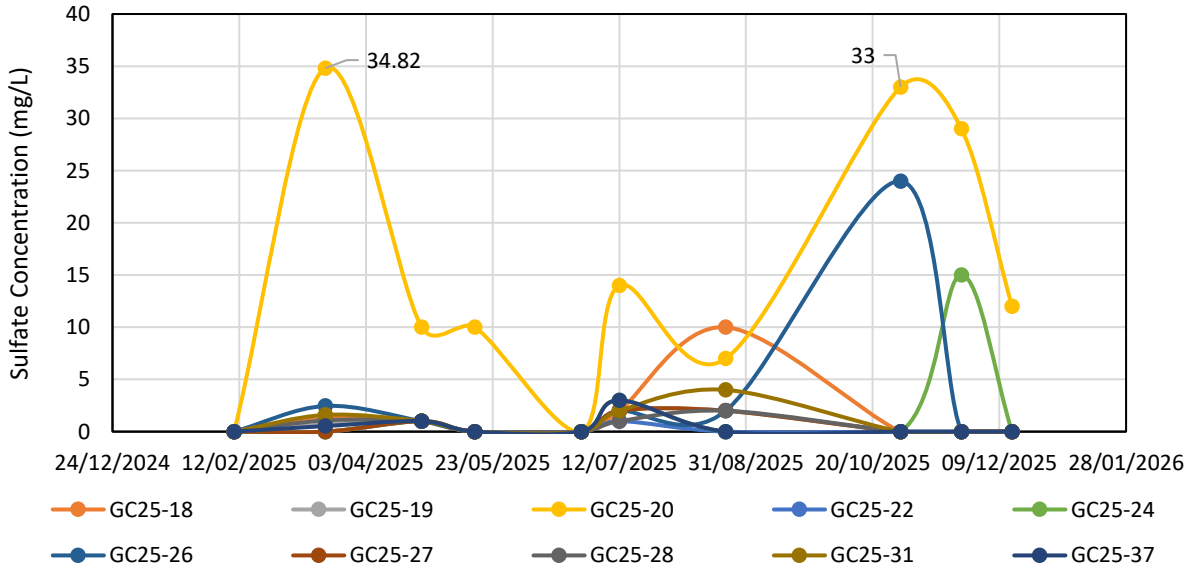


Figure 2-15 Kinetic Cell Leachate pH, Lab Measured

The pH of the kinetic cell leachate, as measured by the lab, shows similar trends and fluctuations noted by onsite measurements (Figure 2-1). In general, the pH of the leachate stays between 5 and 9. The exception is leachate from cell GC25-20 which periodically has pH around 4.5, and leachate from cell GC25-18 which periodically has leachate with pH above 9, due to the abundance of neutralizing material present in the rock (Figure 2-8).



The majority of kinetic cells had sulfate concentrations in the range of 1- 10 mg/L for the duration of the testing period. Sulfate levels were highest in the leachate of GC25-20, at 34.82 mg/L, but these are significantly below the IFC sulfate standards of 250 mg/L (International Finance Corporation (IFC), 2007).

3.0 CONCLUSIONS

Results from the kinetic cells through the end of 2025 show that most leachate pH is above rainwater pH and in the 6-8 range, with the exception of GC25-20 (transition material from Salbora which is relatively small in overall volume) which has leachate at or below rainwater pH in the 4.5-5.5 range, and shows some signs of mild sulfate mineral oxidation. Even in this cell, maximum sulfate levels are only around 35 mg/L, which indicates there is no realized ARD. Electrical conductivity appears to increase as the total volume of leached liters decreases in the dry season due to less rain. Dissolved oxygen appears to be near or at full saturation capacity for most cells.

Metals concentrations are of consistent concern in the leachate from cell GC25-20 (transition material from Salbora, which is a rare rock type on site). Aluminum, arsenic, cadmium, copper, cobalt, and iron are consistently found at levels exceeding EPA water quality reference values. Exceedances are especially magnified at the transitions between dry and wet seasons. Leachate from this cell also showed occasional exceedance of nickel, silver, and zinc water quality standards, usually at the transition between dry and wet seasons.

Other cells show a similar pattern of increased metals in leachate at the transition between dry and wet season, particularly for silver and cadmium, where there are some exceedances of the EPA water quality reference values. However, unlike the leachate from cell GC25-20, the metals concentration in the leachate from the rest of the cells reliably decreases to significantly below reference values during the wet months. This trend indicates that dilution plays an important role in maintaining low levels of metals in contact water.

4.0 RECOMMENDATIONS

The results from 2025 do not show any realized ARD potential, but do confirm the risk of ML during particular times of the year and for particular rock types. Kinetic cells, particularly those with anomalous metals concentrations in leachate should continue to be monitored. GRE recommends continuing monitoring all onsite kinetic cells through 2026.

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Technical Memorandum

DATE:	2 June, 2025	**PROJECT NUMBER:**	24-1450
ATTENTION:	Steve Parsons, Kevin Picket	**COMPANY:**	Mako Mining
PREPARED BY:	Yuliya Subotskaya	**REVIEWED BY:**	Larry Breckenridge

SUBJECT: Mercury Field Program Results

1.0 INTRODUCTION

Global Resource Engineering (GRE) was requested by Mako Mining to conduct the mercury testing field program at the Eagle Mountain Mine Site (the Project). The work plan focused on determining the extent of mercury contamination in areas onsite with known artisanal gold mining activity occurring from the 19th century to the present date. The program aimed to establish a baseline mercury contamination level in both the soils and water onsite for the determination of contamination severity and future environmental liability. The work plan entailed:

- Scanning areas of interest for elemental mercury vapor,
- Collecting soil samples for total mercury (Hg) and methyl mercury (MeHg) analysis,
- Collecting sediment samples for Hg and MeHg,
- Collecting water samples for Hg and MeHg analysis.

The field-testing program was carried out by Yuliya Subotskaya, staff mine water scientist at GRE, from January 8 to 27, 2025.

2.0 BACKGROUND

The Project is located approximately 7 km south of Mahdia Township, a historically active location for small-scale, artisanal mining. Artisanal mining at the site utilized mercury amalgamation for gold recovery. This process involves the deposition of elemental mercury into a slurry of crushed rock, which absorbs gold and is filtered out of the solution. The mercury-gold complex is then subject to heating, which releases mercury vapor and leaves a solid gold precipitate.

With known historical mining in the area, notably in the Mahdia and Minnehaha valleys, and the probable use of mercury by artisanal miners, it was necessary to define the baseline mercury contamination conditions within the Eagle Mountain concession. The extent of this potential

contamination is unknown, but areas of visible artisanal mine working and disturbance are known by Eagle Mountain personnel and can be ascertained from mine waste piles and disturbed soil. These areas are shown in red in Figure 2-1.

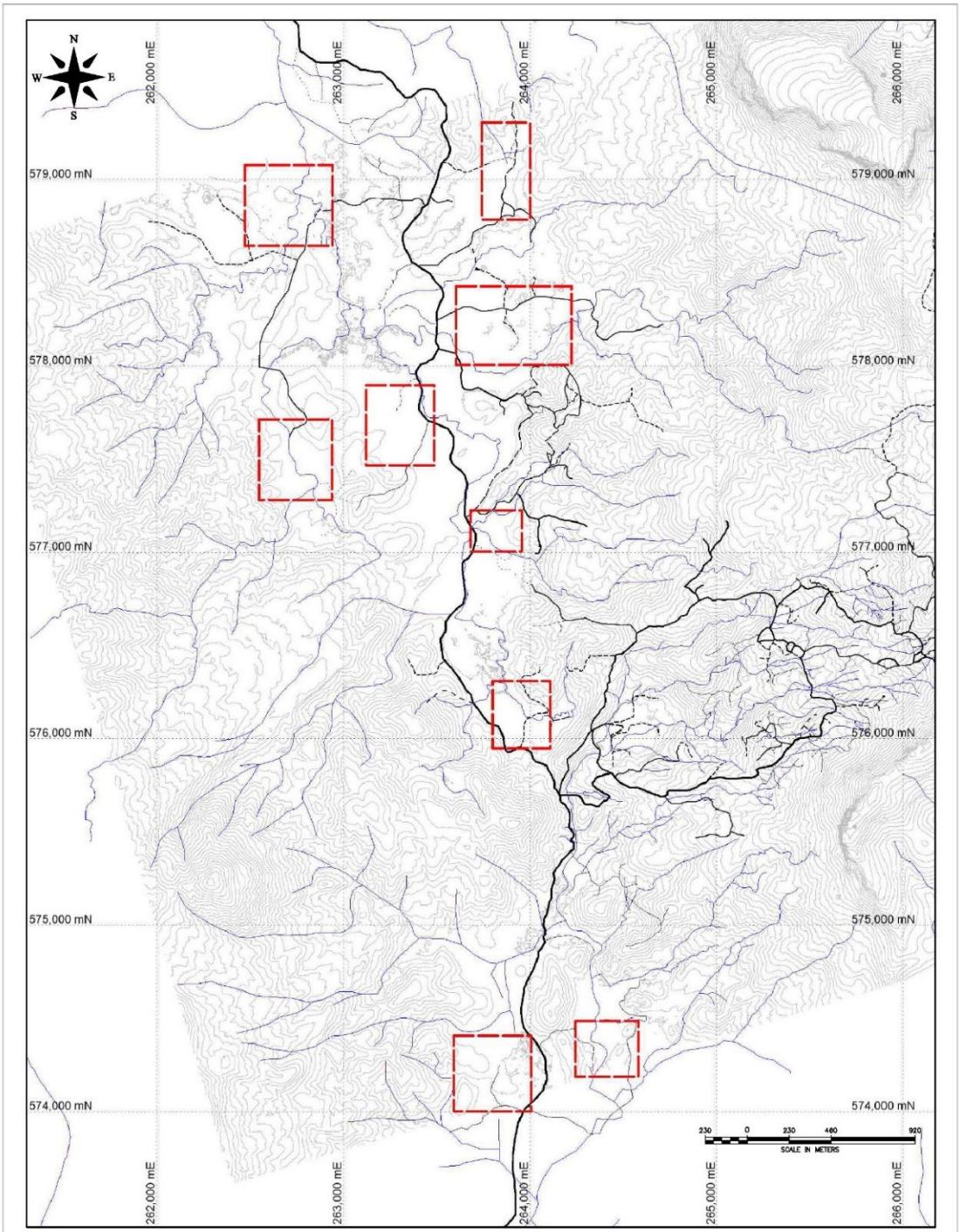

Figure 2-1 Proposed Areas of Mercury Testing

The total area contained by the red squares in Figure 1 is approximately 1.38 km^2.

Mercury is a toxic, regulated metal that can exist in a variety of forms in the environment. The forms of mercury at a site with artisanal mining history may include (roughly most to least prevalent):

- Elemental: Hg(0)
- Mercuric sulfide: HgS
- Organo-chelated: bound to humic matter through functional groups
- Acid-soluble: eg. HgO, HgN
- Water-soluble salt: eg. $HgCl_2$
- Organomercury: directly bonded to the carbon atom, eg. Methyl mercury

Of all the forms of mercury, organomercury - specifically methyl mercury, is the largest driver of human and ecological health risk due to bioaccumulation and biomagnification in the food chain (Morel, Kraepiel, & Amyot, 1998). Methyl mercury is produced from oxidized elemental mercury, as well as acid-soluble and water-soluble mercury species under anaerobic conditions. These conditions could occur in small ponds where historic artisanal mine work is evident. In contrast, mineral-bound and complexed mercury (like sulfide and iron-oxyhydroxide complexes) have relatively low bioavailability, are less reactive, and tend to be the dominant forms at contaminated mining sites (Kim, Brown, & Rytuba, 2000). The relative concentration of different mercury species at a site is entirely dependent on the site's environment, geology, weather, and contamination source, and can vary greatly between neighboring areas (Eckley, et al., 2020).

Under ambient conditions, elemental mercury in the soil can be released into the air as mercury gas (Eckley, et al., 2020). Releases of mercury gas can continue for decades and even centuries after initial deposition. Elevated concentrations of mercury gas emission are correlated with elevated concentrations of elemental mercury in the respective soil (Lucotte, et al., 2012). As a result, a mercury vapor analyzer can be used to scan the area of interest for elevated emissions of mercury gas to locate areas of elemental mercury deposition.

3.0 METHODS

This section presents the onsite mercury vapor testing methods, soil sample collection methods, sediment sample collection methods, and water sample collection methods.

3.1 Mercury Vapor Testing

A Jerome J405 Mercury Vapor Analyzer (MVA), rented from Pine Environmental (of U.S.A.), was brought to the site to perform onsite mercury vapor testing. A plastic sampling tube with a rubber stopper was fitted to enclose the MVA air intake tube. A desiccator insert, composed of anhydrous aluminum sulfate, was sandwiched between cotton balls in the distal portion of the

sampling tube to prevent water vapor from reaching the MVA air intake tube (Figure 3-1). The anhydrous aluminum sulfate in the desiccator was renewed after every half-day of sampling, or when the color of the desiccator material indicated saturation.

Figure 3-1 MVA with Desiccator Insert

Before every sampling day and anytime after the machine was turned off, the sensor warmup sequence was performed and a mercury vapor reading with the zero-air filter inserted was confirmed to be zero. The MVA sensor was regenerated after every sampling day in accordance with the instructions, and the machine was charged overnight.

The following procedure was used to measure mercury vapor in the soil at every location:

1. Using a manual auger, with a diameter of approximately 3 inches, drill into the soil until a final depth of 30 cm is reached. Material removed from the hole should be placed in a neat pile for use in backfill.
2. Insert the MVA (attached plastic sampling tube down with the desiccator inserted) into the hole. Ensure that the tube is 30 cm below ground surface.
    a. Onsite, this was aided by the use of a constructed metal stand to hold the MVA at the necessary position above ground surface (Figure 3-2)
3. Backfill the hole around the MVA sampling tube with the material removed during drilling. Pack down the soil around the sampling tube.

4. Select the survey-mode sample, and set a timer for 1 minute.
5. Record the mercury vapor concentration at 30 sec and 1 minute and end the mercury scan.
6. Remove the MVA and the sampling tube from the hole and wipe off any soil debris from the inside and outside of the sampling tube.

Figure 3-2 MVA Stand and Measurement at Depth Line

The mercury concentrations, as detected by survey mode at 30 sec and 1 minute, were used for measuring soil mercury vapor. The analyzer has a flow rate of 0.75 L/min and this method ensured that the recorded value was a reflection of the air in contact with soil as opposed to accumulated air in the sampling tube.

3.2 Soil Sample Collection

Soil sampling locations were selected after the completion of the mercury vapor testing based on measured MVA mercury concentration, location, and sample type. Soil samples were collected in 250 mL glass canning jars at the exact location of MVA testing. The following procedure was followed for every sample:

1. Remove any vegetation present.
2. Using a clean, manual auger, drill down to 30 cm below ground surface.
3. Using a clean metal spoon and glove, carefully collect the soil 30-40 cm below ground surface to fill the 250 mL glass jar and measure the final depth with a yardstick.

4. Place a layer of parafilm on the lip of the jar and close the jar tightly.
5. Place another layer of parafilm around the outside of the jar, ensuring that the junction of the jar body and lid is adequately sealed.
6. Label the sample with permanent marker both on the glass and on a piece of flagging tape attached to the top of the sample container.

Figure 3-3 Soil Sampling in the Field

A duplicated sample was collected by removing approximately two containers' worth of soil from the bottom of the sampling hole, manually mixing the soil, and filling two jars with the mixture. Collected samples were securely packaged and padded with carboard, foam, and newspaper in a large wooden container, and shipped to SGS Lab in Burnaby, Canada. Recommended holding times were exceeded by 11-15 days for total mercury analysis and 21-35 days for methyl mercury analysis. Although SGS received the samples before the holding time expired, the holding time was exceeded due to the long drying times at room temperature necessary before analysis.

3.3 Sediment Sample Collection

Locations of sediment samples were selected to be in bodies of water (rivers, creeks, and ponds) near artisanal mining disturbance and near soil and mercury vapor testing locations. Sediment

samples were collected in 250 mL glass canning jars using a 3-inch diameter stainless steel Shelby tube. The following procedure was followed for every sediment sample:

1. Place the clean Shelby tube into the sediment and push firmly until the Shelby tube is at least 0.2 meters below the water contact.
2. Using a clean gloved hand or a flat piece of wood, close off the bottom of the Shelby tube by digging next to and under the inserted tube.
3. Lift the tube out of the body of water and let excess water drain out of the bottom of the tube, making sure that the sediment is minimally disturbed.
4. Once no more water drains from the tube, carefully empty the contents of the tube into a sampling container.
    a. If more than 1 sampling container of material was collected in the Shelby tube, use a secondary container to gather the next layer of material.
5. Place a layer of parafilm on the lip of the jar and close the jar tightly.
6. Place another layer of parafilm around the outside of the jar, ensuring that the junction of the jar body and lid is adequately sealed.
7. Label the sample with permanent marker both on the glass and on a piece of flagging tape attached to the top of the sample container.

Figure 3-4 Sediment Sampling with a Shelby Tube

As the exact depth of the sediments was not able to be determined in field, relative depths were noted as deep, medium, and shallow in the order that they came out of the Shelby tube. Shallow sediment was typically 0-20cm below surface, medium sediment was between 20 and 40 cm below surface, and deep sediment was typically 40 to 60 cm below surface. Collected samples were securely packaged and padded with carboard, foam, and newspaper in a large wooden container, and shipped to SGS Lab in Burnaby, Canada. Recommended holding times were exceeded by 11-15 days for total mercury analysis and 21-35 days for methyl mercury analysis. The holding time was exceeded primarily due to long drying times at room temperature necessary before analysis.

3.4 Water Sample Collection

Water samples were collected at the same locations as the sediment samples. This was done by Mako personnel on March 13, 2025, over a month after the collection of the sediment samples. Samples were collected in 60 ml amber glass container. The following procedure was followed for water sample collection and preservation:

1. With clean gloved hands, open the sample container.
2. Submerge the collection container in the water to be sampled.
3. Remove the container from the water and cap securely.
4. Label the container with the proper sample number.

To preserve the samples:

1. Open the sample container.
2. Using a dropper, carefully add 0.1 - 0.2 mL of HCl to the sample, and mix thoroughly.
3. Re-cap the bottle and wrap the junction of the cap and the bottle with parafilm.
4. Store in a cool place until shipment to the lab.

Samples were shipped to Kaizen Laboratory in a padded, aluminum-foil-lined cooler. Analyte hold times were not exceeded and samples arrived in adequate condition.

4.0 RESULTS

4.1 Mercury Vapor Scanning

Over the course of 11 field work days, 378 mercury vapor scans were conducted with the Jerome J405 mercury vapor analyzer (MVA) as outlined in section 3.1. The concentration of mercury vapor in µg/L at 30 and 60 seconds of air intake was recorded, as well as the test location coordinates, time of test, and a brief description of the testing site. Table 4-1 presents the

summary statistics of the mercury vapor concentration in µg/L as detected by the MVA at 60 seconds of air intake. All recorded MVA results are presented in Appendix A.

Table 4-1 Summary Statistics of Mercury Scanning Program

Location	Count	Highest MVA Reading	Lowest MVA Reading	Average MVA Reading	Median MVA Reading
Bowl	41	164.2	0	10.04	2.96
North-east Property Border	23	9.98	0	1.61	4.6
North-west Active Mining Area	129	258.3	0	8.27	2.29
Plant	2	4.47	3.17	3.82	x
Powis	41	3.8	0	1.24	1.61
Salbora	15	4.85	0.61	2.43	1.41
Southeast	28	18.01	0	3.69	1.28
Southwest/TSF 2	12	6.07	0	2.44	1.03
Toucan	11	13.3	0	2.82	0.94
TSF 1	40	16.62	0	1.95	0.75
Waste Dump 1	12	13.26	0	2.89	0.51
Waste Dump 3	24	4.22	0	2.07	0
Overall	378	258.3	0	5.12	1.87

The highest mercury vapor concentrations were detected in soil at the bottom of small pits where rainfall has accumulated and then dried, or in the drainage areas of the fresh artisanal mining workings. Since the workings in the Bowl and North-west areas of the property were the most recent, the highest mercury vapor concentrations were detected there.

Detected mercury vapor concentrations were found to be extremely heterogeneous. There were significant differences in mercury vapor concentrations 1m from an original testing location, indicating that elemental mercury deposition in artisanal mining areas is localized on a sub metre scale. For example, a test location selected randomly in a creek with recent artisanal mining activity showed 164.2 µg/L. Half meter and one meter away of the original testing location detected mercury vapor at 108.4 µg/L and 5.82 µg/L, respectively (Figure 4-1). A similar trend was observed in the North-west active mining area – less than half a meter away from a high concentration reading of 258.3 µg/L in a small dried-up pond, mercury vapor concentrations were 150.2 µg/L.

Figure 4-1 Heterogenous Mercury Vapor Measurement by Creek

Mercury vapor concentrations in older artisanal mine workings were relatively lower when compared to fresh workings. In general, the highest mercury vapor was detected in areas where mercury was likely directly deposited during the artisanal mining process and then mobilized and redeposited proximally by water runoff. These locations included drainage channels that led away from tailings piles, in the area immediately surrounding sluice remnants, and at the base of tailings piles. Low mercury vapor concentrations were generally detected at the tops of tailings piles, in undisturbed areas, and on relatively elevated ground]. The location of every mercury vapor scan is presented in Attachment A.

Limitations

Only elemental mercury present in the soil releases mercury vapors. As a result, the Jerome J405 MVA can only detect the presence of elemental mercury. Additionally, the detection of mercury vapor was confounded with temperature. The Jerome J405 MVA works by absorbing mercury vapor found in the intake air onto a gold plate through amalgamation, and reporting the relative weight difference before and after test initiation as a mercury vapor concentration. Since mercury absorbed onto the gold sensing plate is not removed between samples, it is possible that higher instrument temperatures (i.e. exposure of the instrument to the hot Guyanese sun) re-vaporized mercury from previous tests on the gold plate and resulted in artificially higher readings of mercury vapor.

Additionally, the temperature of the soil where the mercury vapor reading was taking place could have affected the mercury vapor concentrations detected by the MVA. The vapor pressure of mercury is directly proportional to temperature, with higher temperatures exhibiting greater mercury vaporization. As a result, higher soil temperatures due to sun exposure or higher air temperatures may have resulted in higher concentrations of mercury vapor. On the other hand, soil at lower temperatures such as that found under the canopy of trees or tested on a cooler day may have resulted in lower concentrations of mercury vapor.

Although both of these limitations were considered in experimental design, it is likely that these effects still played a part in the results of the mercury vapor analysis. The magnitude of these effects was tested. The mercury vapor at the same location was tested in shaded and in full sun conditions on a scraped slope in the Waste Dump 1 area. The mercury vapor concentration was found to be 2.96 µg/L in sunny conditions and 1.62 µg/L in shady conditions. In general, temperature may have caused up to 2 µg/L difference in mercury vapor concentration.

4.2 Soil Samples

A total of 51 soil samples (including one duplicate QC sample) were collected at select locations where mercury vapor analysis was performed. Samples were skewed to locations with significantly higher mercury vapor readings as described by the methodology in section 3.1, (14.9 µg/L vs 5.1 µg/L, $p = 0.0057$) to ensure that higher levels of mercury were characterized. Thirteen of these samples were tested for methyl mercury in addition to total mercury. As mentioned in the methods section, the laboratory holding times were exceeded for both of these analyses. Exceedance of holding times increases the uncertainty of test results, but it does not necessarily imply that the results are compromised. Although it is possible that results may be biased to lower mercury concentrations, some research indicates that there is no significant difference in total mercury content in soil samples even after 10 years of storage (Navratil, et al., 2018). As a result, GRE deemed the results acceptable, and continued with the analysis. The results for all laboratory analysis are presented in Appendix B.

Total Mercury

Total mercury content in the soil samples ranged from 0.0076 mg/kg to 18.4 mg/kg, with a geometric mean and average mercury concentration of 0.255 mg/kg and 0.779 mg/kg respectively. The average crustal abundance of mercury is 0.08 mg/kg (Taylor & McLennan, 1985). Soil with over five-times average crustal abundance (> 0.4 mg/kg) can be considered enriched in mercury. Only 20 (39%) of 51 samples tested over five-times average crustal abundance. Figure 4-2 shows the distribution of total mercury in the samples.

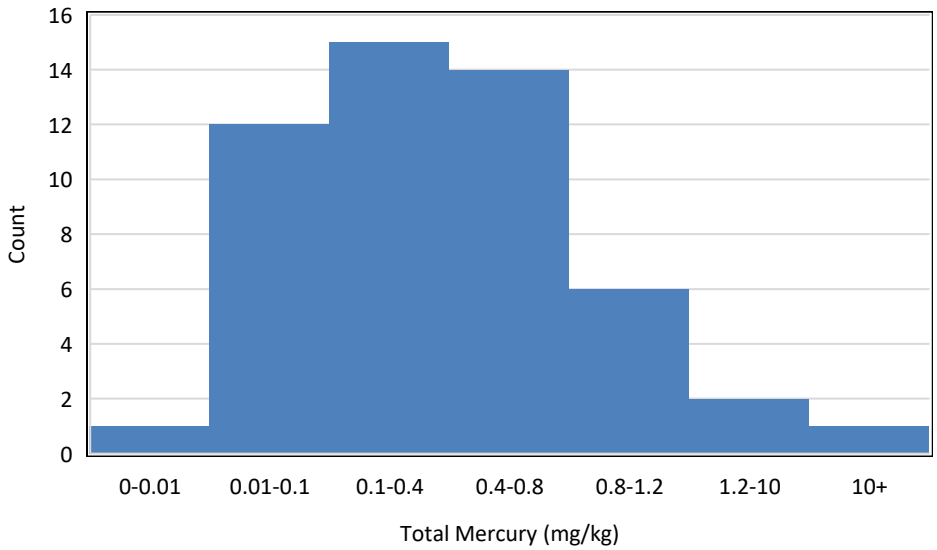

Figure 4-2 Total Mercury Distribution in Samples

The sample taken as a duplicate QC showed a relative percent difference (RPD) of 23.1% in total mercury concentration when compared to the original sample. This RPD falls below the general acceptable range for split/duplicate quality control samples (30%) as established by the Australian Standard for Soils 4482.1-2005 (Committee EV-009 Sampling and Analysis of Soils and Biota, 2005), and the total mercury results are therefore acceptably precise to use in the following analyses. The location of all soil mercury samples are plotted in Attachment B.

The correlation between the total soil mercury content in mg/kg and the concentration of mercury vapor in µg/L at the 60s intake time was plotted in Figure 4-3.

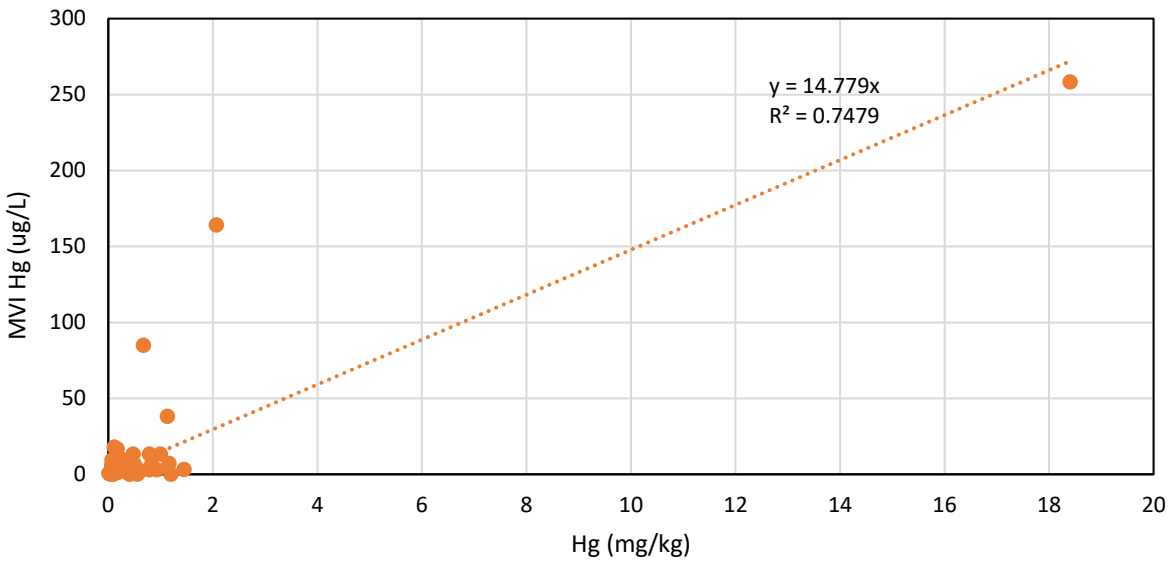

Figure 4-3 Mercury Vapor Concentration vs Total Soil Mercury Content

There is a medium correlation between the concentration of mercury in the soil and the concentration of mercury gas detected by the MVI. The observed correlation is driven by the high-mercury point (18.4, 258.3). When this point is omitted, the correlation strength is reduced to $R^2 = 0.396$. The correlation drops to $R^2 = 0.287$ when only samples that tested below 20 µg/L mercury vapor were considered. This trend indicates that the mercury vapor analyzer is more useful at detecting the presence of high concentrations of mercury as opposed to distinguishing between relatively low levels of mercury. Using the MVA prior to sampling allowed GRE to locate areas of high mercury contamination. Random soil and sediment sampling would likely not have captured any mercury “hot spots”.

This significantly lower correlation between mercury in the soil and mercury vapor at lower levels is likely due to the limitations of mercury vapor testing, as well as the species of mercury present in the samples. As mentioned in Section 4.1, mercury vapor is only released when elemental mercury is present in the soil. If the initially deposited elemental mercury has degraded into other forms due to exposure to environmental conditions and time, it will not be detected in the mercury vapor analysis and thereby impact the correlation. The vapor readings allowed GRE to focus on soil sampling in areas known to have elemental mercury contamination.

For example, the point (1.2, 0) was taken from a pile of tailings along a creek in the jungle of the Toucan area. This location was clearly disturbed by artisanal mining activity, likely within the past year, as there was some plant growth observed on the disturbed piles. Due to the increased shade and coolness under the tree canopy which decreased mercury vapor pressure, the MVA reported a value of 0 µg/L. The laboratory results, on the other hand, showed the presence of 1.2 mg/kg of mercury.

Another interesting example is point (1.45, 3.25), which was taken in the center of the remnants of an old camp structure in a disturbed location at the north-east property boundary in full sun. This also tested at fairly low concentrations of mercury vapor, but had anomalous concentrations of total mercury. This is likely due to the type of mercury deposited in this area. Artisanal miners often burn off the mercury from the mercury amalgam near their camp, so it is likely that the burned off mercury fumes re-deposited in this area as mercuric oxides as opposed to elemental mercury. As a result, there was an anomalous total mercury concentration, but fairly low detection of elemental mercury vapor.

Additionally, there are samples which had relatively high concentrations of mercury vapor, but low overall mercury content. One of these is point (0.114, 18.01) which was taken from a topographic low point of a drain, some distance away from a large, fresh tailings pile in the south-east area of the project with no observable vegetation growth. This is likely explained by the fact that, being a recent pile, the majority of the mercury in the ground was likely still present as elemental mercury and, as a result, gave higher readings of mercury vapor. A point with a similar trend is (0.673, 84.96), which was taken from a culvert in the drainage plain from a fresh tailings pile in full sun in the northwest area of the Project. This particular tailings pile was extremely fresh, as Mako personnel had observed the artisanal miner working that pile a few days before the sample was taken. Mercury vapor was detected at higher levels due to the shorter timespan between when the mercury was likely deposited and when the test was performed.

Methyl Mercury

Methyl mercury in soil ranged from < 0.05 µg/kg to 8.65 µg/kg. The location of all methyl mercury samples are presented in Figure 4.3. There was a general positive correlation between total mercury and methyl mercury content in the soil (Figure 4-4). When the high total mercury point (18.4, 8.52) is removed from the analysis, the correlation increased to $R^2 = 0.74$.

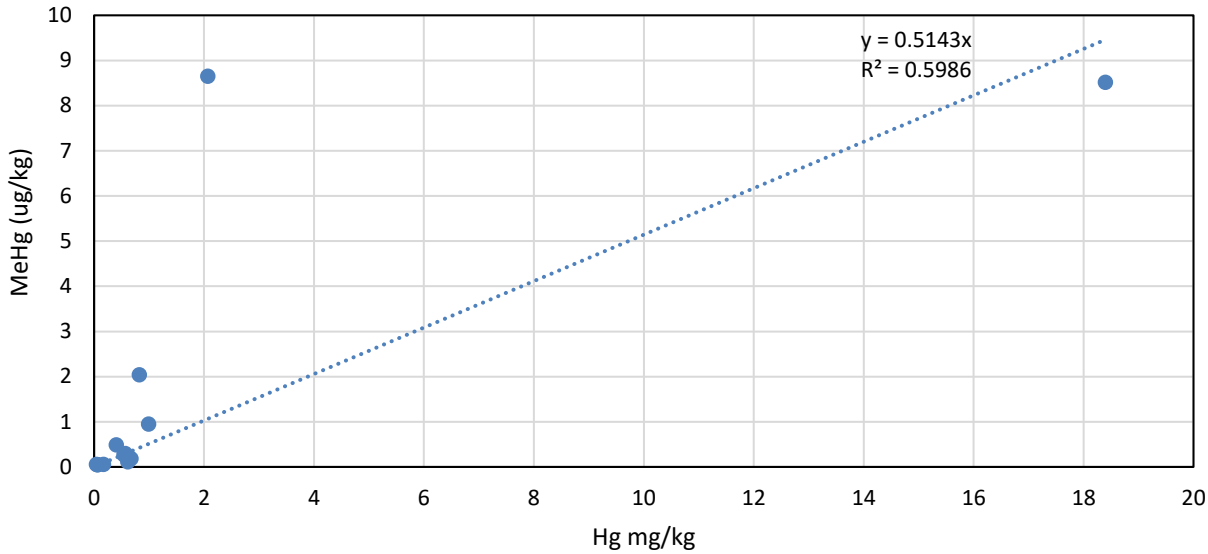

Figure 4-4 Soil Methyl Mercury vs Total Soil Mercury

Highest amounts of methyl mercury were generally found in areas highly disturbed by artisanal mining. This is likely because these areas had the greatest total mercury deposition, which then resulted in proportionately more methyl mercury.

4.3 Sediment Samples

A total of 30 sediment samples were collected at select locations around the project. Sediment samples were taken with a Shelby tube at varying depths as described in Section 3. Mercury in sediment ranged from 0.0352 mg/kg to 4.22 mg/kg, with geometric mean and average mercury concentrations of 0.315 mg/kg and 0.568 mg/kg respectively. Methyl mercury ranged from below 0.05 µg/kg to 2.08 µg/kg. As the sediment samples were sent alongside the soil samples, the laboratory holding times were exceeded for both total mercury and methyl mercury. Although it is possible that results may be biased to lower mercury concentrations, GRE deemed the results acceptable and continued with the analysis.

The highest total mercury sediment was taken at a stream where visible mercury droplets were able to be panned out of the sediment (Figure 4-5). Lower total mercury was generally observed in river sediments, higher total mercury concentrations were generally observed in pond sediments, and stream sediments were found to have a large variance in total mercury content. These trends are likely due to the ability of mercury to accumulate in the sediment.

No trends were discovered in the distribution of mercury through the sediment profile. Some locations showed increased mercury levels with depth, while other locations showed highest mercury concentrations in the sediments closest to the surface. This maybe due to the

chronology of when mercury was used by artisanal miners in specific areas. The locations of all sediment samples are shown in Attachment C.

Figure 4-5 Bead of Mercury in Panned Creek Sediment

4.4 Water Samples

Twelve water samples were collected at the locations of the sediment samples and analyzed for total mercury. Three of these water samples were additionally tested for methyl mercury. All 12 water samples showed total mercury content less than the quantification limit of 0.5 µg/L. Methyl mercury ranged from 0.000081 µg/L to 0.00054 µg /L. The highest methyl mercury concentration was found in pond water, which makes sense, as standing water provides greater opportunity for mercury to speciate into methyl mercury. As all water samples were low in both methyl and total mercury, no correlation between sediment mercury concentration and mercury in water was found. The location of the methyl mercury water samples is shown in Attachment D. The laboratory results are presented in Appendix C.

5.0 CONCLUSIONS

5.1 Soil

Overall, the MVA was a useful predictive tool in locating mercury-contaminated areas. Higher total mercury concentrations were generally found in soil that had higher in-field mercury vapor content. Deviations from this trend were likely due to recency of mercury deposition, type of mercury deposited, and temperature when the mercury vapor analysis was performed.

Soil samples were taken at a variety of mercury vapor content measurement locations. Samples were skewed to locations with significantly higher mercury vapor readings (14.9 µg/L vs 5.1 µg/L, p = 0.0057) to ensure that anomalous mercury "hot spots" were characterized. Total concentrations of mercury in soil samples ranged from 0.0076 mg/kg to 18.4 mg/kg, with 39% of samples enriched above five-times crustal abundance (0.4 mg/kg). Only one sample exceeded the USEPA Residential Soil Screening Level for total mercury (7.1 mg/kg) and no samples exceeded the USEPA Industrial Soil Screening Level for total mercury (30 mg/kg) (US EPA, 2024).

Methyl mercury in soil ranged from below 0.05 µg/kg to 8.65 µg/kg and was positively correlated with total mercury content. No samples exceeded the USEPA Residential or Industrial Soil Screening level for methyl mercury (US EPA, 2024).

Mercury in soil on the project site is heterogenous, and highly localized to areas disturbed by artisanal mining activity. Although higher elemental mercury content is likely found in workings where the mercury has been recently deposited, total mercury content may still be elevated above five-times crustal abundance in areas with older disturbances, although analysis has shown that this occurs in relatively limited number of locations. Interpreting the results of the mercury vapor analysis in the context of these limitations indicate that 10-15% of tested locations at the project contain mercury content greater than five-times crustal abundance (0.4 mg/kg). Based on the results, it is estimated that no more than 1% of areas contain mercury in exceedance of USEPA Residential or Industrial Soil levels and these areas are localized in size and distribution.

5.2 Sediment and Water

Total mercury in sediment of rivers, streams, and ponds at the Project ranged from 0.0352 mg/kg to 4.22 mg/kg. Higher levels of total mercury were generally found in sediment of stagnant water that had been disturbed by artisanal mining activity, and lower levels of total mercury were generally found in the streambeds of rivers. Sediment of streams and creeks showed highly variable levels of total mercury content.

Sediment mercury content was not found to be correlated with mercury content in water at the same locations. All 12 water samples tested below the laboratory quantification limit of 0.5 µg/L. These results indicate that water in the project area that has interacted with disturbed material by artisanal mining activity is not likely to exceed the USEPA Freshwater Criterion Maximum Concentration or Criterion Continuous Concentration of 1.4 µg/L and 0.77 µg/L (US EPA).

Methyl mercury concentrations ranged from 0.000081 µg/L to 0.00054 µg/L. These levels of methyl mercury are comparable to the methyl mercury concentrations detected at other surface water monitoring locations throughout the site and are significantly below the USEPA Human Health Criteria Table reference values of 0.3 µg/L (US EPA).

Mercury deposited by artisanal mining activity into soil and sediments on the project site does not appear to be mobilized significantly into water resources. The highest risk of mobilization and mercury speciation is likely in stagnant waters, however, even these locations test below reference values for both total mercury and methylmercury.

5.3 Overall Conclusion

Despite historically widespread and long-duration mercury use by artisanal miners, the screening and testing program within the Eagle Mountain mineral exploration concession did not discover water contamination or aquatic toxicity risk associated with artisanal mercury soil contamination.

6.0 RECOMMENDATIONS

This study is a broad, screening-level review which utilized mercury vapor to locate areas of anomalous soil mercury content for more detailed analysis of soil, sediment, and water mercury content. This work does not indicate an aquatic contamination or toxicity risk associated with mercury leaching from artisanal mining mercury soil contamination. As a result, GRE does not recommend additional targeted mercury studies unless site conditions change (for example, miners intrude on the concession and there is evidence of a new potential "hot spot"). However, as part of routine baseline data collection (prior to mining) and water quality monitoring during operations, GRE recommends ongoing testing of water onsite for mercury and methyl mercury to continue to monitor the aquatic risk associated with artisanal mining disturbances. As additional deposition of mercury by artisanal miners may influence existing soil and water quality, GRE also recommends that Mako utilize security measures to minimize future artisanal mining disturbances onsite.

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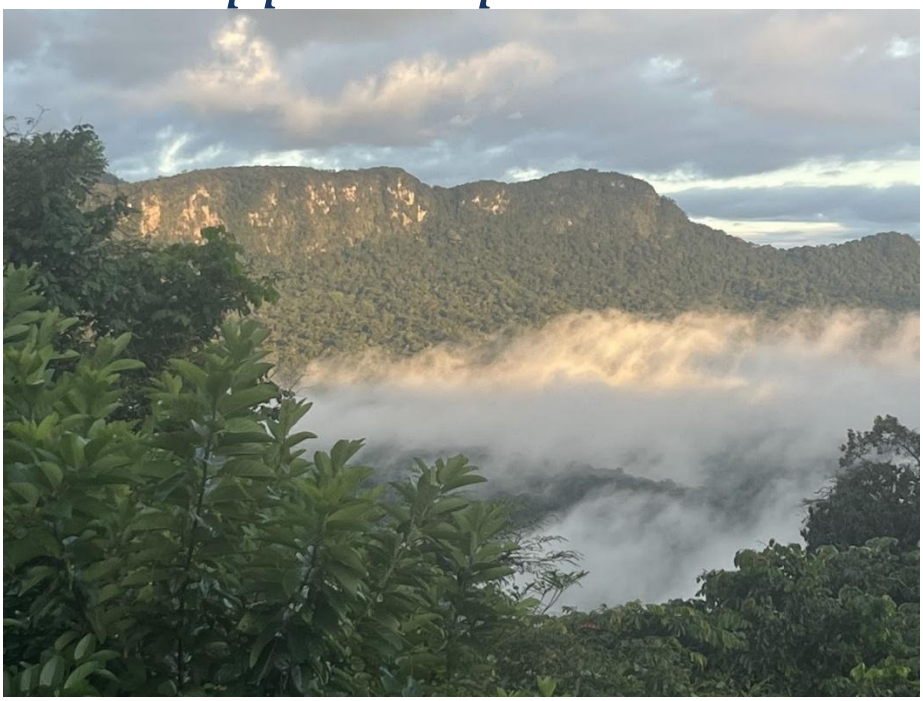
ESIA Support Report



Eagle Mountain Project, Guyana

March 16, 2026

Prepared for:

Mako Mining Corp. and ERM

Prepared by:

Global Resource Engineering, Ltd.

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1.0 INTRODUCTION

At the request of Mako Mining Corp (Mako), Global Resource Engineering (GRE) has been supporting ERM in the creation of an Environmental Impact Statement (EIS) for the Eagle Mountain open pit gold mining development project (the Project). GRE has been developing the following major subject-matter areas for the EIS:

1. Basic Project Description
2. Climate Data and Climate Data Management
3. Baseline Hydrogeologic Characterization
    a. 24-hour pump testing of geotechnical and monitoring wells;
    b. Packer testing of selected geotechnical boreholes;
    c. Vibrating wire piezometer (VWP) installation and monitoring;
    d. Groundwater quality assessment;
    e. Conceptual groundwater model.
4. Baseline Hydrologic (Surface Water) Characterization
    a. Stream discharge measurements;
    b. Total suspended solids (TSS) sample collection plus analysis;
    c. Surface water quality assessment;
    d. Conceptual surface water model.
5. Geochemical Characterization
    a. Acid Rock Drainage (ARD) and Metal Leaching (ML) risk assessment;
    b. Assessment of the water quality impacts of Mine Impacted Water (MIW) including:
        i. Mine contact water (for example, pit dewatering);
        ii. Mine process water (tailings supernatant – the solution that accompanies tailings discharge); and,
        iii. Sediment-laden water resulting from mine-related surface disturbance.
6. Baseline Mercury Study
7. Hydrogeologic Impact Assessment (changes in groundwater conditions)
8. Hydrologic Flow Modeling
9. Site-Wide Water Balance
10. Water Quantity Impact Assessment (changes in site-wide surface water flows, focusing on dry season flow rates)
11. Water Quality Impact Assessment (changes in site-wide water quality resulting from mine operations)

Since the beginning of these programs in July of 2024, a significant amount of data has been collected and analyzed in support of the Project. This report serves as an update on the data

that has been compiled and the data that will be necessary for permitting involved with the Project. Additionally, this report is to serve as supplementary material for Environmental Resources Management (ERM). ERM will use this information for their Environmental and Social Impact Assessment (ESIA). This report is in response to the "data freeze" at the behest of Steve Parsons, the President of Mako, as well.

2.0 PROJECT DESCRIPTION

The Eagle Mountain Project is an open-pit mining development project located near the town of Mahdia, Guyana. Although the EIA will contain a detailed project description, in order for this report to be a stand-alone document, it is necessary to list some key Project facts.

The Project is a gold mining development project using cyanide in a carbon-in-pulp processing circuit. This results in the production of mine tailings (fine grained crushed and milled ore, with the gold processed out of it). Cyanide is destroyed within the plant to levels below 5 ppm of Weak-Acid Dissociable (WAD) cyanide. Cyanide levels are further reduced in the tailings storage facility by UV light and by circumneutral pH conditions.

The project is an open pit with several different pit zones over the project area. These include:

- Eagle Mountain – a series of pits up the lower slopes of Eagle Mountain;
- Salbora (the smallest pit, with higher grade ore);
- Toucan; and,
- Powis

At the time of the data freeze for the EIA, the pits were estimated based on $1800 gold. Pit sizes may (or may not) increase with higher gold prices.

The project will extract primarily a saprolite gold ore for the first four years, then transition to primarily hard rock ore. The mine will operate for at least 15 years, processing 5000 tonnes of ore per day.

The mine will use conventional tailings (wet tailings) disposal in two separate facilities, one in the Mahdia river drainage, and one in the Minnehaha river drainage.

The project will produce 49 Mtonnes of waste rock. This waste rock will largely be used as a buttress for the tailings dams. Other waste rock dumps may exist where necessary within the project area.

Considerable effort will be required to divert and manage surface water, as well as dewatering the pits. All Mine Impacted Water (MIW) must be treated for sediment. It is very likely that settling ponds will require a flocculant dosing system to achieve a low-turbidity discharge.

3.0 CLIMATE

GRE has been working with Mako Mining to compile, evaluate and analyze environmental data. This effort includes climate data. The Project lies within a tropical humid rainforest environment with bi-modal wet seasons (May through July and November through January) followed by dry seasons.

3.1 MEASURED RAINFALL

About 50% of the rain that falls on-site happens during the wet season (Powell, 2024). Precipitation was measured at a single weather station located at the Project camp. After taking the first reading on June 1st, 2021, the weather station has since recorded climate data at 15-minute intervals. Figure 3-1 below depicts the monthly precipitation as captured by the Project meteorology station, while Table 3-1 below presents the values associated with the monthly rainfall.

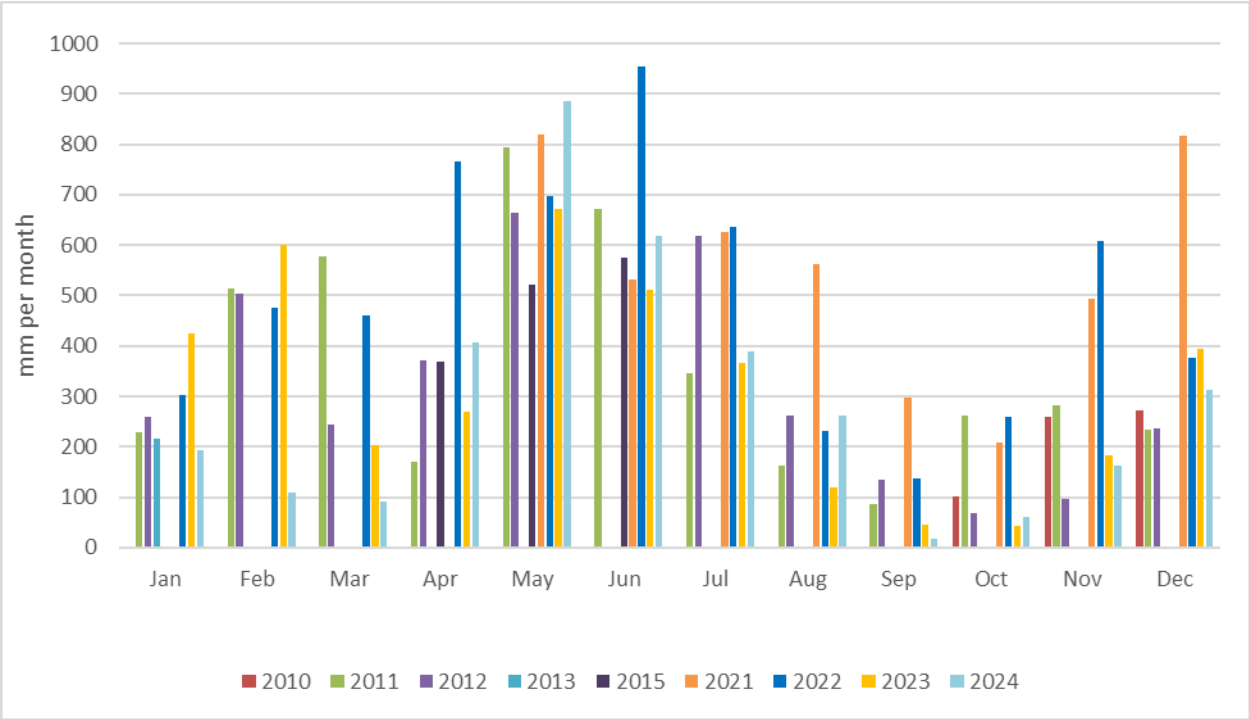


Figure 3-1: Observed Precipitation, Project Meteorology Station

Table 3-1: Project Monthly Historical Precipitation & Totals

Monthly Rainfall (mm)									
Month	2010	2011	2012	2013	2015	2021	2022	2023	2024
Jan	0.00	228.70	260.40	216.00	0.00	0.00	301.65	425.80	193.20
Feb	0.00	515.00	504.80	0.00	0.00	0.00	476.84	600.00	109.80
Mar	0.00	578.60	243.90	0.00	0.00	0.00	459.99	203.20	91.40
Apr	0.00	171.00	371.70	0.00	368.56	0.00	765.77	270.00	407.00
May	0.00	795.20	664.10	0.00	522.80	820.57	696.27	672.00	884.80
Jun	0.00	671.80	3.00	0.00	576.30	532.35	955.23	512.20	617.20
Jul	0.00	346.00	618.70	0.00	0.00	627.07	636.27	367.40	389.40
Aug	0.00	162.70	260.90	0.00	0.00	563.31	230.50	118.60	262.60
Sep	0.00	85.80	135.60	0.00	0.00	297.77	137.28	46.00	18.60
Oct	100.40	262.60	68.50	0.00	0.00	208.40	259.38	43.80	61.60
Nov	260.40	281.50	95.90	0.00	0.00	494.40	607.25	182.20	162.20
Dec	272.40	234.80	236.90	0.00	0.00	817.69	376.74	393.40	312.60
Total	**633.20**	**4333.70**	**3464.40**	**216.00**	**1467.66**	**4361.56**	**5903.17**	**3834.60**	**3510.40**

Yellow highlighted cells represent precipitation years with incomplete data records.

3.2 PROCESSED RAINFALL DATA

Because only 3 complete precipitation years have been captured by the weather station, GRE has utilized NASA-based satellite data to simulate rainfall before 2021. This was a necessary task in determining design storm and potential climate fluctuations from year-to-year. Using different correlation methods and statistical data normalization, GRE was able to generate representative rainfall with observed rainfall as seen in Figure 3-2.

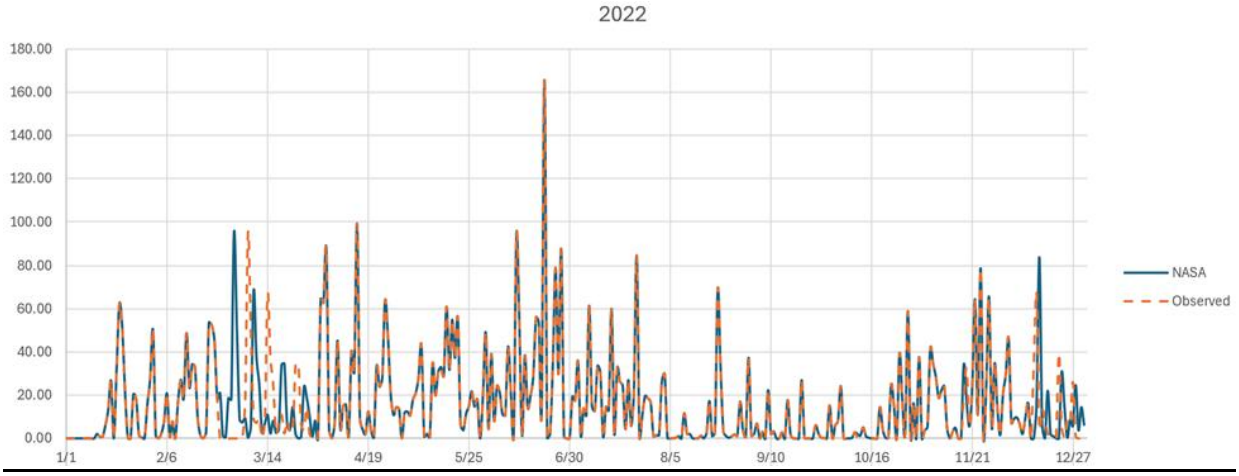


Figure 3-2: Project Observed v. Simulated Precipitation, 2022

Using the statistical normalization, GRE then simulated rainfall from 2000 to 2020. The following Table 3-2 presents the simulated annual rainfall total for the Project.

Table 3-2: Simulated Project Annual Precipitation

Year	Total Precipitation (m)
2000	2.66
2001	2.84
2002	2.95
2003	2.38
2004	2.36
2005	2.63
2006	3.29
2007	2.40
2008	2.92
2009	2.30
2010	3.40
2011	2.47
2012	1.70
2013	2.36
2014	2.92
2015	2.92
2016	2.38
2017	2.56
2018	2.59
2019	2.20
2020	1.79
2021	2.26
2022	5.90
2023	3.83
2024	3.51
2025	0.72

Years 2000-2021 are generated via NASA satellite normalization from observed data. 2025 total only contains January and February.

As demonstrated by Table 3-2, the Project receives from 1.7 to 5.9 meters of rainfall per year.

3.3 OTHER CLIMATE DATA

Aside from precipitation, the on-site meteorological station monitors additional parameters such as temperature and humidity. The average temperature observed by the station is 25 degrees Celsius (°C). Average monthly temperatures over the weather station observed timeframe (2021 through 2024) are presented in Figure 3-3. The nearly four-year data set was also found to have a minimum temperature of 15°C and a maximum of 36°C.

In terms of humidity, the station has recorded an average of 70% which is to be expected in a tropical rainforest environment. According to the 2021 through 2024 record, the station has reported a minimum humidity of 30% in December 2022 and a maximum humidity of 81% in December 2021. Figure 3-4 presents the average monthly humidity as observed by the Project weather station.

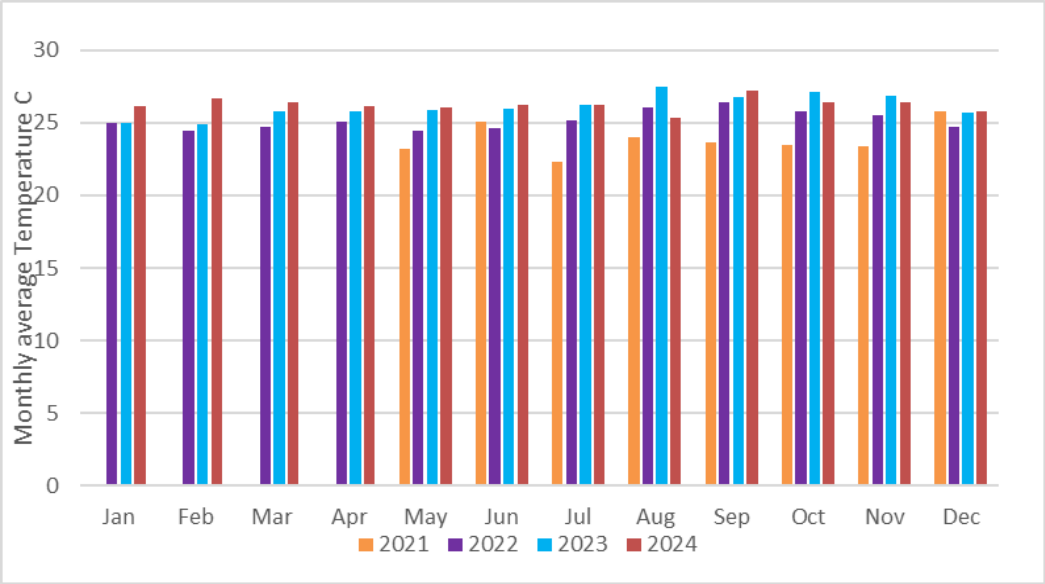


Figure 3-3: Project Historical Temperature

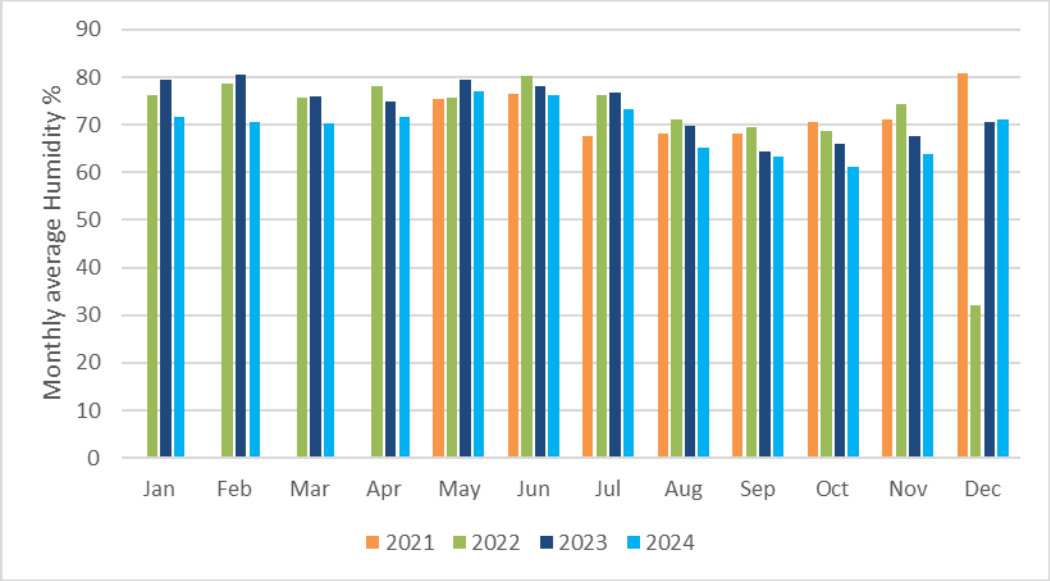


Figure 3-4: Project Historical Humidity

4.0 HYDROGEOLOGIC CHARACTERIZATION

In support of the EIS, GRE executed the site-wide hydrogeologic characterization program.

4.1 GEOTECHNICAL & MONITORING WELLS

From September 2024 to March 2025, GRE personnel traveled to Guyana to conduct a field program investigating the hydrogeology of the Project and focused on the groundwater conditions beneath and around critical Project infrastructure such as pits, waste rock dumps, the plant, and the tailings storage facilities (TSFs). Drawing 1, which can be found at the end of this report, shows the location of the site's current groundwater wells.

The goal of these programs was to install wells across the different stratigraphic units at the project site. Drilling has revealed that the site has three main stratigraphic units – saprolite, a transition zone at the top of the hard rock, and hard rock. Along the river channels, there are alluvial and colluvial deposits. Much of the alluvium has been re-worked by the local miners and has a different, and significantly less-dense texture than if it were material placed by standard alluvial/colluvial deposition.

GRE installed groundwater wells in saprolite or transition materials and conducted packer tests in the hard rock units.

Table 4-1 below is a summary table of the construction details of all of the wells installed during this effort. The wells have been separated into three categories based on the well location within the future Pits or other Infrastructure, with the remainder being placed in a third category labeled Monitoring. These wells will be used to develop the general site groundwater condition.

Table 4-1: Project Well Record

Well ID	Installation Date/Year (MM/DD/YYYY)	Well Dia. (mm)	Total Depth (m)	Screen Interval(s) (m)	WL Max (m bgs.)	WL Min (m bgs.)
PIT WELLS						
GWP-006	12/03/2024	38.10	27.10	9.10-21.10	0.79	1.86
GWP-009	03/08/2025	38.10	60.00	30.00-60.00	4.56	6.36
GWP-016B	11/11/2024	38.10	30.00	20.82-26.94	8.00	21.53
INFRASTURCTURE WELLS						
GWI-001	01/18/2025	38.10	10.14	4.02-10.14	2.90	3.64
GWI-002	02/06/2025	38.10	27.67	6.20-27.67	0.63	1.28
GWI-007	02/12/2025	38.10	18.30	3.05-18.30	0.58	0.80
SITE-WIDE MONITORING WELLS						
GWW-01B	01/16/2025	38.10	19.60	7.60-13.60	0.78	1.99
GWW-02	01/20/2025	38.10	16.50	4.26-13.44	6.78	8.29
STANDPIPE PIEZOMETERS						
EMD-288	06/21/2024	25.40	19.46	12.45-19.46	14.69	19.45
EMD-289	06/20/2024	25.40	28.60	24.03-28.60	19.11	22.60

Dia. = Diameter. WL = Water Level.

EMD-288 and EMD-289 are standpipe piezometers. These piezometers were installed by lowering PVC pipes into the existing exploration boreholes EMD-288 and EMD-289. These piezometers offer useful water level data.

At a minimum, wells were allocated 24-hours to settle before development. This was done to ensure the sand pack would stabilize between the well and aquifer material, as well as allow the bentonite to swell and the concrete surface pad to set. Development typically involved over-pumping of each well to evacuate any residual drilling fluid or sediment within the well and well screen. Using a Grundfos 3 SQE 10C with a CU300 control unit, the water column within the well was removed as rapidly as possible, then the water was allowed to recover until another column could be removed. This development cycle continued until the sediment had been properly removed from the well and screen (as verified by a field turbidimeter), which often required several hours for the entire process. Afterwards, another minimum 24-hours were elapsed before aquifer testing of the wells could commence.

Due to insufficient water column to rapidly remove the well water, some remote groundwater wells were developed using a stainless steel bailer. This method involved surging the water column with the bailer and extracting sufficient sediment and groundwater until well clarity was achieved.

Nearly all groundwater wells on site were developed until the water was clear of sediments. This is necessary because the pump utilized in aquifer testing should not be subjected to prolonged periods of pumping highly turbid water.

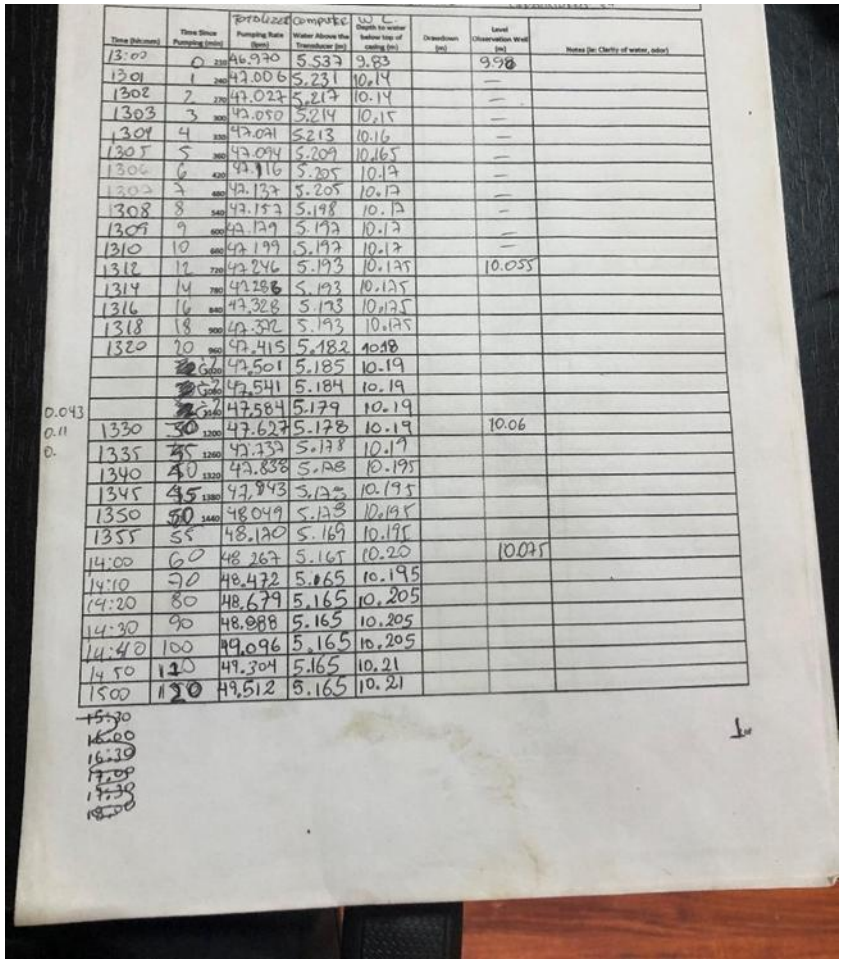
4.2 TESTING MONITORING WELLS: 24-HOUR TESTS

For nearly all aquifer tests, a Grundfos 3 SQE 10C with a CU300 control unit was used over a 24-hour timeframe to drawdown the well to a “maximum possible stress” level and then to maintain drawdown in each of the tested wells. One groundwater well (GWW-02) was too low-yield to be effectively aquifer tested using this method.

Although the depth of the pump varied in each well, the pump was positioned slightly above the well screen or slightly inside the top well-screen, depending on the water level recorded prior to pump installation. This positioning ensured the Grundfos 3 would not cause significant damage to the well screen and disturb the sand pack as it withdrew water from the aquifer.

Discharge was controlled using a potentiometer connected to the CU300 and measured via totalizer at the end of the re-pump discharge line. When the totalizer did not record the volume being discharged, a container of known volume and stopwatch were used to calculate the discharge rate at different intervals throughout the test. This technique is commonly used when a flowmeter or totalizer is not available or malfunctioning (Farr & Whiteman, 2014).

The discharge line varied in length but was a sufficient enough length during each test that discharged water would not interfere with the test. Water elevation was observed and recorded by a transducer (installed slightly above the pump intake and programmed for 1 minute time intervals) and water level meter (for hand-readings measured from top of casing). Water chemistry parameters (pH, electrical conductivity, and temperature) were recorded at different intervals throughout the pump test. All three parameters were carefully monitored to ensure quality data was being collected. Figure 4-1 shows an example pumping test log sheet.



Time (hh:mm)	Time Since Pumping (min)	Pumping Rate (lpm)	Water Above the Transducer (m)	Depth to water below top of casing (m)	Drawdown (m)	Level Observation Well (m)	Notes (ie: Clarity of water, odor)
13:00	0	46.970	5.537	9.83		9.98	
1301	1	47.006	5.231	10.14		—	
1302	2	47.027	5.217	10.14		—	
1303	3	47.050	5.214	10.15		—	
1304	4	47.071	5.213	10.16		—	
1305	5	47.094	5.209	10.165		—	
1306	6	47.116	5.205	10.17		—	
1307	7	47.137	5.205	10.17		—	
1308	8	47.157	5.198	10.17		—	
1309	9	47.179	5.197	10.17		—	
1310	10	47.199	5.197	10.17		—	
1312	12	47.246	5.193	10.175		10.055	
1314	14	47.288	5.193	10.175			
1316	16	47.328	5.193	10.175			
1318	18	47.372	5.193	10.175			
1320	20	47.415	5.182	10.18			
	17	47.501	5.185	10.19			
	1080	47.541	5.184	10.19			
	1140	47.584	5.179	10.19			
1330	30 1200	47.627	5.178	10.19		10.06	
1335	35 1260	47.737	5.178	10.19			
1340	40 1320	47.838	5.18	10.195			
1345	45 1380	47.843	5.173	10.195			
1350	50 1440	48.049	5.173	10.195			
1355	55	48.170	5.169	10.195			
14:00	60	48.267	5.165	10.20		10.075	
14:10	70	48.472	5.165	10.195			
14:20	80	48.679	5.165	10.205			
14:30	90	48.888	5.165	10.205			
14:40	100	49.096	5.165	10.205			
14:50	110	49.304	5.165	10.21			
1500	120	49.512	5.165	10.21			

Figure 4-1: Example Pump Test Log

After the pumping period, GRE recorded water levels during the recovery period. Water levels from the transducer and water level meter were recorded to track the pumped well recovery. The test was officially concluded once 90% of the pre-stress (steady-state) water level was recovered, which varied from a couple hours to several days.

4.3 TESTING MONITORING WELLS: SLUG-OUT TESTS

One well at the Project, GWW-02, had insufficient recharge which could not or did not sustain 24 hours of continuous pumping/drawdown. Due to this circumstance, the well underwent a slug-out test instead. A typical slug-out test requires a container of known volume (such as a bailer) to be gently submerged into the top of a monitoring well water column, then rapidly removed and the water discarded into a bucket. As the water level inside the well recovers, water level elevations are recorded via water level meter (hand-readings) or transducer until the water level has returned to 95% of the initial water level. GRE followed this approach by using the Grundfos 3 pump to evacuate water from the well. Pumping continued until most of the water above the

pump was removed and a constant water level was sustained for a short amount of time (between 1-2 minutes).

Afterwards, the pump was turned off and the well was allowed to recover. During this time, water level observations were recorded based on the water level above a transducer and the initial water level before pumping commenced. This operation was repeated two more times to ensure multiple recovery curves could be analyzed to corroborate the K-value of the unit being tested. Before a second or third slug was removed, ample time was set aside for the well to reach ≥ 95% recovery.

4.4 ANALYSIS OF AQUIFER TESTS

GRE utilized AquiferTest Pro 10.0 (AQTPro) and United States Geological Survey Spreadsheets for the Analysis of Aquifer-Test and Slug-Test Data, Version 1.2 (USGS spreadsheets) to analyze and hydrogeologically define each tested aquifer.

AQTPro is a software package from Waterloo Hydrogeologic with the ability to analyze, interpret, and visualize pumping and slug test data through type curve fitting (Waterloo Hydrogeologic. Inc., 2020). Due to the environment in which most of these tests were performed, unconfined aquifer type curves for the pump tests (Neuman type curves) and slug-out tests (Dagan type curves) were selected and adjusted to fit the drawdown and recovery data from each test.

USGS spreadsheets were used to analyze most of the recovery data obtained from the wells. Recovery analyses using the Cooper-Jacobs Recovery type curve were used for every well with observed recovery periods. Each recovery curve was properly adjusted to fit the late-time data in each analysis to ensure that the aquifer response to the drawdown was appropriately captured (as there was potential for water in the pump and discharge line to fill the well once the pump was turned off).

Table 4-2 below presents the results of the pumping and recovery analyses.

Table 4-2: Project Well Test Analyses

Well ID	Date of Test (MM/DD/YYYY)	Material	Analysis Type	K (cm/s)	K, Geo. Mean (cm/s)
PIT WELLS					
GWP-006	01/12/2025	Transition Zone	Neuman	3.38×10^{-3}	2.53×10^{-3}
	01/13/2025		CJ	1.90×10^{-3}	
GWP-009	03/11/2025	Saprolite	Neuman	1.87×10^{-5}	2.52×10^{-5}
	03/12/2025		CJ	3.40×10^{-5}	
GWP-016B	01/14/2025	Saprolite	Neuman	4.03×10^{-6}	4.79×10^{-6}

	01/15/2025		CJ	5.70×10^{-6}	
INFRASTRUCTURE WELLS					
GWI-001	01/23/2025	Transition Zone	Neuman	2.14×10^{-4}	9.02×10^{-5}
	01/24/2025		CJ	3.80×10^{-5}	
GWI-002	03/04/2025	Transition Zone	Neuman	3.00×10^{-4}	5.14×10^{-4}
	03/05/2024		CJ	8.80×10^{-4}	
GWI-007	02/28/2025	Transition Zone	Neuman	2.90×10^{-4}	3.88×10^{-4}
	03/01/2025		CJ	5.20×10^{-4}	
MONITORING WELLS					
GWW-01B	01/18/2025	Saprolite	Neuman	5.94×10^{-5}	3.85×10^{-5}
	01/19/2025		CJ	2.50×10^{-5}	
GWW-02	01/27/2025	Transition Zone	Dagan (1)	8.94×10^{-6}	1.25×10^{-5}
			Dagan (2)	1.46×10^{-5}	
			Dagan (3)	1.53×10^{-5}	

K = Hydraulic Conductivity. Geo. Mean = Geometric Mean. Neuman = unconfined aquifer drawdown test analysis. CJ (Cooper-Jacobs) = unconfined aquifer pump test recovery analysis. Dagan = unconfined aquifer slug-out test analysis.

The results of the tests present the following:

- Saprolite was found to be in the range of 1.00×10^{-5} cm/s to 1.00×10^{-6} cm/s. This is comparative to a silt or fine sand (Domenico & Schwartz, 1990). Since the Project saprolite is typically composed of fine-grained materials, these analyses support that observation. This observation is additionally supported by geotechnical classification which has identified the saprolite as a silt.
- The Transition Zone has a greater range of K-values than the saprolite, spanning 1.00×10^{-3} cm/s to 1.00×10^{-5} cm/s. Hydraulic conductivities of this magnitude are between a coarse sand and fine sand (Domenico & Schwartz, 1990). This larger range is to be expected as Transition Zone material is known to have differing levels of fracturing and weathering that can vary immensely from area to area. The transition zone throughout the Project is also quite narrow, making it difficult to isolate this layer, which could be another cause for the range in K-values.

4.5 PACKER TESTING

Packer testing was conducted throughout the Project on boreholes designated for the pits and future infrastructure characterization. From September 2024 to March 2025, GRE conducted multiple packer tests within the boreholes drilled as part of the Project geotechnical investigation.

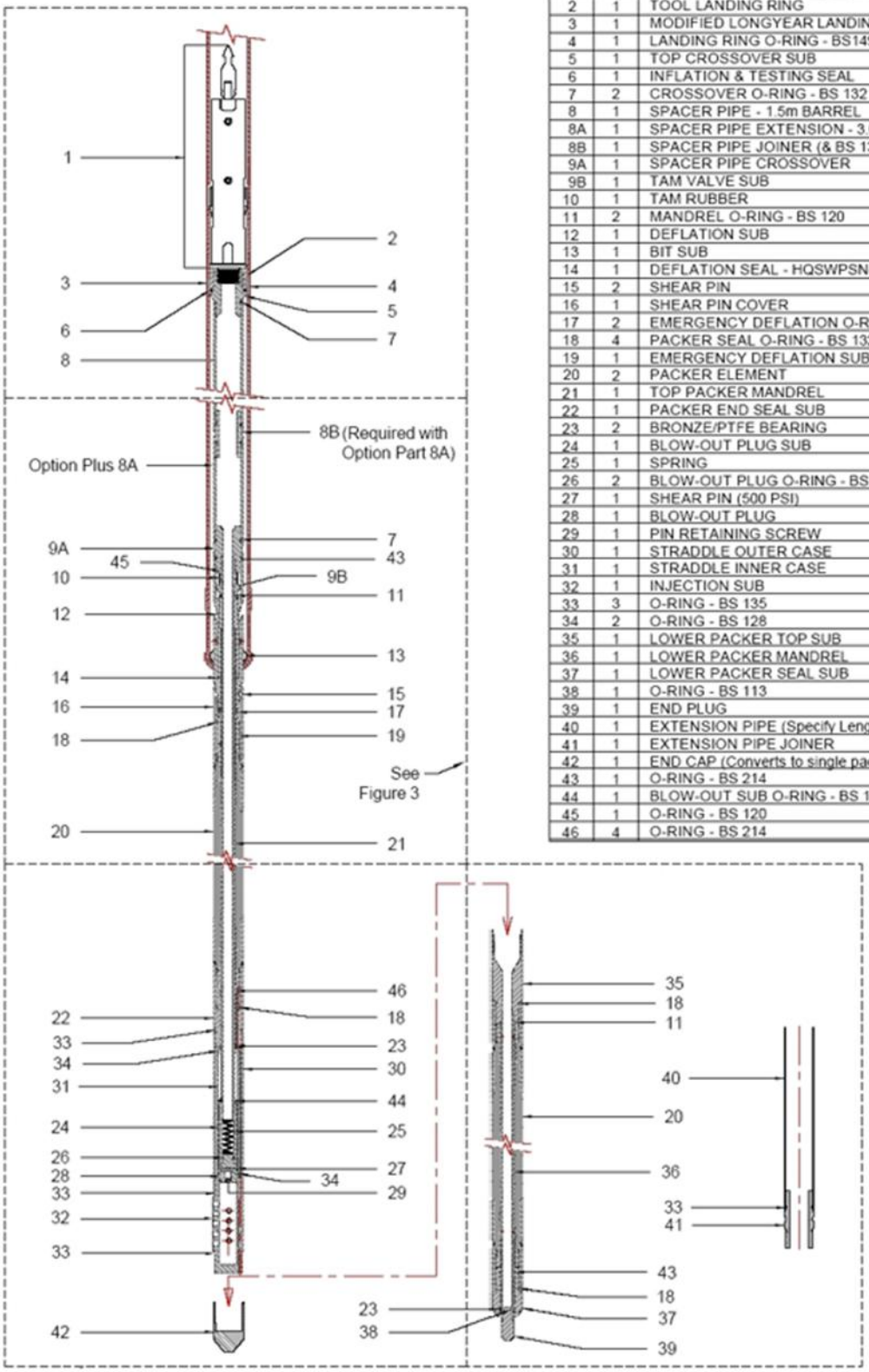
4.6 PACKER TEST EXECUTION

Packer Tests were conducted according to a standard (Royle) using an IPI inflatable packer and HQ-SWiPS shear-pin activated water injection system.

Because preliminary testing showed that the generalized rock mass was low in hydraulic conductivity and low in rock quality (RQD), testing was deliberately focused on visible fractures. A typical test was completed according to the following protocol:

1. GRE engineers or geologists examined the core for visible fractures or areas of low rock quality as the core was extracted or from the core box.
2. GRE selected a testing interval, using the bottom of the boring as the end of each interval.
3. GRE instructed the drillers to remove drill rods from the borehole to just above the packer testing zone and fill the hole with clean water up to the top of the last drill rod.
4. The packer and injection apparatus were then attached to the drill rig winch and slowly lowered, then released to the bottom of the drill rods.
5. Once it was confirmed that the apparatus was sitting and sealed on the drill rod shoe, a water injection head was secured to the top drill rod, and water was injected at a controlled rate and pressure into the drill rods.
6. Using a manifold to control the rate and pressure of the water being injected, GRE slowly raised the pressure to fill the inflatable packer and eventually break the shear pin.
7. Once the pin sheared, the water would begin flowing into the formation and the packer test could commence.

See Figure 4-2 through Figure 4-4 for detailed diagrams describing the packer test installation.



PART No.	QTY	DESCRIPTION
1	1	STANDARD LONGYEAR BACKEND
2	1	TOOL LANDING RING
3	1	MODIFIED LONGYEAR LANDING RING
4	1	LANDING RING O-RING - BS149
5	1	TOP CROSSOVER SUB
6	1	INFLATION & TESTING SEAL
7	2	CROSSOVER O-RING - BS 132
8	1	SPACER PIPE - 1.5m BARREL
8A	1	SPACER PIPE EXTENSION - 3.0m BARREL
8B	1	SPACER PIPE JOINER (& BS 132 O-rings)
9A	1	SPACER PIPE CROSSOVER
9B	1	TAM VALVE SUB
10	1	TAM RUBBER
11	2	MANDREL O-RING - BS 120
12	1	DEFLATION SUB
13	1	BIT SUB
14	1	DEFLATION SEAL - HQSWPSN-35N
15	2	SHEAR PIN
16	1	SHEAR PIN COVER
17	2	EMERGENCY DEFLATION O-RING - BS 126
18	4	PACKER SEAL O-RING - BS 132
19	1	EMERGENCY DEFLATION SUB
20	2	PACKER ELEMENT
21	1	TOP PACKER MANDREL
22	1	PACKER END SEAL SUB
23	2	BRONZE/PTFE BEARING
24	1	BLOW-OUT PLUG SUB
25	1	SPRING
26	2	BLOW-OUT PLUG O-RING - BS 118
27	1	SHEAR PIN (500 PSI)
28	1	BLOW-OUT PLUG
29	1	PIN RETAINING SCREW
30	1	STRADDLE OUTER CASE
31	1	STRADDLE INNER CASE
32	1	INJECTION SUB
33	3	O-RING - BS 135
34	2	O-RING - BS 128
35	1	LOWER PACKER TOP SUB
36	1	LOWER PACKER MANDREL
37	1	LOWER PACKER SEAL SUB
38	1	O-RING - BS 113
39	1	END PLUG
40	1	EXTENSION PIPE (Specify Length)
41	1	EXTENSION PIPE JOINER
42	1	END CAP (Converts to single packer)
43	1	O-RING - BS 214
44	1	BLOW-OUT SUB O-RING - BS 120
45	1	O-RING - BS 120
46	4	O-RING - BS 214

Figure 4-2: Packer Assembly Diagram

Figure 4-3: Packer Assembly Before Testing

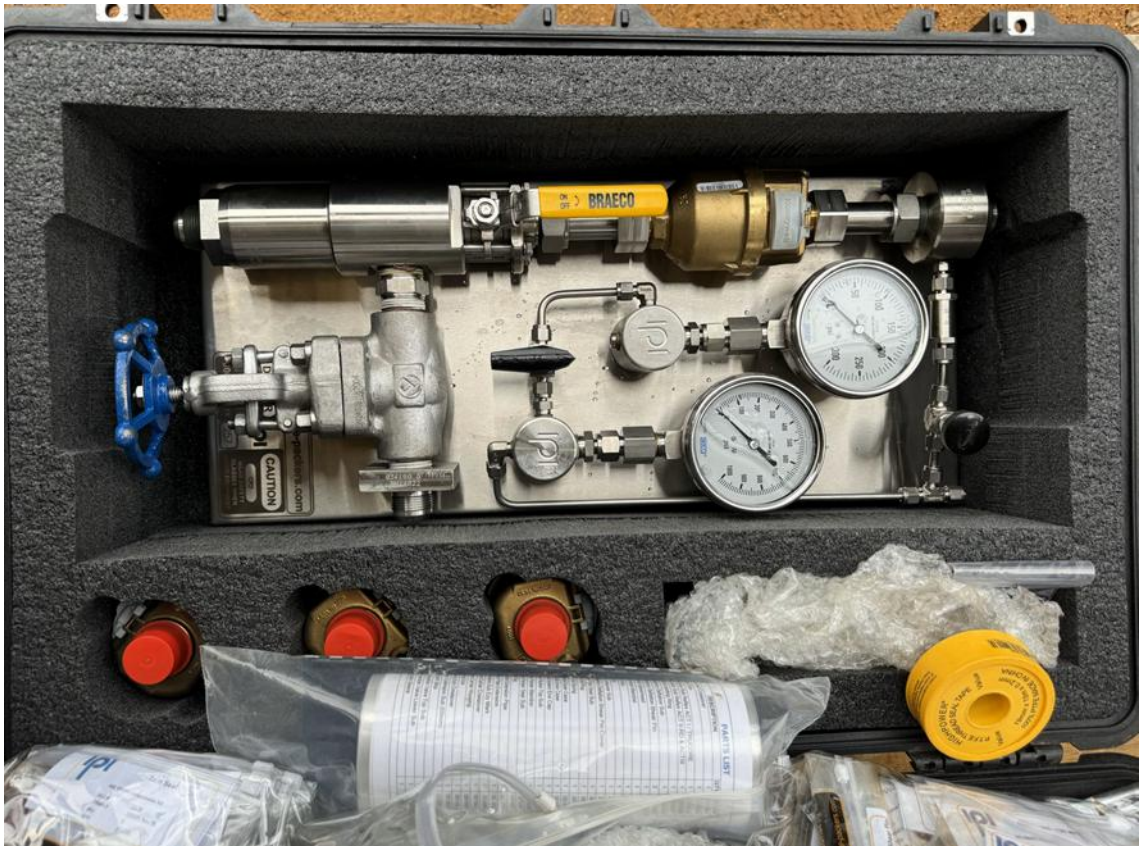


Figure 4-4: Packer Test Injection Manifold

Every packer test followed the same three step-up, two step-down procedure. Once water began to flow into the fracture or fault zone, GRE decreased the pressure using the manifold to the minimum amount of pressure for water to still flow into the zone. GRE then recorded the flow rate using a mechanical flow meter attached to the manifold and a stopwatch. Once three similar flow rates were observed on the first "step", the pressure was increased to approximately the "mid-point" of the maximum pressure the formation could handle (without creating additional fracturing). Then, the new flow rates were monitored until three similar readings were recorded. This continued for another step up to the maximum pressure, followed by two steps that decreased the pressure to approximately the same "mid-point" as step 2 and the minimum pressure as step 1, respectively. See Figure 4-5 below for an example packer pressure step test.

Step	Gauge Pressure	Flow Meter Readings [l/s]								
		1	2	3	4	5	6	7	8	9
1	51.0	0.1541	0.1546	0.1544	0.1542					
2	95.0	0.1691	0.1678	0.1676	0.1675	0.1672				
3	165.0	0.3600	0.3594	0.3556	0.3578	0.3587				
4	95.0	0.2667	0.2639	0.2649	0.2639	0.2642	0.2635			
5	49.0	0.2092	0.2112	0.2132	0.2155	0.2121	0.2160	0.2157	0.2153	0.2148

Figure 4-5: Example Packer Test

4.7 PACKER TEST ANALYSIS

Once the packer test data was logged, GRE used AquiferTest 10.0 (Waterloo Hydrogeologic, 2020) to process the data into hydraulic conductivities over the tested interval. AQTPro is an industry-standard aquifer test analysis software developed by Waterloo Hydrogeologic that can accurately interpret data from all types of aquifers in all types of test conditions (including packer tests in a hard-rock environment). GRE utilized the Lugeon Test analysis as this is analogous to the packer testing completed in the field. Before data could be input into the Lugeon analysis, the geometry and dip angle of the boring needed to be input into AQTPro. Figure 4-6 displays the geometry needed to define the Pit GEOT-005 boring with the packer test #1 interval.

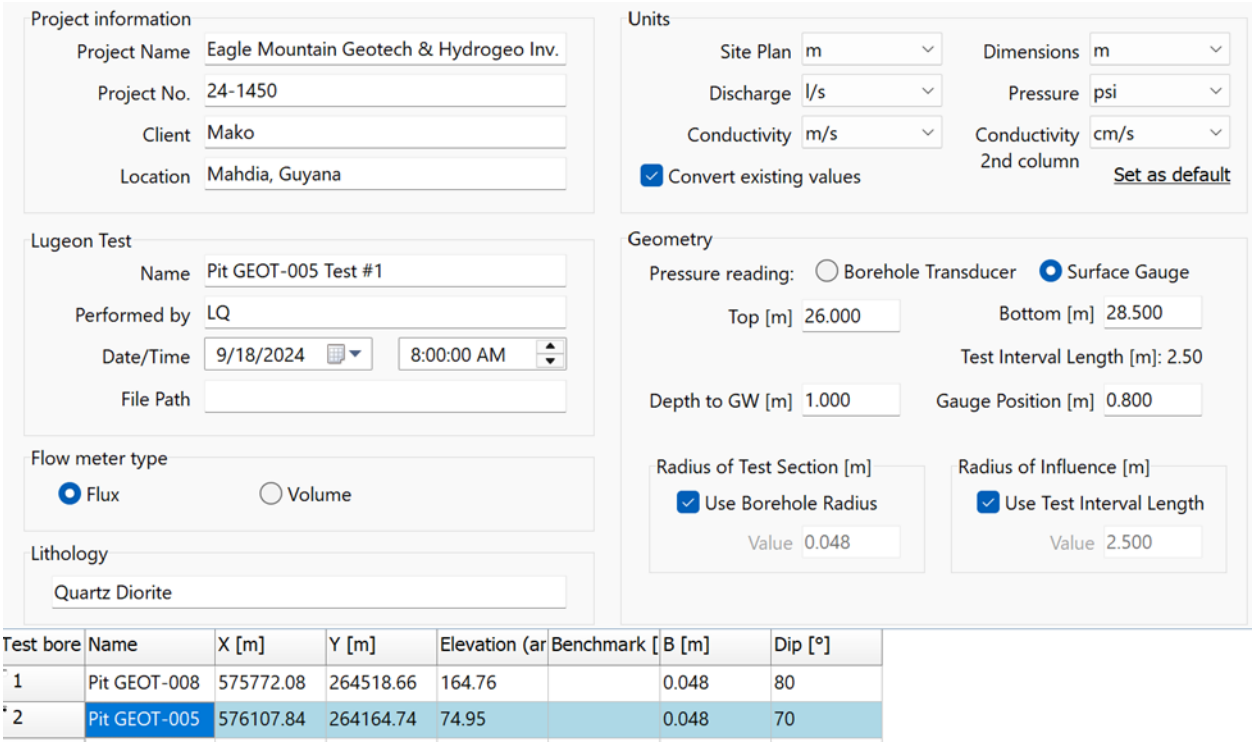


Figure 4-6: Pit GEOT-005 Packer Test #1 Geometry Definition

After defining the borehole and interval, data from the field test was entered into AquiferTest Pro (Figure 4-5). The data was then automatically processed by the program through the production of table results (Figure 4-7) and three diagrams (Figure 4-8).

Average Flow Rate	Hydraulic Conductivity		
	[m/s]	[cm/s]	Lugeon
0.6883	1.09E-5	1.09E-3	106.2
0.9524	1.05E-5	1.05E-3	101.8
1.3444	9.16E-6	9.16E-4	89.0
0.8567	9.42E-6	9.42E-4	91.6
0.6166	9.78E-6	9.78E-4	95.1
Average	**9.95E-6**	**9.95E-4**	**96.8**

Figure 4-7: Table Results from Pit GEOT-005, Packer Test #1

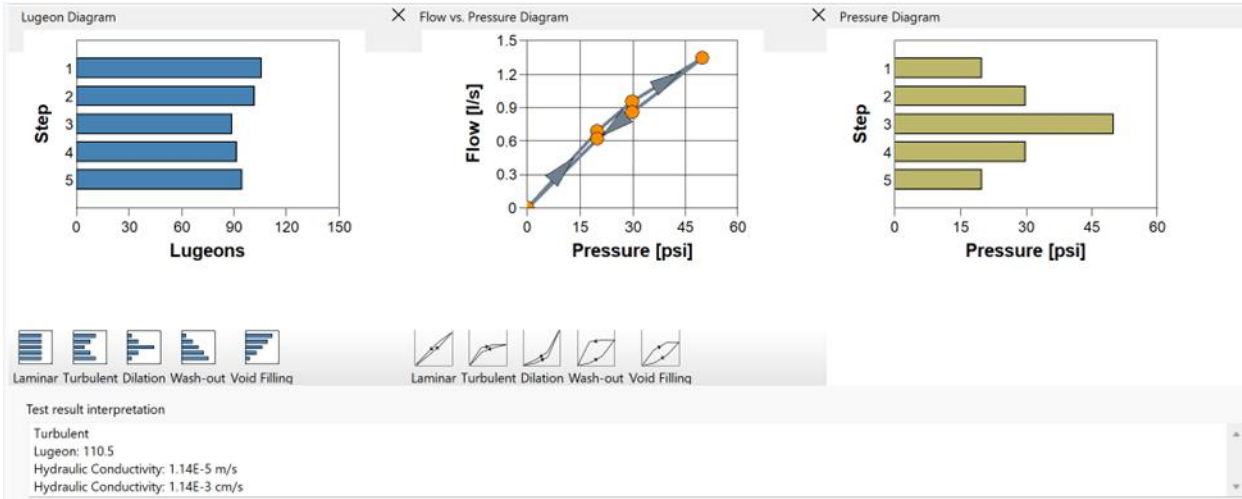


Figure 4-8: Diagram Results from Pit GEOT-005, Packer Test #1

The Lugeon Diagram and Flow vs. Pressure Diagram were used to determine the type of lugeon analysis most appropriate for the specific packer test data. Lugeon analysis options include laminar, turbulent, dilation, wash-out, and void filling. According to this test, the most appropriate analysis is the turbulent analysis, since turbulent analyses reflect a hard-rock geologic environment with minor to moderate fracturing (Houlsby, 1976). Upon choosing the appropriate analysis, the program adjusts the table result hydraulic conductivity (which defaults as laminar analysis) to a hydraulic conductivity indicative of the analysis chosen. For a turbulent result, the K-value is slightly lower than laminar, as flow is much more resisted in hard-rock environments (typical turbulent interpretation (Houlsby, 1976)) versus a uniform, low-seepage aquifer (typical laminar interpretation (Houlsby, 1976)). This data processing was done for every packer test conducted in 2024 and 2025.

Table 4-3 and Table 4-4 below summarize the results of the packer tests according to the lithologies tested in each packer test.

Table 4-3: Project Packer Test Results

Hole No.	Test No.	Date of Test	From (m)	To (m)	Interval Length (m)	Material Tested	K (cm/s)
EAGLE MOUNTAIN DEPOSIT							
Pit GEOT-010	2	10/03/2024	41.50	55.00	13.50	Granodiorite	1.92×10^{-4}
Pit GEOT-013	1	11/13/2024	37.00	42.00	5.00	Granodiorite	5.41×10^{-6}
Pit GEOT-014	1	09/25/2024	22.00	26.00	4.00	Mafic Volcanic	6.65×10^{-5}
	2	09/28/2024	34.00	49.50	15.50	Granodiorite	1.10×10^{-4}
Pit GEOT-015	1	10/09/2024	19.00	34.50	15.50	Granite	7.11×10^{-5}
	3	10/09/2024	37.00	70.50	33.50	Granite	7.55×10^{-5}
POWIS DEPOSIT							
Pit GEOT-005	1	09/18/2024	26.00	28.50	2.50	Quartz Diorite	9.95×10^{-4}

	2	09/18/2024	38.00	40.00	2.00	Quartz Diorite	2.44×10^{-5}
	3	09/19/2024	55.00	57.00	2.00	Quartz Diorite	1.10×10^{-5}
TOUCAN DEPOSIT							
Pit GEOT-004	1	11/16/2024	13.50	34.50	21.00	Granodiorite	9.58×10^{-8}
SALBORA DEPOSIT							
Pit GEOT-011	1	11/25/2024	38.50	54.50	16.00	Basalt	1.83×10^{-4}
	2	11/26/2024	56.50	90.00	33.50	Basalt	4.18×10^{-5}
Pit GEOT-012	1	11/29/2024	32.50	36.00	3.50	Mafic Volcanic	5.84×10^{-4}
	2	11/30/2024	38.50	55.00	16.50	Mafic Volcanic	1.60×10^{-4}
WASTE DUMPS							
Infr GEOT-002	1	02/05/2025	36.00	42.00	6.00	Meta-Sediment	8.32×10^{-4}
TAILINGS STORAGE FACILITIES (TSFs)							
Infr GEOT-003	1	01/26/2025	35.50	41.70	6.20	Meta-Sediment	9.12×10^{-3}
	2	01/26/2025	38.50	41.70	3.20	Meta-Sediment	6.25×10^{-3}
Infr GEOT-006	1	02/15/2025	23.50	31.50	8.00	Gabbro	4.17×10^{-4}
Infr GEOT-007	1	02/11/2025	21.00	30.00	9.00	Mafic Volcanic	5.00×10^{-4}
PLANT							
Infr GEOT-008	1	11/21/2024	21.50	30.00	8.50	Mafic Intrusion	2.38×10^{-6}
Infr GEOT-009	1	02/09/2025	36.00	42.00	6.00	Meta-Sediment	2.25×10^{-4}

Pit GEOT-004 only has two steps (typical test has five steps for determining K). Pit GEOT-010 Test #1 terminated due to insufficient fracture flow to complete test. Pit GEOT-15 Test #2 abandoned due to lack of flow after 20 psi of injection pressure.

Table 4-4: Project Packer Test Summary

	Number of Tests	Hydraulic Conductivity (cm/s)			
		Geometric Mean	Average	Maximum	Minimum
Qz Diorite	3	6.44×10^{-5}	3.43×10^{-4}	9.95×10^{-4}	1.10×10^{-5}
Granodiorite	4	1.02×10^{-5}	7.69×10^{-5}	1.92×10^{-4}	9.58×10^{-8}
Granite	2	7.33×10^{-5}	7.33×10^{-5}	7.55×10^{-5}	7.11×10^{-5}
Mafic Int.	1	2.38×10^{-6}	2.38×10^{-6}	2.38×10^{-6}	2.38×10^{-6}
Basalt	2	8.75×10^{-5}	1.12×10^{-4}	1.83×10^{-4}	4.18×10^{-5}
Mafic Vol.	4	2.36×10^{-4}	3.28×10^{-4}	5.84×10^{-4}	6.65×10^{-5}
Meta-Sed.	4	1.81×10^{-3}	4.11×10^{-3}	9.12×10^{-3}	2.25×10^{-4}
Gabbro	1	4.17×10^{-4}	4.17×10^{-4}	4.17×10^{-4}	4.17×10^{-4}
All tests	**21**	**1.14×10^{-4}**	**1.06×10^{-3}**	**9.12×10^{-3}**	**9.58×10^{-8}**

The following comparative conclusions can be drawn from the above table:

- GRE believes that 231 meters of packer test borings with a total of 21 tests is an acceptable level of testing and sampling for this phase of the Project. In the next stages of project design, development, and characterization, additional testing should be considered for pit wall stability and other areas throughout the Project that are to be considered for infrastructure.
- Considering that the conductivity of a fractured bedrock is 1.00×10^{-7} cm/s to 1.00×10^{-2} cm/s (Domenico & Schwartz, 1990), GRE believes that the overall rock mass exhibits an expected total conductivity, with a geometric mean of 1.14×10^{-4} cm/s.
- The maximum measured hydraulic conductivity is 9.12×10^{-3} cm/s, which is the conductivity range typically associated with a uniform fine sand (A. Freeze, 1979). As a result, GRE believes that the highest packer test reading is respective of other packer test results of fractured bedrock aquifers according to literature (Domenico & Schwartz, 1990).
- These conclusions were made in spite of a field-testing protocol which preferentially selected fractured intervals with the greatest potential to report conductivity results above the accepted minimum (1.00×10^{-9} cm/s) of the packer device.

4.8 VIBRATING WIRE PIEZOMETERS (VWPS)

VWPs were installed in selected pit boreholes at pre-determined depths based on the location of fractured rock and the results of packer testing. Drawing 2, at the end of this report, shows the location of the installed VWPs. VWPs are an industry-standard monitoring tool which is suited for hard-rock applications, deep boreholes, and inclined boreholes. They are capable of measuring pore pressure in a fracture zone within a grouted borehole (Geokon, 2019).

The installation method is as follows:

8. After the completion of a borehole and before installation, a depth to water measurement was taken using a water level meter to determine which depth(s) the VWP needed to be installed (there are many locations where a “deep” and “shallow” VWP were installed in the same borehole).
9. Once the target location(s) were determined for each VWP, the first VWP was prepared according to the instruction manual (Geokon, 2019). This included the hydration of the filter and the collection of “zero” readings at the well head prior to installation.
10. The VWP was taped upside-down (to retain filter saturation) to a 1-inch PVC tremie pipe.
11. Pipes were lowered to the necessary depth to place the VWP (or VWPs) across from the zone of interest.
12. A cement-bentonite grout was pumped into the tremie pipe to fill the borehole from the bottom-up. The grout mixture met the specifications for a “medium to hard soils” grout as listed in Table 1 of the installation manual.
13. The grout was pumped into the tremie pipe until it displaced all water in the borehole, and grout flowed at the surface. As it cured, the grout level dropped.
14. To complete the installation, the grout was “topped up” to the surface, and the VWP cables were included in a PVC stickup.

VWP readings were collected periodically during installation and upon completion of installation. These values (and the zero prior to installation) were saved in an installation log along with the serial number for each VWP.

4.9 VWP RESULTS

The following Table 4-5 presents the current (as of May 12th, 2025) observations of the VWPs at the Project.

Table 4-5: Project VWP Summary

ID	Easting	Northing	Elevation (m)	Depth (m bgs)	Install DTW from Surface (m bgs)	Install WE from VWP (m)	Maximum WE (m)	Minimum WE (m)
EAGLE MOUNTAIN DEPOSIT								
VWP-09S	264518.66	575772.08	164.76	39.00	8.54	152.66	125.15	128.72
VWP-10S	265767.00	576618.00	392.32	31.51	8.86	392.32	376.99	380.68
VWP-11D	265767.00	576618.00	392.32	54.16	8.86	380.30	365.55	371.28
VWP-15	264955.00	576460.00	244.00	49.50	11.67	211.09	210.47	211.40
VWP-16S	265356.00	575737.00	281.47	12.69	5.92	273.42	274.57	275.17
VWP-17D	265356.00	575737.00	281.47	46.51	5.92	273.84	272.28	273.99
VWP-18S	266498.00	576416.00	582.56	24.90	8.32	557.64	575.75	579.73
VWP-19D	266498.00	576416.00	582.56	67.74	8.32	568.77	547.92	554.52
POWIS DEPOSIT								
VWP-05S	264164.74	576107.84	74.95	22.50	1.00	73.39	70.83	73.39
VWP-06D	264164.74	576107.84	74.95	66.00	1.00	62.03	59.10	60.98
TOUCAN DEPOSIT								
VWP-3S	264045.00	576875.66	79.27	7.90	7.64	NA	NA	NA
VWP-4D	264045.00	576875.66	79.27	66.00	7.64	57.79	57.32	57.83
SALBORA DEPOSIT								
VWP-12S	264125.00	577730.00	128.00	24.50	21.00	103.89	103.65	103.93
VWP-13D	264125.00	577730.00	128.00	88.20	21.00	80.56	79.10	83.13
VWP-14S	264085.00	577785.00	108.00	55.00	21.19	86.81	64.71	69.87

Easting, Northing, and Elevation refer to the borehole in which the VWP(s) was/were installed. bgs = below ground surface. DTW = Depth to Water. WE = Water Elevation. NA = Not Applicable.

So far, these VWPs have been able to capture the end of the 2024 wet season, as well as some of 2025. Although only a small timeframe has been observed, the following conclusions can be made from the available data:

- Water elevation does not vary significantly throughout the limited timeframe, averaging 2.95 m among the wet and dry seasons.
- Six locations have nested VWPs (more than one in a single borehole). All six locations have a downward vertical water pressure gradient where the water level in each sensor is lower than the sensor above it.
- Including the first reading after installation, VWP-3S has consistently observed negative water pressures. This indicates that the water level at this elevation in the borehole is below the VWP sensor. This VWP proves the null-hypothesis in that the water level has consistently trended below 7.90 meters below ground surface but above 66.00 meters below ground surface (VWP-4D).

Overall, the available VWP data shows that the site is unlikely to encounter highly-pressurized fracture zones because most boreholes show a downward vertical gradient. The data also shows that slight seasonal changes in pressure can be seen in nearly all VWPs (Figure 4-9), likely transmitted through the grout. As the data collection continues, this statement may be modified to reflect new data.

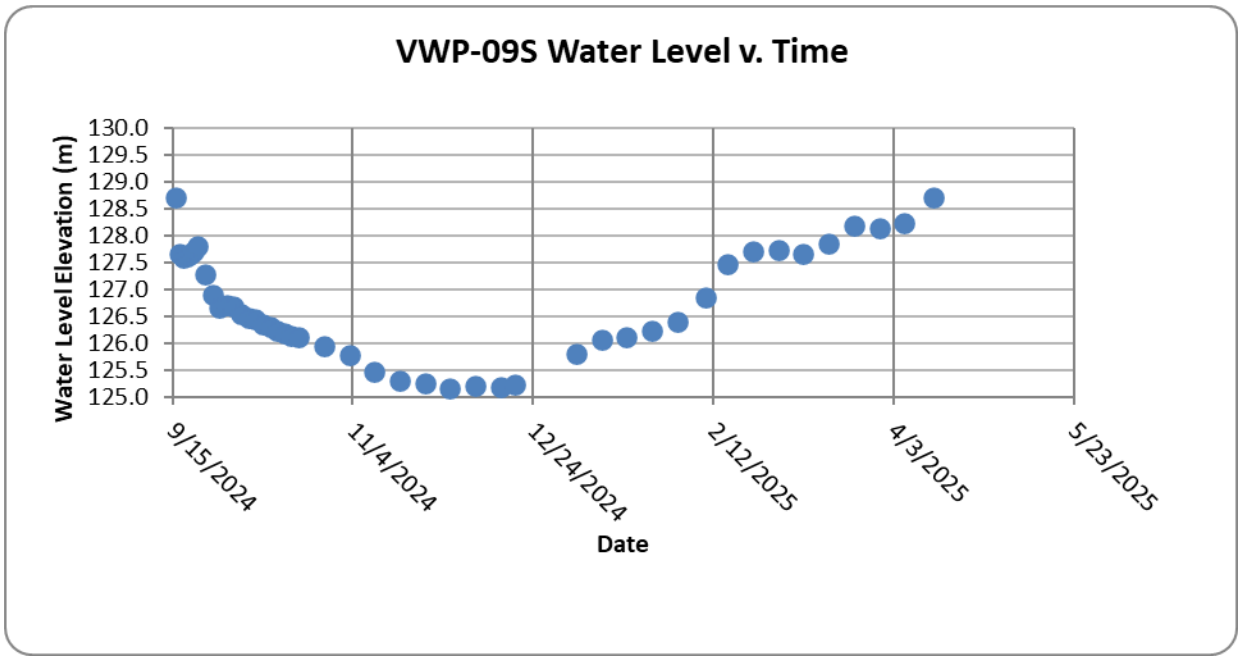


Figure 4-9: Example VWP Water Level Log, VWP-09S

4.10 CONCEPTUAL GROUNDWATER MODELS

The following is a schematic of the conceptual groundwater model prior to mining.

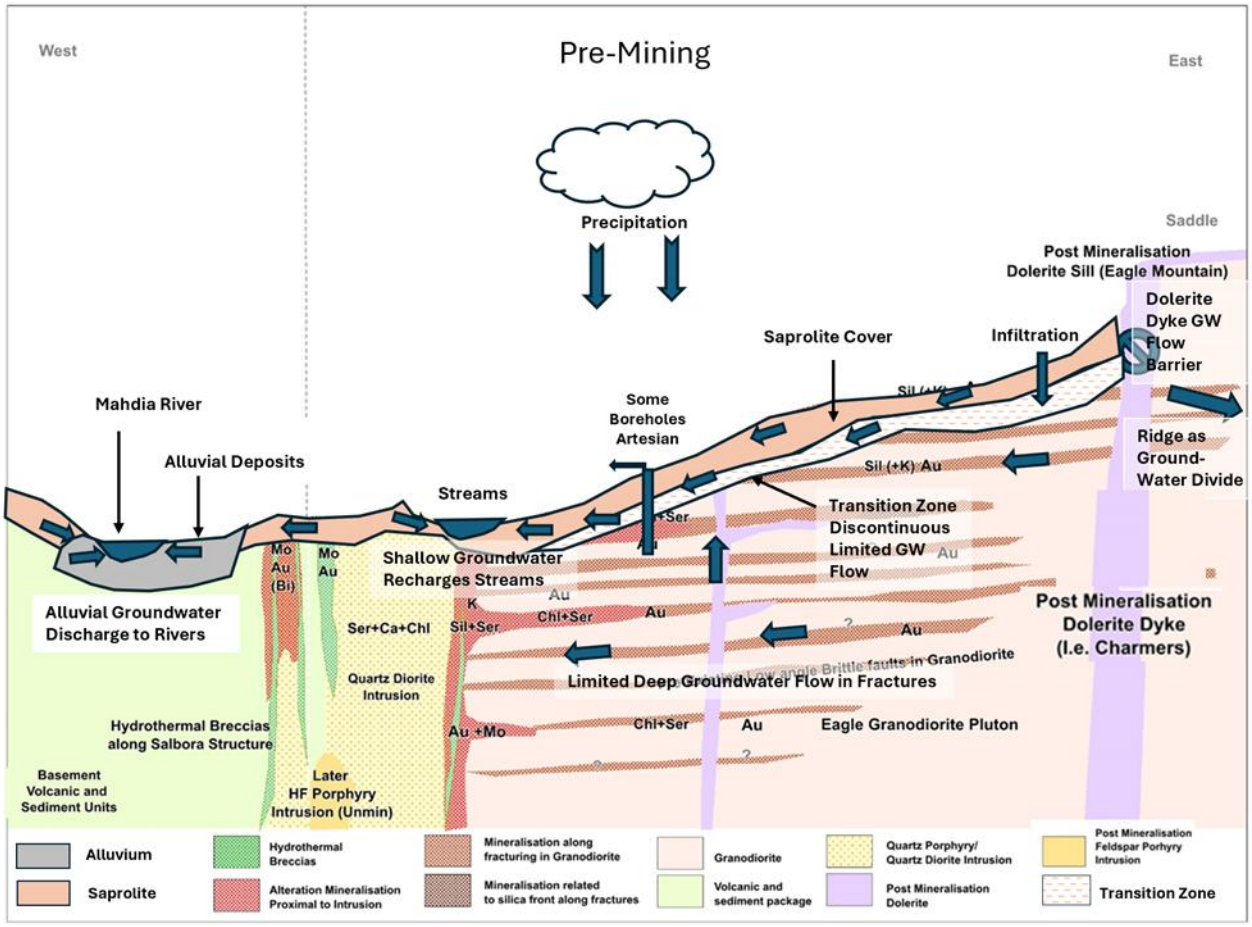


Figure 4-10: Pre-Mining Conceptual Groundwater Model

It has the following elements:

1) The site is a high recharge environment with heavy rain, and soils which permit significant infiltration of rainwater into the groundwater system.
2) The site has relatively impermeable bedrock (~$1x10^{-5}$ cm/s). Occasional fractures exist which have higher conductivity, but in general, the bedrock can be considered as an aquitard, rather than an aquifer.
3) Shallow groundwater is hosted in the saprolite formation, and in some cases, in a weathered rock zone at the top of the bedrock.
4) The weathered rock zone is often thin or not present at all. It cannot be considered a uniform site-wide aquifer, but locally, it hosts groundwater and typically has a slightly higher conductivity than the saprolite above it.
5) Groundwater reports on a short flow pathway to surface water. Over the entire project domain, streams are gaining with respect to groundwater. In general, the lower elevation streams are perennial, the higher elevation streams may be ephemeral.

6) Groundwater levels change during the bi-modal wet season and dry season cycles. Average change is ~1-5 meters in elevation, depending on location. Higher elevation groundwater is more subject to elevation change.
7) There is a poorly-developed alluvial deposit which follows the bed of the Mahdia and Minnehaha rivers. This material is slightly more conductive than the saprolite (largely because it has been washed of fines by miners over the last 100 years).
8) Both the Madhia and Minnehaha Rivers are the ultimate discharge point for groundwater within the project area.
9) Occasional conductive fractures exist in the hard rock. These can convey water and also can have hydrostatic pressure which is higher than the surface of the ground. This creates artesian well (or borehole) conditions. Artesian conditions are defined as a well which has flowing groundwater at the surface. Artesian conditions indicate that the hydrostatic pressure of future pit walls should be monitored and considered.
10) There are no groundwater users in the project area. All water use is surface water use.
11) There is no significant irrigated agriculture in the region.

The During Mining conceptual hydrogeologic model is shown in Figure 4-11.

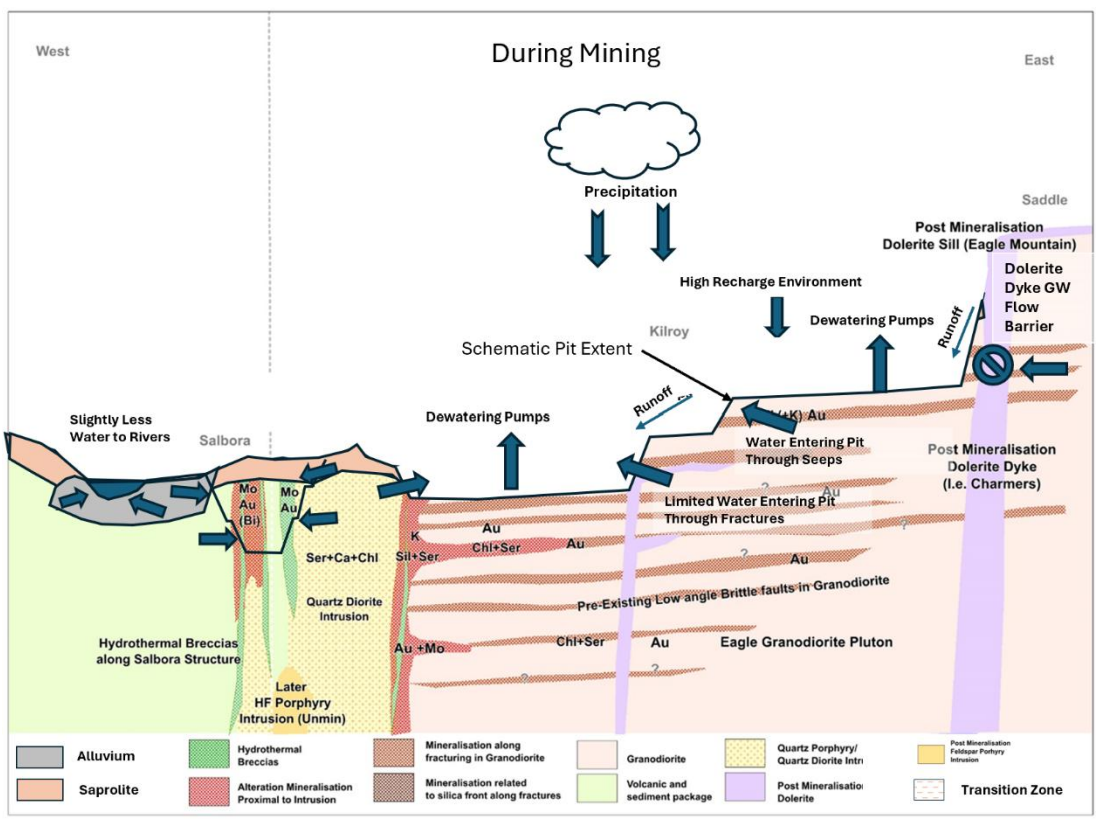


Figure 4-11: During Mining Conceptual Groundwater Model

It has the following elements:

- Pits will be dug over a wide spatial area, focusing for the first four years on exclusively the saprolite-hosted ore deposits. This will create wide, shallow pits. These pits will have significant seepage from pit walls, and pit slope stability will be an essential consideration of the pit design.
- Dewatering sumps will capture in-pit groundwater and will convey it to either sedimentation ponds or the mine process. Because of the net excess water environment (see Section 11.0), most of the pit dewatering water is discharged to the environment after sedimentation. Geochemical sampling (See Section 12.0) indicates that sediment will be the only water quality concern.
- As mine life continues, the pits will exploit hard-rock ore. Pit walls will seep groundwater, and this groundwater may be structurally controlled. Preliminary hydrogeologic testing (see Section 4.0) indicates that there is no evidence for a significant structurally-controlled water bearing unit in the hard rock. However, GRE recommends on-going testing and monitoring.
- Pit dewatering is largely recycled back into the rivers after pumping. This may result in a higher-than normal discharge of total surface water. However, it is inevitable that the hydrogeologic system will change, and less groundwater will naturally report to area streams.

The Post-Mining conceptual hydrogeologic model is shown in Figure 4-12.

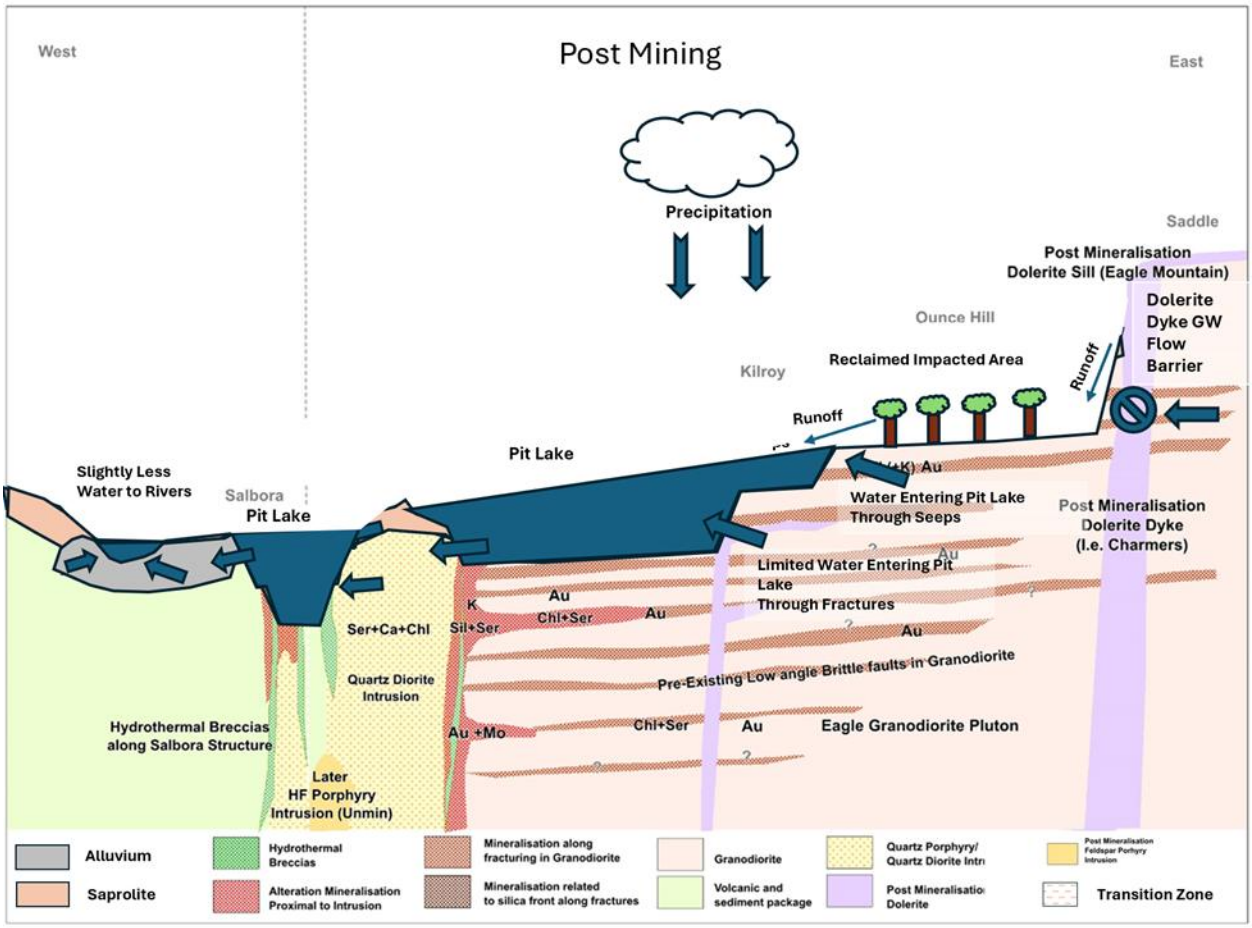


Figure 4-12: Post-Mining Conceptual Groundwater Model

- Pits will form pit lakes. Based on the geochemical characterization (Section 6.0), it is not anticipated that these lakes will have any water quality issues. It is likely that they will support fish and other aquatic wildlife.
- The reclaimed impacted ground (waste dumps, TSF surface, plant site) have a similar hydrogeologic function as the natural ground. It will be a vegetated, high-infiltration surface.
- The shallow groundwater, a short flow path to a stream hydrogeologic system will be re-established.
- The pit lakes will become a part of the hydrogeologic system, receiving upgradient seepage, and creating down-gradient seepage.
- Local rivers will likely be similar in flow dynamics during mining as in prior to mining, but the pit lakes may stabilize seasonal differences resulting in higher baseflow conditions during dry months.

The conceptual model has been utilized in subsequent work products such as the 3D predictive groundwater flow model used to determine the pit dewatering rates and the mine's impact to the local and regional hydrogeologic system.

5.0 HYDROLOGIC CHARACTERIZATION

Since July 2024, GRE has been working with personnel at the Project to characterize the site-wide hydrology. To accomplish this, GRE has worked with and trained site personnel to obtain discharge measurements from several streams around the Project. The following sections will present the hydrology program and protocol as defined by GRE.

5.1 STREAM DISCHARGE

Since June 2024, 33 semi-monthly streamflow measurements have been taken at several locations throughout the Project (see Drawing 3). The technique used to collect this data and the results from these measurements are presented in the sections below.

5.1.1 DISCHARGE MEASUREMENT AND RESULTS

The following is the standard technique used to obtain stream discharge measurements:

1) Use a tape measure and span it across the river so it's running perpendicular to the flow;
2) Record total width of river;
3) Determine approximately 20 locations (called stations) within this width that are representative of the discharge of the river, aiming for 16 to 18 evenly-spaced stations in the main flowing portion and the remaining stations outside the main flow but where there's still water depth to record;
4) Measure and record the depth of the water at each station then measure the velocity at each station at sixth tenths the total depth of each station (Figure 5-1);
5) Once all stations have velocity measurements, view final output, and record calculated discharge (International Organization for Standardization, 2021).

Figure 5-1: On-site personnel recording stream velocity at a station

Velocity measurements have been conducted and collected by a SonTek FlowTracker2 (FT2) handheld Acoustic Doppler Velocimeter (ADV), an ultrasonic flow measurement device used extensively throughout the hydrogeology industry. Once these velocities were measured and recorded, the FT2 displayed how representative each station was (as a percentage) in determining the final total discharge of the stream with the maximum percentage recorded in the final output. A maximum percentage of 10% or below represented an ideal discharge measurement (Xylem Inc., 2019). Due to this ideal being defined for evenly bottomed, sandy streams in the Midwest of the United States, the team used a 15% or below standard for uneven, sandy to muddy, rainforest climate streams. If this value was exceeded, the person/technician recording the data needed to reconsider the locations of the stations (red bars in Figure 5-2 indicate suggested locations for adding more stations while green and yellow bars indicate representative discharge percentages). Once a final discharge was calculated by the FT2, the value was recorded and saved on the device. This value was also recorded in a field notebook as well.

Figure 5-2: Example output of the FT2 discharge profile

Table 5-1 below summarizes the discharge measurements obtained throughout the Project as of May 12th, 2025. Figure 5-3 through Figure 5-4 present observed changes in discharge in the South Salbora River and the Minnehaha River, respectively.

Table 5-1: Project Surface Water Discharge Summary

					Discharge (m^3/s)			
Name	**Location ID**	**Easting**	**Northing**	**No. Readings**	**Geometric Mean**	**Average**	**Maximum**	**Minimum**
S Salbora River	Location A	263685.00	577127.00	15	0.072	0.169	0.511	0.027
Minnehaha River	Location B	264077.00	574956.00	13	0.353	0.445	1.223	0.035
Mahdia River	Location C	262883.00	578711.00	4	0.295	0.295	0.313	0.278
Deer Creek	Location D	***	***	0	NM	NM	NM	NM
Mahdia Water Supply	Location E	***	***	1	0.355	0.355	0.355	0.355
Not Named	Location G	***	***	0	NM	NM	NM	NM
Baboon Creek	Location H	***	***	0	NM	NM	NM	NM

NM = Not measured. *** = to be filled in by ERM (using coordinates from water quality sheets).

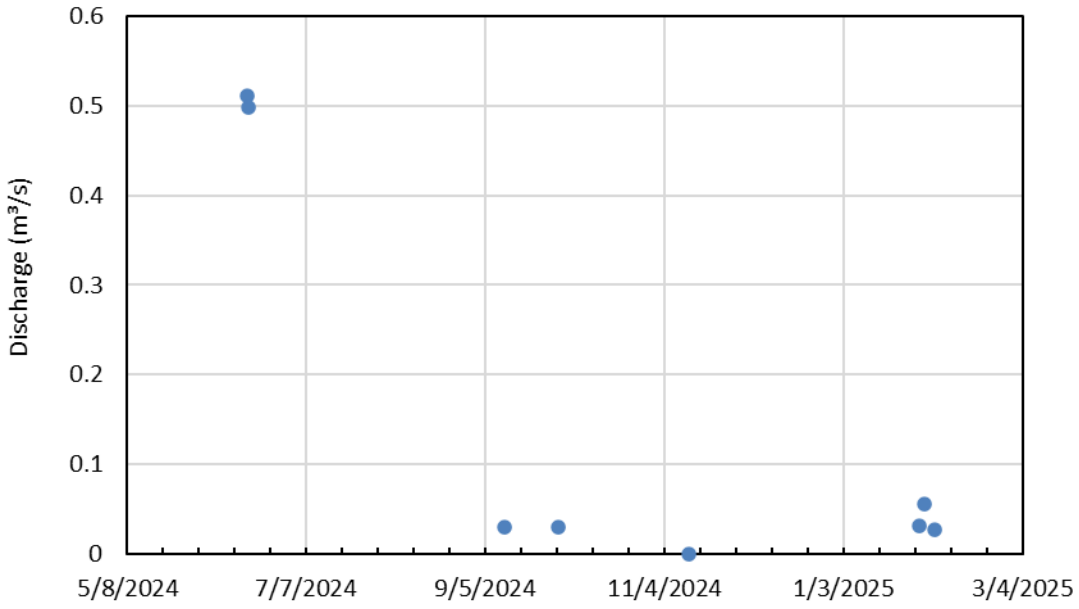


Figure 5-3: Discharge vs Time, South Salbora River

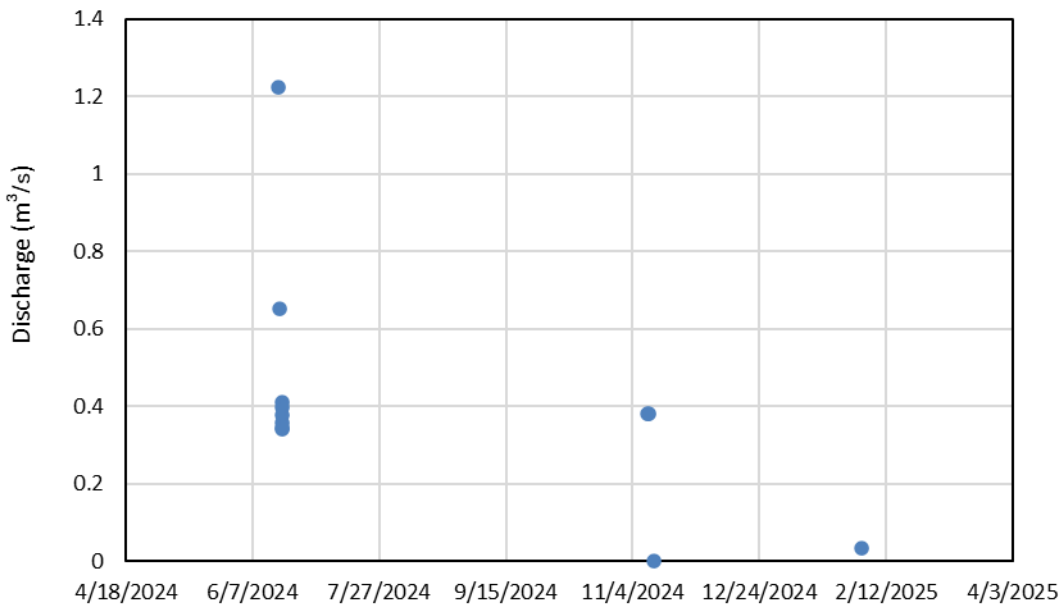


Figure 5-4: Discharge vs Time, Minnehaha River

The purpose of this report is to facilitate the transfer of data between GRE and ERM. In lieu of this, some data may be unavailable from one party and will be amended by the other party. The table cells in Table 5-1 with "***" are one such case of this data gap. ERM will supply the necessary information once the report has been handed off.

Other than the data gaps, the discharge values in Table 5-1 will change as there have been many measurements (more than three each) that have yet to be logged for Locations A through C and Location E. Another important note is that the maximum value for Location B is skewed, as this value was the peak discharge recorded from the Minnehaha during the development of its storm hydrograph.

Based on the current data available in Table 5-1, it appears the measurable discharge in the rivers and streams at the Project is relatively consistent. The S Salbora river does vary considerably, but not as dramatically as expected in a rainforest climate. Because of this, more data will need to be collected before official conclusions can be made as only the dry seasons (2024 and 2025) have been captured in the field.

5.1.2 SEDIMENT SAMPLING & PROTOCOL

Along with the flow sampling, a total suspended solids (TSS) sampling program was also initiated during the June 2024 site visit and has continued for many of the surface water locations.

The purpose of the program was to measure the change in soil erosion over time. Samples were collected periodically, and samples were collected deliberately after heavy rain events to capture the full range of naturally-occurring TSS values. All of the samples that have been obtained within

the Project have been sent to a lab off-site for analysis. Mako has procured baseline samples (between storm events, during the dry and wet season for a total of 2 sample periods) and storm samples (during storm event[s], during the dry and wet season for a minimum of 2 sample periods) from many of the surface water locations. The method by which these samples were obtained is discussed in the following section.

5.1.3 SEDIMENT SAMPLING: OFF-SITE LABORATORY ANALYSIS

The off-site laboratory TSS program involved collecting water samples in bottles for each stream location. Two samples were collected for baseline conditions (one for dry season, one for wet season) while other samples were collected during storm conditions (hourly sampling during dry season storm, hourly sampling during wet season storm).

The goal was to measure the amount of suspended solids in different streams as the streams are flowing under baseline and storm conditions as mentioned above. The technique was to simply take an empty water bottle, submerge it in the center of the flowing stream, cap the bottle once it is full of water, and label the sample appropriately. These samples were then transported off-site to Kaizen labs for TSS analysis.

5.1.4 SEDIMENT SAMPLING RESULTS

The current (as of May 12th, 2025) total suspended solids (TSS) sample results are summarized in Table 5-2 below. Figure 5-5 through Figure 5-7 show how TSS has changed over time in the South Salbora River, the Minnehaha River, and Deer Creek respectively.

Table 5-2: Project Total Suspended Solids (TSS) Summary

					TSS (mg/L)			
Name	Location ID	Easting	Northing	No. Samples	Geometric Mean	Average	Maximum	Minimum
S Salbora River	Location A	577127.00	263685.00	8	15.04	24.82	56.10	3.33
Minnehaha River	Location B	574956.00	264077.00	11	36.69	111.92	830.20	3.80
Mahdia River	Location C	578711.00	262883.00	5	27.47	33.18	61.30	13.30
Deer Creek	Location D	***	***	8	4.24	13.75	84.7	1.00
Mahdia Water Supply	Location E	***	***	1	12.00	12.00	12.00	12.00
Not Named	Location G	***	***	1	18.70	18.70	18.70	18.70
Baboon Creek	Location H	***	***	1	AR	AR	AR	AR

*** = to be filled in by ERM (using coordinates from water quality sheets). AR = Awaiting Results from lab.

Once again, there is a data gap in Table 5-2 cells as indicated by "***". These data points will be filled in by ERM once this report has been transferred to ERM.

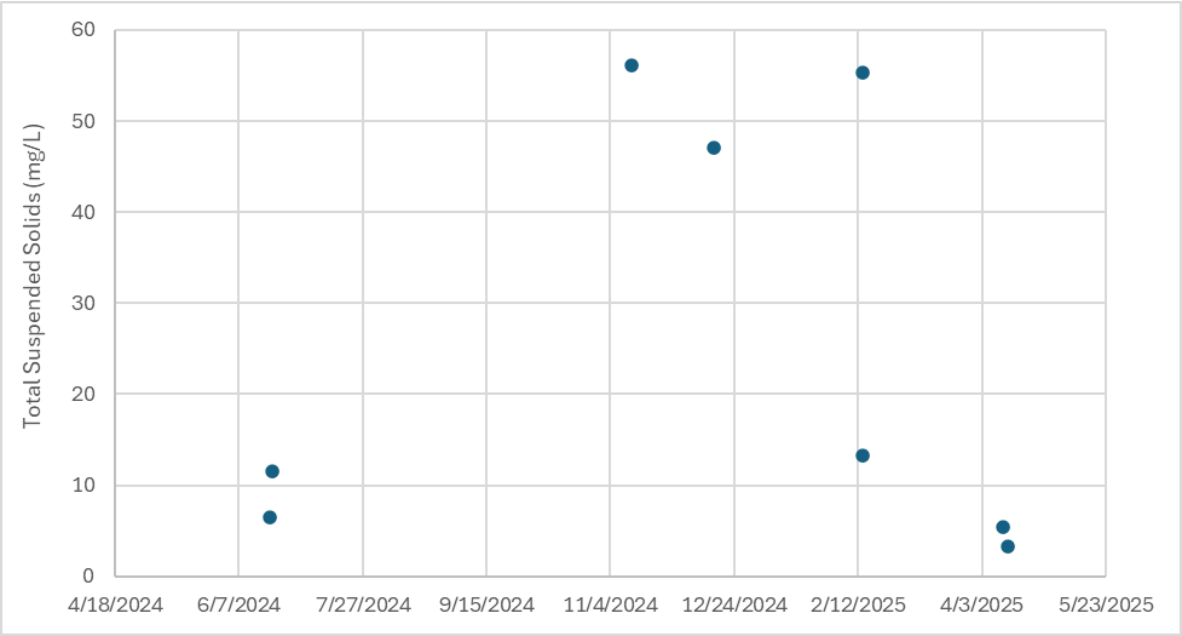


Figure 5-5: TSS vs Time, South Salbora River

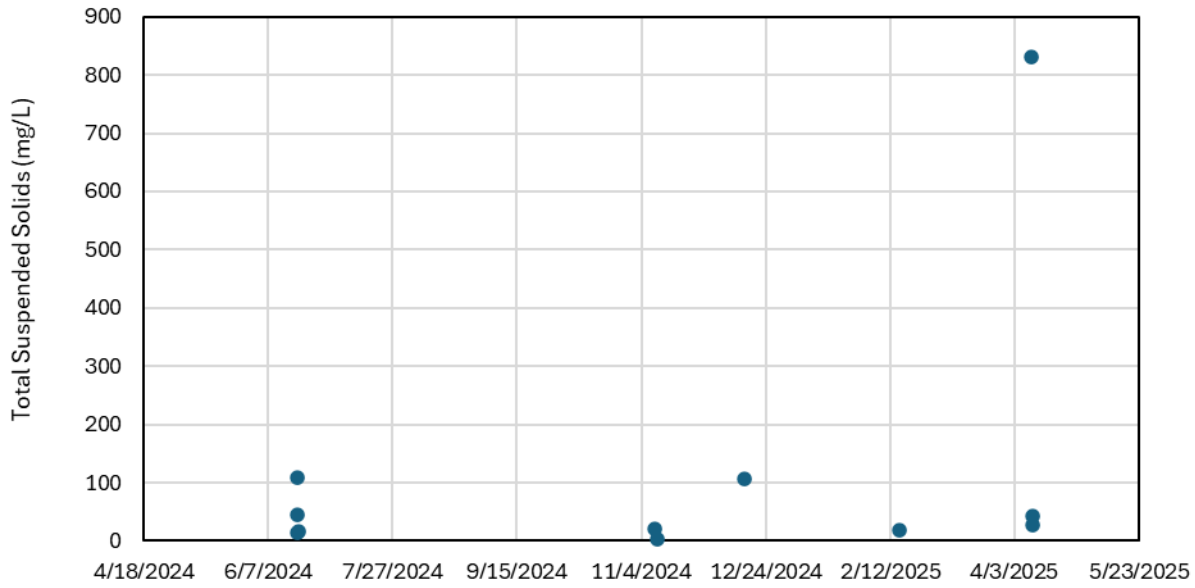


Figure 5-6: TSS vs Time, Minnehaha River

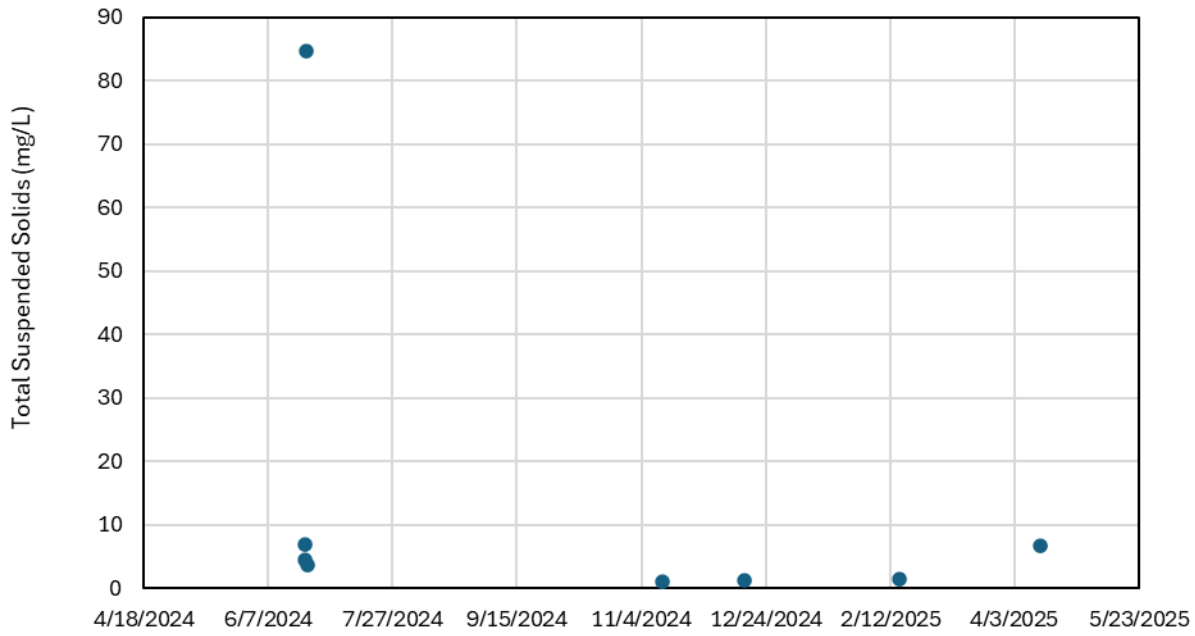


Figure 5-7: TSS vs Time, Deer Creek

The most important interpretation from Table 5-2 is based on the very large discrepancy between the most concentrated (maximum TSS) samples and the geometric mean. Such a large variation means that a majority of the sediment that is transported within and along the Project rivers and streams occurs during specific events, such as large amounts of rainfall or storms. This is to be expected in any region but is especially important in understanding site erosion at the Project.

According to Table 5-2, the location with the most TSS samples is Location B, or the Minnehaha River. The reason behind so many samples is due to a storm that was manually captured by the on-site team and GRE on June 18th, 2024. This information was then used to generate a storm hydrograph to understand the Minnehaha River response to storm events. Figure 5-8 below depicts the change in discharge of the Minnehaha River after a minor storm event.

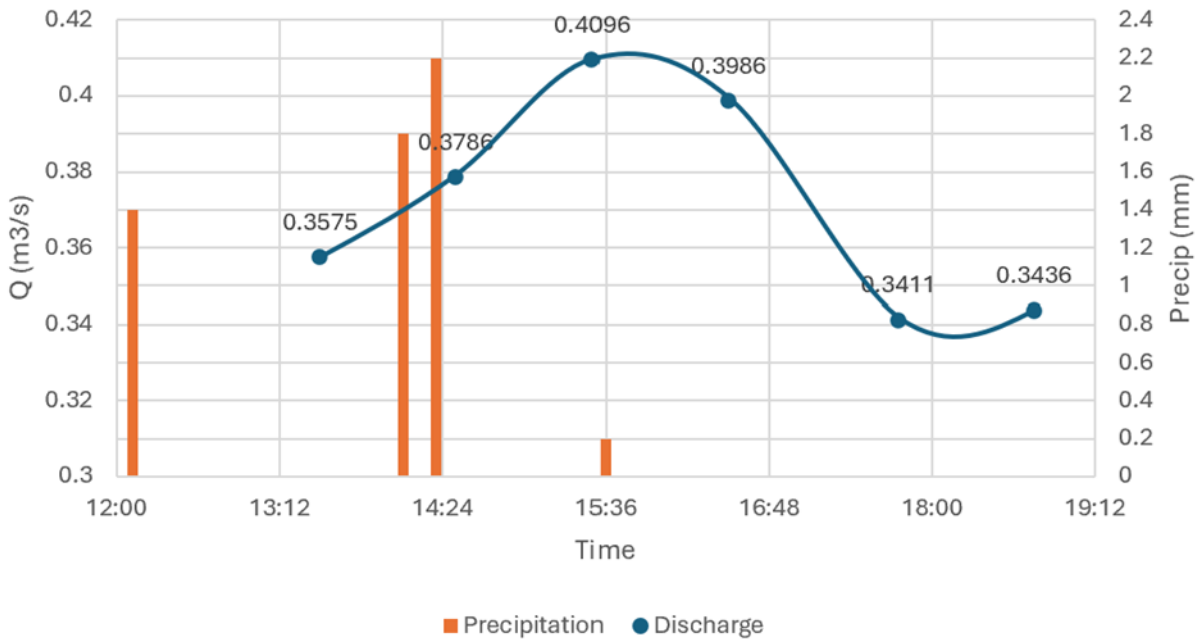


Figure 5-8: Storm Hydrograph, Minnehaha River

Using the information embedded in the storm hydrograph and the TSS samples that have since been processed, a correlation between discharge and TSS can be made. Figure 5-9 below shows the change in discharge over this time period with TSS samples that were collected during the flow measurements.

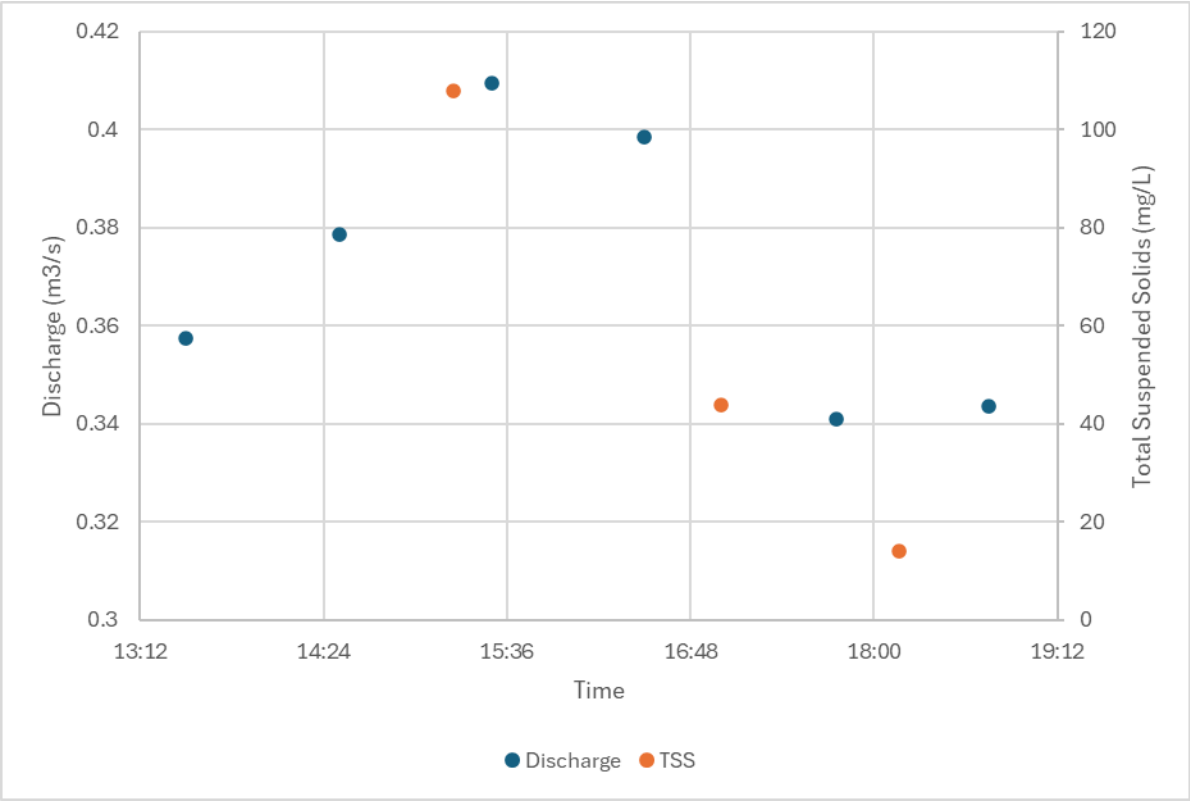


Figure 5-9: TSS & Discharge, Minnehaha River

As presented in the above figure, it appears that there is a positive correlation between total suspended solids and discharge where an increase in discharge equates to an increase in TSS. This conclusion supports the previous observation noted in Table 5-2 where larger TSS concentrations are correlated to large discharge events. Again, this will be important to consider in future mine planning beyond this phase of the Project.

5.2 CONCEPTUAL SURFACE WATER FLOW MODELS

The surface water flow model is similar to the aforementioned groundwater flow conditions.

5.2.1 PRE-MINING

The pre-mining hydrologic system has the following characteristics:

- Heavy rainfall and abundant groundwater discharge result in gaining streams for the entirety of the stream length.
- At lower elevations, heavy rains also result in large river flows and occasional flooding.
- Lowlands are often saturated with permanent wetlands and/or ponds, and seasonal wetlands form in the rainy months due to “backwater” effects where rain cannot drain away fast enough.

- High-elevation streams can be ephemeral, but most streams are perennial.
- Areas with high gradients often have rocky streambeds because high-energy flows have eroded away fine-grained sediments.
- Heavy vegetation prevents erosion in most places, but exposed ground is subject to high erosion rates due to the high-energy rainfall and runoff, and the fine-grained saprolite soils.

Water quality is generally very good. There are few sources of contamination within the project area. The sources of contamination in baseline conditions are limited to the exploration camp (which treats its grey water) and miners who have illegally intruded on the Mako concession. A baseline mercury study (see Section 7.0) was conducted to quantify the mercury risk.

5.2.2 DURING MINING

During mining, the majority of the surface water is routed around mine facilities. Pit dewatering will be a major source of surface water (after sediment control). A site-wide water balance (Section 11.0) has been created to quantify the changes in water flows around the site. Water will be discharged from the TSFs, seepage and runoff will discharge from the WRSFs, and the mine will discharge from the pit dewatering. All of these sources of water will be managed such that sediment and chemistry will be within Guyana regulatory discharge standards.

5.2.3 POST MINING

Pit lakes will form. These will be large and stable sources of surface water. It is probable that the post-mining surface water system will have higher overall baseflow (dry season flows) than prior to mining.

6.0 GEOCHEMICAL CHARACTERIZATION

The geochemical characterization has been presented in its entirety to ERM under a separate title.

7.0 BASELINE MERCURY CONDITIONS

The mercury characterization has been presented in its entirety to ERM under a separate title.

8.0 HYDROGEOLOGIC IMPACT ASSESSMENT

As mentioned in Section 4.4, the mine will have an impact on the hydrogeologic system. In order to quantify this impact, GRE created a three-dimensional, time-variant (transient) groundwater

flow model (3D GW Model) to predict the interaction between the hydrogeologic system and the project.

The 3D GW Model was used to accomplish two major goals. The first goal was to determine the amount of water generated by pit dewatering as the pits are developed through time, and the second objective was to determine the impact of this pit dewatering on local river flows and water levels. In order to fulfill these groundwater modeling goals, GRE utilized Visual MODFLOW Flex.

8.1 GROUNDWATER MODELING THROUGH VISUAL MODFLOW FLEX

Visual MODFLOW Flex is an industry-standard, finite difference groundwater flow modeling software which provides a user interface for MODFLOW analysis and calibration packages that can be displayed in a 3D environment (Waterloo Hydrogeologic Website). GRE selected MODFLOW-NWT to model and simulate site groundwater conditions. MODFLOW-NWT was chosen for its nonlinear drying and rewetting capabilities that other MODFLOW codes lack. This version of MODFLOW is also used for solving unconfined aquifer equations, which define the Project groundwater system.

8.2 CONCEPTUAL MODEL

The conceptual groundwater model is presented in Section 4.4. Figure 8-1 is a reproduction from the prior section and presented here for consistency.

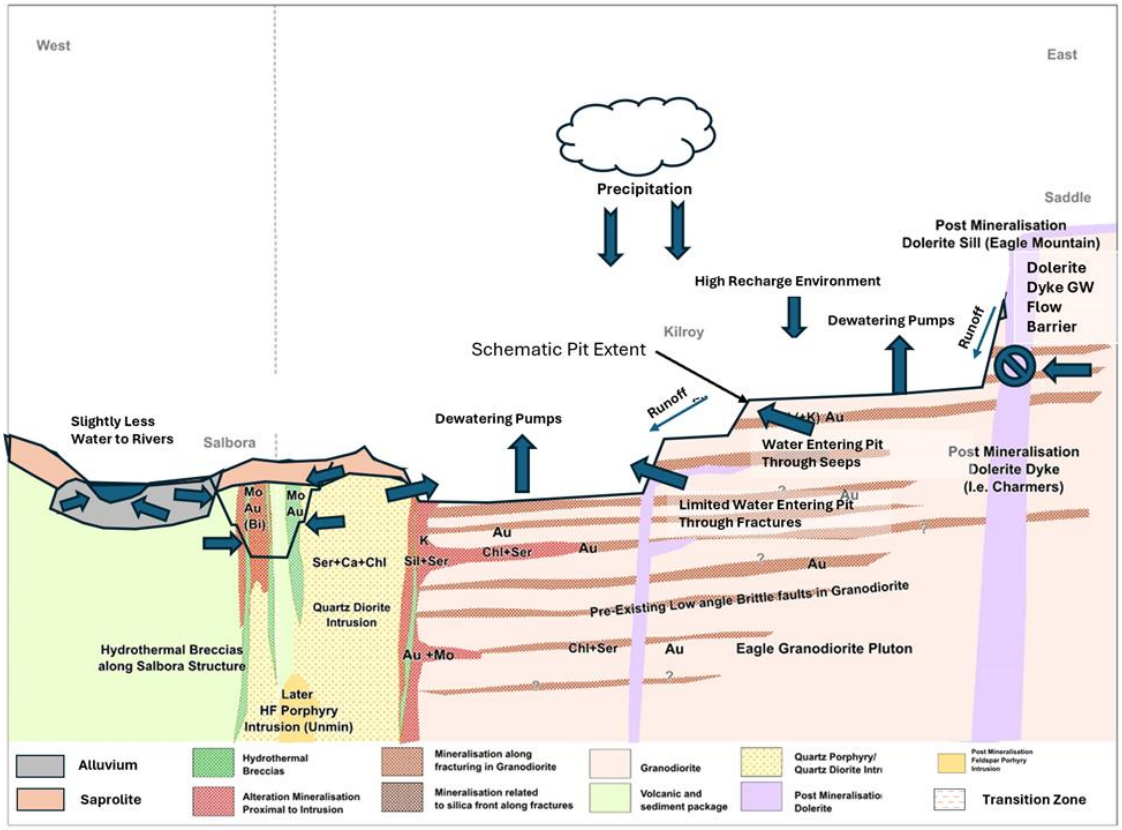


Figure 8-1:Conceptual Groundwater Model

8.3 TOPOGRAPHY AND MODEL DOMAIN

The topography was provided by Mako. The model domain was selected to be far enough from the major mine infrastructure so that the edge effects do not impact the model results, and so that the topographic coverage was sufficient. Figure 8-2 shows an isometric view (vertically exaggerated in the z-direction) of the model domain and topography.

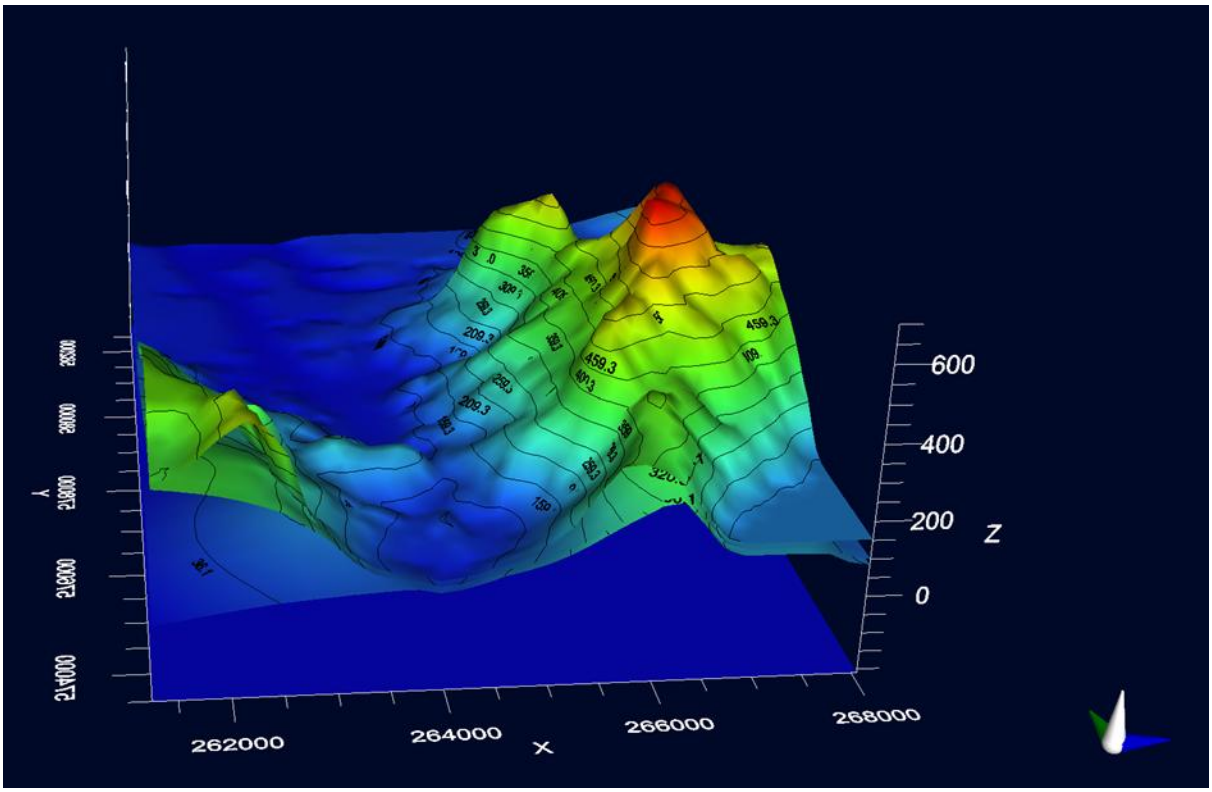


Figure 8-2:Eagle Mountain 3D GW Model Topographic Iso-view

MODFLOW models are a matrix of discretized geologic space with layers, rows and columns. As a result, it is necessary to turn the site topography and geology into a discretized MODFLOW matrix. The following subsections describe this method and its assumptions.

8.4 MODEL GRID

Across the layers, GRE defined a finite difference grid for the site. This grid has been defined to ensure the simulation calculates groundwater conditions as accurately as possible in and around planned pit areas while keeping simulation run times at a minimum. To accomplish this, GRE refined the grid around the actively mined portion of the site as well as deactivated grid cells along the eastern ridge of Eagle Mountain and other cells outside of the active mine domain (inside the red square). Figure 8-3 below presents the refined grid with deactivated cells in blue.

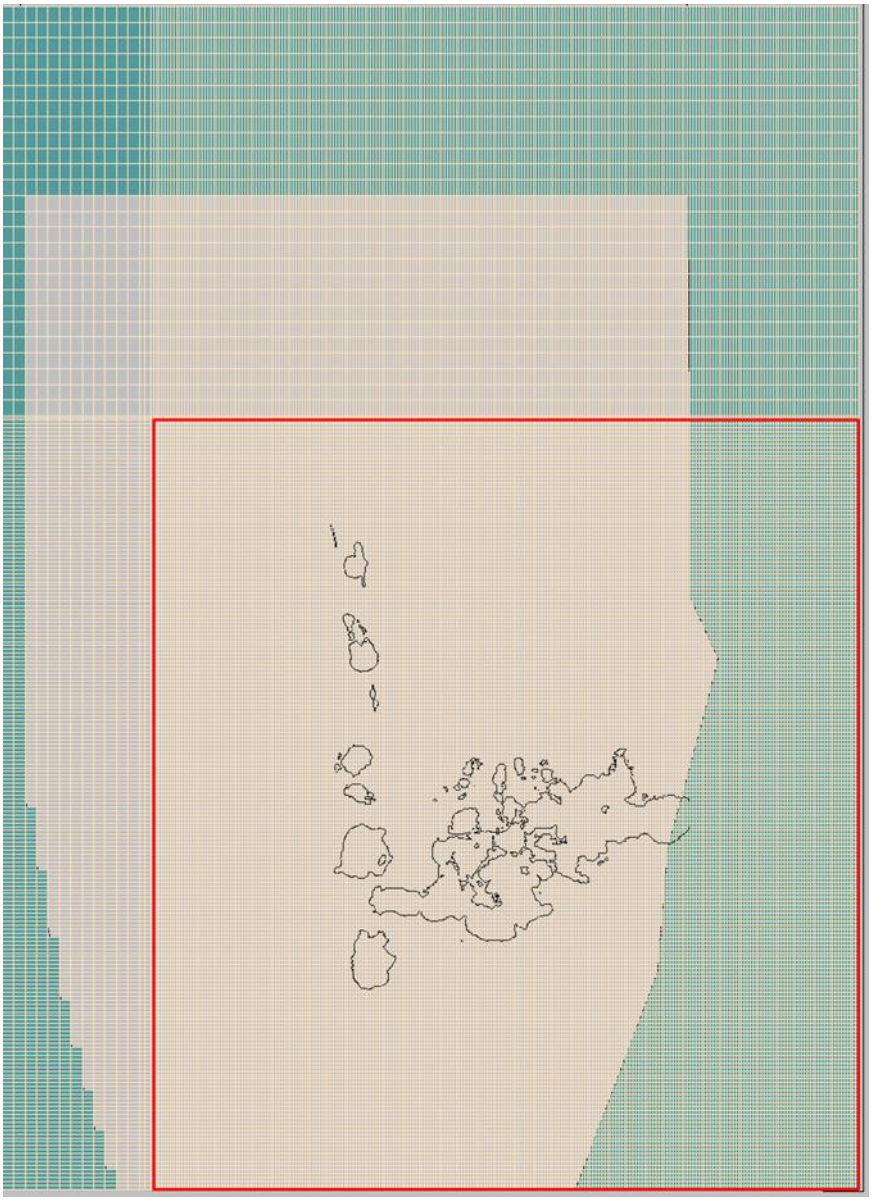


Figure 8-3: Eagle Mountain MODFLOW Grid with Year 15 Pit Outlines & Area of Refinement (red square)

In this manner, GRE created the model domain and model grid to simulate the best-available geologic model of the EM site.

8.5 MODEL STRATIGRAPHY AND GEOLOGY

The model stratigraphy is the definition of the horizontal layers (if any) which comprise the geologic domain. There are three main stratigraphic units present on the site:

- Saprolite
- Transition Zone

- Hard Rock

Hard rock is a packet of geologic materials which does not necessarily comport with a “layering” approach. As seen in Figure 8-1, there are different units within the hard rock, some which conform with horizontal orientations, and some which do not. It is necessary within MODFLOW to assign each part of the geologic domain a layer and a “zone”. Zones are defined by a single property value (such as hydraulic conductivity) and often also defined by a single rock type. In this case, Layer 1 is saprolite (Zone 1), Layers 2 and 3 are Zone 2, and it is frequently a transition zone (unless it does not exist) and Layers 4-11 are hard rock. These hard rock layers are assigned the appropriate zone to correspond with the rock type.

The following figures show how layering and zone definition have been used to capture the geologic model of the site. Table 8-1 shows the mapping of zones to material types, and hydraulic conductivity values.

Table 8-1: Groundwater Model Conductivity Properties

Zone Number	Material Type*	Kx, Ky, Kz (cm/s)
1	Saprolite	5.00×10^{-6}
2	Transition Zone	1.00×10^{-3}
3	Volcanic Package: granite, basalt, mafic volcanics	1.37×10^{-5}
4	Eagle Granodiorite	5.00×10^{-6}
5	Gabbro	4.17×10^{-4}
6	West Sediments: Meta-sediments	4.33×10^{-4}
7	Diorite Porphyries	6.44×10^{-6}
8	West Sediments: Silica Flooded Meta-Sediments	7.55×10^{-3}
9	Volcanic Package: Mafic Intrusion	1.00×10^{-6}
10	Alluvium/Colluvium^	1.57×10^{-3}
11	Eagle Mountain Valley-Fill Sediments^	1.57×10^{-3}

*Many of these materials, such as the Volcanic package, are based on the Leapfrog geologic model provided by Kevin Pickett to GRE in March 2025. ^Values for these materials are based on literature values for the appropriate material type (Domenico & Schwartz, 1990).

Figure 8-4 shows how these zones were assigned in Layer 1.

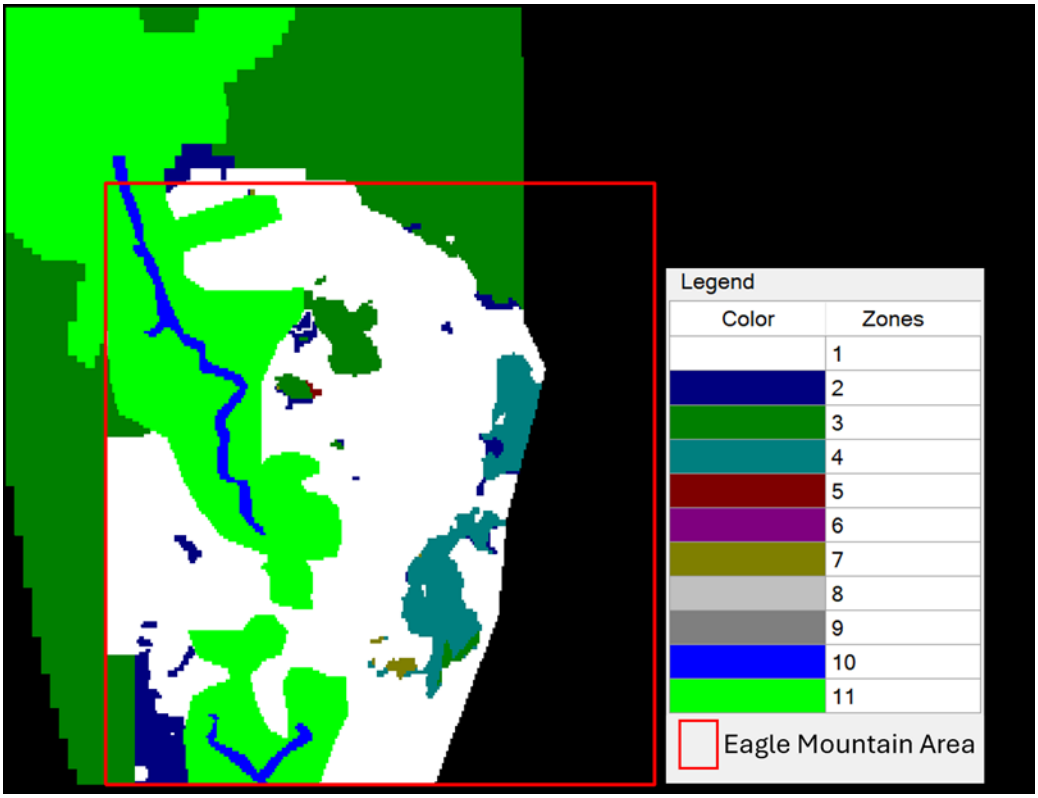


Figure 8-4: Conductivity Distribution, Surface Layer

For example, one can see the application of Zone 10, an alluvial deposit formation, along the drainage of the Mahdia river and the Minnehaha river (which has two branches). A wider zone of low-lying alluvial colluvial material fills the valley bottoms, and saprolite (zone 1) covers most of the rest of the model domain. One can also see the outcrops of various rock types (e.g. Zone 3 and Zone 4) around the site including a dolerite outcrop forming the spine of Eagle Mountain. Figure 8-5 shows the zones in Layer 3.

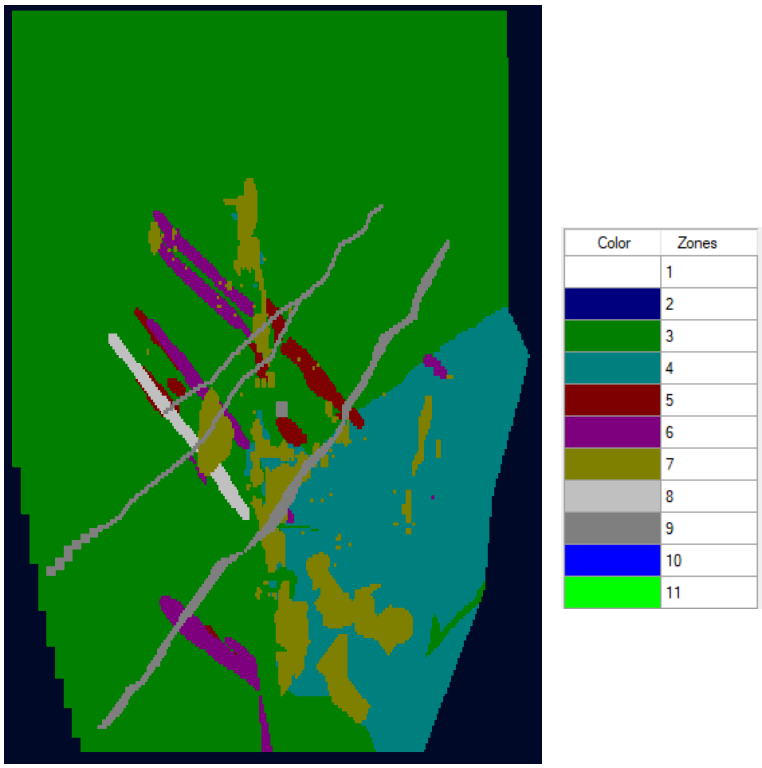


Figure 8-5: Conductivity Distribution, Top of Hard Rock Layer

In Layer 3, one can see other elements of the geologic model including Northeast-Southwest oriented vertical dolerite dyke structures (which continue into deeper layers). These dykes are made of high-competency hard rock and serve as groundwater flow barriers. Other elements of the geologic model, including gabbro formations, may serve as preferential groundwater flow pathways, but in general, the dykes were found to be more important (see Section 8.14). To capture the complexity of the geologic system, GRE has employed 11 total layers to simulate the Leapfrog geologic model.

Figure 8-6 shows this model in cross section through the model domain (row 150, through the center of the future Eagle Mt. Pit) which shows how complicated 3D geology was defined within the MODFLOW grid.

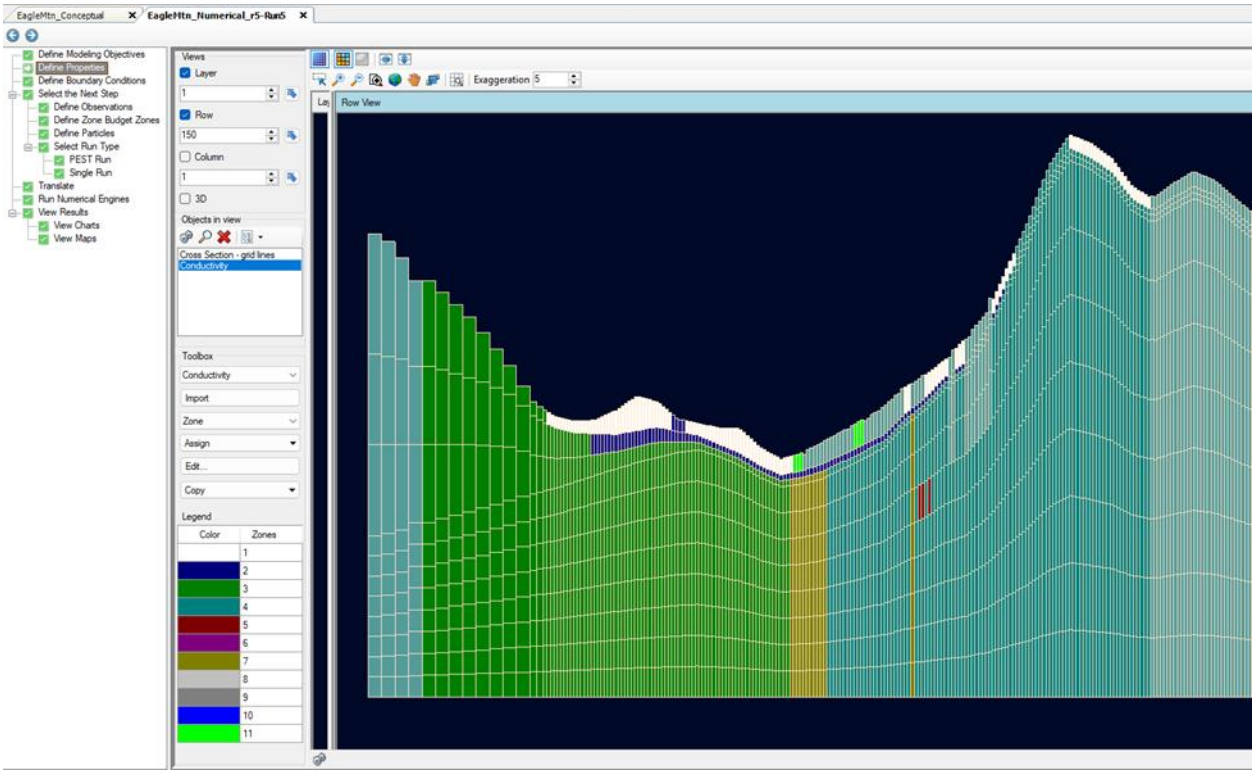


Figure 8-6: MODFLOW Discretization of the Geologic Model

8.6 MODEL PROPERTIES

Associated with the geologic model discretization, GRE defined hydrogeologic properties. In general, the properties were matched to rock types in the geologic model. Where necessary, more than one property was assigned to a rock type or to a unit to better-match hydrogeologic testing or to achieve a better calibration of the model.

GRE defined data within the four major properties: Conductivity (K), Storage (Ss, Sy, ne, and nT), UZF (EPS, THTs and THTi), and Initial Heads (h).

8.6.1 MODEL PROPERTIES, CONDUCTIVITY

The model conductivity zones have been discussed in the previous section; it is by hydraulic conductivity zone definition that the rock types are simulated within the model domain. Hydraulic conductivity values (shown in Table 8-1: Groundwater Model Conductivity Properties) were selected to match field testing, and to achieve the best-possible model calibration.

8.6.2 MODEL PROPERTIES, STORAGE

Since the wells installed on-site were all single wells, and because multiple-well aquifer tests are required to determine field storage, GRE was unable to obtain storage values from the well

pumping tests. Instead, GRE has used literature values that best represent the saprolite (sand), transition zone (gravel), and hard rock (granite) (Morris & Johnson 1967; Heath 1983; Batu 1998). Table 8-2 below summarizes the storage properties assigned to each zone/material type.

Table 8-2: Groundwater Model Storage Properties

Zone Number	Material Type	Specific Yield (Sy)	Specific Storage (Ss, m^{-1})	Effective Porosity (ne)	Total Porosity (nT)
1	Saprolite	0.2	1.00×10^{-4}	0.2	0.465
2	Transition Zone	0.15	6.89×10^{-5}	0.2	0.32
3	Hard Rock	0.01	3.28×10^{-6}	0.01	0.1

These properties were assigned to the appropriate layer, zone and rock type.

8.7 MODEL BOUNDARY CONDITIONS

Boundary Conditions (BCs) are used in MODFLOW analyses to assign attributes to the model that are reflective of the site environment and to define what must occur on the edges of the model domain. Boundary conditions include: precipitation/infiltration, evapotranspiration, surface water features, no-flow boundaries, and other factors that can influence the output of the model. With this project, GRE has chosen several BCs, or packages, to best reflect site conditions. The packages chosen for this model are recharge (RCH), drain (DRN), and constant head (CHD).

8.7.1 RECHARGE (RCH)

The RCH package in MODFLOW is used to represent groundwater recharge from precipitation. For simplicity, GRE made groundwater recharge represent rainfall minus runoff, soil evaporation, and plant transpiration (in other words, net recharge to the water table). Two zones were utilized: one zone represents infiltration for the valley (Zone1) while the other zones represent infiltration for the hills/mountains (Zone2 for the East hills/Eagle Mountain & Zone4 for the West hills).

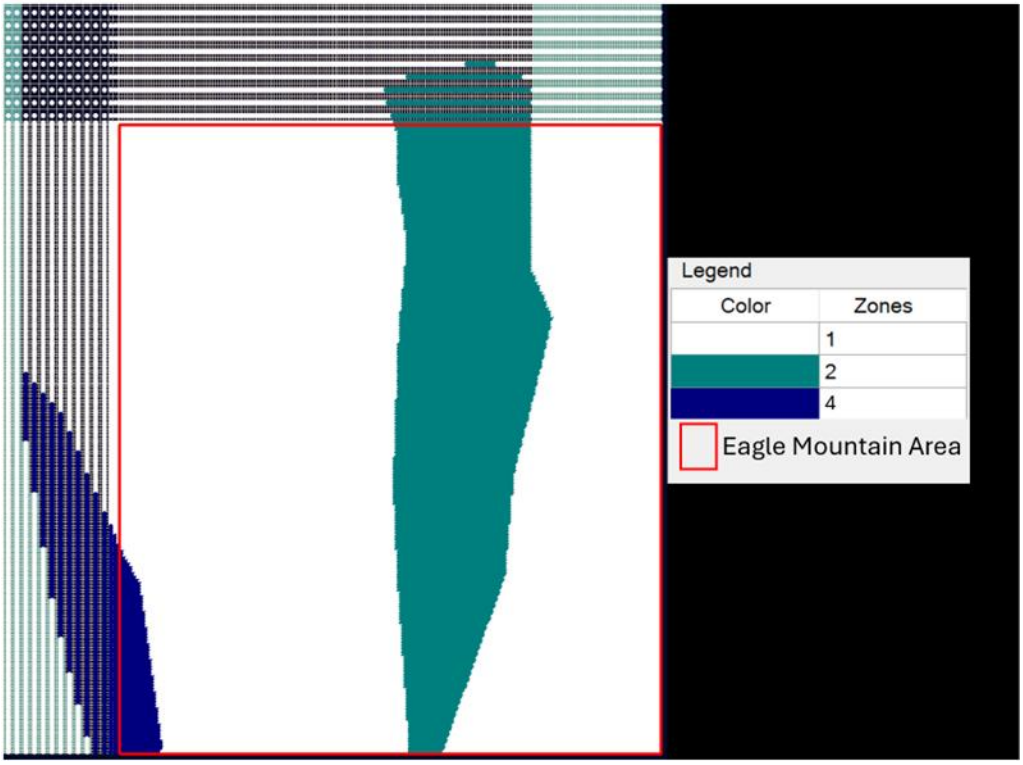


Figure 8-7: Groundwater Model Recharge (RCH) Zones

The recharge values for each zone were determined based on precipitation data for the model day (January 12th, 2025) and infiltration percentages according to the type of material and location. The steady state model requires an average recharge. Section 8.10 discusses seasonal recharge in a transient model run. Table 8-3 below provides the recharge input as assigned in the model.

Table 8-3: Groundwater Model Recharge Boundary Condition

Zone Number	Representative Area	Recharge (mm/d)
1	Site Valley	0.5
2	East Hills/Eagle Mountain	1.5
4	West Hills/Mountains	1.5

8.7.2 DRAIN (DRN)

The two major river networks, the Mahdia for the north and the Minnehaha in the south, are represented as drain cells. The DRN package is used to represent gaining streams, which as mentioned in Section 4.0, are the only type of streams in the model domain.

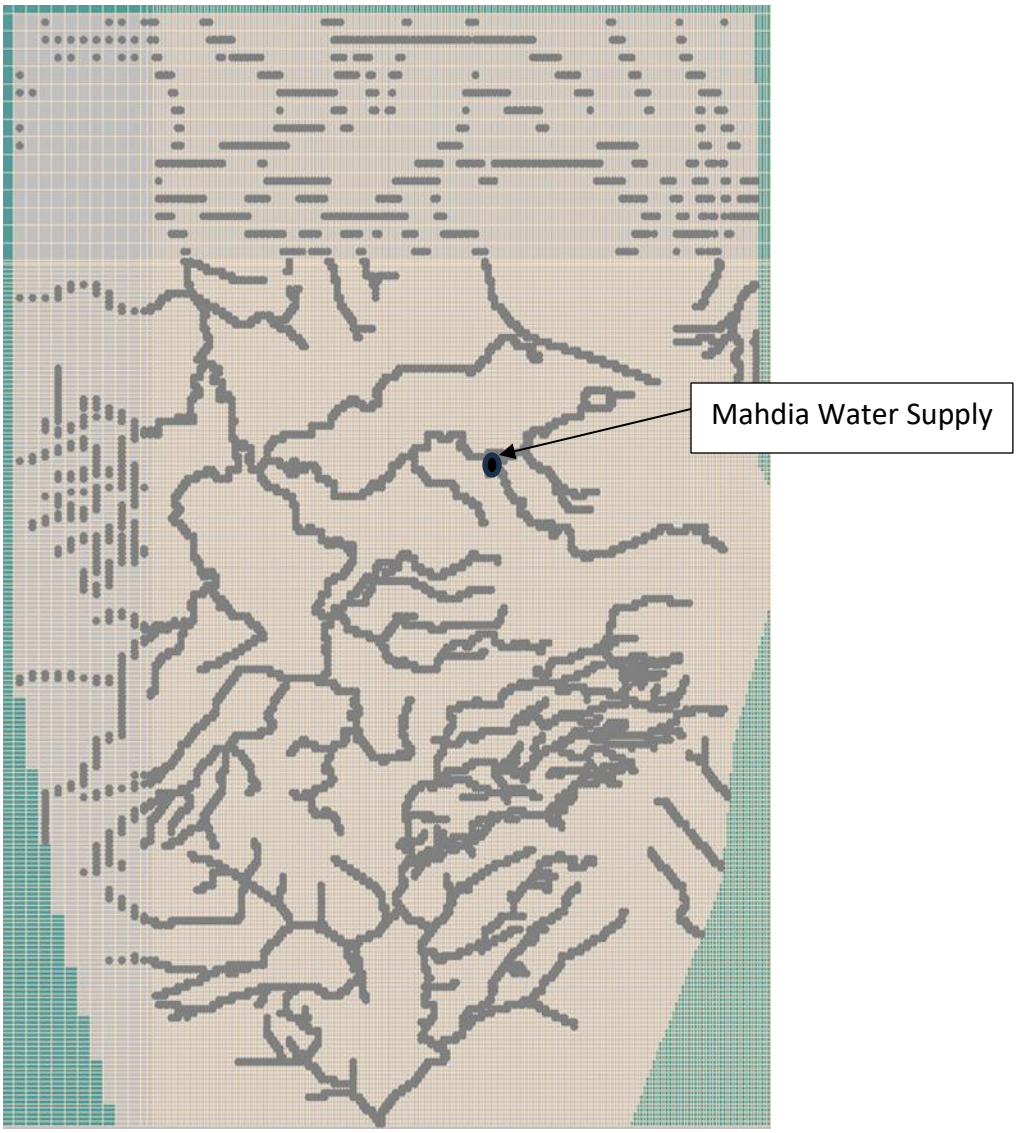


Figure 8-8: Groundwater Model Gaining Streams (Drain Cells in Dark Gray)

GRE assigned the drain elevation to the estimated stage of water in the stream – a uniform 1 meter above ground surface. All drains have a streambed conductance of 1000 m^2/day. The conductance is set to represent gravelly riverbeds. The Mahdia water supply intake weir is noted on Figure 8-8. It lies in a drainage basin that is hydrologically independent from the Eagle Mountain pit drainage basin, and upgradient from the Salbora pit development.

8.7.3 CONSTANT HEAD (CHD)

The model requires at least a few constant head cells to assist in solver convergence. GRE assigned two CHD BCs that represent the Mahdia and Minnehaha outlets. Values for each CHD were determined based on ground surface elevation plus 1 meter. This water level represents a 1m water level in each streambed.

Once all of these parameters were assigned to the appropriate step in the model construction, GRE ran the model and began adjusting the variables to achieve a calibrated steady-state model.

8.8 NO FLOW BOUNDARY CONDITIONS

No flow boundary conditions were defined on the ridgetops adjacent to the Mahdia and Minnehaha valleys. These boundary conditions comport with the regional conceptual model.

8.9 STEADY-STATE MODEL CALIBRATION

Steady-state models (models which do not vary over time) are not very useful when simulating the dynamic impact of a mining project. Additionally the steady-state model is required as the starting point to subsequent simulations. The steady-state model must be calibrated to two main metrics: the measured water levels in the model domain, and the baseflow (dry season) water discharge measured in the rivers.

The site has a network of standpipe piezometers and vibrating wire piezometers which are used as a calibration metric. These water level observations cover the full range of values from low-elevation wells to high elevation VWPs installed in geotechnical boreholes.

GRE started with a steady-state model that best represents conditions captured on January 12th, 2025. This date in particular was chosen because all of the VWPs and wells were installed and had an observed value. Table 8-4 shows the VWP and well observations on January 12th, 2025. The observed value in question is presented as “Head (m)” in the table below.

Table 8-4: Steady-State Groundwater Model Observation Values

Name	Easting (m)	Northing (m)	Depth (m)	Head (m)
EMD-288	264743	575726.5	165.41	171.74
EMD-289	264802.8	575731.2	168.15	177.85
GWP-006	264100	576150	58.9	86.7
GWP-009	265052	575615	176.9	233.7
GWP-016B	265862	576205	374.16	397.31
GWI-001	262717	577620	63.16	71.67
GWI-002	263261	577526	43.33	71.39
GWI-007	263873	574550	76.57	95.22
GWW-01B	262366	578874	44.87	63.87
GWW-02	262785	578623	45.8	56.43
VWP-19D	266498	576416	519.34	552.86
VWP-18S	266498	576416	562.18	580.91
VWP-17D	265356	575737	244.58	282.3
VWP-16S	265356	575737	278.4	284.36
Name	**Easting (m)**	**Northing (m)**	**Depth (m)**	**Head (m)**
VWP-15	264955	576460	176.87	193.1

VWP-14S	264085	577785	50.68	62.78
VWP-13D	264125	577730	31.64	94.47
VWP-12S	264125	577730	95.34	94.47
VWP-11D	265767	576618	330.62	359.11
VWP-10S	265767	576618	353.27	370.76
VWP-09S	264518.7	575772.1	115.2	114.64
VWP-06D	264164.7	576107.8	25.65	76.75
VWP-05S	264164.7	576107.8	69.15	87.69
VWP-4D	264045	576875.7	21.41	65.51
VWP-3S	264045	576875.7	79.51	77.75

GRE adjusted the recharge values and the hydraulic conductivity values (within the range of observed testing), to match the water levels of the site.

Figure 8-9 shows the calibration results – a comparison between observed heads (horizontal axis) and simulated heads (vertical axis). This calibration had a reasonable percent error of 3.49% of the total head difference within the model domain.

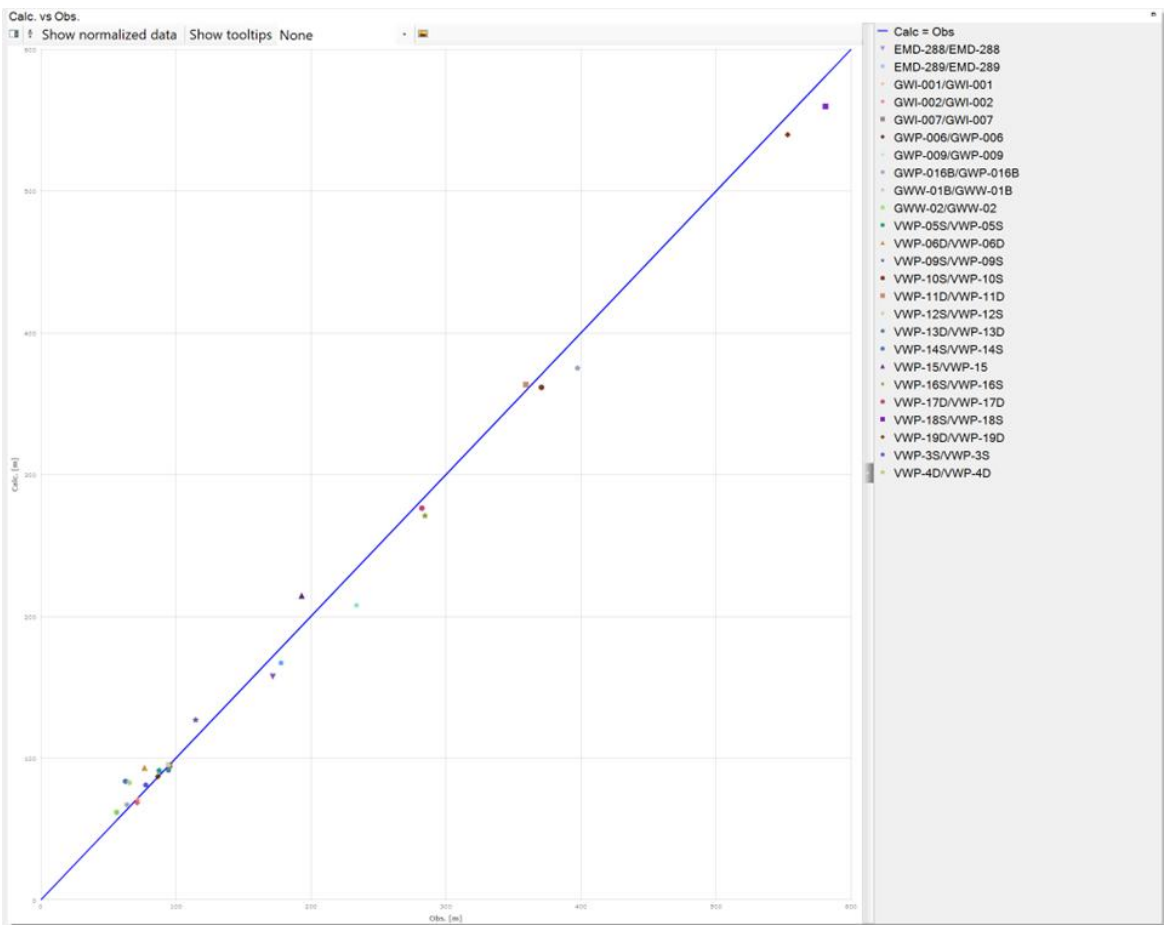


Figure 8-9: Steady-State Groundwater Model Results: Calibrated

Baseflow readings in the Mahdia river were similar to field readings that measured 0.28 m^3/s and 0.31 m^3/s.

After completing the steady-state model calibration, the model was used as the foundation upon which all of the transient numerical models were built.

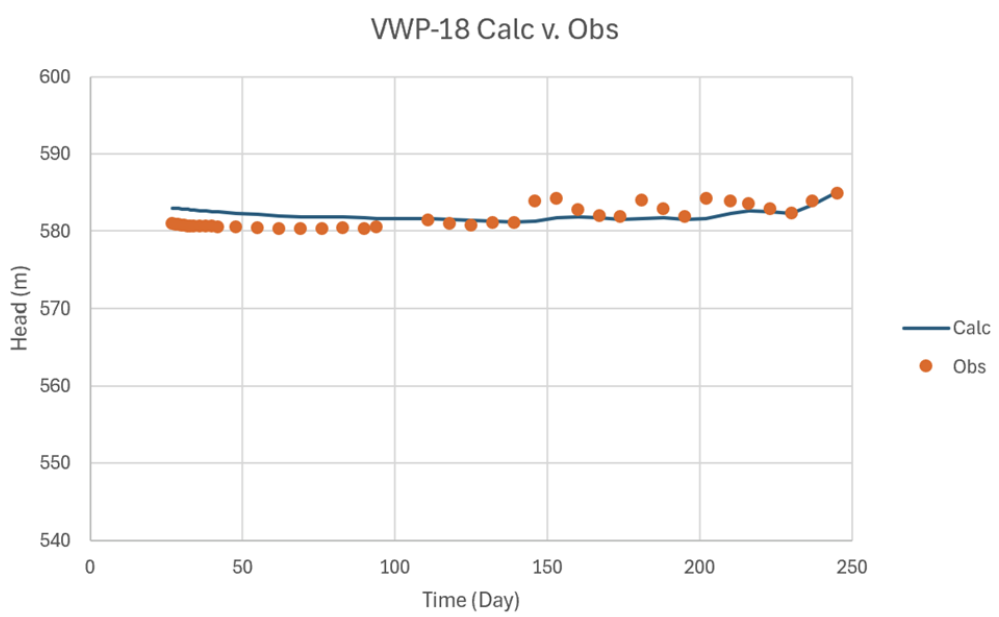
8.10 TRANSIENT NUMERICAL MODEL INPUTS & DEVELOPMENT

With the steady-state model calibration complete, GRE built a pre-mining transient (time variant) model to simulate the seasonal hydrogeologic response to the site's rainfall conditions.

First, GRE had to establish a time frame in which the pre-mining changes to the groundwater level could be compared to observed data. As an early-phase development project, the Eagle Mountain mine does not have a long record of water level readings; the first record from these devices was recorded September 16th, 2024, while the latest recorded value (as per the data freeze memo) was May 20th, 2025. This timeframe was duplicated by the transient model timeline of 246 days.

GRE created a recharge vs time boundary condition to simulate the bi-modal wet season observed on the site. The best calibration was achieved with infiltration on the hills (Zone2 and Zone4) at 12% of total annual precipitation and an infiltration rate of 8% in the valley (Zone1).

After applying these recharge rates, GRE ran the pre-mining model. Figure 8-10 shows the results of the pre-mining model after calibration, where each point represents the observed (recorded on-site) head values while each line represents calculated (simulated) heads through time.



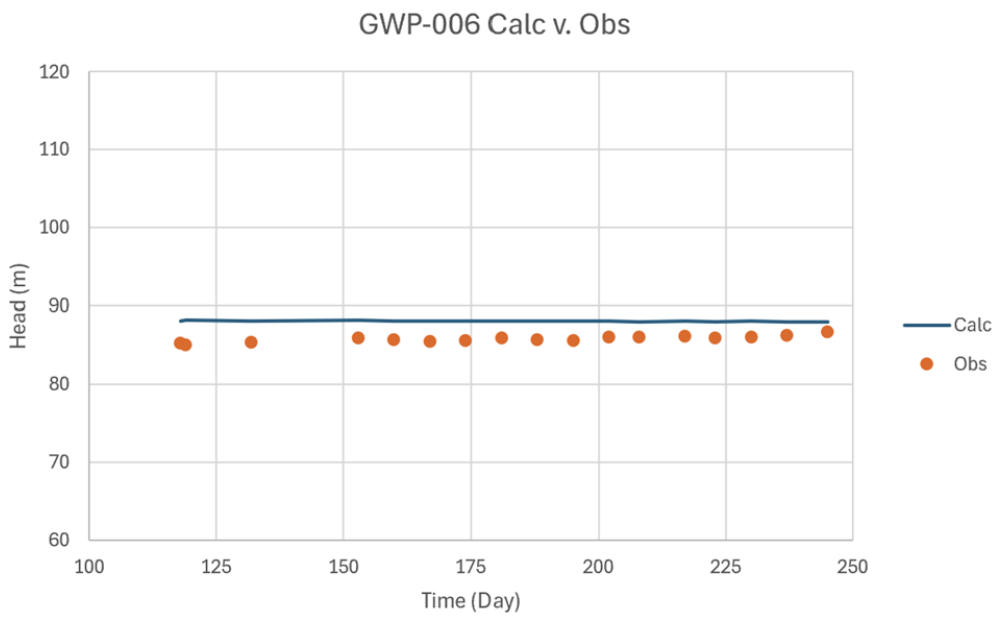


Figure 8-10: Transient Pre-Mining Groundwater Model Calibrated Results

The table below shows the daily rainfall for each month as assigned to each RCH zone.

Table 8-5: Transient Mining Groundwater Model Recharge BC Values

Month	Zone1 Recharge (Valley, mm/d)
January	0.44
February	0.66
March	0.24
April	0.25
May	.072
June	0.6
July	0.44
August	0.11
September	0.05
October	0.02
November	0.2
December	0.25

After the steady-state and the transient calibration, the groundwater model was a reasonable simulation of the observed groundwater conditions prior to mining. The next step in the 3D GW model process was to simulate the impact of the Eagle Mountain mine development timeline.

8.11 SIMULATING THE OPEN PIT

The excavation of the pits varies over time, space and depth. To accurately simulate the dewatering and hydrogeologic impacts, one must simulate the mine plan. The lateral and vertical extents of each pit were determined based on the annual PEA pits shells provided by Mako to GRE in early 2025. An open pit mine can be simulated in MODFLOW using a drain cell on the edge of the pit, and inactive cells (representing open air) in those cells that have been excavated. In this case, the drain cell is set at the layer bottom to allow for the seepage of groundwater into the pit (and subsequent water removal from pit sumps and pumps). GRE selected annual pit shells which experienced major changes as simulating all 15 years of mine life was not feasible. GRE selected mine years 1, 3, 7 and 15 as the best yearly pit shells to simulate. Figure 8-11 through Figure 8-14 depict the development of the pit extent in Layer 1.

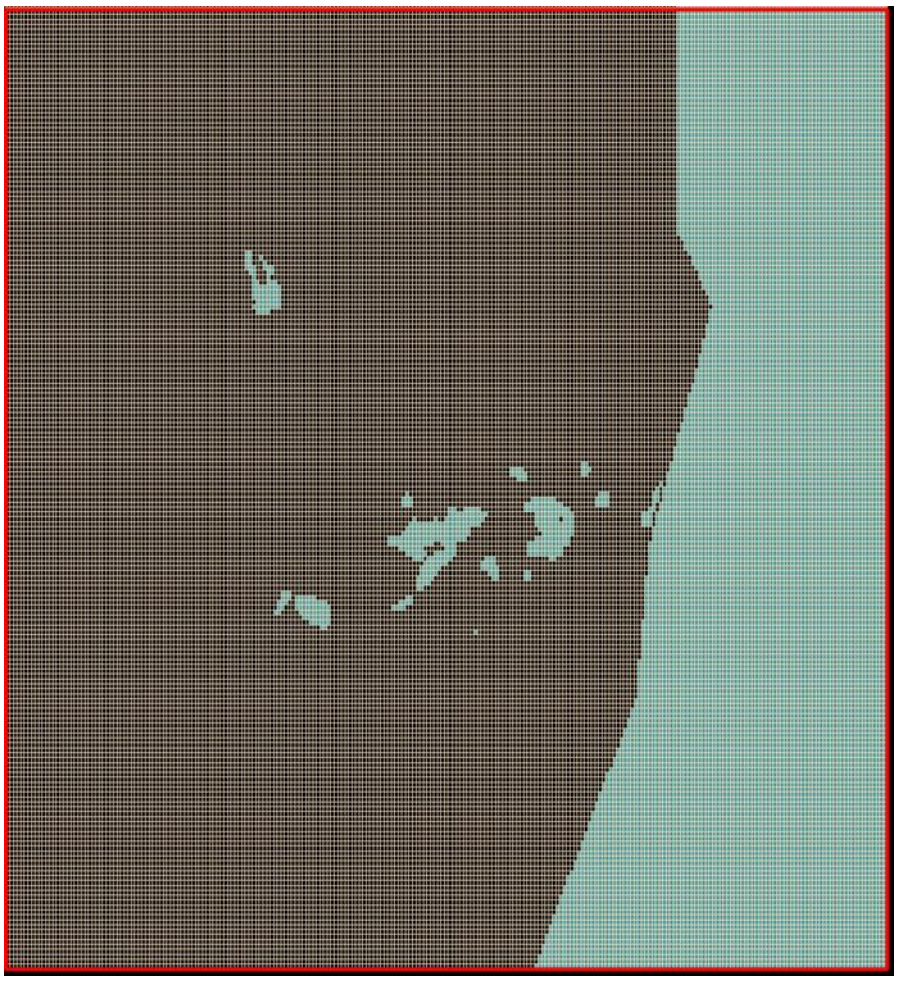


Figure 8-11: Transient Mining Groundwater Model Pits Year 1

Figure 8-12: Transient Mining Groundwater Model Pits Year 3

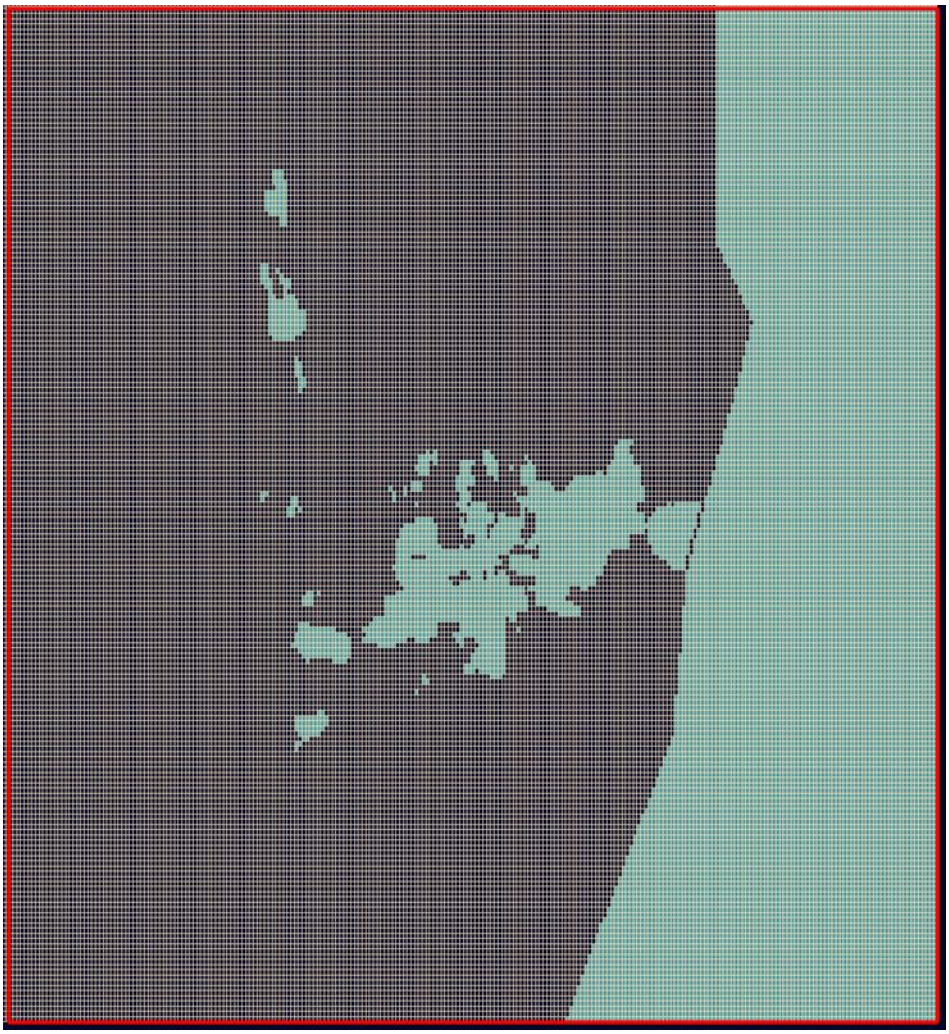


Figure 8-13: Transient Mining Groundwater Model Pits Year 7

Figure 8-14: Transient Mining Groundwater Model Pits Year 15

Each pit was represented in deeper layers based on the pit depth, and the models are hooked together like boxcars on a train – with the output from the prior model used as the input for the next model. By running the models sequentially using this method, GRE captured the transient spatial and depth changes of the EM mine over time.

8.12 ZONE BUDGET SETUP

As mentioned previously, the ultimate goal of the groundwater model is to determine pit dewatering and its effect on the groundwater system. To accomplish this, GRE needed to assign Zone Budgets to the DRN BCs surrounding the pits and defining the extents of the rivers. Zone budgets allow the user to set an area of observation for which the model outputs flows.

The Zone Budget tool in Visual MODFLOW Flex assigns zones much like the four major properties, but the zone defined as a Zone Budget is primarily used to determine how much water is going into or out of the indicated zone. Figure 8-15 below depicts the Pit Year 15 model with Zone Budget zones for the watersheds and each individual pit. By comparing the flow into and out of these zones, the groundwater model can predict the pit dewatering for each pit, and the change in groundwater discharging to rivers in the Mahdia and Minnehaha basins.

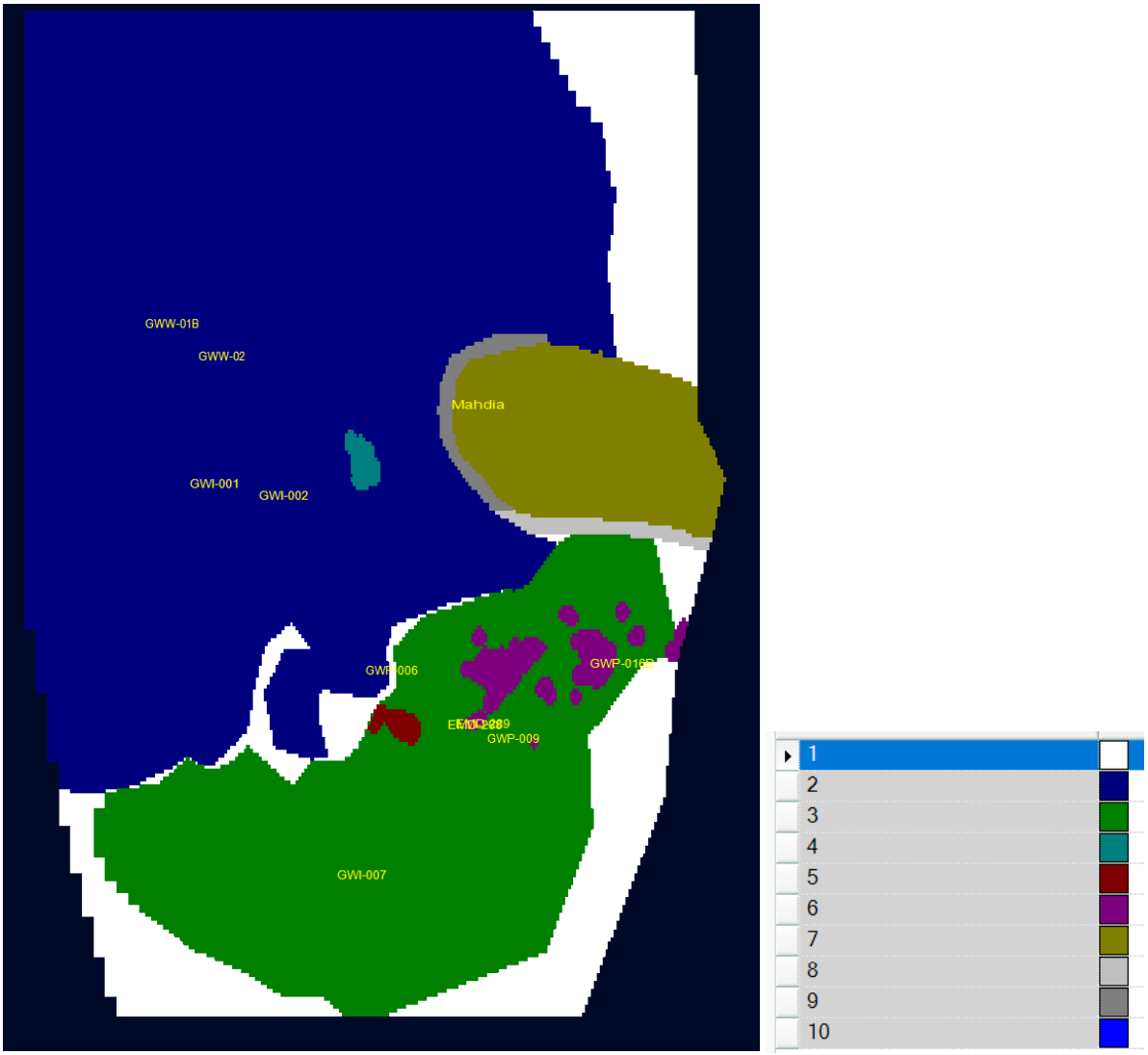


Figure 8-15: Transient Mining Groundwater Model, Pit Year 15, Zone Budget Zones

One can see that zone budgets have been used to define each pit. In addition, the Mahdia water supply has been bounded by three zones, one which covers the drainage basin upgradient from the weir and water collection point (Zone 7), one which defines the southern boundary of the basin (Zone 8), and one which defines the downgradient, western boundary (Zone 9). With these three zones, it is possible to quantify the impacts that the project may have on this drainage basin.

8.13 MODEL RESULTS

The model results are summarized in the sections below.

8.13.1 MODEL BENCHMARK – PRE-MINING TRANSIENT RESULTS.

The first model result was the "transient pre-mining" result. This result is the model output from running the transient rainfall condition for a number of years to achieve a dynamic steady state which reflects the seasonal pre-mining conditions. The following mine life analyses were all based on the results of the transient pre-mining model. Figure 8-16 shows the pre-mining water table elevation map.

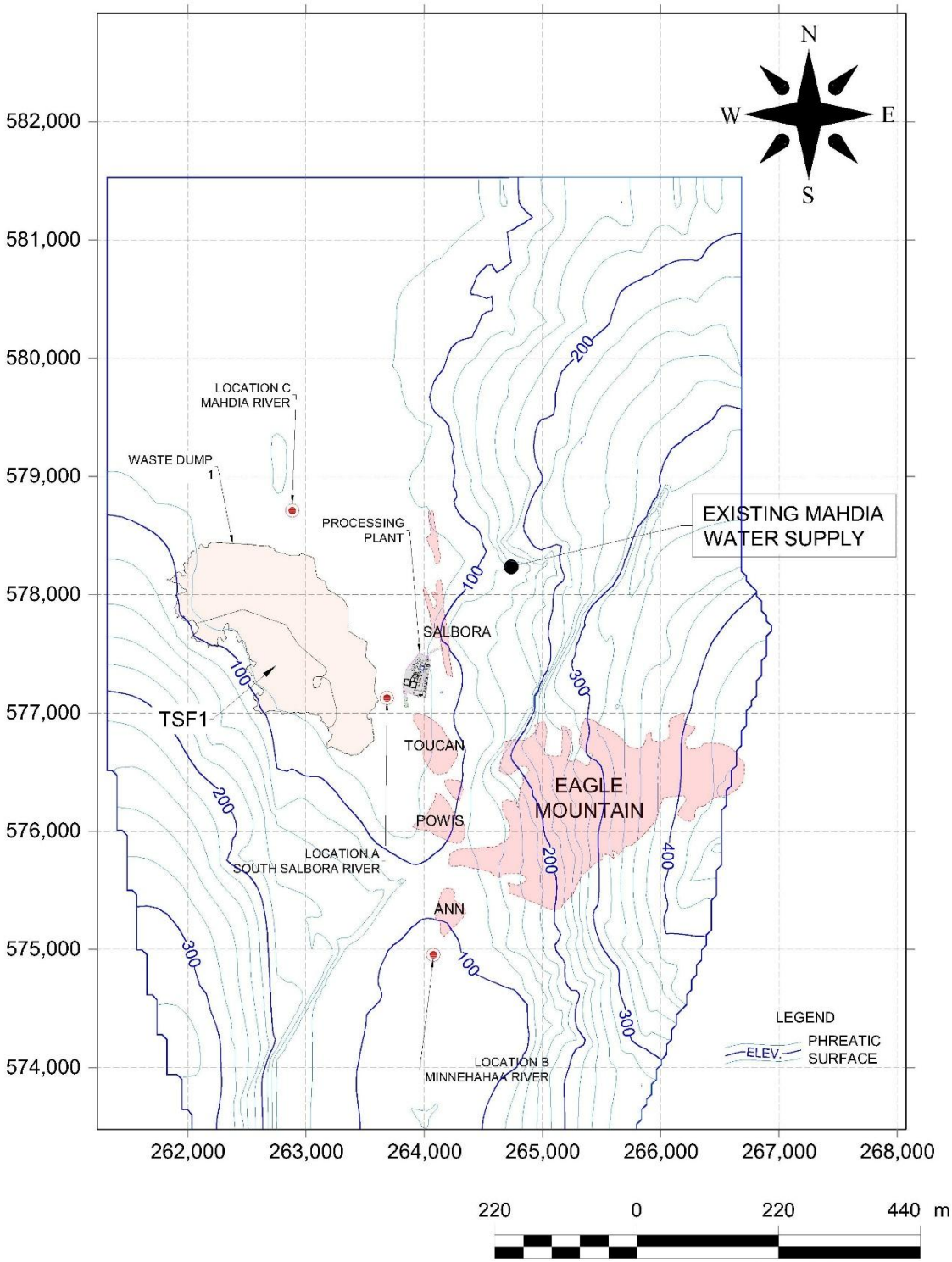


Figure 8-16: Pre-Mining Water Table Elevation Map

In Figure 8-16, one can see the outline of the future pits which do not yet exist in the model. In many areas, there is a 1-10 meter change between wet season and dry season water levels in the transient pre-mining model. This complicates the calculation of drawdown impacts from mining.

GRE focused on the changes to dry-season water levels in further analyses, as those have the greatest potential to impact groundwater availability.

8.13.2 PIT DEWATERING PREDICTION

Pit dewatering results are presented in Figure 8-17 through Figure 8-20. In all cases, the model shows a higher inflow in the first months in which the pit is "opened" in the model. This is the result of the discretization of time in the models into discrete pit development phases (see Section 8.11), and it does not reflect continuous pit development. As a result, GRE utilized the groundwater inflow after the model had stabilized at each pit phase as the estimated pit dewatering volume for that mining phase.

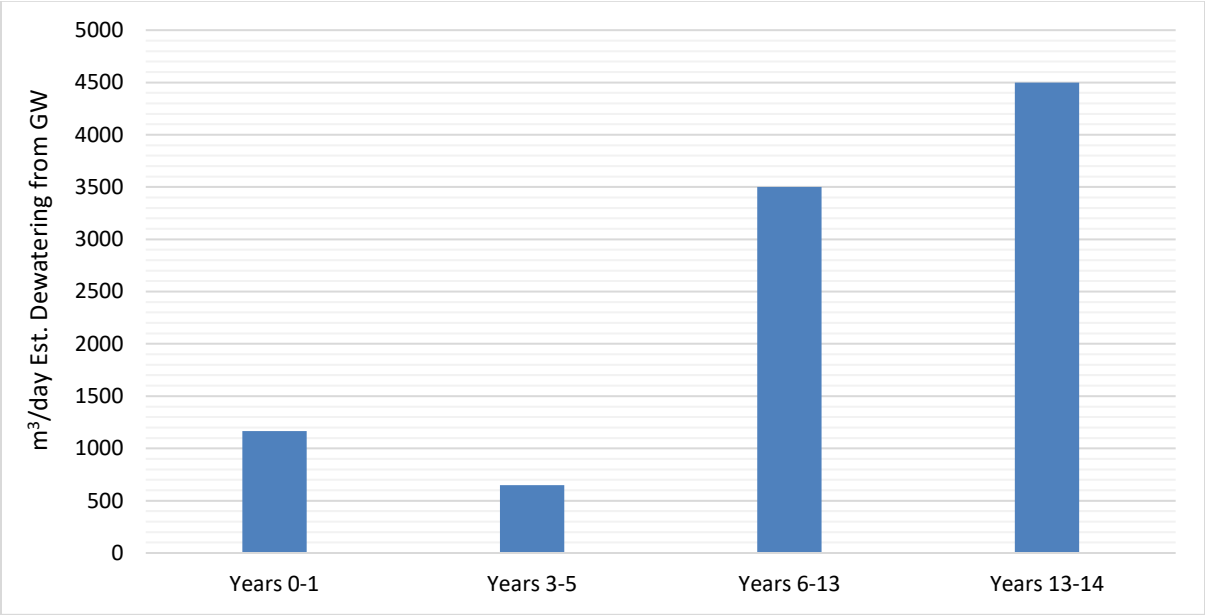


Figure 8-17: Estimated Salbora Pit Dewatering

One can see the following trends in Salbora pit dewatering:

1) In Year 3-5 ,the pit reaches a steady-steady state inflow lower than the initial because of diminished storage inflows
2) Late in mine life, the pit is larger and deeper, resulting in more inflows. The PEA pit also includes southern extensions which are included in the Salbora zone budget, and which result in higher dewatering.

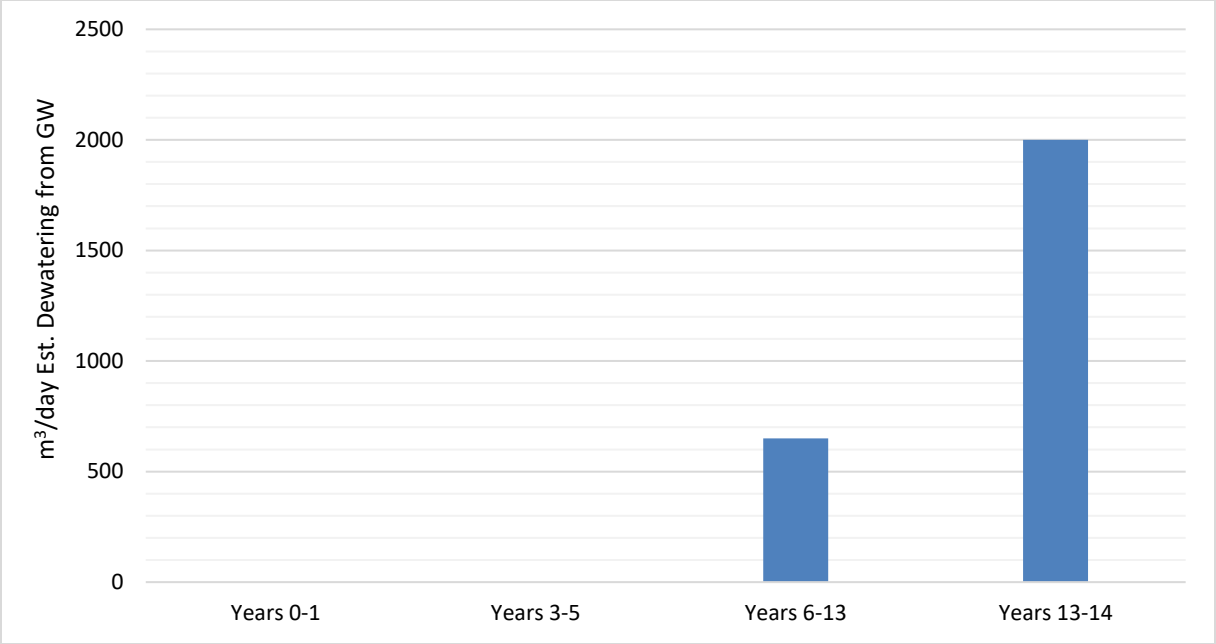


Figure 8-18: Estimated Toucan Pit Dewatering

Toucan is not developed until later in mine life. As it increases in size and depth in years 6-14, the dewatering flow increases.

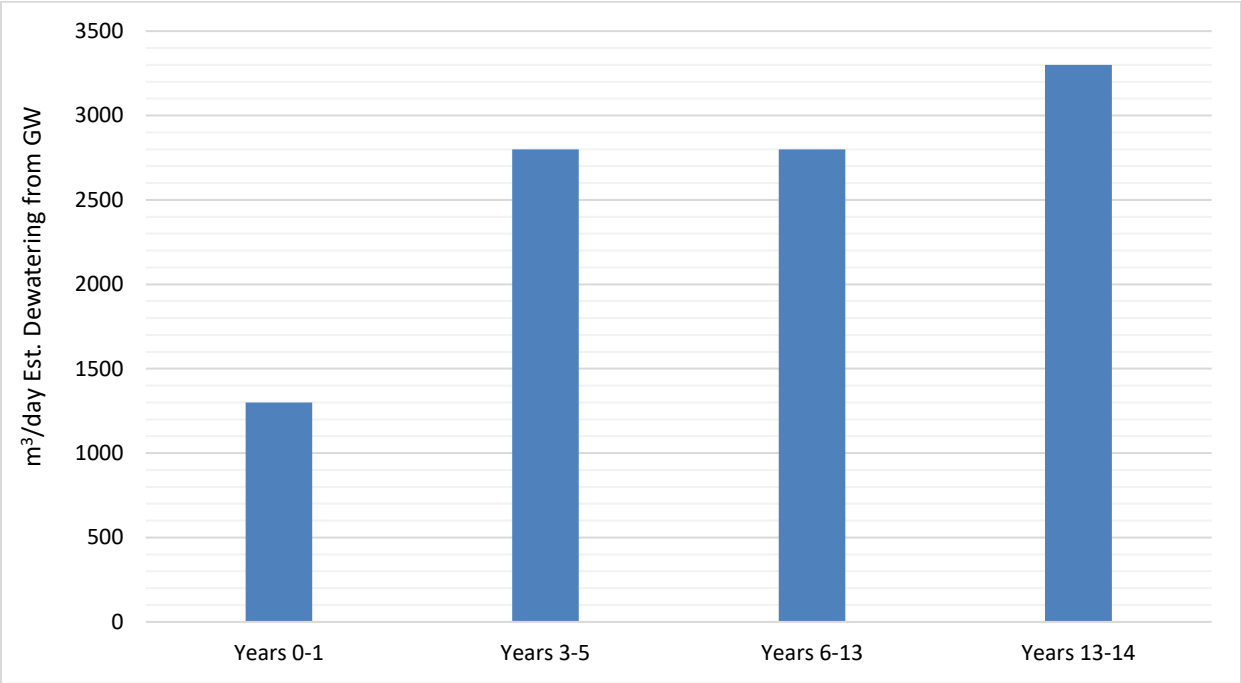


Figure 8-19: Estimated Powis Pit Dewatering

Powis is developed early in mine life. As a result, the dewatering increases with pit size, and stays relatively stable later in mine life.

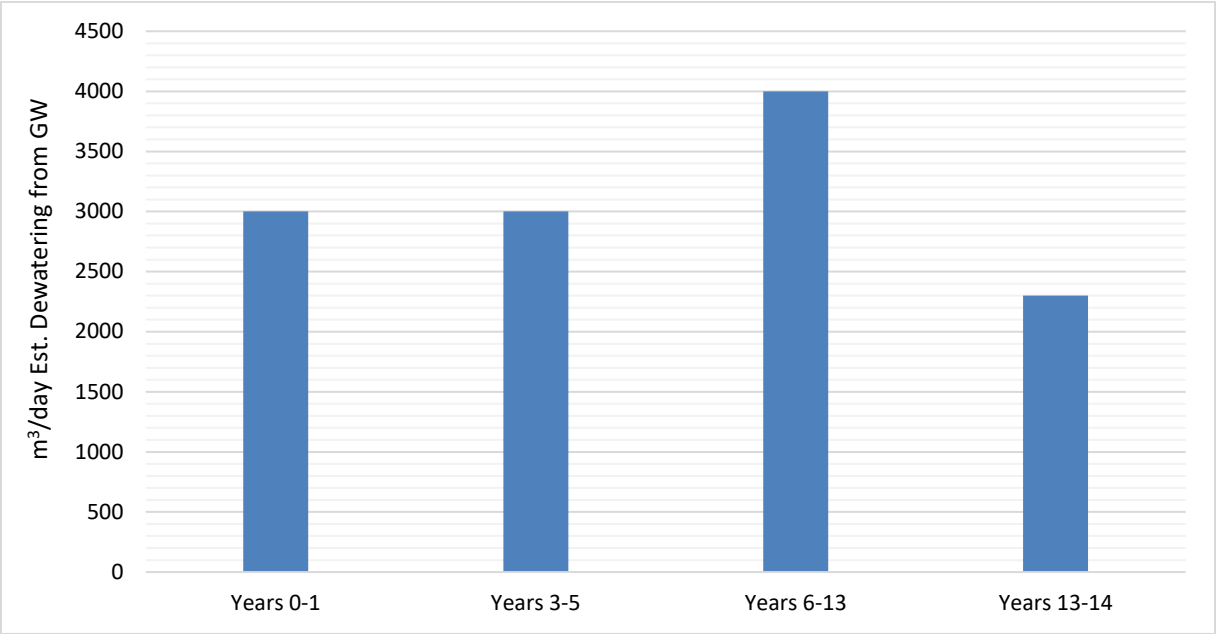


Figure 8-20: Estimated Eagle Pit Dewatering

Eagle Mountain is large, but its dewatering per unit surface area is lower than pits along the North-South mineralized trend because it has less alluvium and colluvium in the pit walls. Later in mine life, dewatering stabilizes because the pit is at maximum extent, and does not draw as much dewatering from storage

Total cumulative project dewatering is estimated in Figure 8-21.

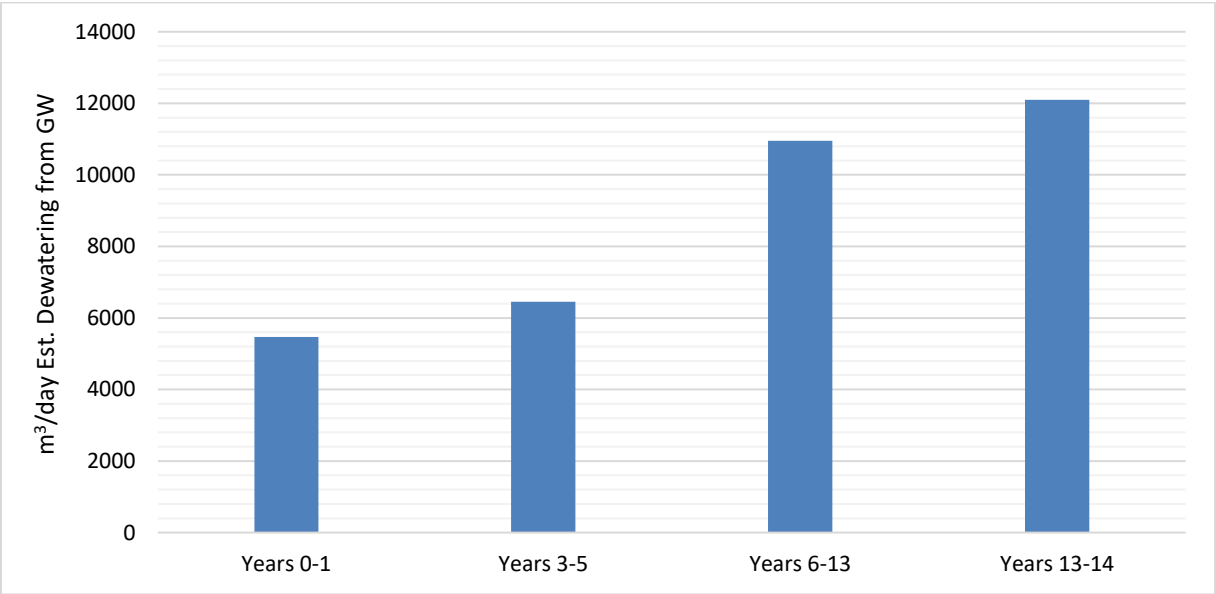


Figure 8-21: Estimated Project-Wide Dewatering

The maximum estimated pit dewatering from groundwater is 140 L/s late in mine life.

8.13.3 GROUNDWATER INFLOWS TO PITS COMPARED TO DIRECT PRECIPITATION

It is important to put this dewatering from groundwater in context of dewatering from direct precipitation. For example, the Eagle Mountain pit is 2,488,079 m^2 at end-of-life. Total average annual precipitation for the last five years is ~ 4000 mm/year. This averages to ~27,500 m^3/day of dewatering from direct precipitation. As seen in Figure 8-20, the maximum groundwater dewatering from the EM pit is ~4000 m^3/day. This makes groundwater roughly 15% of the total annual dewatering requirement. It also makes it clear that the pit dewatering system must be sized based on rainfall and groundwater inflows, with rainfall always being the larger share.

8.13.4 GROUNDWATER IMPACT MODELING

The model simulated the depression of the water table through pit dewatering. Figure 8-22 shows the selected cross section location, and Figure 8-23 through Figure 8-26 demonstrate the effect of the pit excavation on the water table.

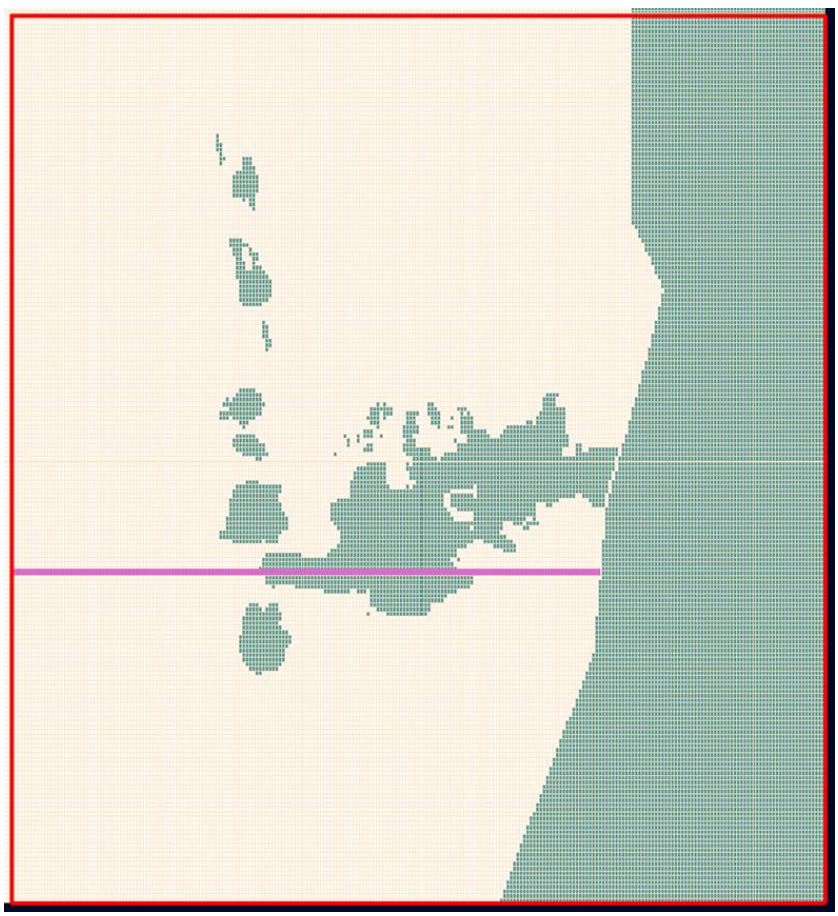


Figure 8-22: Location of Cross-Section for Transient Groundwater Model Pits Water Table (Purple Line)

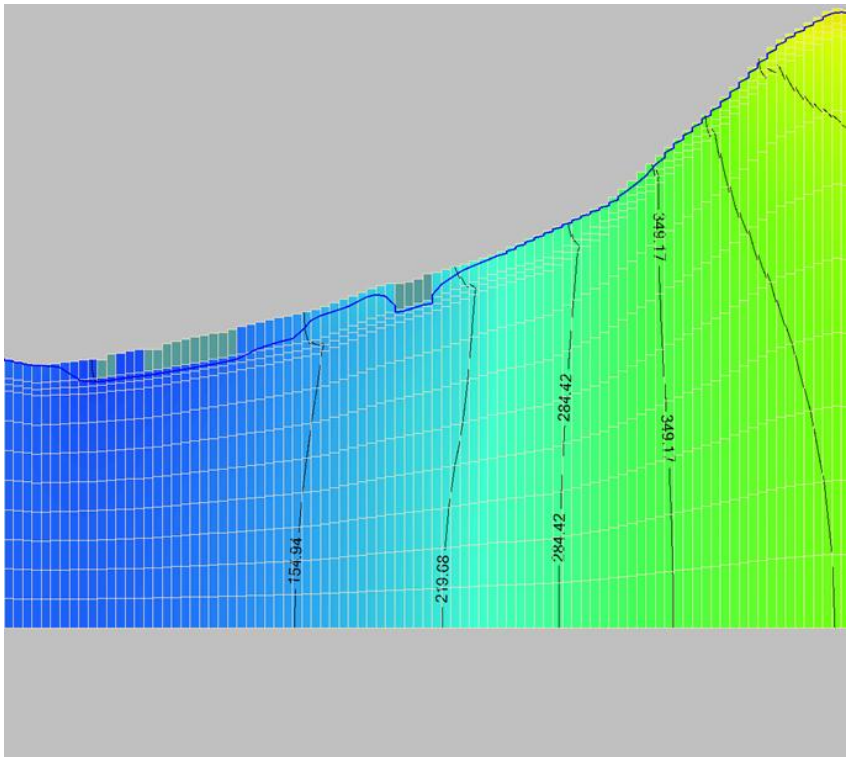


Figure 8-23: Transient Mining Groundwater Model Pits Year 1 Water Table

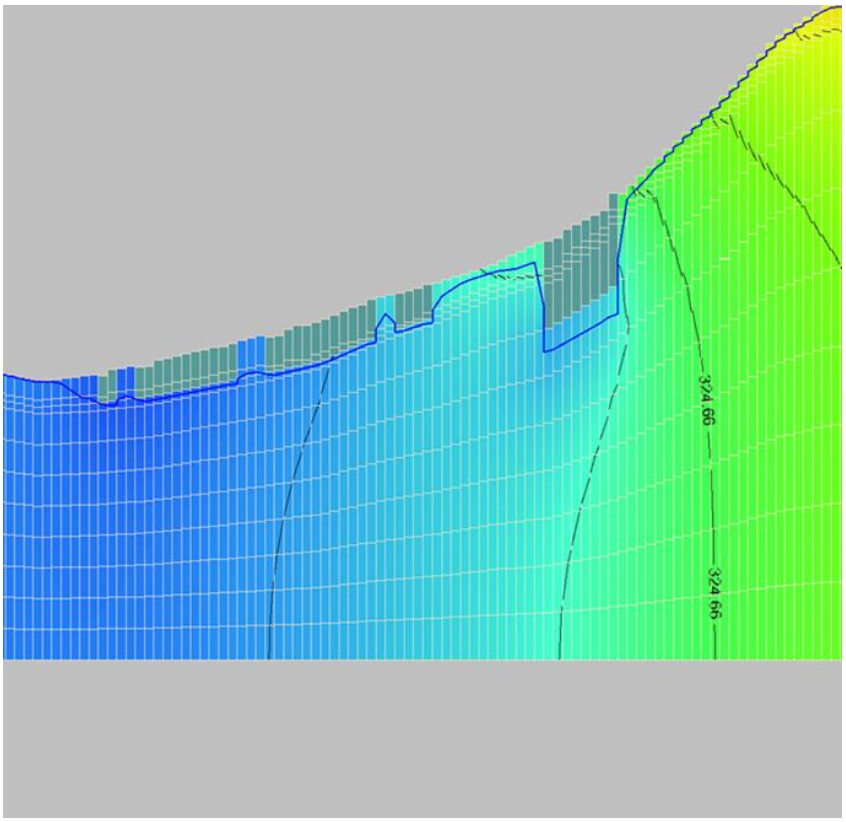


Figure 8-24: Transient Mining Groundwater Model Pits Year 3 Water Table

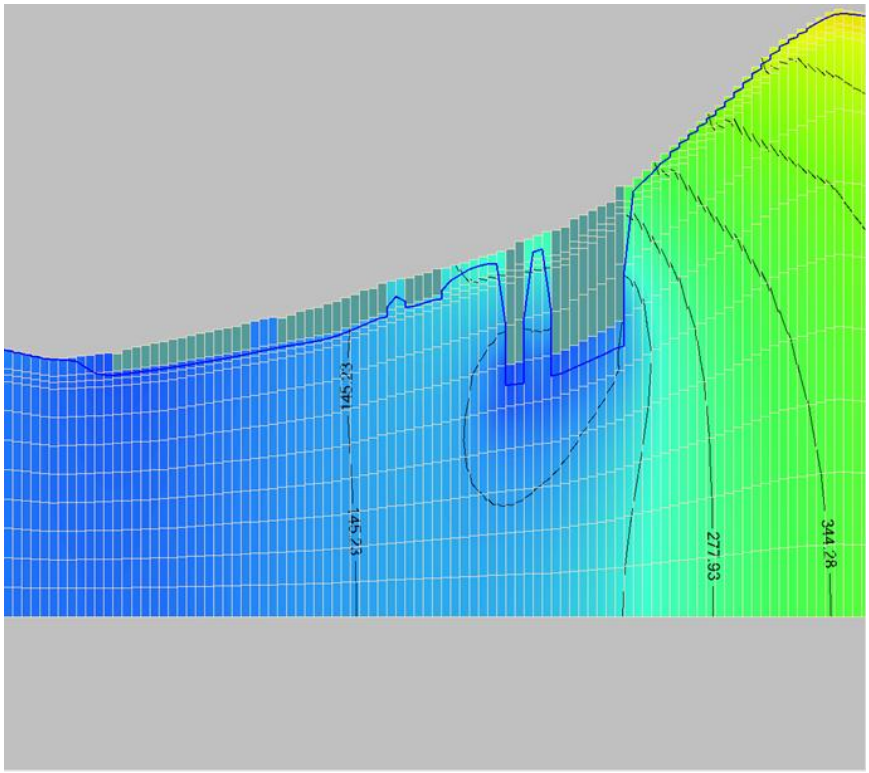


Figure 8-25: Transient Mining Groundwater Model Pits Year 7 Water Table

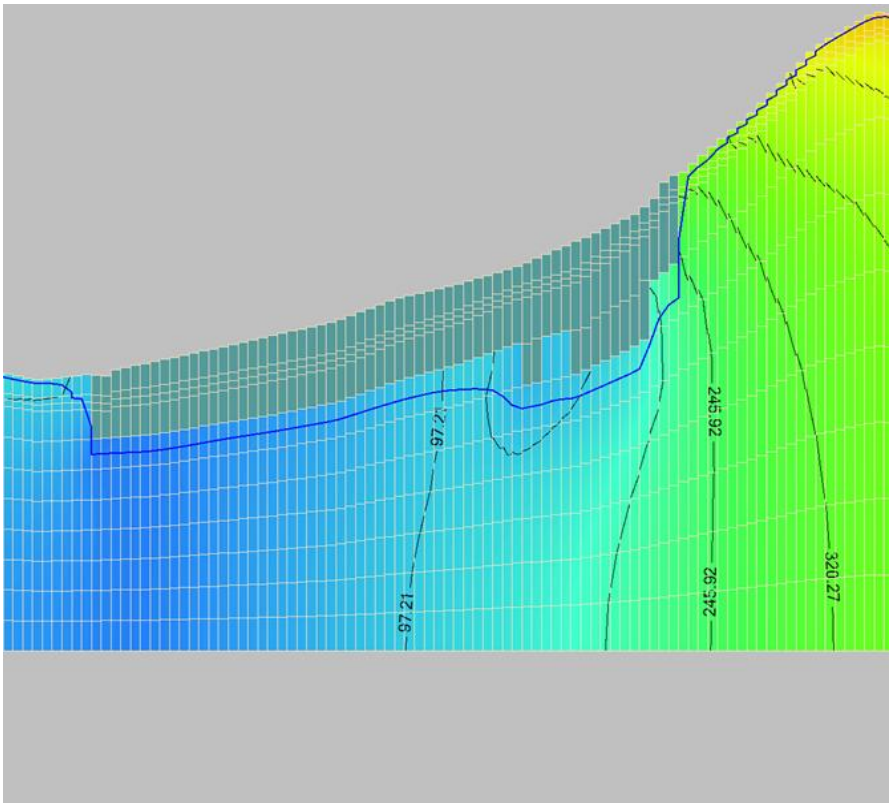


Figure 8-26: Transient Mining Groundwater Model Pits Year 15 Water Table

The figures above show that the model is simulating pit dewatering and its associated drawdown.

The abstraction of pit dewatering water and the removal of the streams within the pit extent may have an impact on the local and regional hydrogeologic system. The groundwater model can predict the change in water levels (dewatering) from the pit, and it can also simulate the change in the overall quantity of water that streams gain from groundwater discharge.

Drawdown due to the influence of pit dewatering throughout the selected mine years are shown in

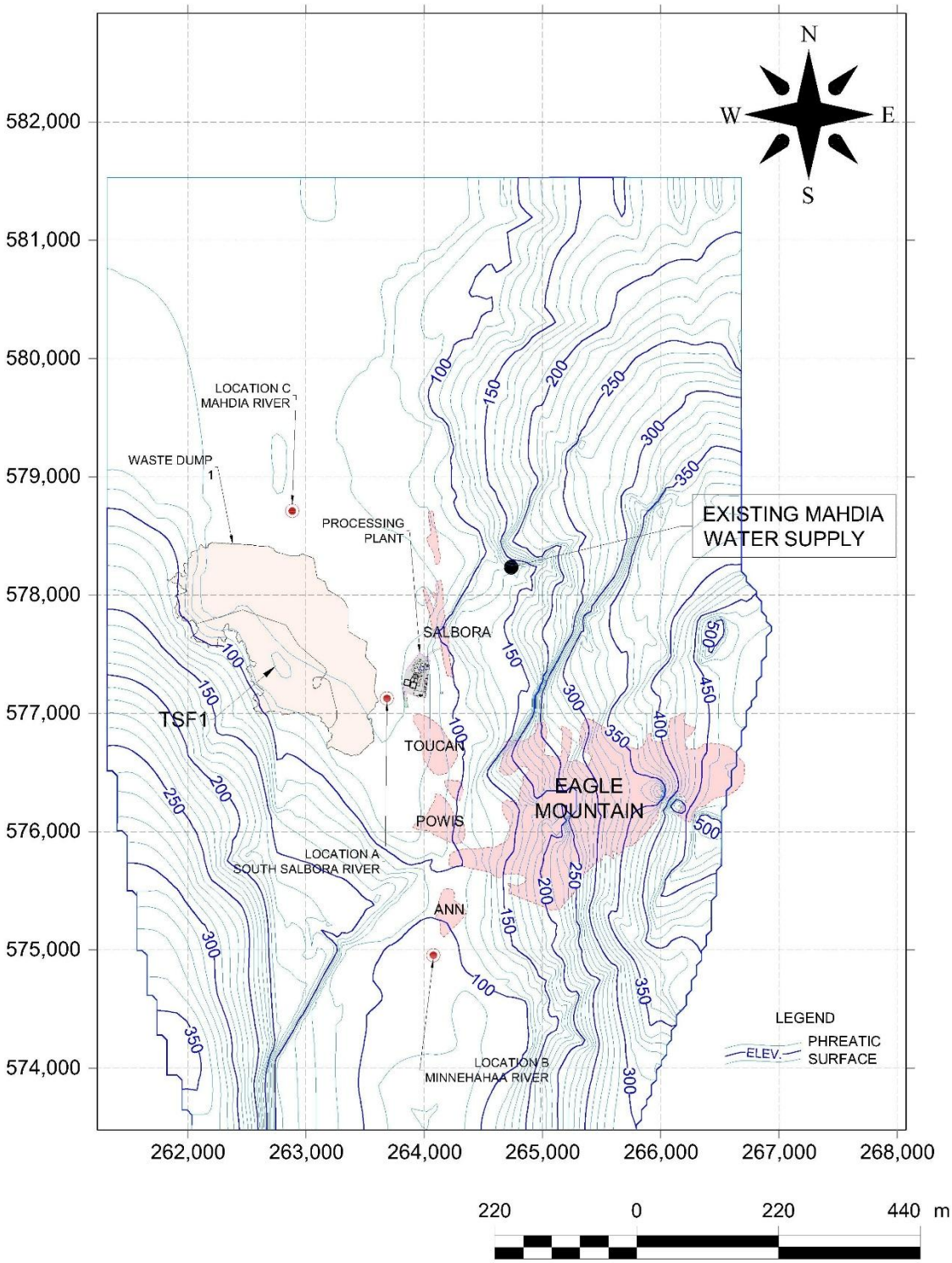


Figure 8-27 through Figure 8-31.

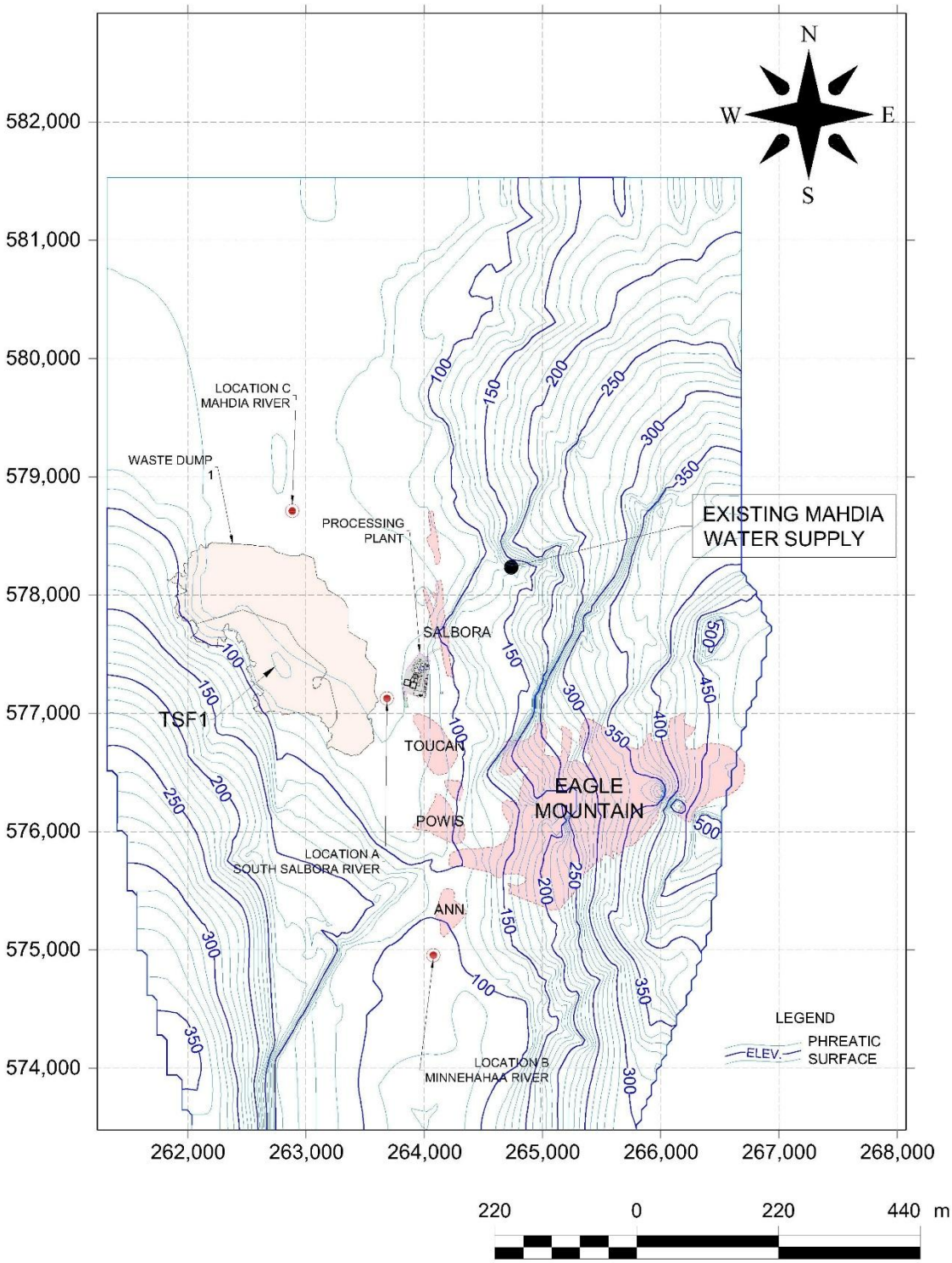


Figure 8-27: End of Year 1 Water Table Contours

After two years of mining (years 0-1), one can see minimal localized impacts around the Eagle Mountain deposit. At year 5, the water table contours begin to show the impacts of mining.

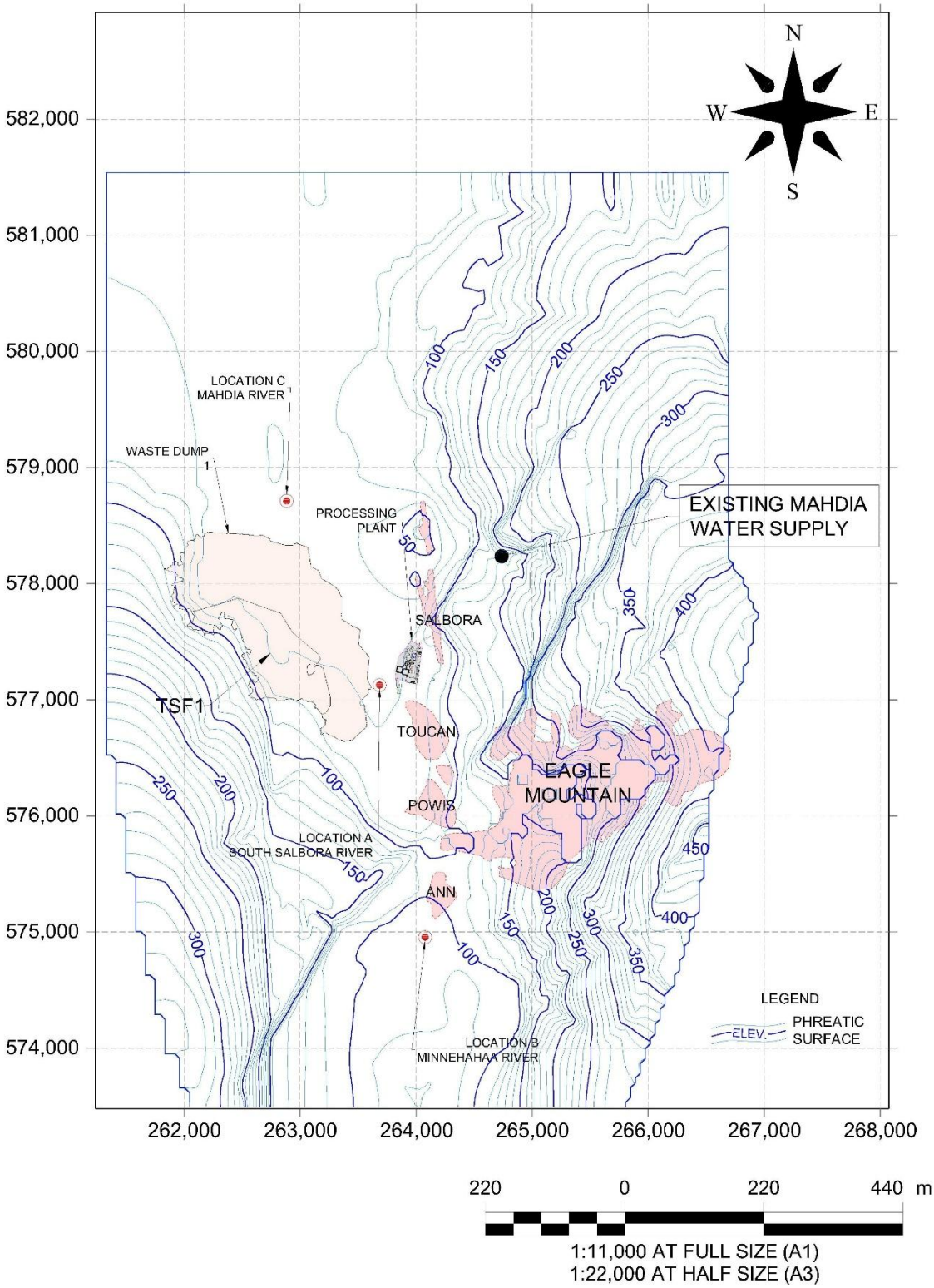


Figure 8-28: End of Year 5 Water Table Contours

After five years, localized drawdown in the Eagle Mountain and Salbora pits are visible.

Figure 8-29 shows the water table elevations after year 12.

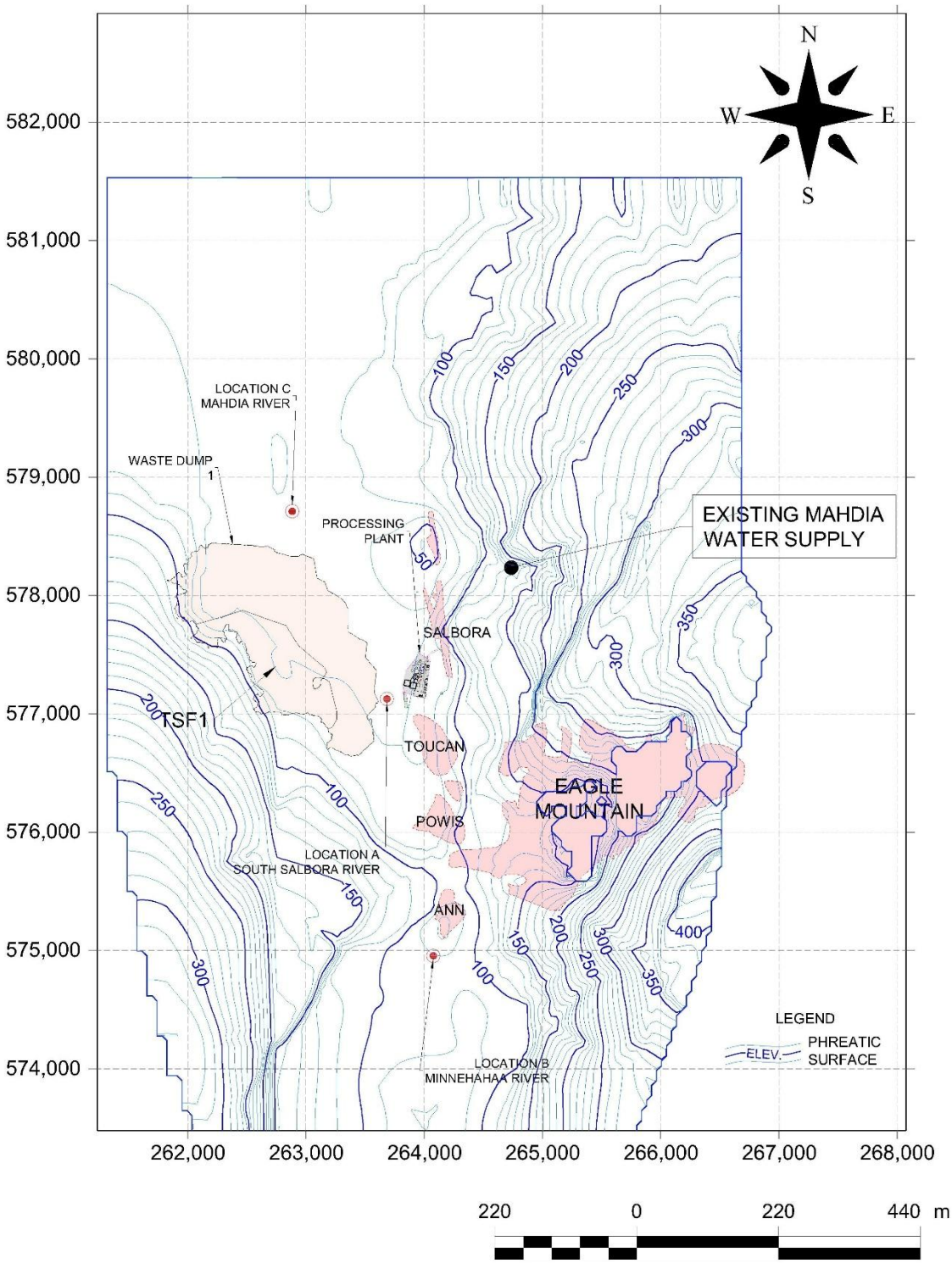


Figure 8-29: End of Year 12 Water Table Contours

After year 12, one can see a larger impact immediately next to the pit, but much of the water table further from the pits, including the Mahdia drainage basin, is unchanged.

Figure 8-30 shows the end of mine life water table elevation map.

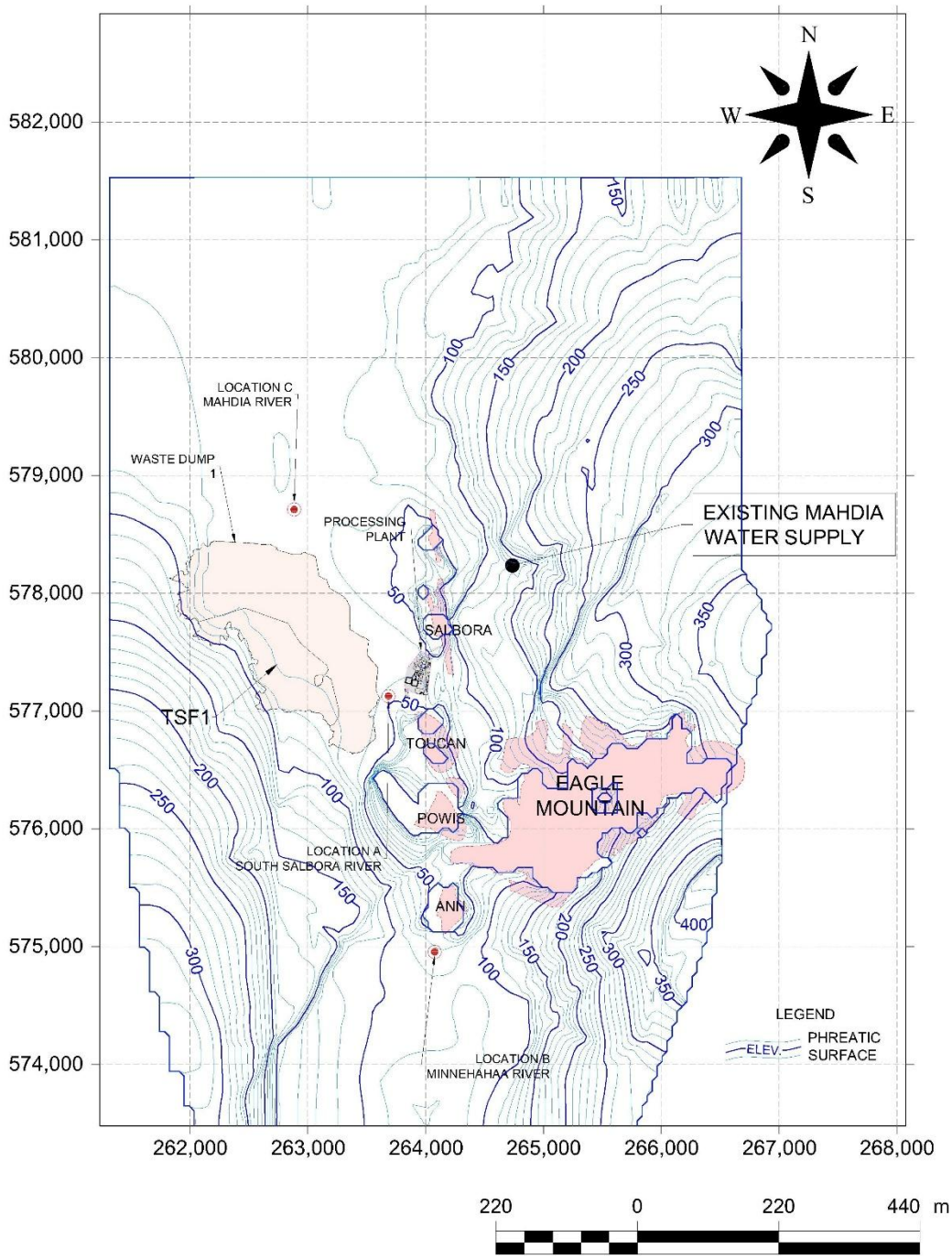


Figure 8-30: End of Mine Life Water Table Contours

At the end of mine life, one can see localized impacts, but also that the Mahdia drainage basin has had no significant drawdown. There are several reasons that the drawdown is localized:

- This is a high recharge environment. Drawdown is limited by infiltration from precipitation.
- Not much water is contained in the low-conductivity saprolite, transition, and hard rock zones. Most water in the project area is surface water.
- Low conductivity hard rock prevents the propagation of drawdown impacts.
- Very low conductivity dolerite dykes cross the project (see Section 8.5). These dykes compartmentalize groundwater impacts by creating natural barriers between the pit and parallel drainage basins to the north (like the Mahdia water supply catchment).

Drawing 4 shows the end-of-mine life (maximum) drawdown contours. These contours are constrained to the south side of the dolerite dykes and do not substantially extend beneath the Mahdia Water Supply catchment. Furthermore, they do not extend off of the Project mine concession and do not impact any existing (or future) community groundwater well.

8.13.5 IMPACTS TO THE MAHDIA WATER SUPPLY DRAINAGE

As seen in prior figures, the Mahdia Water supply river drainage is northern, sub-parallel surface water drainage basin with no mining infrastructure (neither pits nor facilities). This drainage basin has been deliberately left pristine. For the Eagle Mountain pit to have an impact on the Mahdia water supply, it must have drawdown propagate through a ridge which is partially defined by a dolerite dyke. As seen in Section 8.12, the groundwater model contains two “zone budget” zones designed to determine any cross-basin impacts – one zone to see if the Salbora drawdown is impacting upstream, and one to see if the Eagle Mountain pit is impacting across the ridge and the dyke.

Zone budget results throughout the mine life show that nearly zero cross-basin exchange exists. Less than 5 m^3/day (0.06 L/s). The deepening of the EM pit has no significant impact on the flux through a plane drawn along the southern ridge of the Mahdia water supply drainage basin

The impact downstream is equally insignificant. The zone between the Salbora pit and water supply tracks the changes in east-west water flow downgradient. Throughout mine life, flow across this boundary varies from 20 m^3/day to 70 m^3/day (0.2 L/s to 0.8 L/s) this change is well within the error range of the PFS-level groundwater flow model and shows no significant impacts. As for the Mahdia water supply itself, assessing impacts is best done by looking at the minimum flows – the lowest flow of the calendar year. Figure 8-31 shows compares the pre-mining steady state benchmark (see Section 8.12) to the minimum result from each of the “boxcar” models.

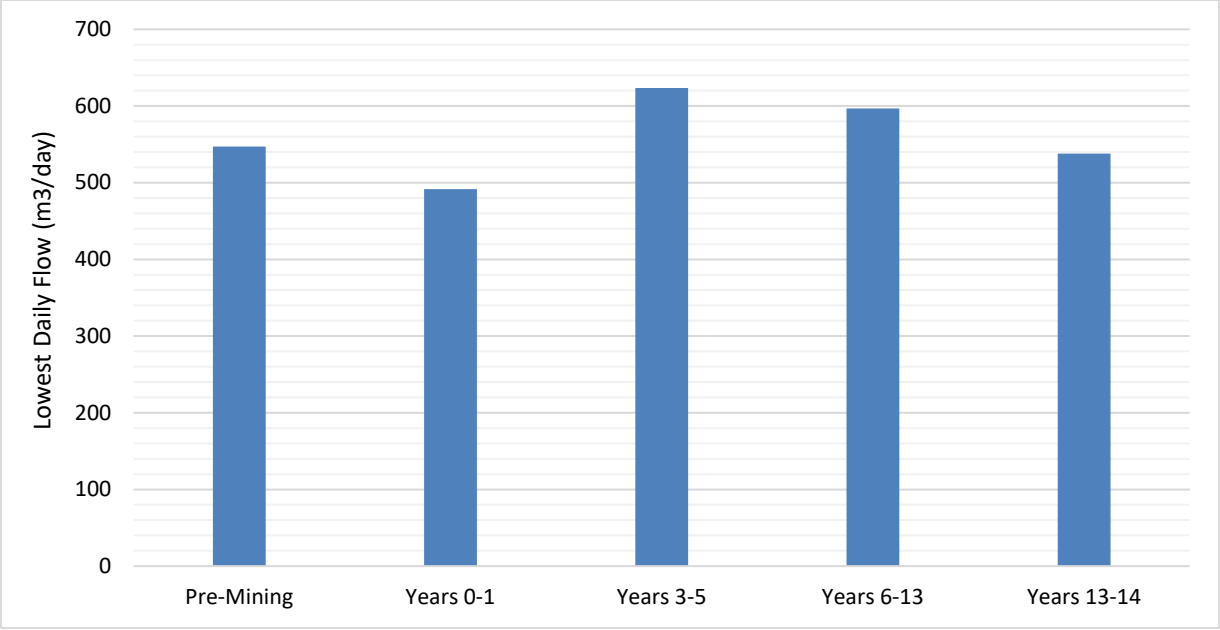


Figure 8-31: Minimum Flow (Baseflow) Comparison at the Mahdia Water Supply

The differences between the minimum values are well within the error range of the groundwater model and demonstrate that there is no significant impact to the Mahdia water supply from the dewatering of the Project open pits.

8.14 GROUNDWATER MODEL LIMITATIONS

The groundwater model is based on early Project data. This data, by nature, is limited because the project is in an early stage of development. Additional water level data and hydrogeologic testing is required to better-characterize the aquifer conditions and to better assess the groundwater system. Furthermore, the project will have a different mine plan after it has been optimized during more-rigorous study phases (and in response to different metals prices). The groundwater model is sufficient for the EIS stage but requires revision as the project works through the development timeline.

9.0 HYDROLOGIC IMPACT ASSESSMENT

Barr engineering, with support from GRE, was tasked with modeling surface water runoff for the site in two time periods: pre-mining (prior to development, or the condition at the date of this report), and post-mining, with the full scale project development. These flow conditions can be compared to predict how flow changes may change due to the project development. This work forms the basis for subsequent water quantity impact assessments (see Section 12.0).

9.1 BASELINE SURFACE WATER FLOW MODELING

An existing conditions surface water flow model was developed by the GRE-Barr team in HEC-HMS to simulate baseline conditions, incorporating both land use and climate factors. Only one subbasin in the project landscape had corresponding precipitation and streamflow data necessary for calibration. That subbasin includes the Minnehaha River and the future location of the Eagle Mountain open pit (Figure 9-1).

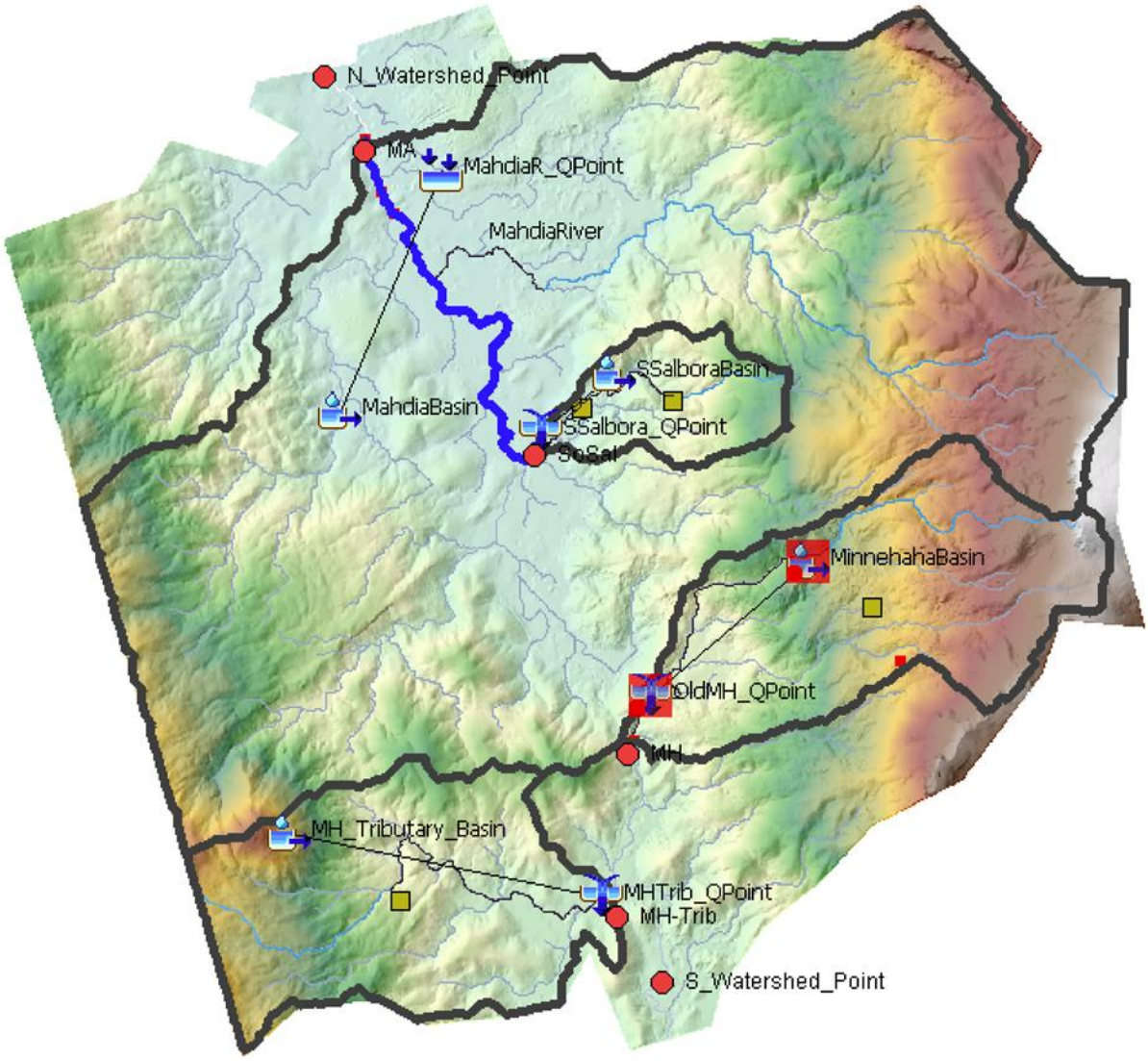


Figure 9-1: HEC-HMS Subbasins for Existing Conditions Model

Calibration was performed by GRE using the limited available dataset. Climate inputs for calibration included rainfall data from an on-site weather station located 1.21 km from the test area and stream discharge measurements collected using a FlowTracker2 across a stream profile every 15-30 minutes (as discussed in Section 4.0). The model was calibrated using a 4-hour storm

event, applied with a 15-minute timestep and a total rainfall of 5.6 mm and the corresponding streamflow monitoring data over a 7-hour period (Figure 9-2).

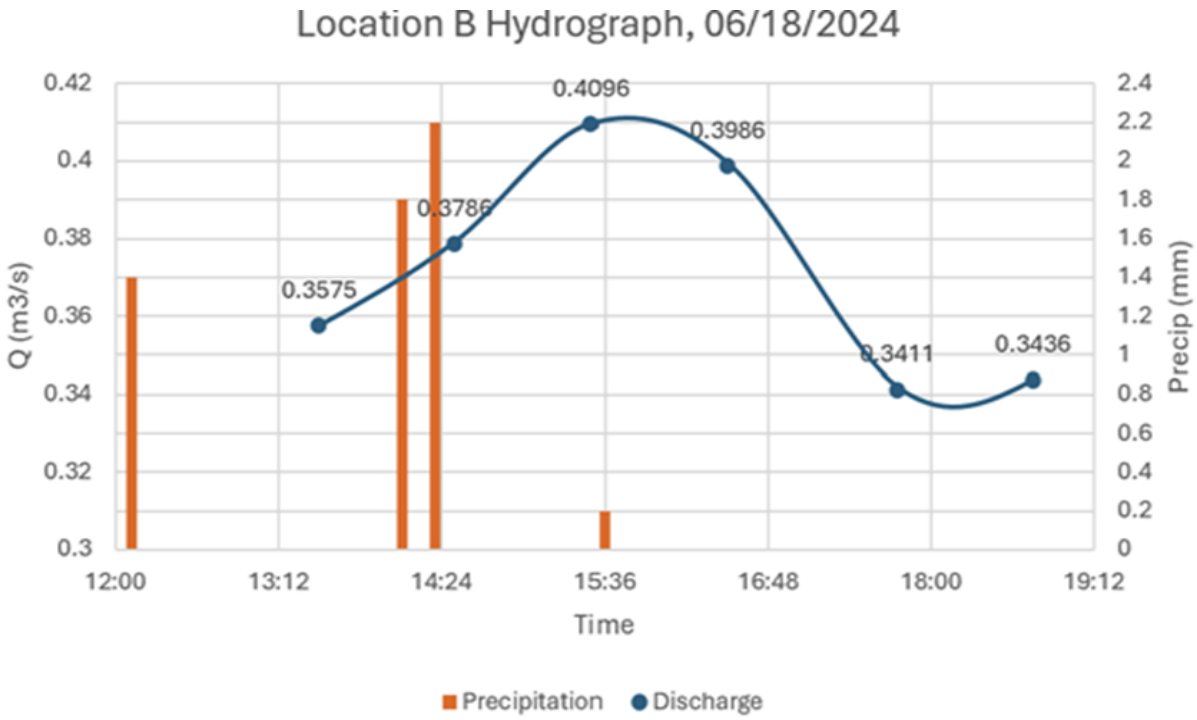


Figure 9-2: Minnehaha River Storm Hydrograph Data for Calibration

Although there was limited data, calibration of the existing conditions model produced peak discharge and total discharge volumes similar to observed data for the calibration dataset (Figure 9-3).

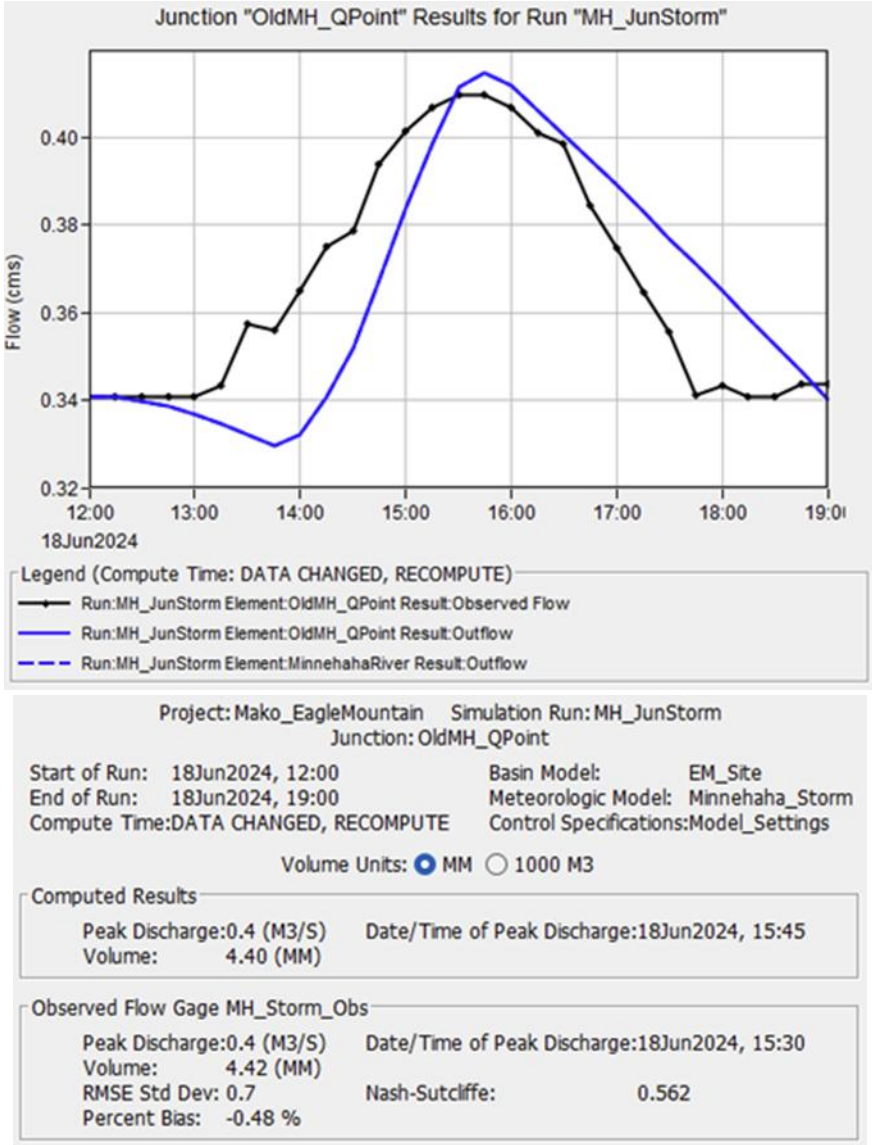


Figure 9-3: HEC-HMS Model Hydrograph Results (blue) versus Observations (black)

9.2 WITH-PROJECT SURFACE WATER FLOW MODELING & RESULTS

Subbasins for the future conditions surface water flow model were delineated to inform the routing of non-contact water around future mine features to natural streams. The future mining features include mine pits, tailings, waste dumps, and buildings (see Drawing 5). A future conditions DEM was constructed by mosaicking an existing conditions 1m DEM of the mining area, which was provided to GRE by the client, and a 200m DEM of the extended area, which was obtained from the USGS. Using this combined DEM, subbasins were delineated (see Drawing 5) Drainage ditches (blue lines in Drawing 5) were then estimated to route runoff around future mining features.

The location and footprint of the future mining features were provided by GRE. The delineated subbasins were imported into HEC-HMS along with a NASA normalized daily precipitation dataset (2000-2024), supplied by GRE (see Section 4.0). Barr used parameters from GRE's existing conditions HEC-HMS model as the basis for parameterization of the future conditions model. For each subbasin, parameters were either from the calibrated existing conditions model or were scaled based on the subbasin area and physical features.

9.3 MODEL ASSUMPTIONS, SIMPLIFICATIONS, AND LIMITATIONS

Because this work was completed at an early stage of project development, several simplifying assumptions were necessary to balance available data, project scope, and the need for a practical modeling framework. These assumptions are considered appropriate for a screening-level assessment and provide a reasonable basis for evaluating potential hydrologic responses under future conditions.

The future conditions topography was assumed to be the same topography represented in the existing conditions DEM, with only the footprint of the proposed mining features modified. No roads or culverts were modeled. The model was run at a daily timestep, consistent with the historical NASA normalized daily precipitation dataset used as input. Although the calculated time of concentration, T_c, for the small subbasins were much shorter than one day, HEC-HMS automatically adjusted T_c to 24 hours, the surface storage coefficient to 12 hours, and the linear reservoir groundwater storage coefficient to 12 hours.

It is important to note that the storm event used for calibration had a precipitation depth of 5.6 mm with a streamflow response of approximately 7 hours. By comparison, the historical precipitation record (2000-2024) indicates an annual depth ranging from 1.7-6.0 m/year, with an average depth of 2.8 m/yr, or 7.63 mm/day.

The existing conditions runoff ratio (direct runoff/precipitation) for the Minnehaha River subbasin is 0.162. The future conditions runoff ratio is 0.206 for all subbasins except the two subbasins representing the buildings (Plant Site and Blast Magazine), which were considered 100% impervious (1.000). It is assumed this small difference in runoff ratio is due to the initial abstraction being a large percentage of the calibration rainfall event (5.6 mm in under 4 hours).

9.4 CONCLUSION

As stated above, the existing conditions baseline surface water flow model was calibrated by GRE and used by Barr to parameterize the future conditions with project surface water flow model. The output from the future conditions HEC-HMS model includes daily runoff from each of the 45 subbasins. These data were then summed by subbasin to produce annual runoff for each

subbasin. The results are to be used in the site water balance and to inform design of site infrastructure.

10.0 SITE-WIDE WATER BALANCE

10.1 INTRODUCTION & OBJECTIVES

GRE created a dynamic, time-variant site-wide water balance (SWWB) for the Eagle Mountain project in support of the ESIA. The goals for this effort included resolving the following questions:

- Even in the driest of weather conditions, does the site (through pit dewatering, watershed runoff, other local sources) produce enough water to maintain a consistent production of 5000 tonnes per day (tpd) of production? If not, what makeup water sources are required?
- How much excess Mine Impacted Water (MIW) is produced by the mine, and from which sources does it occur?
- Will the discharge of excess MIW impact the water quality of local and regional surface water?

This water balance is an integration of all prior sources of data including climate, surface water flow models, groundwater flow models, and plant design parameters (from Mako's engineering team). For this effort, GRE decided to use the Monte-Carlo simulation software, GoldSim™.

10.2 WATER BALANCE MODELING THROUGH GOLDSIM

GoldSim is a computer program that is used for dynamically modeling complex systems in engineering, science and business. This program is an industry-standard tool for the creation of water balances because it can easily link many different elements of the balance in a single interconnected model, and because GoldSim can manage Monte-Carlo style probabilistic simulations.

Using the Monte Carlo functions, GoldSim supports risk analysis by predicting the behavior of hydrologic systems while quantitatively representing the system's inherent uncertainty and risks.

10.2.1 CONCEPTUAL MODEL & INITIAL SETTINGS

Before developing a water balance model in GoldSim, GRE held several discussions with Mako engineers throughout mid-2025 about creating a conceptual site-wide water balance, as well as a conceptual flow diagram of the processing plant and mill. Figure 10-1 and Figure 10-2 below present the final products of the discussion.

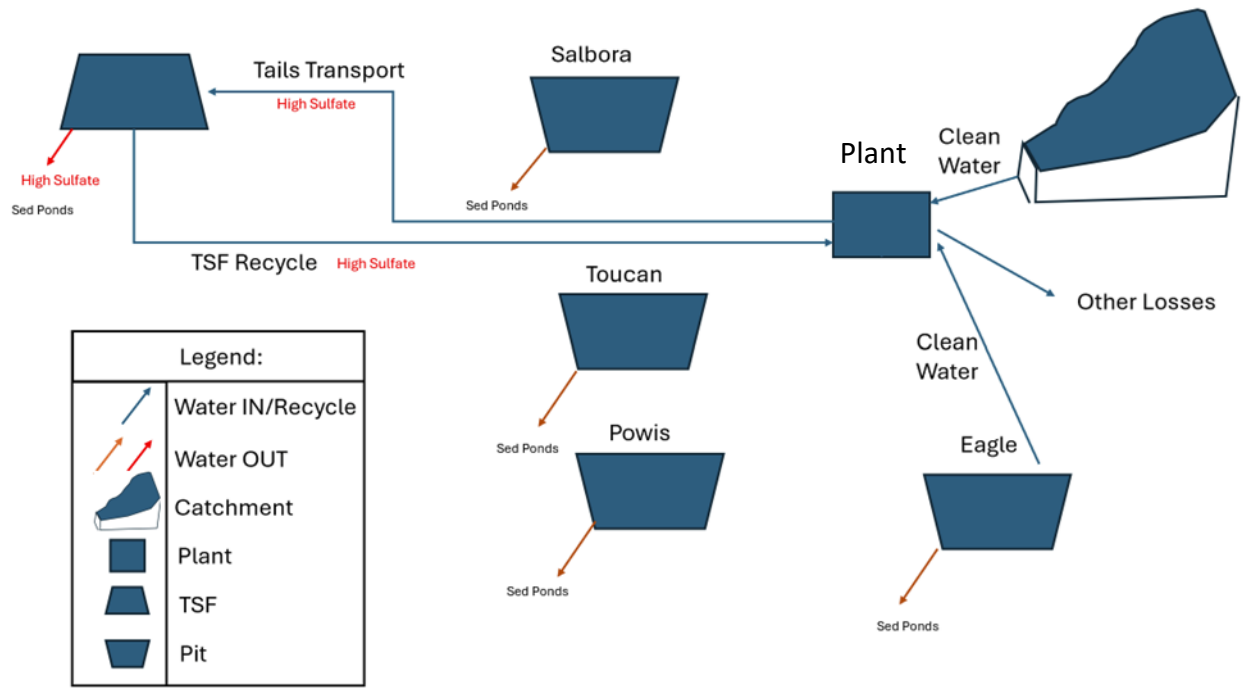


Figure 10-1: Eagle Mountain Conceptual Water Balance Model

The Plant is the center of Figure 10-1. It receives water from three main sources: upgradient catchments, pit dewatering and tailings recycle water. The plant discharges water to the TSF. Each individual pit has the option to discharge water to the environment, but only after sediment control (Sed Ponds). The plant requires ~15,000 m^3/day of water to meet the processing target of 5000 tpd of ore-grade material. Figure 10-2 shows the plant process water balance used to supply and manage the plant water system.

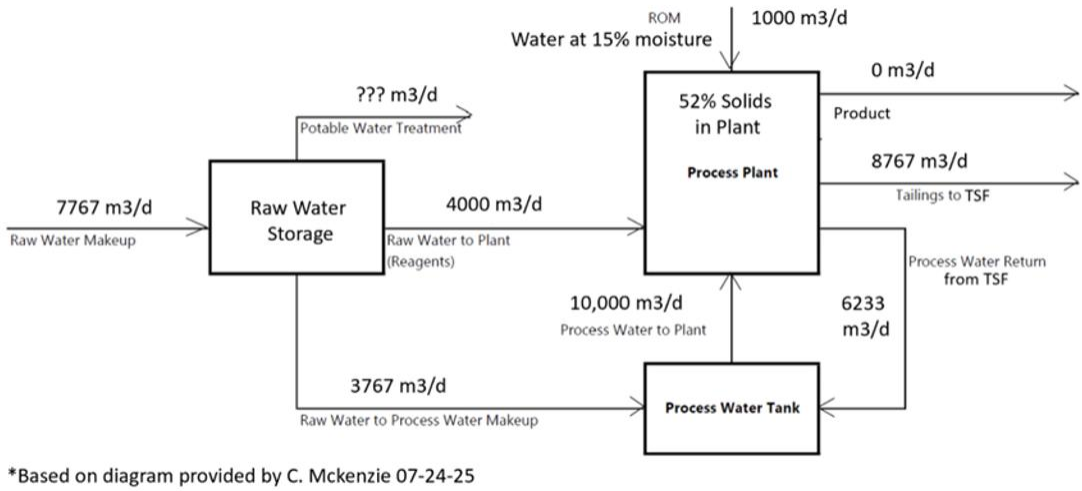


Figure 10-2: Eagle Mountain Conceptual Process Flow Diagram

Figure 10-2 is best understood in terms of losses, storage, and inputs.

LOSSES

It is important to discuss losses first , because the make-up of losses drive the plant water balance. The primary loss of water in the Mako project is the water entrainment and evaporation occurring in the conventional (wet) tailings disposal facility. In Figure 10-2, the total water going to the TSF is divided into two arrows – the water sent to tailings (8767 m^3/day) and water discharged to the TSF but ultimately recycled either from tailings thickeners or from the TSF pond (6233 m^3/day). This results in a net loss in the tailings of ~ 2535 m^3/day.

INPUTS

The primary water inputs are as follows:

- Fresh water from unimpacted upgradient catchments or pit dewatering; and
- Ore moisture (incidental moisture captured in 5000 tpd of ore delivered to the plant).

The raw water makeup must therefore equal the losses. Thus, 7767 m^3/day of fresh water and 1000 m^3/day in ore moisture equal the entrainment loss of 8767 m^3/day discussed above.

STORAGE

Two storage ponds are present, the Raw Water Storage and the Process Water Tank. The Raw Water Storage is designed to even out seasonal variations in water supply. It is fresh water obtained from an unimpacted drainage basin or good-quality water from pit dewatering. In nearly-equal volumes, it provides water directly to the plant for use in reagent mixing, gland seal water, or other water-quality sensitive elements of the project. It also provides water to the Process Water Tank.

The Process Water Tank receives water from the Raw Water Pond and from recycle water coming from the TSF. As a result, it is higher in sulfate than fresh water because it is a mix of fresh water and supernatant solution in a mix of roughly 1 part fresh water and 2 parts recycle water from the TSF.

WATER QUALITY CONSIDERATIONS

Water quality is important for process operations and it must be considered in how the water is recycled in the water balance. Samples of the supernatant solution have shown relatively high concentrations-- ranging from 4000 mg/L sulfate to 1400 mg/L sulfate. This sulfate is largely the result of the use of sodium metabisulfite (SMBS) in the destruction of cyanide in the following chemical equation:

$Na_2S_2O_5 + 2O_2 + H_2O + 2CN(WAD) \rightarrow 2\ CNO^- + 2NaHSO_4$

The sodium bisulfate ($NaHSO_4$) disassociates into sulfate in water.

It is important to note that the dose of SMBS is not optimized in the early-stage metallurgical testing. It is heavily dosed to achieve a target of <1.0 mg/L WAD cyanide after cyanide destruction. However, in practice it is likely that the effluent WAD cyanide target will be <5 mg/L WAD cyanide. This makes the current supernatant test work a significant over-estimate of the likely sulfate concentration because the differential reagent quantity required to go from 5 mg/L down to 1 mg/L is non-linear. Reducing the WAD cyanide to <1 mg/L is complicated by chemical interference and reaction inefficiency. Therefore, as a worst-case scenario, the plant water balance uses fresh water as the sole-source for elements of the plan which are water-quality sensitive. Another water quality concern is that the excess water discharged from the TSFs will require management to comply with a 250 mg/L discharge standard (which is the US EPA secondary standard). The management of water quality in the TSF discharge water is discussed in Section 12.0.

LIMITATIONS TO THE CONCEPTUAL MODEL

Unfortunately, the full life-of-mine SWWB cannot be completed because it is dependent on the site layout, which is still a work in progress. GRE's engineers are working on layouts for the waste dumps, the TSFs and the plant. As a result, it is necessary to make a best estimate on the site layout based on the data freeze memo in early summer, 2025. To do this, GRE captured two year-long snapshot simulations. One snapshot covers mining year 15, when the TSF1 is full, and TSF2 is not yet in operation. The other snapshot is near the end of mine life when TSF2 is full, and TSF1 is not yet closed. These two snapshots capture the highest-risk conditions for water quality (i.e. the maximum excess water discharge conditions for both the Mahdia and Minnehaha drainage basins) and are therefore conservative estimates of the LOM impacts.

Because a clear stage vs storage vs time relationship cannot yet be created, GRE has used the maximum extent of TSF1 and the maximum extent of TSF2.

GRE acknowledges that design changes in TSF1 have, since the data freeze, made TSF2 unnecessary. It is therefore best to consider only the first snapshot of TSF1 as a filled facility.

10.2.2 MODEL CONSTRUCTION

GRE constructed a deterministic water balance model with probabilistic capabilities. Deterministic elements are concrete – for example , flowrates and reservoir stages recorded at a specific point in time or over a specific timeframe. Probabilistic elements, on the other hand, rely on probability distributions to provide data outputs. The primary probabilistic elements in the model are climate data and evaporation data.

CONSTRUCTING WATER BALANCE CLIMATE

Figure 10-3 below depicts the construction of the Mill & Plant portion of the water balance.

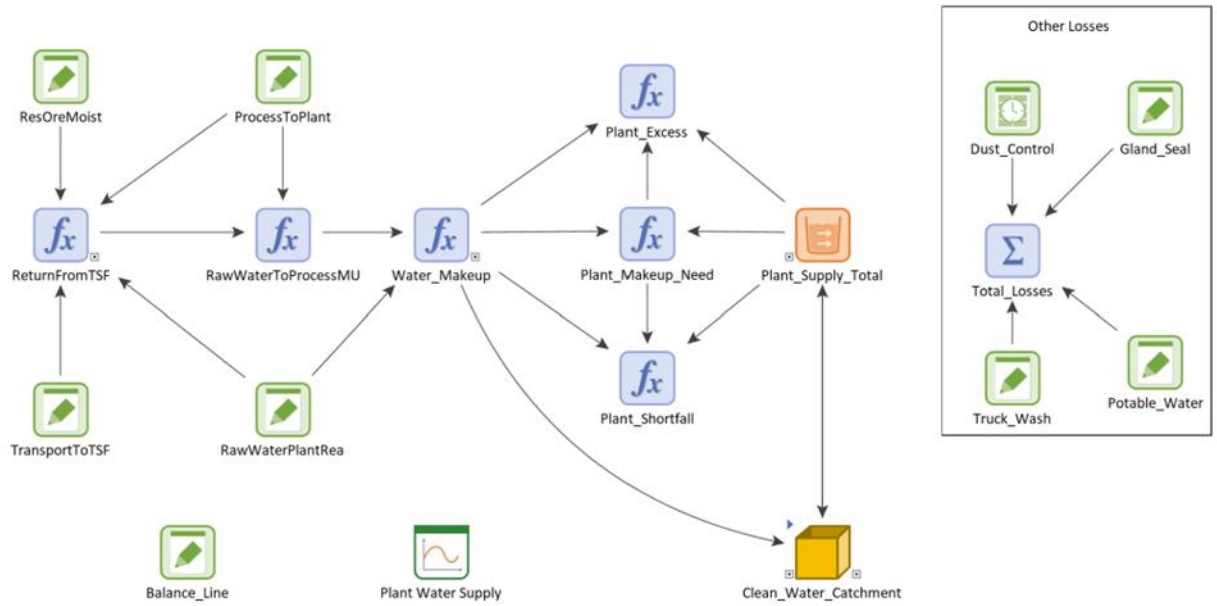


Figure 10-3: Water Balance Model Mill & Plant Structure

As presented above, the GoldSim model elements mirror the flow diagrams provided by the Mako engineers (see Figure 10-2). Additionally, the nearby catchment was included in the diagram because it will provide some of the "clean" water needed for the plant. All surface water runoff values were taken from the surface water flow model (see Section 9.0).

CONSTRUCTING WATER BALANCE PITS

Each of the four pits are represented within the model (Figure 10-4) as several Pool elements that receive water from direct precipitation and from groundwater sources (see Section 4.0). Any water from the Eagle Pit is conveyed to the Plant as another "clean" water make-up source. All other pits are assumed to be pumped to sediment ponds (the individual Pool elements) then discharged to the environment as indicated by the conceptual model.

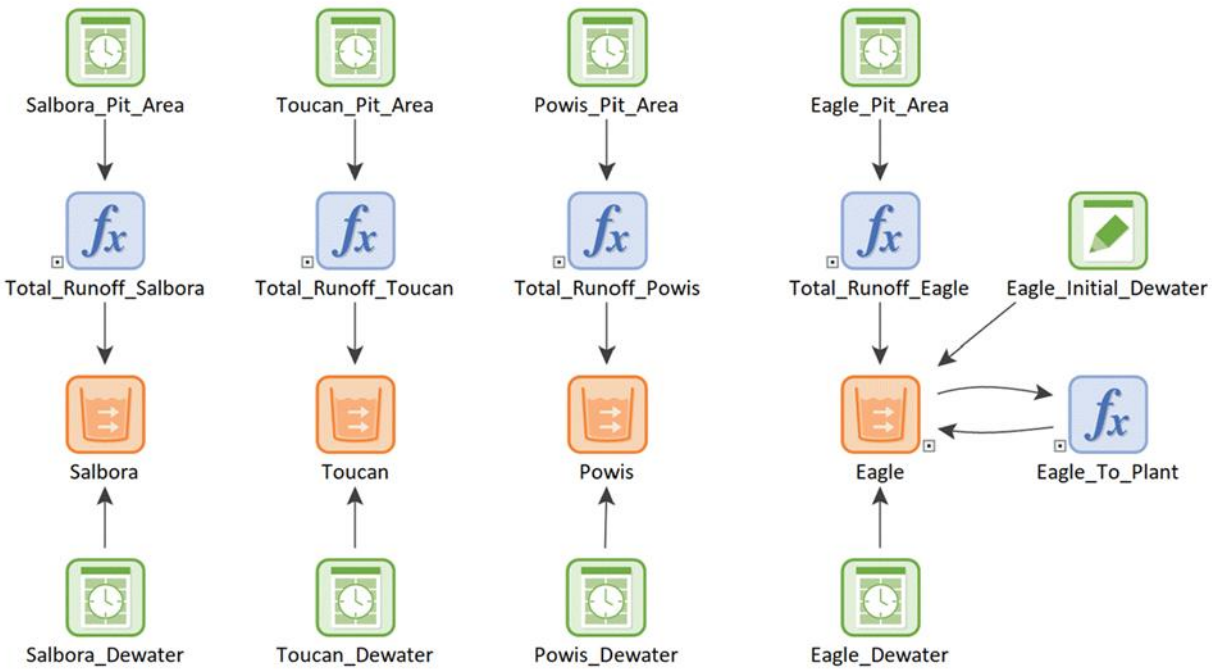


Figure 10-4: Water Balance Model Pits Structure

CONSTRUCTING WATER BALANCE PLANT PRODUCTION

The Project has a target production rate of 5000 tpd of ore. Ore delivered into the plant impacts the water balance in two ways:

- It contains a small amount of moisture, which must be considered; and,
- Each tonne of ore requires water for processing. This process water eventually becomes supernatant solution, and reports to the TSF.

These elements have been incorporated into the water balance.

CONSTRUCTING WATER BALANCE TAILINGS STORAGE FACILITIES

The tailings facilities have the largest water exchange into and out of them, thus making them the most significant element of the water balance. There are several different stages of TSF operation in the water balance:

- Filling TSF1
- Filling TSF2 after TSF1 has reached its maximum capacity, yet prior to TSF1 closure
- Filling TSF2 after the concurrent closure of TSF1
- Closure of TSF2

As mentioned previously, the TSF2 scenarios may be obsolete, but have been presented for completeness. Each of these stages will be discussed below.

TSF1 FILLING

Figure 10-5 demonstrates the constructed TSF1 infrastructure in the GoldSim model.

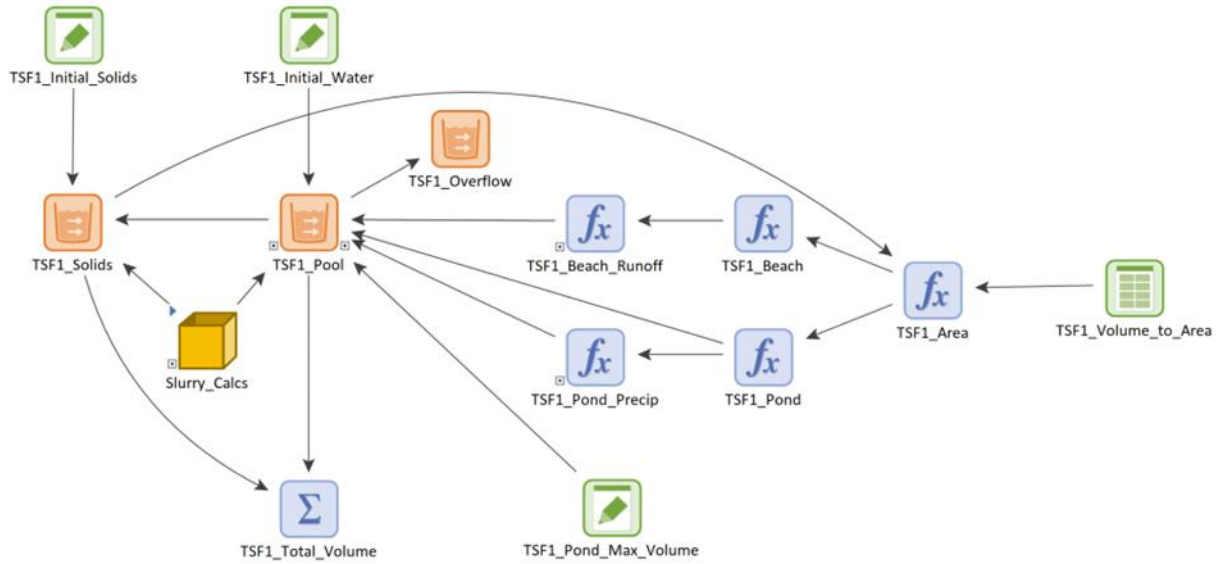


Figure 10-5: Water Balance Model TSF1 Filling Structure

TSF1 is filled with a slurry of ore and supernatant at a 30% solids (weight of water to weight of tailings) ratio. As it fills, the TSF forms a beach and a tailings pond. Water interchanges include:

- Supernatant solution which arrives in the TSF slurry;
- Direct precipitation which falls on the TSF pond;
- Direct precipitation which falls on the TSF beach;
- Reclaim water which is recycled from a TSF barge;
- Excess water (if any) which must be discharged to the environment because it is in excess of the safe storage capacity of the TSF;
- Evaporation which occurs off the TSF pond or beach; and,
- Seepage out of the TSF.

The last two elements have not been included in the WB because it is not a significant portion of the TSF water balance.

TSF1 FULL, PRE-RECLAMATION

For a period of the mine life, the TSF1 is exposed to the environment, but is not closed. During this period, the TSF will have excess water to discharge to the environment. This discharge will cease once TSF1 has been closed.

TSF2 OPERATIONS

If it is added back into the plan, TSF2 will operate exactly as per TSF1 above in Figure 10-5.

EXCESS WATER ISSUES

As mentioned in Section 10.2.1 above, the sulfate discharge from the TSF must be managed so that the project is in compliance with environmental regulations. As a result, the model results must be produced in conjunction and in context with geochemical modeling. In other words, water quality requirements *drive* the water balance with regards to TSF excess water discharge.

10.3 MODEL RESULTS

The following sections describe the completed GoldSim model results. As mentioned in Section 10.2.2.4, the scenarios modeled are:

- TSF1 in operation, TSF2 not in operation; and,
- TSF1 out of operation, but not closed, and TSF2 in operation.

PLANT SUPPLY RESULTS

Even under the driest conditions modeled, the project does not have a water deficit. Figure 10-6 through Figure 10-8 below present the graphical results of the plant water supply, with any shortfalls in red below the “0” line and any excess water in green above the “0” line. One can see that over the course of a simulated year; the project frequently has an excess water condition and never has a water shortage. This excess water condition will obligate discharge to the environment. Section 11 discusses this discharge and its potential impact to water quality. It is important to note that this excess discharge could be from the TSF or could be from the plant. In either case, GRE has assessed impacts.

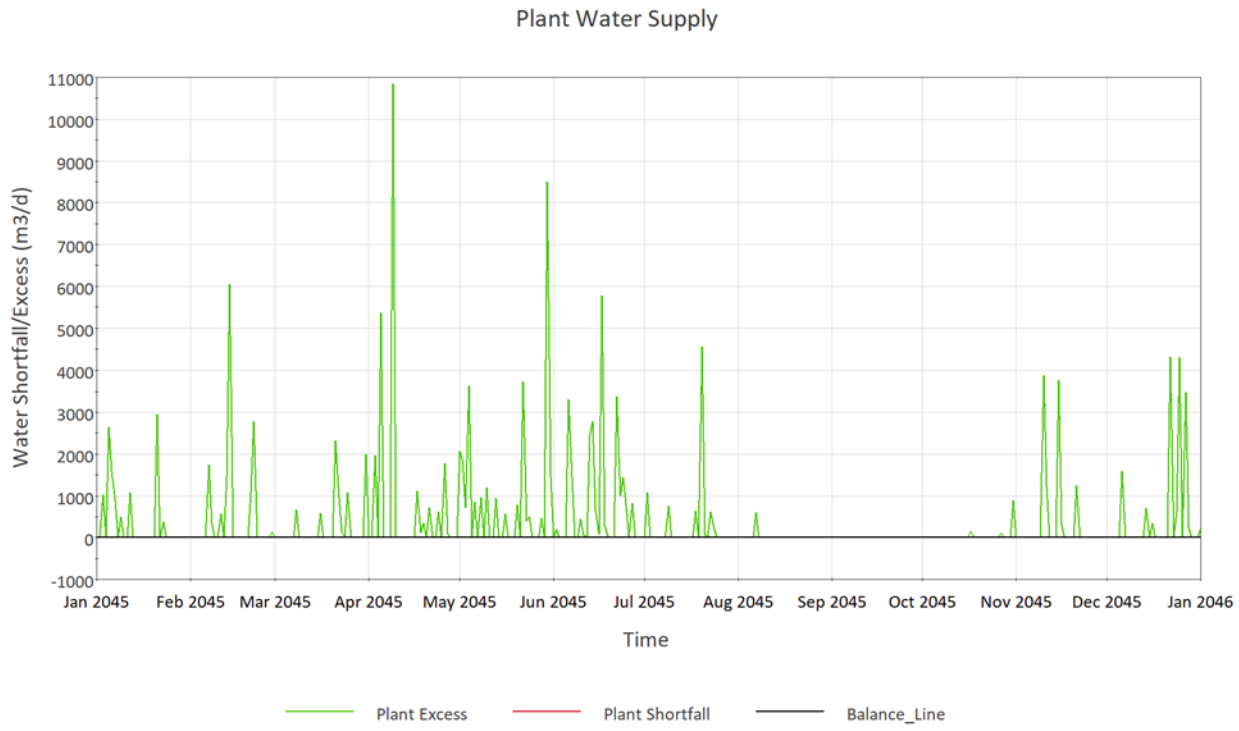


Figure 10-6: Water Balance Model Results, Plant Water Supply Wet Season

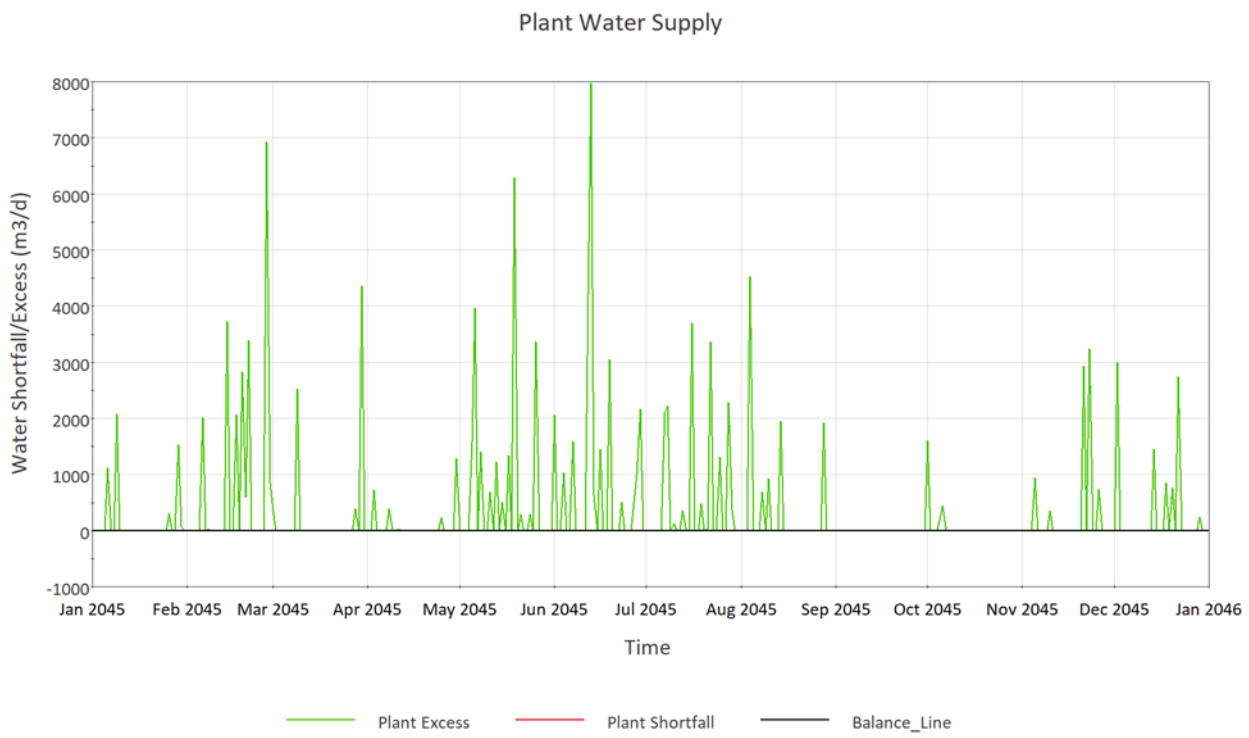


Figure 10-7: Water Balance Model Results, Plant Water Supply Average Season

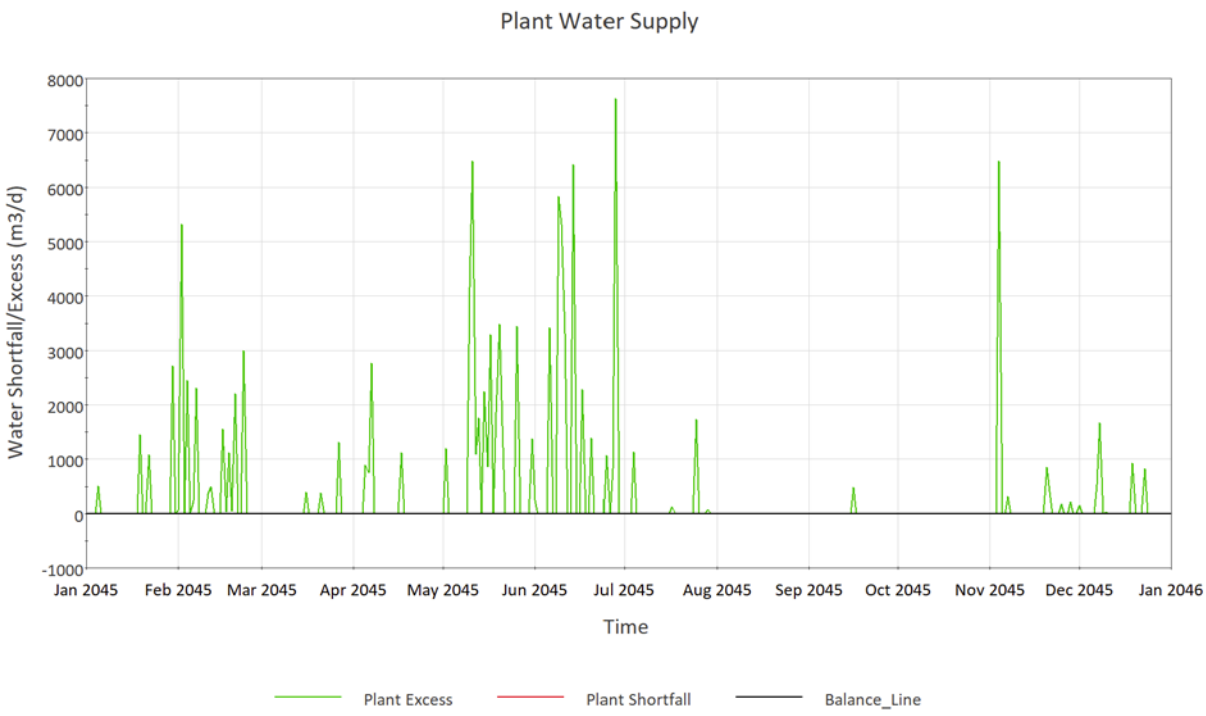


Figure 10-8: Water Balance Model Results, Plant Water Supply Dry Season

This result is consistent with expectations for a project in a rainforest.

TSF1 AND TSF2 EXCESS WATER

Due to the rate at which TSF water is recycled to the plant, under the modeled conditions, TSF1 could be managed with zero discharge of excess water to the environment. However, the plant will have excess water, and for operational flexibility, this excess water may be discharged from TSF1 instead of the plant as required by operations. As a result, one should consider that Figure 10-6, 10-7 or 10-8 may have Plant Excess or TS1 excess interchangeably.

TSF2, when modeled, showed similar results. Excess water exists at either the Plant or TSF2, and this PFS water balance retains the flexibility of discharging from one or both. In the case of TSF2, the water quality models make reasonable assumptions on the discharge of excess water to the Minnehaha Creek (see Section 12).

10.3.2 MODEL LIMITATIONS

All models have limitations. Some of the key limitations of the water balance at this stage of project development are:

- Model Duration: The model currently includes only two year-long snapshots of the full mine development timeline. As such, they are not a complete record of the water conditions for the life of the mine. However, they capture a highest risk condition.

This makes them useful to the EIA, but ongoing work will require a full revision of the water balance.

- Runoff coefficients: The water balance model relies on the surface water model. The surface water model has assumptions on the runoff coefficient (the percent of rain that reports to surface water out of the total rain). This is a sensitive parameter, which is different for each land use which should be verified and validated.
- TSF beach and TSF Pond: The design of the TSF is not sufficiently advanced to determine the exact percentage of TSF beach vs TSF pond present during the snapshots simulated. This proportion was fixed (20% pond, 80% beach) but requires revision.
- Tailings entrainment: Water trapped in the pore matrix of mine tailings (tailings entrainment) is likely the single-largest sink (loss) of water on the site. Additional test work is required to determine the consolidation behavior of the tailings and the ultimate entrainment quantity in mine tailings.
- Dataset: A limited climate dataset exists. Most data was taken from NASA sources, and these sources lack site-specific rainfall rates and the impact of micro-climates. More meteorological analysis is required to improve climate modeling.
- Data Freeze: This water balance has “data freeze” mine infrastructure, which may change after project optimization studies are complete.
- Water Storage: The current water balance estimates the size of the TSF ponds and the sediment ponds needed.

Based on the current data available, it is within GRE’s opinion that these water balances satisfy what is required by the EIA. However, as the mine begins to develop, proper care and consistent updating of these water balances must be done to ensure mine processing can continue as planned.

11.0 SURFACE WATER QUANTITY ASSESSMENT

11.1 INTRODUCTION

Mine development will cause changes in the stream flows of the two major rivers that drain the Eagle Mountain site. These rivers are the Mahdia river to the North and the Minnehaha Creek to the South. Figure 9.1 and Drawing 5 provides a map with the delineation between the rivers and associated watersheds.

The water balance has determined that the project has sufficient water to run operations, but it is also necessary to predict the impact mining will have on the water supply for communities downstream. To accomplish this, GRE gathered outputs from the groundwater model (Section

8.0), surface water model (Section 9.0), and the water balance (Section 10.0) to investigate whether mining will have a positive (greater river flow) or negative (lesser river flow) influence at a specific point of compliance (POC) for each of the rivers.

11.2 SURFACE WATER QUANTITY CONCEPTUAL MODEL

Figure 11-1 shows the key elements and point of compliance (POC) for the surface water quantity impact assessment.

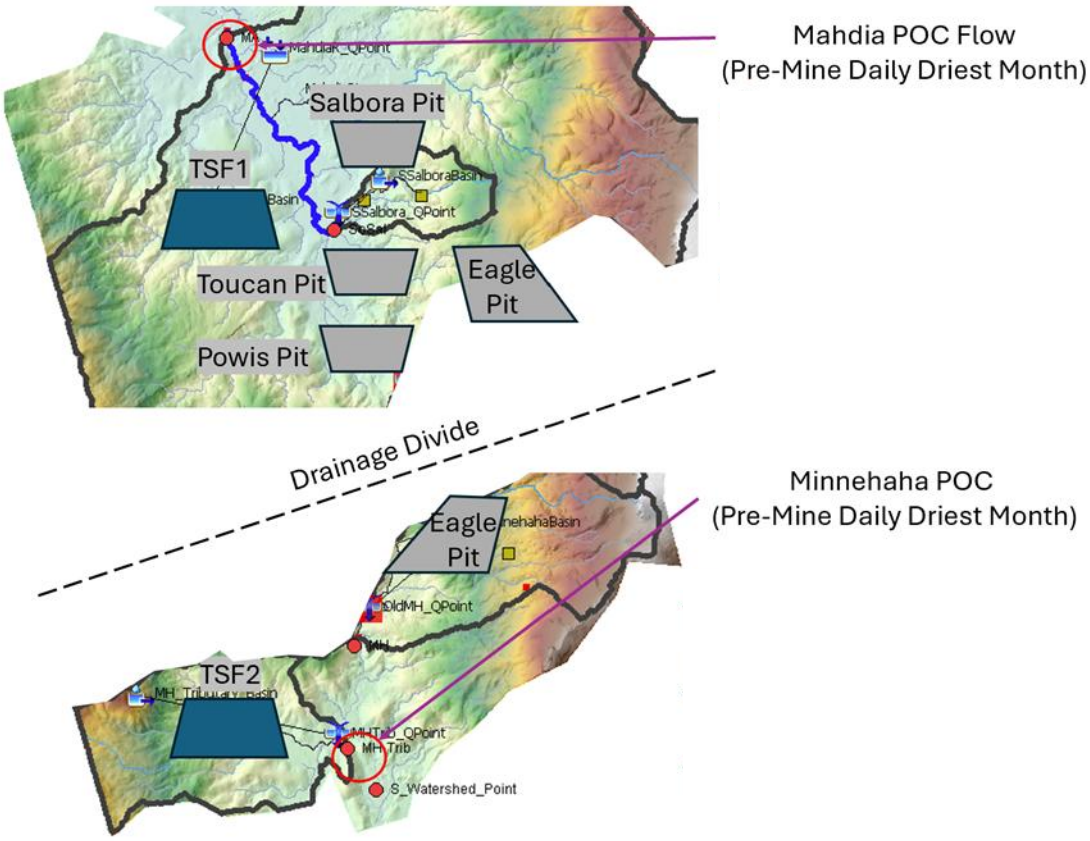


Figure 11-1: Surface Water Quantity Conceptual Model

The "with project" hydrologic system differs from the pre-mining hydrologic system in the following ways:

- Both the Mahdia and Minnehaha Creek watersheds are going to gain water/flow from pit dewatering (after proper sediment control)
    - The Salbora, Powis, and Toucan pit dewatering water will be discharged to the Mahdia River
    - One-half of the Eagle Mountain pit dewatering water will go to the Mahdia River, and one-half will go to the Minnehaha Creek.

- During wet periods, the Mahdia River will gain flow from excess water discharge from either the plant or TSF1. If TSF2 is part of the future plan, it will discharge to Minnehaha Creek.
- Both drainage basins will see increased runoff because the impacted land surfaces including pit walls, pit bottoms, disturbed ground, TSF ponds, and TSF beaches have higher unit runoff (runoff per unit area, per unit time) than fully-vegetated ground.
- Transpiration, a large part of a tropical water balance, will be decreased as vegetation is removed.
- In impacted areas (see Contact Basins in Drawing 5), water that previously flowed into streams will be re-routed to pit sumps, tailings ponds, or surface water diversions. Some impacted areas will not have runoff per-se (such as water that falls inside the TSF). This water must be properly accounted for in the "with project" model.
- Unimpacted areas within the project footprint (see Non-Contact Basins in Drawing 5) will have the same runoff, but may be diverted into channels. M1, M2, M3 and M4 are examples of upgradient basins which will have the same runoff with the project as without.
- ~2534 m^3/day can be considered "consumed" by mining operations (see Figure 10-2). Most of this is water entrainment in the tailings.

The following subsections discuss the assessment of the surface water quantity impacts.

11.3 PRE-MINING STREAM FLOWS

Because abundant water is available in the wet season, GRE performed a deterministic water quantity impact assessment on the pre-mining driest month (September 2020) from the NASA dataset (see Section 3.0 for details). An analysis of dry conditions will provide insight to water quantity impacts for the "worst case scenario" possible for the site.

Table 11-1 below shows the discharge of each river during the selected timeframe, and forms the "low flow baseline".

Table 11-1: Pre-Mining Driest Month Flow Rates

Driest Simulated Month:	Mahdia	Minnehaha
	Average Daily Flow m^3/day	
Week 1	6,963	2,316
Week 2	3,398	1,130
Week 3	2,522	839
Week 4	2,100	698
Total Monthly Flow (m^3)	109,952	36,570

It is against this baseline that GRE will ascertain if the mining project increases or decreases streamflow during the driest time of the year at the point of compliance. The area upgradient from the Mahdia POC is ~ 19,700,000 m^2. This equates to a flow per square meter of roughly 5.5 liters of baseflow per square meter, per month. For the Minnehaha Creek, that value is 4.4 Liters of baseflow per square meter, per month.

11.4 DRY SEASON DEWATERING

The transient groundwater model has a bi-modal recharge function corresponding to the bi-modal wet season of the site. As a result, it is capable of determining the seasonal variation of pit dewatering. It is important to note that very little seasonal variation was predicted. For example, at end-of mine life, the difference in Salbora *groundwater inflows* between wet and dry seasons was ~5%. This is because of the time lag effect of groundwater. (It should be noted that the actual dewatering (including direct precipitation) removed from the sumps will be strongly and rapidly influenced by any rainfall.)

As a result, in rain-free periods, the pit sumps receive a steady flow rate corresponding to the values shown in Section 8.13.

11.5 MAHDIA RIVER STREAM FLOWS, DRY MONTH

Calculating the Mahdia River dry month flows requires the accounting of baseflow discharge from impacted basins, unimpacted basins, and mine water management practices.

As mentioned previously, the pre-mining runoff conditions and gaining stream conditions exist for nearly all of the non-contact watersheds shown on Drawing 5. For example, M01-M04 located upgradient from the TSF, are not impacted at all, nor are M13 and M14 upstream from the Mahdia water supply. Some subbasins are only slightly impacted. For example, on Drawing

5, M11, M12, M15, M16, M18, M19, and M20 cover large areas of the watershed above the POC, and will be subject only to water diversion, not land use change.

With this in mind, looking at the point of compliance during a dry month, the following holds true:

- Discharge from TSF: This is equal to 0 m^3/day.This corresponds to the "flat line" areas of Figures 10-6, 10-7 and 10-8. The TSF still stores water, but discharges none.
- Discharge from Salbora GW inflows (pit dewatering): See Figure 8-17, a minimum of 650 m^3/day, and a maximum of 4500 m^3/day.
- Discharge from Toucan GW Inflows (pit dewatering): See Figure 8-18, a minimum of zero, a maximum of 2000 m^3/day.
- Discharge from Powis GW Inflows (pit dewatering), See Figure 8-19, a minimum of 1300 and a maximum of 3300 m^3./day.
- One Half the discharge from Eagle Mountain, See Figure 8-20. A minimum of 1150, a maximum of 2000 m^3/day.
- Consumptive use by the plant of ~2500 m^3/day. This is constant throughout the year, yet during the dry month, it is sourced from TSF reclaim water and pit dewatering.
- During mining, not all areas have runoff (see first bullet on the TSF). No runoff areas and areas that would be double-counting water (for example, gaining streams within pit extents) must be subtracted from the balance at a rate equal to the baseflow per square meter calculated in Section 11.3 multiplied by the area with these conditions.
- During mining, some impacted sub-basins have equal discharge. For simplicity, GRE assumes that upgradient sub-basins M1 through M4 (see Drawing 5) provide the same baseflow during mining as after mining.

The equation then becomes:

With project flows = Unimpacted Drainage Discharge

+ Pit Dewatering

– "double count" areas

– no runoff areas

– Consumptive use

Table 11-2 shows the results of this calculation and the predicted ***increase*** in dry season baseflows as mining progresses.

Table 11-2: With -Project Streamflow Discharge Increase in Driest September, Mahdia River

Model Period	Increase in Baseflow Rate from Mining (m^3/day)	Increase in total Baseflow m^3/month
Years 0-1	2,509.	75,276
Years 3-5	3,026.	90,788
Years 6-13	7,026	210,788
Years 13-14	9,026	270,788

Returning to the values shown in Table 11-1, the minimum increase in surface water flows occurs at the beginning of mining, and is an increase of ~68%. By the end of mine life, this increase is equivalent to ~2.4 times higher baseflow (~270,000 m^3/month additional water in the "dry September" worst case) .

11.6 MINNEHAHA CREEK STREAM FLOWS

A similar condition exists for the Minnehaha Creek. This drainage receives ½ of the Eagle Mountain dewatering water but has no consumptive use by the plant (which is in the other drainage basin). It does have a modest "double count" area within the EM pit rim. The calculation results in a net increase in dry season baseflow in all stages of mine life, and is shown in Table 11-3.

Table 11-3: With -Project Streamflow Discharge Increase in Driest September, Minnehaha Creek

Model Period	Increase in Baseflow from Mining (m3/day)	Increase in total Baseflow m^3/month
Years 0-1	1,541	46,258
Years 3-5	1,541	46,258
Years 6-13	2,041	61,258
Years 13-14	1,191	35,758

Looking at the driest conditions, the project will at least double dry season Minnehaha Creek flows.

11.7 CONCLUSIONS

Even under the driest climate conditions, the discharge to the Mahdia and Minnehaha watersheds are expected to increase. The communities downstream are not expected to incur a water shortage as a result of mining operations and can expect increased water flows in the Mahdia and Minnehaha river systems.

11.8 MODEL LIMITATIONS

The following comprises the assumptions and limitations of the predictive model for surface water quantity.

- Climate: rainfall is the only climate parameter accounted for in the streamflow baseline values.
- Runoff: changes in runoff due to the development of mine infrastructure are estimated from the water balance and from the unit discharge assumptions discussed above.
- Precipitation: as mentioned in previous sections, the precipitation record for Eagle Mountain specifically only spanned 2022 through 2024. All other years, 2000 through 2021, were developed from NASA satellite data. Additional weather data will need to be developed to improve this and other models.
- Additional Accompanied Limitations: this section of the report relies on the output of several models developed by GRE and the GRE-Barr team. Within each of these models and as discussed previously, the assumptions/limitations of these models and their results then impact the results of this model. Thus, any and all changes or improvements made to the models mentioned in this section which generate different outputs must be used to revise the model results of this section.

12.0 WATER QUALITY IMPACT ASSESSMENT

12.1 INTRODUCTION

The geochemical study of Eagle Mountain waste rock and tailings indicated that tailings products are likely to be inert, and non-acid generating. However, the results showed that some metals and salts in tailings supernatant are elevated above WBG EHS Guidelines for Runoff and Effluent to Surface Water and U.S. EPA secondary drinking water standards for sulfate (US EPA). Supernatant is process water that is also used for the slurry transport of tailings in the metallurgy process.

Table 12-1: Supernatant Chemistry and Standards

Parameter (mg/L)	Saprolite, Early Mine Life	Hard rock, Late Mine Life	Saprolite, Early Mine Life	Hard rock, Late Mine Life	US EPA Secondary Drinking Water Standards	WBG EHS Runoff Guidelines
	Eagle Mountain		Salbora			
Sulfate	2100	4000	2100	3700	250	NR
Weak Acid Dissociable Cyanide	0.42	<0.1	0.89	<0.1	NR	0.5
Total Cyanide	4.19	5.91	1.52	21	NR	1
Arsenic	0.0046	0.0088	0.0054	0.0046	NR	0.1
Cadmium	0.000055	0.0046	0.000055	0.000062	NR	0.05
Chromium (VI)	0.268	0.00017	0.0416	0.00012	NR	0.1
Copper	0.025	2.31	0.051	0.284	NR	0.3
Iron	1.68	2.96	0.064	5.24	NR	2
Lead	0.0296	0.0122	0.00507	0.00355	NR	0.2
Mercury	0.00012	0.00020	<0.00001	<0.00001	NR	0.002
Nickel	0.0431	0.0196	0.0004	0.0005	NR	0.5
Zinc	0.003	0.27	<0.002	<0.002	NR	0.5
Total Nitrogen	NR	NR	NR	NR	NR	10
Total Phosphorus	0.031	0.025	0.01	0.011	NR	2
Total Suspended Solids	NR	NR	NR	NR	NR	50

NR = Not reported. Less than symbol (<) indicates lab results that were below detection limit.

As mentioned in Section 10.2.1.4 above, the metallurgical testing, specifically cyanide detoxification, was designed to produce a supernatant solution that is generally representative of the solution in the final plant design. It is important to note, however, that the objective of the lab testing was to produce supernatant with a WAD CN of less than 1 mg/L. This is lower than what is expected for the actual plant operation and therefore utilized higher doses of sodium metabisulfite than may be present in the actual circuit. Because of the different feed ore material, there is a significant difference in the water quality in the supernatant produced from the process of saprolite-hosted ore when compared to the hard-rock hosted ore. These differences can be seen in the table above and have been incorporated into the modeling.

It is clear from the water balance results (see Section 10.0) that excess water must be discharged from the TSFs during the mine life. It was hypothesized that the water quality in the receiving environment could be managed if the TSF excess water could be discharged at a ratio such that the elevated metals and salts in the supernatant could be diluted to meet WBG EHS water quality guidelines. To validate this hypothesis, GRE created a PHREEQC model to determine the necessary mixing at weighted average discharge ratios required to consistently meet regulatory requirements. PHREEQC is an industry standard geochemical modeling platform which considers dilution, equilibrium, solubility, and precipitation reactions. It is ideally suited to predict the geochemical behavior of mixed water streams.

For simplicity, only metals and respective cations and anions that tested above detection limit were considered in the water quality model. GRE used chloride as the charge balance element for the modeling, as chloride is unregulated and does not greatly impact the concentrations of other compounds in solution.

12.2 TAILINGS STORAGE FACILITY – WATER BALANCE

As presented in the GRE water balance (see Section 10.0), the TSF1 storage facility is gradually filled with tailings solids and accompanying supernatant. The TSF also receives an additional water input of rainfall that falls on the entire surface area. For the geochemical mixing model, GRE assumed that any water that accumulates in the TSF over the maximum pond volume is the amount of water that will need to be treated and discharged.

Based on the results of the water balance, TSF1 is unlikely to overflow during operation due to the maximization of recycled water from the TSF being used in the plant process. However, GRE has planned for this possibility. TSF2, as mentioned previously, is no longer in the plan, but if it is constructed, is predicted to overflow only in highly wet conditions for the same reason.

12.3 MAHDIA RIVER FLOW RATES

The Mahdia river will be the ultimate receiving water body of any discharges from TSF1. The flow rates of the river at (0578711 E, 0262883 N) were measured by GRE personnel in January and February of 2025 using FlowTracker2. As these measurements were taken during the dry season, they represent baseflow of the river. Those results are presented below.

Table 12-2: Mahdia River Measured Flow Rates

Date	Time	Flow (m^3/s)	Flow (m^3/day)
1/28/2025	12:57	0.2782	24,036
2/2/2025	06:45	0.3125	27,000

Barr Engineering analyzed available NASA data from 2000-2024 alongside the watershed areas of the project site to create a watershed discharge model for the entire site area (see Section 10). The total yearly discharge in the area was summed, and wettest, driest, and median discharge year on record was determined (2022, 2012, and 2018 respectively). GRE then looked at the average monthly discharge rates for only the Mahdia River contributing watershed for the selected years of interest. The graph of discharge vs time for the three years of interest are shown below.

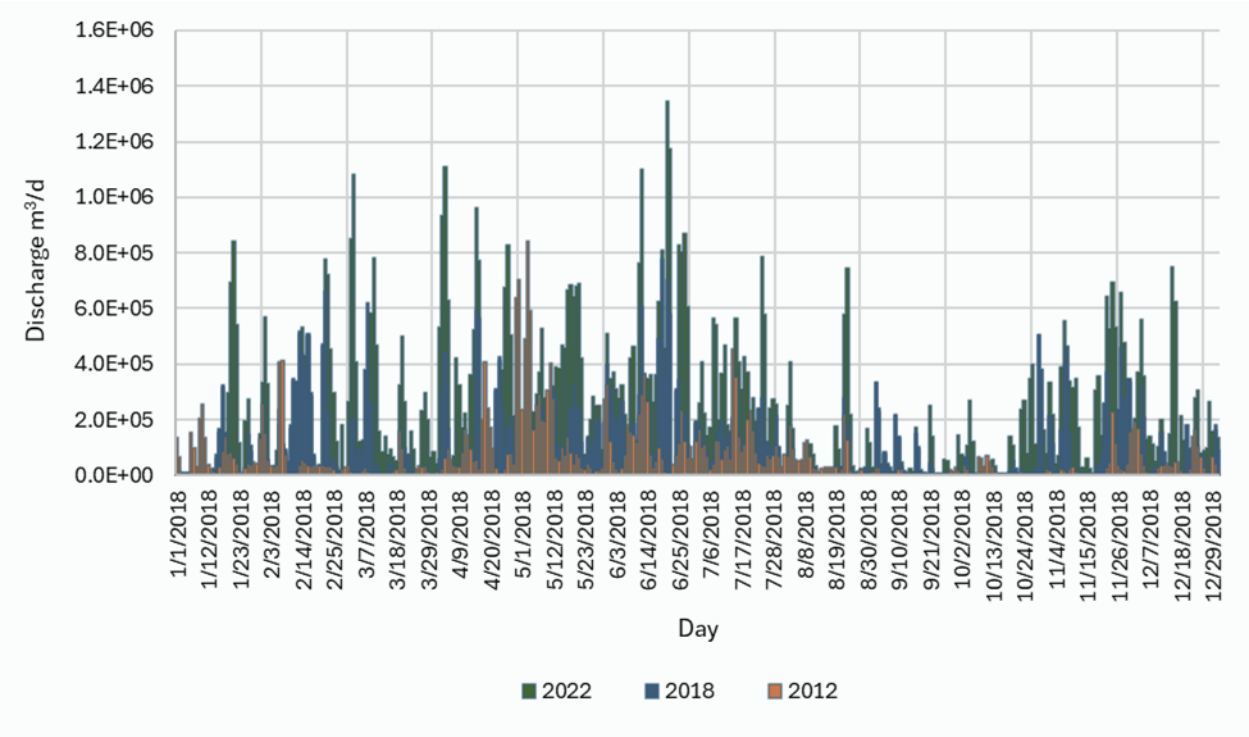


Figure 12-1: Discharge to Mahdia River, Wet, Median, and Dry Conditions

As seen from Figure 12-1, the variance in discharge on a day-to-day basis can be quite great, ranging from 0 m^3/d to 1,346,0460 m^3/d, depending on the precipitation conditions. To simplify the flow rates for the geochemical model, GRE utilized the average discharge rate as calculated by Barr Engineering.

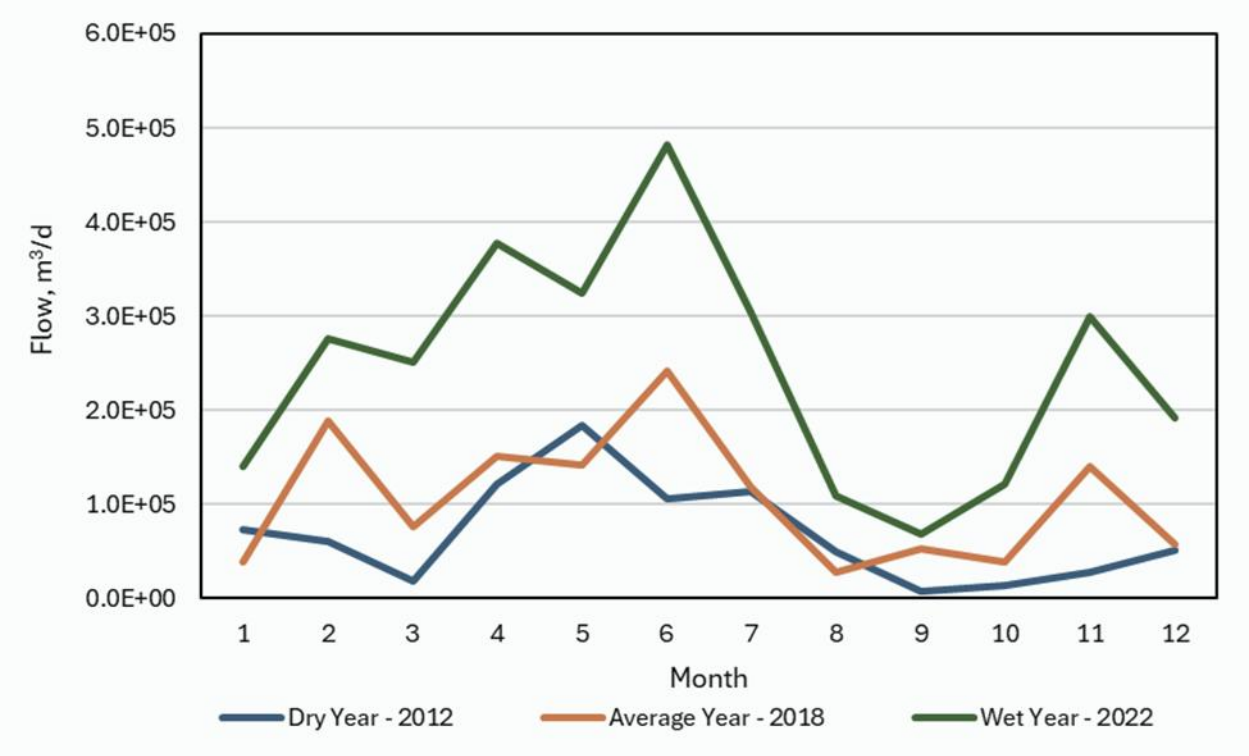


Figure 12-2: Average Monthly Mahdia River Flow, Varying Precipitation Conditions

12.4 MINNEHAHA RIVER FLOW RATES

The Minnehaha river will be the ultimate receiving water body of any discharges from TSF2 (if it is added back into the plan). The flow rates of the river at were measured by GRE personnel in February of 2025 using FlowTracker2. Additionally, GRE personnel were able to capture a storm hydrograph in June of 2024, and flow measurements using a weir in November of 2024. As these measurements were taken during the dry season, they represent baseflow of the river. Those results are presented below.

Table 12-3: Minnehaha River Measured Flow Rates

Date	Time	Flow (m^3/s)	Flow (m^3/d)
11/09/2024	16:00	0.38	32,832
11/10/2024	09:24	0.38	32,832
02/02/2025	08:52	0.0353	3,049

To simplify the flow rates for the geochemical model, GRE utilized the average discharge rate as calculated by Barr Engineering (see Section 9.0). The average daily flow each month used in the modeling is presented below.

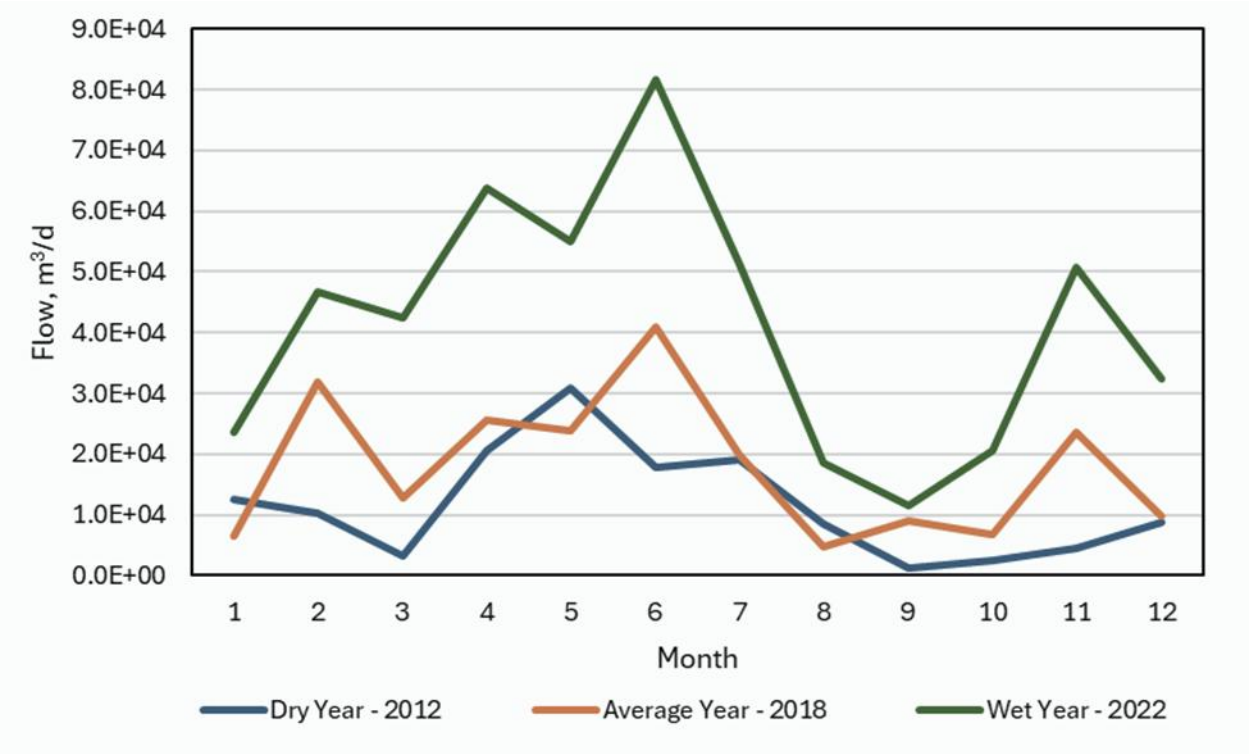


Figure 12-3: Average Monthly Minnehaha River Flow, Varying Precipitation Conditions

12.5 RIVER WATER QUALITY

The water quality of both rivers has been monitored since the beginning of 2025. Two rounds of water samples:, one taken on Jan. 21, 2025, and one taken on March 22, 2025, have been sent for laboratory analysis of total and dissolved metals, sulfates, and other relevant parameters. Additionally, the pH, temperature, electrical conductivity, and dissolved oxygen have been periodically measured in the field from March 2025 – June 2025. GRE used the average of all these testing efforts to establish the river water quality in PHREEQC. Any analyte that tested below detection limit was assumed to be insignificant for the water quality model and was not input. GRE used chloride as the charge balance element for the modeling, as chloride is unregulated and does not greatly impact the concentrations of other compounds in solution. Additionally, GRE had to increase the alkalinity of the Minnehaha river water to 21 mg/L from the tested 5.2 mg/L to allow for convergence of the model.

12.6 PHREEQC MODEL RESULTS

12.6.1 TSF1

GRE established the mixing ratios of supernatant to river water throughout mine life that would comply with the standards/reference values shown in Table 12.1. To do this, GRE first determined

the water quality of any overflow that would occur from TSF1 in dry, average, and wet conditions by mixing the appropriate amount of incoming supernatant with tailings deposition, precipitation, and beach runoff. The resulting water quality for overflow in early mine life (EML) where primarily saprolite tailings are being deposited and later mine life (LML) where primarily hard rock tailings are being deposited in reference to the standards in Table 1 are shown below. EML assumes only saprolite tailings deposition in the TSF at a ratio of 4:1 Eagle Mountain saprolite to Salbora and Toucan saprolite. LML assumes hard rock only tailings deposition into the TSF at a ratio of 4:1 Eagle Mountain hard rock to Salbora and Toucan hard rock with no additional contaminant contribution to the supernatant from existing saprolite tailings in the TSF (which will be buried in the facility).

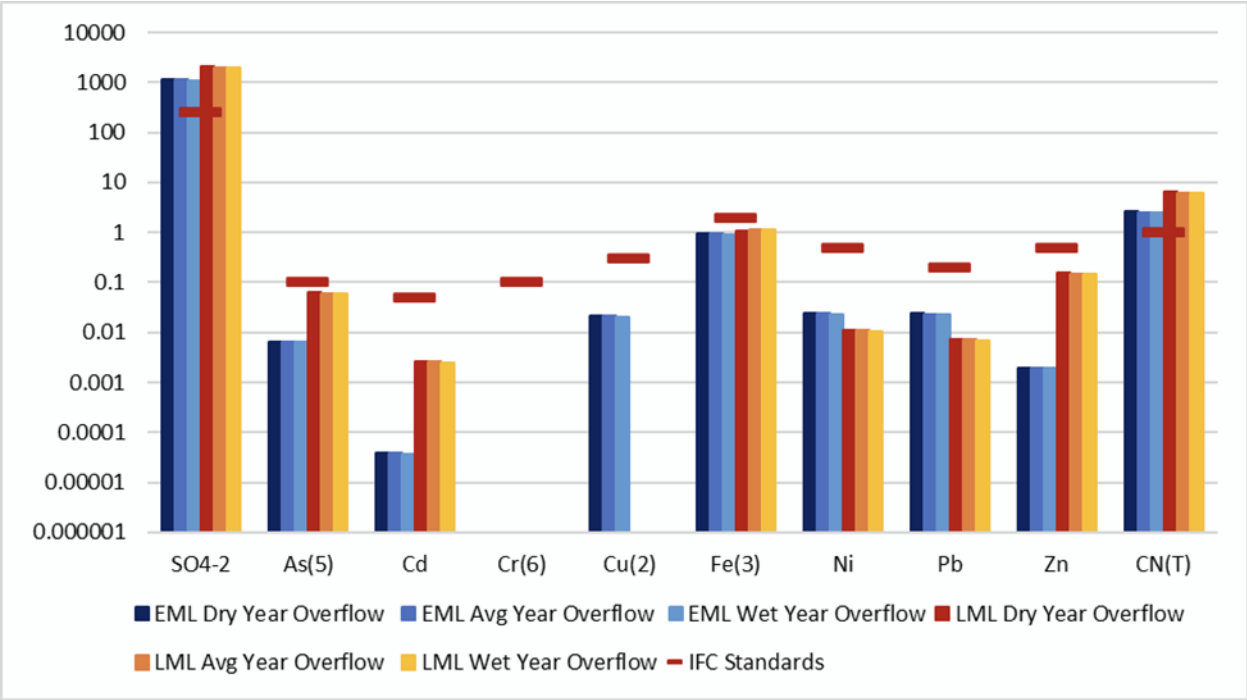


Figure 12-4: TSF1 Overflow Water Quality, Varying Precipitation Conditions

The overflow, by itself, is predicted to exceed the standards for sulfate and total cyanide in both EML and LML and must be further diluted to meet water quality standards. The bar graph below shows different mixing ratios of the dry year overflow and the Mahdia River for both EML and LML. In the legend, the percentage represents the volume percent of dry year overflow. For example, LML 20% represents the water quality upon the mixing of 20% LML overflow discharge and 80% Mahdia River water.

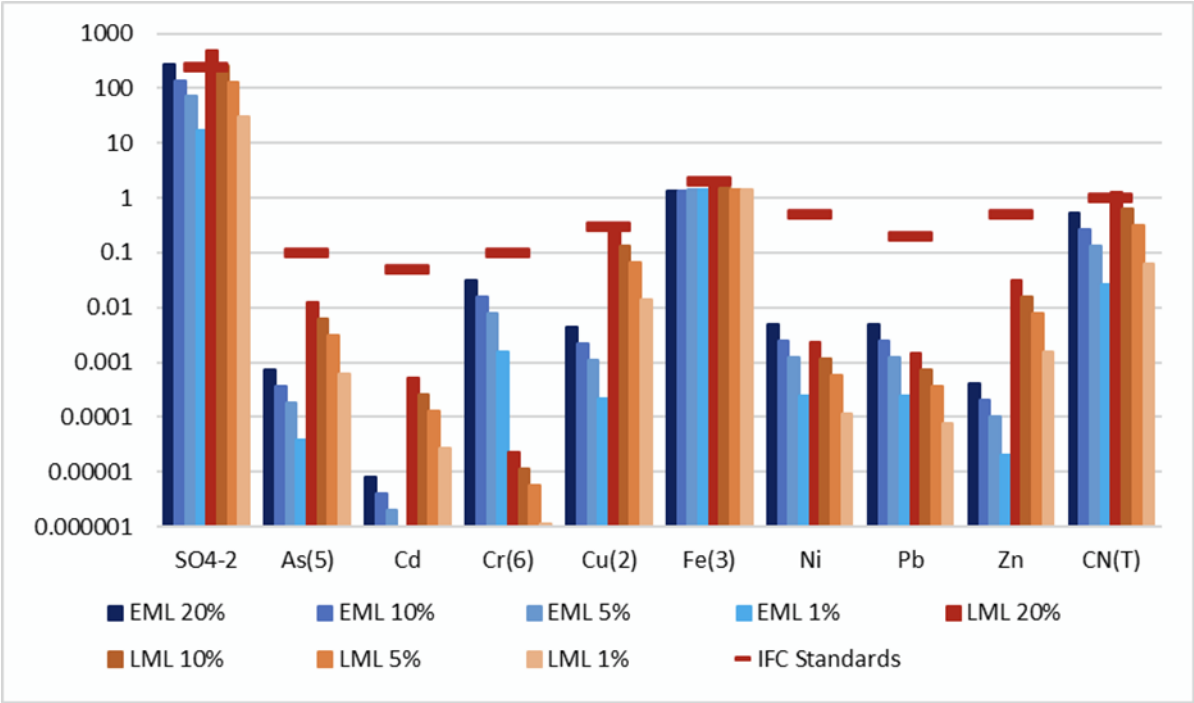


Figure 12-5: TSF1 Mixing Model Contaminant Concentrations

Modeling indicates that the water quality during later mine life is of potentially greater risk than early mine life, which is consistent with what is expected, because the test results for hardrock tailings supernatant showed higher metals and sulfate when compared to saprolite tailings supernatant (see Table 12.1). The modeling shows that the majority of regulated metals do not exceed IFC standards throughout mine life, even at a 20% contribution from the TSF overflow. However, sulfate is a parameter of concern. To discharge sulfate below the EPA secondary drinking water standard of 250mg/L, the TSF1 overflow must be discharged at a maximum of 10% volume of the Mahdia River.

If required, TSF2 will commence and tailings deposition into TSF1 will cease. In this condition, TSF1 will only be subject to incoming rainfall which will mix with the hard rock tailings solution and be discharged. To simulate the water quality during this time, GRE assumed the tailings pond supernatant will be diluted by varying rainfall conditions (pH 5.5) and beach runoff, with the resulting mixture representing TSF1 overflow. For the water quality modeling purposes, the pond size was assumed to be 407,835 m^3, and rainfall and beach runoff were calculated based on the area for wet, average, and dry conditions. The figure below shows the predicted water quality in the first year post operation (PO) that tailings deposition stops into TSF1 in comparison to IFC Standards for varying precipitation conditions, as well as the resulting water quality upon the mixing varying percentages of the PO dry year overflow with Mahdia river water.

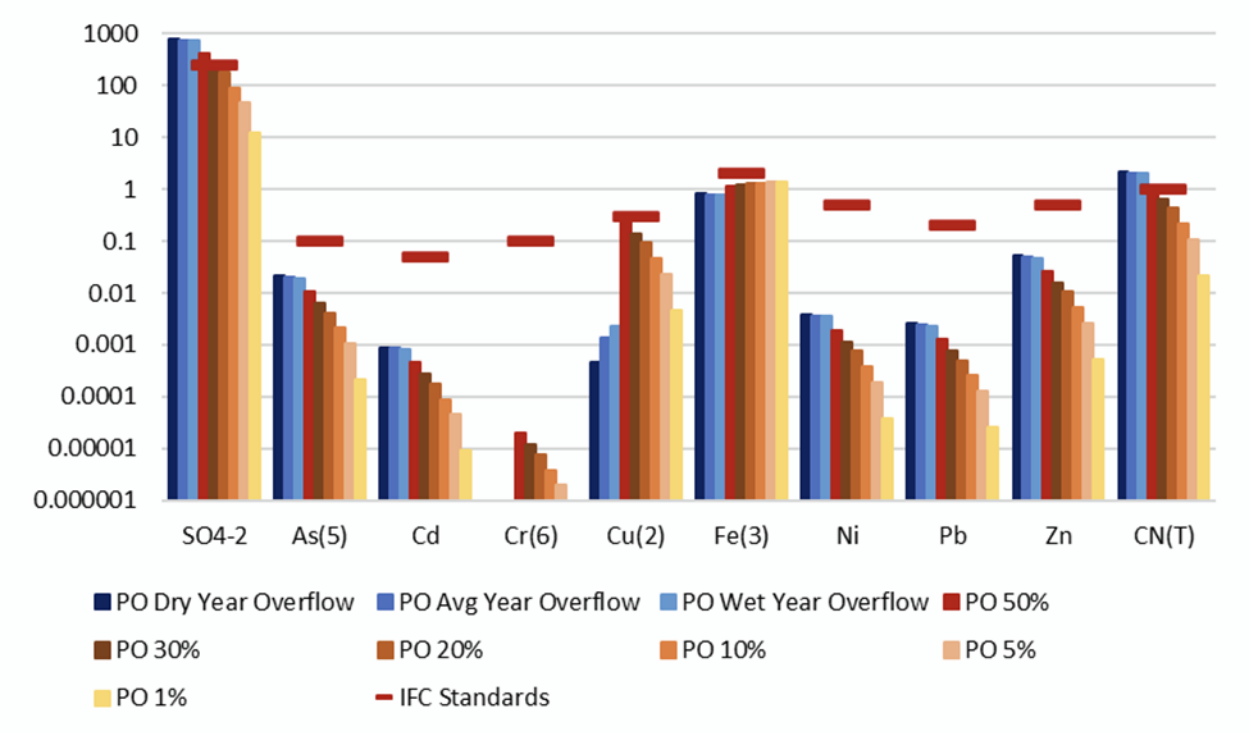


Figure 12-6: TSF1 Mixing Model, Inactive State Contaminant Concentrations

The only predicted exceedance of water quality standards in the raw overflow from TSF1 post operation is sulfate and total cyanide. A mixing ratio of 20% TSF1 overflow with the Mahdia River meets all discharge water quality standards. It is important to note that over time, the overflow water quality should get better, as the supernatant solution gets more and more diluted by rainfall and beach runoff.

12.6.2 TSF2

As mentioned previously, TSF2 has been removed from the plan. However, if needed, TSF2 will operate after TSF1 has been filled. As with TSF1, GRE established the mixing ratios of TSF overflow to river water throughout mine life that would comply with IFC water quality standards that are applicable to the project. GRE additionally used the EPA sulfate secondary reference value of 250mg/L (at which taste and smell of the water can be affected) to evaluate water quality. GRE first determined the water quality of any overflow that would occur from TSF2 in dry, average, and wet conditions by mixing the appropriate amount of incoming supernatant with tailings deposition, precipitation, and beach runoff. It was assumed that only hard rock tailings would be deposited into TSF2 at a ratio of 4:1 Eagle Mountain hard rock to Salbora and Toucan hard rock. It was also assumed that the initial TSF2 pond volume was 478,047 m^3. The regulated contaminant concentrations at varying overflow mixing ratios with the Minnehaha river (i.e. LML 30% corresponds to the water quality upon the mixing 30% volume of TSF2 overflow with 70% volume of Minnehaha River water) are graphed below.

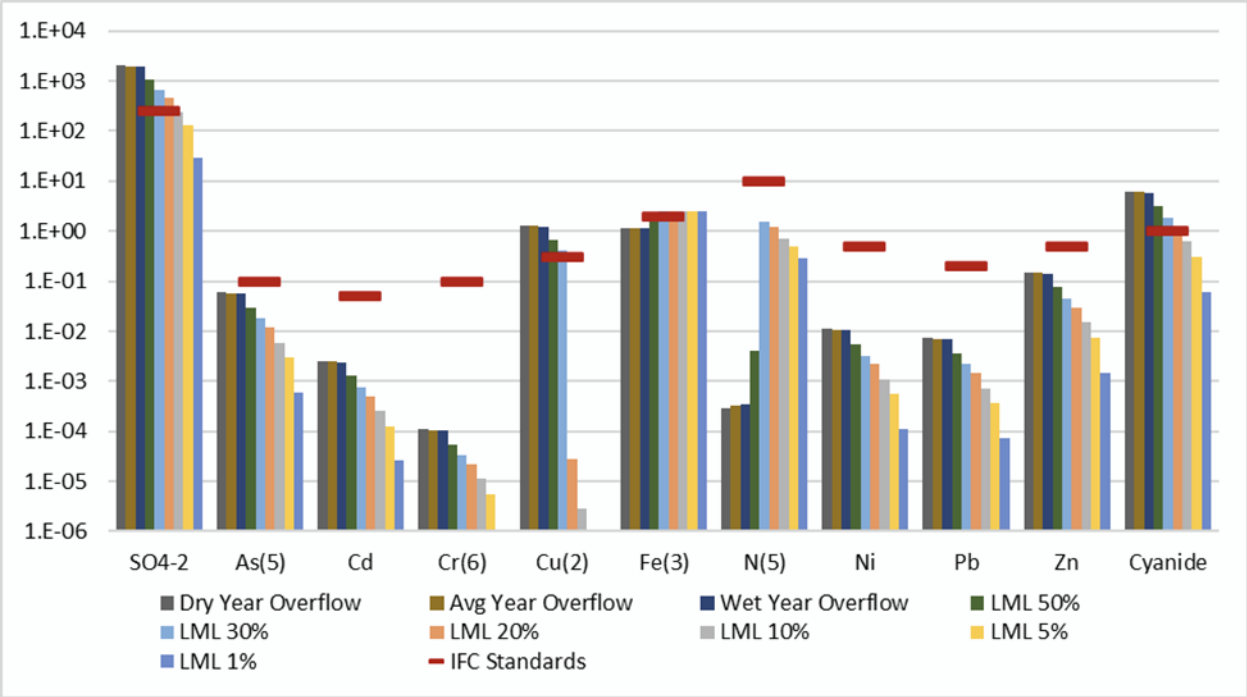


Figure 12-7: TSF2 Mixing Model Contaminant Concentrations

The Minnehaha river has higher background total iron concentrations than the Mahdia, so all levels of mixing result in discharge that is above the IFC reference value of 2 mg/L. Metals and sulfate in the overflow discharge from TSF2 are not expected to exceed IFC reference values when mixed at 10% discharge to the Minnehaha river water.

12.7 POND SIZING

In order to ensure that water quality standards are met, the project will need settling/mixing ponds that allow for the controlled mixing and storage of TSF overflow and natural waters before discharge. Although the water balance does not predict significant overflow from TSF1 (or TSF2, if it becomes part of the plan), a settling pond will be needed to store any excess water and settle out sediment before discharge to the receiving rivers. At the current state of the project, GRE recommends ponds of 50,000 m^3 at the toe of each TSF to capture any overflow.

12.8 LIMITATIONS

The current state of water quality modeling is consistent with a pre-feasibility study level technical report by NI 43-101 standards. As a result, the conclusions are subject to change as the site-specific knowledge increases. For example, the supernatant water quality samples were taken off early-stage Project metallurgical test work that has not been optimized for cyanide destruction efficiency and minimum sulfate concentrations.

13.0 CONCLUSIONS

This technical report, and the ancillary reports presented to ERM (such as the geochemical characterization and the mercury characterization report), are intended to present the existing scientific background and the state-of-the practice predictive modeling tools used to determine the potential water quality and quantity impacts resulting from the development of the Eagle Mountain Mining project.

It is essential to note that no mining projects in the world are without environmental impacts. When compared to the population of known gold mining development projects around the world, it is GRE's technical opinion that the Eagle Mountain project falls in a Low to Moderately Low risk profile with regards to water-related risks. This technical option is based on the fact that:

- The project appears to have no Acid Rock Drainage (ARD) or metal leaching (ML) water quality issues. This applies to all forms of mine waste leachate and runoff, and extends to pit dewatering water.
- The project has no significant impact on the Mahdia water supply weir and surface collection system;
- The project has a net-increase in surface water flows during operations in both the Mahdia River and Minnehaha Creek, and
- Groundwater drawdown is localized, and does not have receptors (no locals use groundwater wells).

Sediments will be a serious concern, and there is a chance that sulfate discharge from the TSFs must be managed, but these are issues which most mining projects hold in common.

GRE sees this as a beginning point for ERM's evaluation of the water-related impacts and welcomes further discussion on the studies contained in this report.

14.0 REFERENCES

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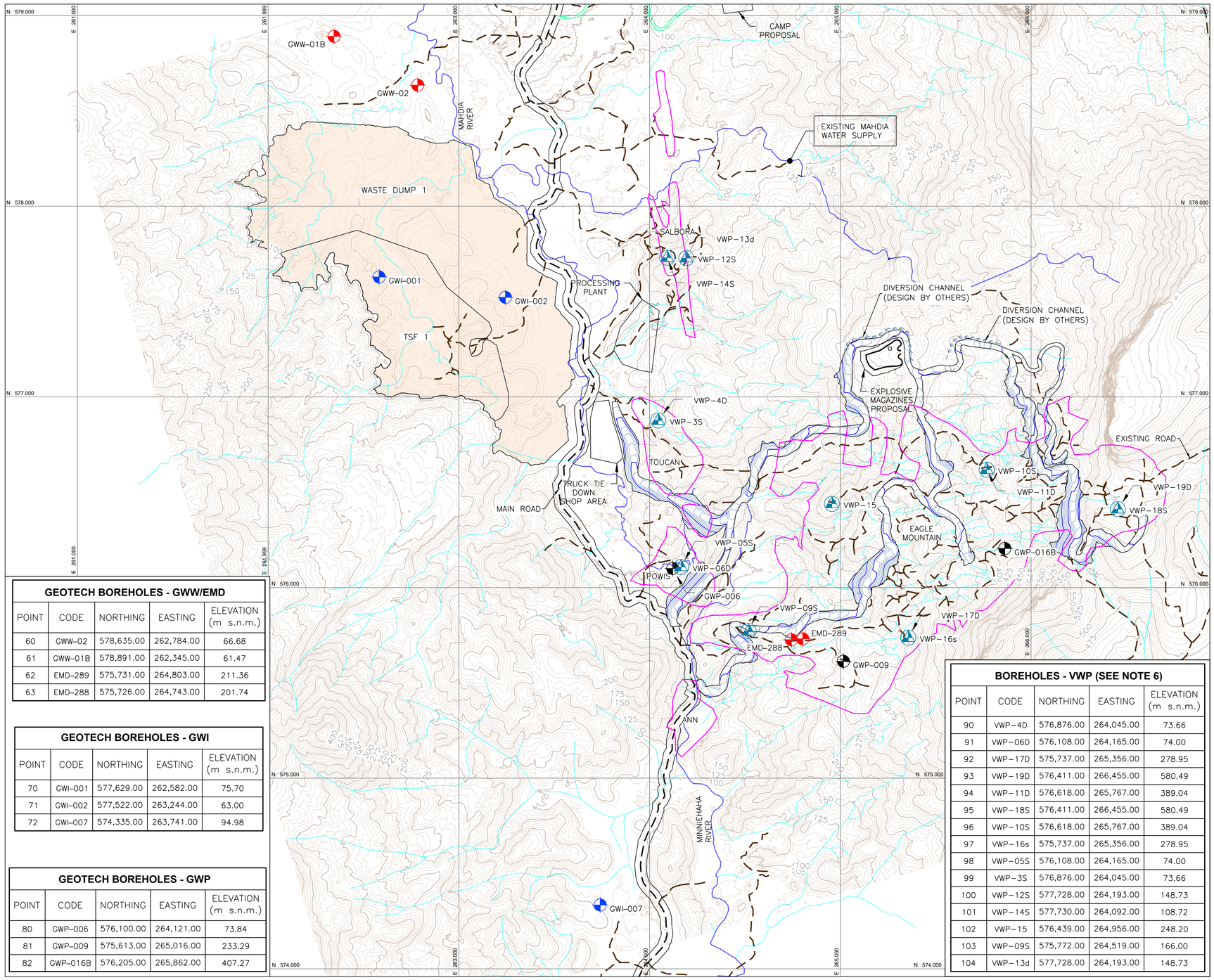
Drawing 1



LEGEND

- EXISTING GROUND, CONTOURS AND ELEVATION 5–25 METERS
- FOOTPRINTS GRE DESIGN PROPOSAL
- DESIGN SURFACES BY OTHERS (MAKO MINING CORP.) CONTOURS AND ELEVATION 5–25 METERS
- PROPOSAL/INVESTIGATION AREA
- MAIN ROAD
- ROADS (LENGHT AND AVERAGE SLOPE)
- RIVERS (TRIBUTARY)
- RIVERS (MAIN)
- PIT AREAS
- DIVERSION CHANNEL DESIGN BY OTHERS (MAKO MINING CORP.)
- VWP CODE — BOREHOLE FOR INSTALLING VIBRATING WIRE PIEZOMETER
- GWW,EMD
- GWI
- GWP

NOTES:

1. THE TOPOGRAPHY OF THE NATURAL TERRAIN OF THE PROJECT WAS PROVIDED BY MAKO MINING CORP.
2. THE ROADS SURFACE IN THE AREA CALLED EAGLE MOUNTAIN WERE BUILT BY MAKO MINING CORP.
3. ANY DESIGN REFERRED TO AS "DESIGN BY OTHERS" WAS NOT PROPOSED BY GRE.
4. EACH MAGENTA ZONES IS A PROPOSED AREA FOR PIT ACTIVITY. THESE AREAS DO NOT REPRESENTS FINAL LIMITED PIT, THEY WOULD BE CHANGED.
5. ANN PIT IS A PROPOSAL ZONE.
6. VWP LOCATIONS ONLY REPRESENT BOREHOLES FOR INSTALLING VWP INSTRUMENTS.
7. THE ELEVATION AT EACH BOREHOLE IS THE ELEVATION AT GROUND LEVEL AND DOES NOT REPRESENT THE DEPTH OF THE BOREHOLE.

GEOTECH BOREHOLES - GWW/EMD

POINT	CODE	NORTHING	EASTING	ELEVATION (m s.n.m.)
60	GWW–02	578,635.00	262,784.00	66.68
61	GWW–01B	578,891.00	262,345.00	61.47
62	EMD–289	575,731.00	264,803.00	211.36
63	EMD–288	575,726.00	264,743.00	201.74

GEOTECH BOREHOLES - GWI

POINT	CODE	NORTHING	EASTING	ELEVATION (m s.n.m.)
70	GWI–001	577,629.00	262,582.00	75.70
71	GWI–002	577,522.00	263,244.00	63.00
72	GWI–007	574,335.00	263,741.00	94.98

GEOTECH BOREHOLES - GWP

POINT	CODE	NORTHING	EASTING	ELEVATION (m s.n.m.)
80	GWP–006	576,100.00	264,121.00	73.84
81	GWP–009	575,613.00	265,016.00	233.29
82	GWP–016B	576,205.00	265,862.00	407.27

BOREHOLES - VWP (SEE NOTE 6)

POINT	CODE	NORTHING	EASTING	ELEVATION (m s.n.m.)
90	VWP–4D	576,876.00	264,045.00	73.66
91	VWP–06D	576,108.00	264,165.00	74.00
92	VWP–17D	575,737.00	265,356.00	278.95
93	VWP–19D	576,411.00	266,455.00	580.49
94	VWP–11D	576,618.00	265,767.00	389.04
95	VWP–18S	576,411.00	266,455.00	580.49
96	VWP–10S	576,618.00	265,767.00	389.04
97	VWP–16s	575,737.00	265,356.00	278.95
98	VWP–05S	576,108.00	264,165.00	74.00
99	VWP–3S	576,876.00	264,045.00	73.66
100	VWP–12S	577,728.00	264,193.00	148.73
101	VWP–14S	577,730.00	264,092.00	108.72
102	VWP–15	576,439.00	264,956.00	248.20
103	VWP–09S	575,772.00	264,519.00	166.00
104	VWP–13d	577,728.00	264,193.00	148.73

N
W E
S

220 0 220 440 METERS
1:11,000 TO (ANSI-D)
1:22,000 TO (ANSI-B)

BASE TOPOGRAPHY CONTOUR INTERVAL: 5 METERS

No.	Description	By	Date
02	SURVEY COORDINATE SYSTEM IN PSAD5621 N	CLIENT	07/23
01	2023 LIDAR SURVEY, JULY, 15 2023	CLIENT	07/23

REFERENCES

Rev	By	Apr	Description	Date
0	ER	LB	ISSUED FOR CLIENT	10/20/25

REVISIONS

SCALE: AS SHOWN

Design: GRE
Draw: ER
Revised by: LB
Aprobed by: LB

Prepared by: GLOBAL RESOURCE ENGINEERING

Prepared for: MAKO MINING CORP.

Title: BOREHOLE LOCATIONS

0 REVISION

Project: PRE–FEASIBILITY STUDY

Project No. 24–1450

Date: MARCH 2026

DRAWING 01

LOCATION: D:\Documentos\001–Global Resource\06–Eagle Mountain\Larry\Información actual\02–Eagle Montain Project\Planos\ERM–Drawings\01–BOREHOLE LOCATIONS.dwg DATE: 3/9/2026 8:58 a.m. PLOT SCALE = 1:25.4 PLOTTED BY: LUIS A. C.L.

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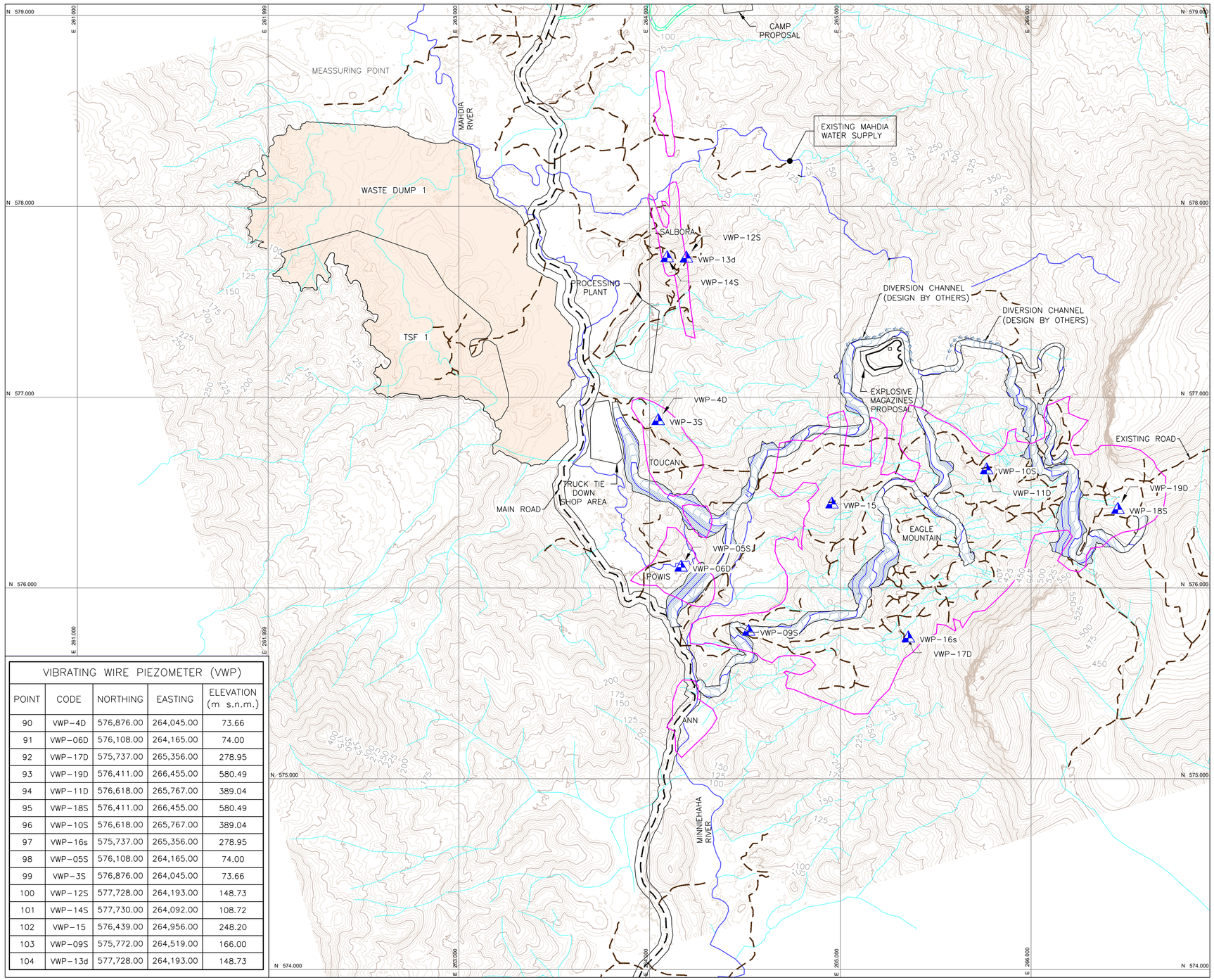

VIBRATING WIRE PIEZOMETER (VWP)				
POINT	CODE	NORTHING	EASTING	ELEVATION (m s.n.m.)
90	VWP-4D	576,876.00	264,045.00	73.66
91	VWP-06D	576,108.00	264,165.00	74.00
92	VWP-17D	575,737.00	265,356.00	278.95
93	VWP-19D	576,411.00	266,455.00	580.49
94	VWP-11D	576,618.00	265,767.00	389.04
95	VWP-18S	576,411.00	266,455.00	580.49
96	VWP-10S	576,618.00	265,767.00	389.04
97	VWP-16s	575,737.00	265,356.00	278.95
98	VWP-05S	576,108.00	264,165.00	74.00
99	VWP-3S	576,876.00	264,045.00	73.66
100	VWP-12S	577,728.00	264,193.00	148.73
101	VWP-14S	577,730.00	264,092.00	108.72
102	VWP-15	576,439.00	264,956.00	248.20
103	VWP-09S	575,772.00	264,519.00	166.00
104	VWP-13d	577,728.00	264,193.00	148.73

LEGEND

- EXISTING GROUND, CONTOURS AND ELEVATION 5–25 METERS
- FOOTPRINTS GRE DESIGN PROPOSAL
- DESIGN SURFACES BY OTHERS (MAKO MINING CORP.) CONTOURS AND ELEVATION 5–25 METERS
- PROPOSAL/INVESTIGATION AREA
- MAIN ROAD
- ROADS (LENGHT AND AVERAGE SLOPE)
- RIVERS (TRIBUTARY)
- RIVERS (MAIN)
- PIT AREAS
- DIVERSION CHANNEL DESIGN BY OTHERS (MAKO MINING CORP.)
- VWP CODE — VIBRATING WIRE PIEZOMETER

NOTES:

1. THE TOPOGRAPHY OF THE NATURAL TERRAIN OF THE PROJECT WAS PROVIDED BY MAKO MINING CORP.
2. THE ROADS SURFACE IN THE AREA CALLED EAGLE MOUNTAIN WERE BUILT BY MAKO MINING CORP.
3. ANY DESIGN REFERRED TO AS "DESIGN BY OTHERS" WAS NOT PROPOSED BY GRE.
4. EACH MAGENTA ZONES IS A PROPOSED AREA FOR PIT ACTIVITY. THESE AREAS DO NOT REPRESENTS FINAL LIMITED PIT, THEY WOULD BE CHANGED.
5. ANN PIT IS A PROPOSAL ZONE.
7. THE ELEVATION AT EACH VWP IS THE ELEVATION AT GROUND LEVEL AND DOES NOT REPRESENT THE DEPTH OF THE VWP INSTALLATION.

N W E S

220 0 220 440 METERS

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1:22,000 TO (ANSI-B)

BASE TOPOGRAPHY CONTOUR INTERVAL: 5 METERS

No.	Description	By	Date
02	SURVEY COORDINATE SYSTEM IN PSAD5621 N	CLIENT	07/23
01	2023 LIDAR SURVEY, JULY, 15 2023	CLIENT	07/23

REFERENCES

Rev	By	Apr	Description	Date
0	ER	LB	ISSUED FOR CLIENT	10/20/25

REVISIONS

SCALE: AS SHOWN

Design: GRE
Draw: ER
Revised by: LB
Aprobed by: LB

Prepared by: GRE GLOBAL RESOURCE ENGINEERING

Prepared for: MAKO MINING CORP.

Title: VIBRATING WIRE PIEZOMETER LOCATIONS

0 REVISION

Project: PRE–FEASIBILITY STUDY

Project No. 24–1450

Date: MARCH 2026

DRAWING 02

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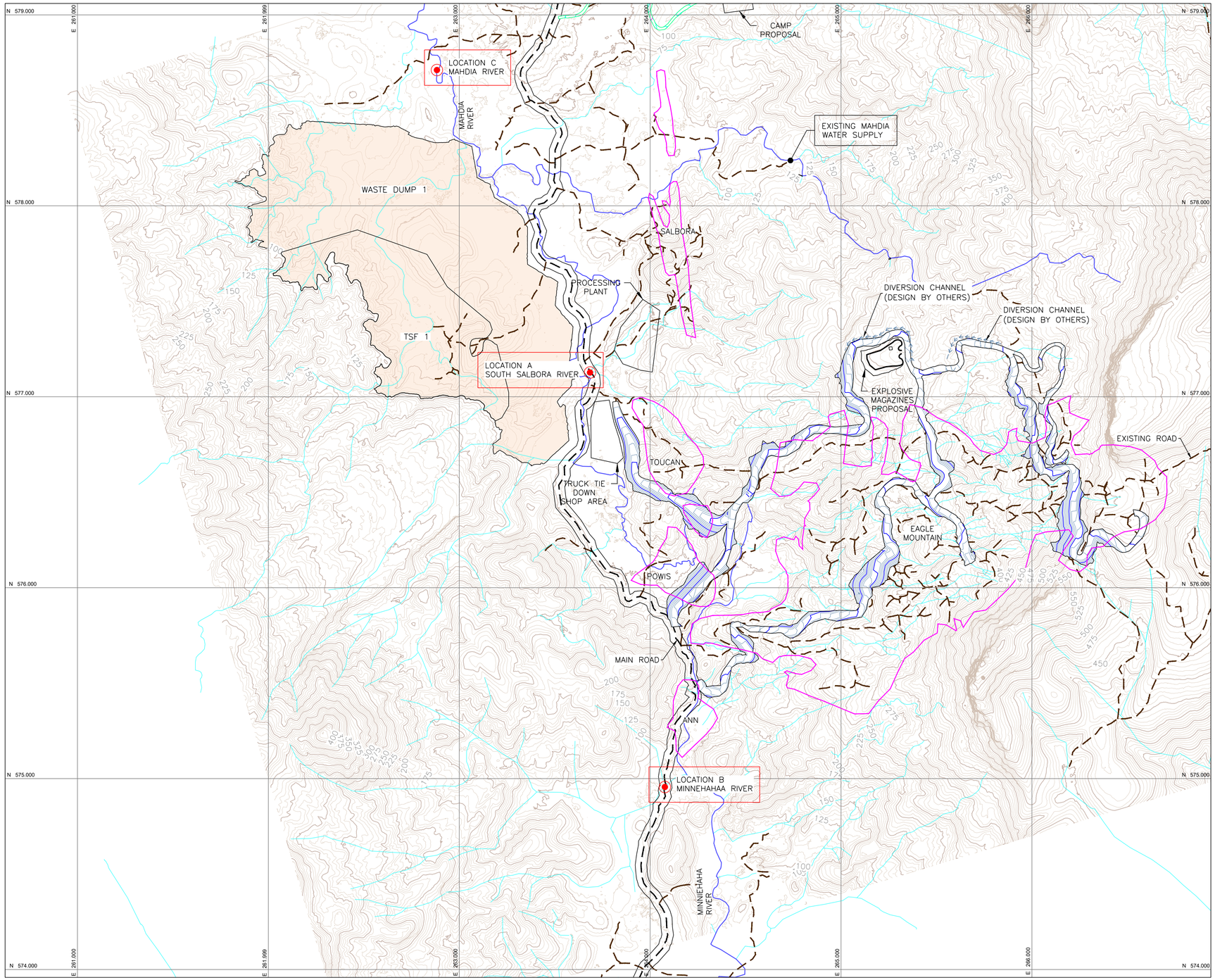

LEGEND

- EXISTING GROUND, CONTOURS AND ELEVATION 5–25 METERS
- FOOTPRINTS GRE DESIGN PROPOSAL
- DESIGN SURFACES BY OTHERS (MAKO MINING CORP.) CONTOURS AND ELEVATION 5–25 METERS
- PROPOSAL/INVESTIGATION AREA
- MAIN ROAD
- ROADS (LENGHT AND AVERAGE SLOPE)
- RIVERS (TRIBUTARY)
- RIVERS (MAIN)
- PIT AREAS
- DIVERSION CHANNEL DESIGN BY OTHERS (MAKO MINING CORP.)
- CODE NAME RIVER — WATER MONITORING

WATER MONITORING LOCATIONS			
NAME	CODE	NORTHING	EASTING
MAHDIA RIVER	LOCATION C	578,711.00	262,883.00
MINNEHAHAA RIVER	LOCATION B	574,956.00	264,077.00
SOUTH SALBORA RIVER	LOCATION A	577,127.00	263,685.00

NOTES:

1. THE TOPOGRAPHY OF THE NATURAL TERRAIN OF THE PROJECT WAS PROVIDED BY MAKO MINING CORP.
2. THE ROADS SURFACE IN THE AREA CALLED EAGLE MOUNTAIN WERE BUILT BY MAKO MINING CORP.
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4. EACH MAGENTA ZONES IS A PROPOSED AREA FOR PIT ACTIVITY. THESE AREAS DO NOT REPRESENTS FINAL LIMITED PIT, THEY WOULD BE CHANGED.
5. ANN PIT IS A PROPOSAL ZONE.

N W E S

220 0 220 440 METERS

1:11,000 TO (ANSI-D)
1:22,000 TO (ANSI-B)

BASE TOPOGRAPHY CONTOUR INTERVAL: 5 METERS

No.	Description	By	Date
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01	2023 LIDAR SURVEY, JULY, 15 2023	CLIENT	07/23

REFERENCES

Rev	By	Apr	Description	Date
0	ER	LB	ISSUED FOR CLIENT	10/20/25

REVISIONS

SCALE: AS SHOWN

Design: GRE
Draw: ER
Revised by: LB
Aprobed by: LB

Prepared by: GRE GLOBAL RESOURCE ENGINEERING

Prepared for: MAKO MINING CORP.

Title: WATER MONITORING LOCATIONS

0 REVISION

Project: PRE–FEASIBILITY STUDY

Project No. 24–1450

Date: MARCH 2026

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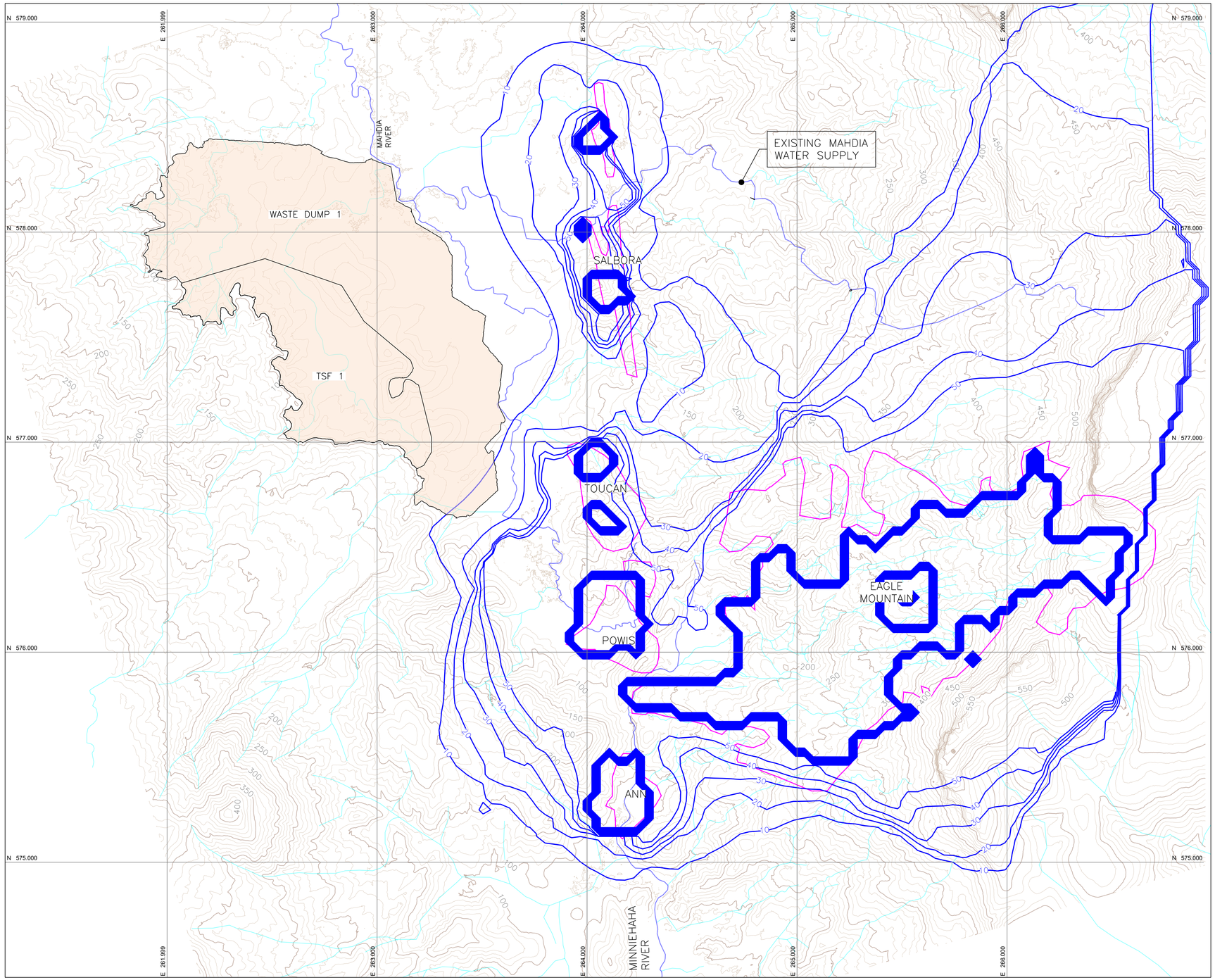

LEGEND

- EXISTING GROUND, CONTOURS AND ELEVATION 10–50 METERS
- RIVERS (TRIBUTARY)
- RIVERS (MAIN)
- PIT AREAS
- WATER LEVEL (UNDERGROUND)

NOTES:

1. THE TOPOGRAPHY OF THE NATURAL TERRAIN OF THE PROJECT WAS PROVIDED BY MAKO MINING CORP.
2. EACH MAGENTA ZONES IS A PROPOSED AREA FOR PIT ACTIVITY. THESE AREAS DO NOT REPRESENTS FINAL LIMITED PIT, THEY WOULD BE CHANGED.
3. ANN PIT IS A PROPOSAL ZONE.

N W E S

200 0 200 400 METERS

1:10,000 (ANSI-D)
1:20,000 (ANSI-B)

BASE TOPOGRAPHY CONTOUR INTERVAL: 10 METERS

No.	Description	By	Date
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01	2023 LIDAR SURVEY, JULY, 15 2023	CLIENT	07/23

REFERENCES

Rev	By	Apr	Description	Date
0	ER	LB	ISSUED FOR CLIENT	10/20/25

REVISIONS

SCALE: AS SHOWN

Design: GRE
Draw: ER
Revised by: LB
Aprobed by: LB

Prepared by: GLOBAL RESOURCE ENGINEERING

Prepared for: MAKO MINING CORP.

Title: LAYER 1: SAPROLITE AND ALLUIVUM / COLLUVIUM

0 REVISION

Project: PRE–FEASIBILITY STUDY

Project No. 24–1450

Date: MARCH 2026

DRAWING 04

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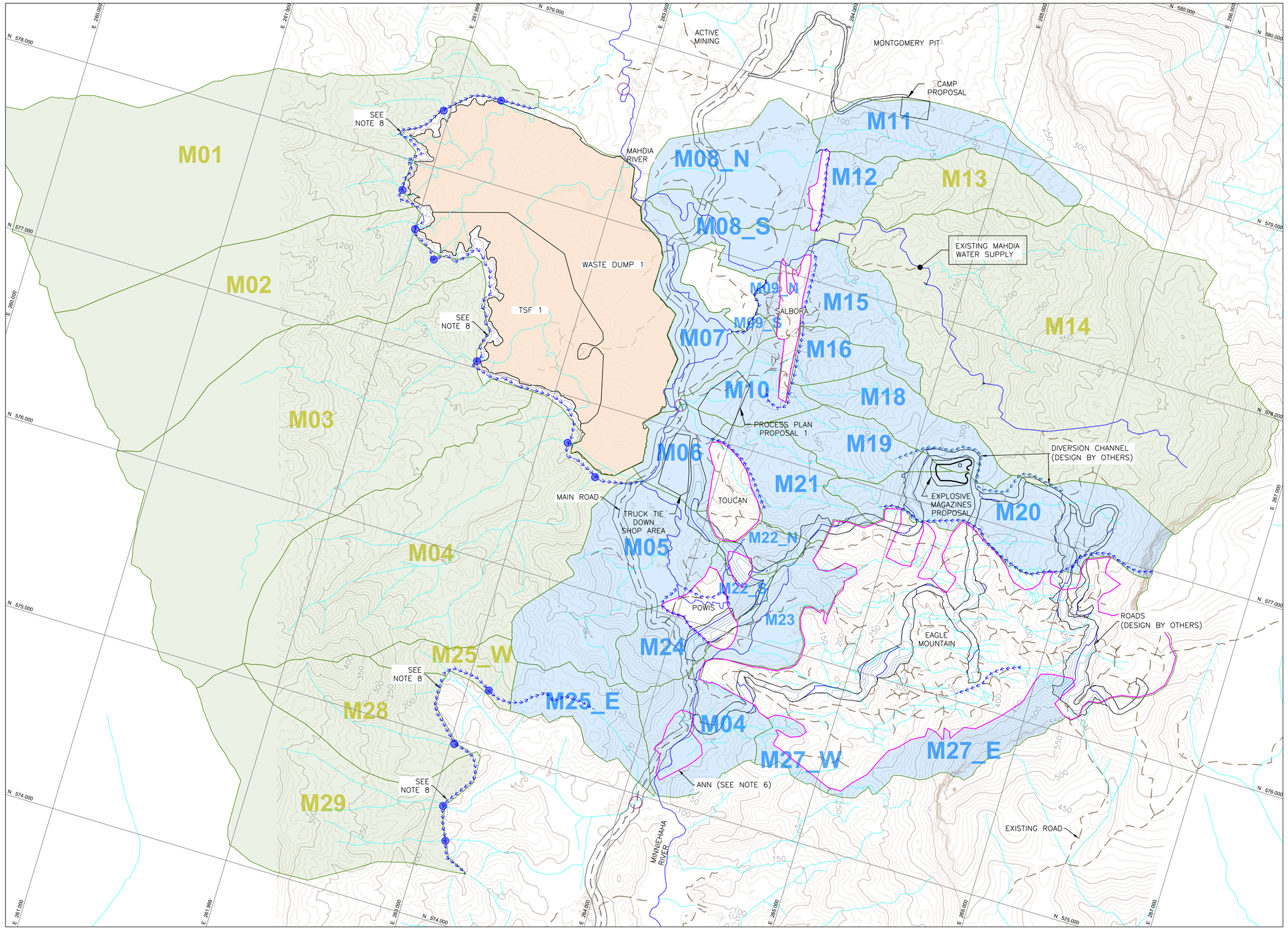
Drawing 5



LEGEND
(SALVO DENOTADO LO CONTRARIO)

- EXISTING GROUND, CONTOURS AND ELEVATION 25–50 METERS
- FOOTPRINTS GRE DESIGN PROPOSAL
- DESIGN SURFACES BY OTHERS (MAKO MINING CORP.) CONTOURS AND ELEVATION 25–50 METERS
- CONTACT SUB WATER SHED
- NON CONTACT SUB WATER SHED
- PROPOSAL AREA
- MAIN ROAD
- ROADS (LENGHT AND AVERAGE SLOPE)
- RIVERS (TRIBUTARY)
- RIVERS (MAIN)
- PIT AREAS
- DIVERSION CHANNEL DESIGN BY OTHERS (MAKO MINING CORP.)
- DITCHS DESIGN
- POND LOCATION PROPOSAL
- MAKO MINING CORP. MONITORING LOCATIONS

NOTES:

1. THIS PLAN SHOWS THE NATURAL RUNOFF AND STORM DRAINAGE, AS WELL AS THE DIRECTION AND EXTENSIONS OF THE BASIN. THIS DEFINES THE NATURAL OUTFLOW AND THE CATCHMENT AREA FOR THE PROJECT FLOW (DESIGN STORM), WHICH WAS USED TO DESIGN THE WATER MANAGEMENT INFRASTRUCTURE IN ORDER TO PROTECT THE TSF1 FROM SATURATION.
2. THE TOPOGRAPHY OF THE NATURAL TERRAIN OF THE PROJECT WAS PROVIDED BY MAKO MINING CORP.
3. THE ROADS SURFACE IN THE AREA CALLED EAGLE MOUNTAIN WERE BUILT BY MAKO MINING CORP.
4. ANY DESIGN REFERRED TO AS "DESIGN BY OTHERS" WAS NOT PROPOSED BY
5. EACH MAGENTA ZONES IS A PROPOSED AREA FOR PIT ACTIVITY. THESE AREAS DO NOT REPRESENTS FINAL LIMITED PIT, THEY WOULD BE CHANGED.
6. ANN PIT IS A PROPOSAL ZONE.
7. PONDS AND CHANNELS WOULD BE CHANGED WITH MORE DETAIL WHEN PITS ZONE HAS BEEN DEFINED.
8. ARROWS ON DIVERSION CHANNELS MAY NO ALWAYS CONFORM WITH TOPOGRAPHIC GRADIENT. THIS DETAIL WILL BE RESOLVED IN SUBSEQUENT ENGINEERING PHASES.

N W E S

275 0 275 550 825
SCALE IN METERS
BASE TOPOGRAPHY CONTOUR INTERVAL: 10 MTS

No.	Description	By	Date
02	SURVEY COORDINATE SYSTEM IN PSAD5621 N	CLIENT	07/23
01	2023 LIDAR SURVEY, JULY, 15 2023	CLIENT	07/23

REFERENCES

Rev	By	Apr	Description	Date
0	ER	LB	ISSUED FOR CLIENT	10/20/25

REVISIONS

SCALE: AS SHOWN

Design: GRE
Draw: ER
Revised by: LB
Aprobed by: LB

Prepared by: GRE GLOBAL RESOURCE ENGINEERING

Prepared for: MAKO MINING CORP.

Title: PROPOSED WATERSHED AND WATER MANAGEMENT PLAN

0 REVISION

Project: PRE–FEASIBILITY STUDY

Project No. 24–1450

Date: MARCH 2026

DRAWING 05

LOCATION: D:\Documentos\001–Global Resource\06–Eagle Mountain\Larry\Información actual\02–Eagle Montain Project\Planos\ERM–Drawings\07–EM–ProposedWatershedWaterManagementPlan.dwg DATE: 3/9/2026 9:28 a.m. PLOT SCALE = 1:25.4 PLOTTED BY: LUIS A. C.L.

APPENDIX A

TSF1 SCENARIO OVERFLOW RESULTS

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	0
2/4/2045	0
2/5/2045	0
2/6/2045	0
2/7/2045	0
2/8/2045	0
2/9/2045	0
2/10/2045	0
2/11/2045	0
2/12/2045	0
2/13/2045	0
2/14/2045	0
2/15/2045	0
2/16/2045	0
2/17/2045	0
2/18/2045	0
2/19/2045	0
2/20/2045	0
2/21/2045	0
2/22/2045	0
2/23/2045	0
2/24/2045	0
2/25/2045	0
2/26/2045	0
2/27/2045	0
2/28/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	0
3/2/2045	0
3/3/2045	0
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4/30/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
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6/27/2045	0
6/28/2045	0
6/29/2045	0
6/30/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	0
7/2/2045	0
7/3/2045	0
7/4/2045	0
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8/28/2045	0
8/29/2045	0
8/30/2045	0
8/31/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
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9/3/2045	0
9/4/2045	0
9/5/2045	0
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10/28/2045	0
10/29/2045	0
10/30/2045	0
10/31/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	0
11/2/2045	0
11/3/2045	0
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12/27/2045	0
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12/29/2045	0
12/30/2045	0
12/31/2045	0
1/1/2046	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
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1/2/2045	0
1/3/2045	0
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2/25/2045	0
2/26/2045	0
2/27/2045	0
2/28/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
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3/2/2045	0
3/3/2045	0
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4/29/2045	0
4/30/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
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6/28/2045	0
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TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
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8/30/2045	0
8/31/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
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10/28/2045	0
10/29/2045	0
10/30/2045	0
10/31/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	0
11/2/2045	0
11/3/2045	0
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12/30/2045	0
12/31/2045	0
1/1/2046	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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1/3/2045	0
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2/28/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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4/19/2045	0
4/20/2045	0
4/21/2045	0
4/22/2045	0
4/23/2045	0
4/24/2045	0
4/25/2045	0
4/26/2045	0
4/27/2045	0
4/28/2045	0
4/29/2045	0
4/30/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	0
5/2/2045	0
5/3/2045	0
5/4/2045	0
5/5/2045	0
5/6/2045	0
5/7/2045	0
5/8/2045	0
5/9/2045	0
5/10/2045	0
5/11/2045	0
5/12/2045	0
5/13/2045	0
5/14/2045	0
5/15/2045	0
5/16/2045	0
5/17/2045	0
5/18/2045	0
5/19/2045	0
5/20/2045	0
5/21/2045	0
5/22/2045	0
5/23/2045	0
5/24/2045	0
5/25/2045	0
5/26/2045	0
5/27/2045	0
5/28/2045	0
5/29/2045	0
5/30/2045	0
5/31/2045	0
6/1/2045	0
6/2/2045	0
6/3/2045	0
6/4/2045	0
6/5/2045	0
6/6/2045	0
6/7/2045	0
6/8/2045	0
6/9/2045	0
6/10/2045	0
6/11/2045	0
6/12/2045	0
6/13/2045	0
6/14/2045	0
6/15/2045	0
6/16/2045	0
6/17/2045	0
6/18/2045	0
6/19/2045	0
6/20/2045	0
6/21/2045	0
6/22/2045	0
6/23/2045	0
6/24/2045	0
6/25/2045	0
6/26/2045	0
6/27/2045	0
6/28/2045	0
6/29/2045	0
6/30/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	0
7/2/2045	0
7/3/2045	0
7/4/2045	0
7/5/2045	0
7/6/2045	0
7/7/2045	0
7/8/2045	0
7/9/2045	0
7/10/2045	0
7/11/2045	0
7/12/2045	0
7/13/2045	0
7/14/2045	0
7/15/2045	0
7/16/2045	0
7/17/2045	0
7/18/2045	0
7/19/2045	0
7/20/2045	0
7/21/2045	0
7/22/2045	0
7/23/2045	0
7/24/2045	0
7/25/2045	0
7/26/2045	0
7/27/2045	0
7/28/2045	0
7/29/2045	0
7/30/2045	0
7/31/2045	0
8/1/2045	0
8/2/2045	0
8/3/2045	0
8/4/2045	0
8/5/2045	0
8/6/2045	0
8/7/2045	0
8/8/2045	0
8/9/2045	0
8/10/2045	0
8/11/2045	0
8/12/2045	0
8/13/2045	0
8/14/2045	0
8/15/2045	0
8/16/2045	0
8/17/2045	0
8/18/2045	0
8/19/2045	0
8/20/2045	0
8/21/2045	0
8/22/2045	0
8/23/2045	0
8/24/2045	0
8/25/2045	0
8/26/2045	0
8/27/2045	0
8/28/2045	0
8/29/2045	0
8/30/2045	0
8/31/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
9/1/2045	0
9/2/2045	0
9/3/2045	0
9/4/2045	0
9/5/2045	0
9/6/2045	0
9/7/2045	0
9/8/2045	0
9/9/2045	0
9/10/2045	0
9/11/2045	0
9/12/2045	0
9/13/2045	0
9/14/2045	0
9/15/2045	0
9/16/2045	0
9/17/2045	0
9/18/2045	0
9/19/2045	0
9/20/2045	0
9/21/2045	0
9/22/2045	0
9/23/2045	0
9/24/2045	0
9/25/2045	0
9/26/2045	0
9/27/2045	0
9/28/2045	0
9/29/2045	0
9/30/2045	0
10/1/2045	0
10/2/2045	0
10/3/2045	0
10/4/2045	0
10/5/2045	0
10/6/2045	0
10/7/2045	0
10/8/2045	0
10/9/2045	0
10/10/2045	0
10/11/2045	0
10/12/2045	0
10/13/2045	0
10/14/2045	0
10/15/2045	0
10/16/2045	0
10/17/2045	0
10/18/2045	0
10/19/2045	0
10/20/2045	0
10/21/2045	0
10/22/2045	0
10/23/2045	0
10/24/2045	0
10/25/2045	0
10/26/2045	0
10/27/2045	0
10/28/2045	0
10/29/2045	0
10/30/2045	0
10/31/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	0
11/2/2045	0
11/3/2045	0
11/4/2045	0
11/5/2045	0
11/6/2045	0
11/7/2045	0
11/8/2045	0
11/9/2045	0
11/10/2045	0
11/11/2045	0
11/12/2045	0
11/13/2045	0
11/14/2045	0
11/15/2045	0
11/16/2045	0
11/17/2045	0
11/18/2045	0
11/19/2045	0
11/20/2045	0
11/21/2045	0
11/22/2045	0
11/23/2045	0
11/24/2045	0
11/25/2045	0
11/26/2045	0
11/27/2045	0
11/28/2045	0
11/29/2045	0
11/30/2045	0
12/1/2045	0
12/2/2045	0
12/3/2045	0
12/4/2045	0
12/5/2045	0
12/6/2045	0
12/7/2045	0
12/8/2045	0
12/9/2045	0
12/10/2045	0
12/11/2045	0
12/12/2045	0
12/13/2045	0
12/14/2045	0
12/15/2045	0
12/16/2045	0
12/17/2045	0
12/18/2045	0
12/19/2045	0
12/20/2045	0
12/21/2045	0
12/22/2045	0
12/23/2045	0
12/24/2045	0
12/25/2045	0
12/26/2045	0
12/27/2045	0
12/28/2045	0
12/29/2045	0
12/30/2045	0
12/31/2045	0
1/1/2046	0

APPENDIX B

TSF2 SCENARIO OVERFLOW RESULTS

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	10229
2/4/2045	10229
2/5/2045	17564
2/6/2045	17564
2/7/2045	20546
2/8/2045	32821
2/9/2045	32821
2/10/2045	32821
2/11/2045	32821
2/12/2045	32821
2/13/2045	33936
2/14/2045	33936
2/15/2045	33936
2/16/2045	33936
2/17/2045	39031
2/18/2045	42370
2/19/2045	49991
2/20/2045	53356
2/21/2045	65269
2/22/2045	65269
2/23/2045	65269
2/24/2045	73362
2/25/2045	74894
2/26/2045	75145
2/27/2045	75145
2/28/2045	75145

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	0
2/4/2045	0
2/5/2045	0
2/6/2045	0
2/7/2045	0
2/8/2045	0
2/9/2045	0
2/10/2045	0
2/11/2045	0
2/12/2045	0
2/13/2045	0
2/14/2045	0
2/15/2045	0
2/16/2045	0
2/17/2045	0
2/18/2045	0
2/19/2045	0
2/20/2045	0
2/21/2045	0
2/22/2045	0
2/23/2045	0
2/24/2045	0
2/25/2045	0
2/26/2045	0
2/27/2045	0
2/28/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	75145
3/2/2045	75145
3/3/2045	75145
3/4/2045	75145
3/5/2045	75145
3/6/2045	75145
3/7/2045	75145
3/8/2045	75145
3/9/2045	75145
3/10/2045	75145
3/11/2045	75145
3/12/2045	75145
3/13/2045	75145
3/14/2045	75145
3/15/2045	75145
3/16/2045	75145
3/17/2045	75145
3/18/2045	75145
3/19/2045	75145
3/20/2045	75145
3/21/2045	75145
3/22/2045	75145
3/23/2045	75145
3/24/2045	75145
3/25/2045	75145
3/26/2045	75145
3/27/2045	75145
3/28/2045	75145
3/29/2045	75145
3/30/2045	75145
3/31/2045	75145
4/1/2045	75145
4/2/2045	75145
4/3/2045	75145
4/4/2045	75145
4/5/2045	75145
4/6/2045	75145
4/7/2045	75145
4/8/2045	77049
4/9/2045	77049
4/10/2045	77049
4/11/2045	77049
4/12/2045	77049
4/13/2045	77049
4/14/2045	77049
4/15/2045	77049
4/16/2045	77049
4/17/2045	77049
4/18/2045	77049
4/19/2045	77049
4/20/2045	77049
4/21/2045	77049
4/22/2045	77049
4/23/2045	77049
4/24/2045	77049
4/25/2045	77049
4/26/2045	77049
4/27/2045	77049
4/28/2045	77049
4/29/2045	77049
4/30/2045	77049

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	0
3/2/2045	0
3/3/2045	0
3/4/2045	0
3/5/2045	0
3/6/2045	0
3/7/2045	0
3/8/2045	0
3/9/2045	0
3/10/2045	0
3/11/2045	0
3/12/2045	0
3/13/2045	0
3/14/2045	0
3/15/2045	0
3/16/2045	0
3/17/2045	0
3/18/2045	0
3/19/2045	0
3/20/2045	0
3/21/2045	0
3/22/2045	0
3/23/2045	0
3/24/2045	0
3/25/2045	0
3/26/2045	0
3/27/2045	0
3/28/2045	0
3/29/2045	0
3/30/2045	0
3/31/2045	0
4/1/2045	0
4/2/2045	0
4/3/2045	0
4/4/2045	0
4/5/2045	0
4/6/2045	0
4/7/2045	0
4/8/2045	0
4/9/2045	0
4/10/2045	0
4/11/2045	0
4/12/2045	0
4/13/2045	0
4/14/2045	0
4/15/2045	0
4/16/2045	0
4/17/2045	0
4/18/2045	0
4/19/2045	0
4/20/2045	0
4/21/2045	0
4/22/2045	0
4/23/2045	0
4/24/2045	0
4/25/2045	0
4/26/2045	0
4/27/2045	0
4/28/2045	0
4/29/2045	0
4/30/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	77049
5/2/2045	77049
5/3/2045	77049
5/4/2045	77049
5/5/2045	77049
5/6/2045	77049
5/7/2045	77049
5/8/2045	77049
5/9/2045	77049
5/10/2045	77049
5/11/2045	80751
5/12/2045	109185
5/13/2045	116524
5/14/2045	126576
5/15/2045	126576
5/16/2045	134670
5/17/2045	140990
5/18/2045	156813
5/19/2045	157034
5/20/2045	167307
5/21/2045	183913
5/22/2045	193136
5/23/2045	193136
5/24/2045	193136
5/25/2045	193136
5/26/2045	193136
5/27/2045	193961
5/28/2045	193961
5/29/2045	193966
5/30/2045	193966
5/31/2045	193966
6/1/2045	201712
6/2/2045	205882
6/3/2045	206366
6/4/2045	206366
6/5/2045	206366
6/6/2045	206366
6/7/2045	213837
6/8/2045	213837
6/9/2045	213837
6/10/2045	234715
6/11/2045	258465
6/12/2045	274463
6/13/2045	275253
6/14/2045	275573
6/15/2045	303687
6/16/2045	305049
6/17/2045	305049
6/18/2045	311245
6/19/2045	311245
6/20/2045	311245
6/21/2045	311449
6/22/2045	311449
6/23/2045	311449
6/24/2045	311449
6/25/2045	311449
6/26/2045	313686
6/27/2045	313686
6/28/2045	323754
6/29/2045	356512
6/30/2045	356512

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	0
5/2/2045	0
5/3/2045	0
5/4/2045	0
5/5/2045	0
5/6/2045	0
5/7/2045	0
5/8/2045	0
5/9/2045	0
5/10/2045	0
5/11/2045	0
5/12/2045	0
5/13/2045	0
5/14/2045	0
5/15/2045	0
5/16/2045	0
5/17/2045	0
5/18/2045	0
5/19/2045	0
5/20/2045	0
5/21/2045	0
5/22/2045	0
5/23/2045	0
5/24/2045	0
5/25/2045	0
5/26/2045	0
5/27/2045	0
5/28/2045	0
5/29/2045	0
5/30/2045	0
5/31/2045	0
6/1/2045	0
6/2/2045	0
6/3/2045	0
6/4/2045	0
6/5/2045	0
6/6/2045	0
6/7/2045	0
6/8/2045	0
6/9/2045	0
6/10/2045	0
6/11/2045	0
6/12/2045	0
6/13/2045	0
6/14/2045	0
6/15/2045	0
6/16/2045	0
6/17/2045	0
6/18/2045	0
6/19/2045	0
6/20/2045	0
6/21/2045	0
6/22/2045	0
6/23/2045	0
6/24/2045	0
6/25/2045	0
6/26/2045	0
6/27/2045	0
6/28/2045	0
6/29/2045	0
6/30/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	356512
7/2/2045	356512
7/3/2045	356512
7/4/2045	356512
7/5/2045	356582
7/6/2045	356582
7/7/2045	356582
7/8/2045	356582
7/9/2045	356582
7/10/2045	356582
7/11/2045	356582
7/12/2045	356582
7/13/2045	356582
7/14/2045	356582
7/15/2045	356582
7/16/2045	356582
7/17/2045	356582
7/18/2045	356582
7/19/2045	356582
7/20/2045	356582
7/21/2045	356582
7/22/2045	356582
7/23/2045	356582
7/24/2045	356582
7/25/2045	356582
7/26/2045	356582
7/27/2045	356582
7/28/2045	356582
7/29/2045	356582
7/30/2045	356582
7/31/2045	356582
8/1/2045	356582
8/2/2045	356582
8/3/2045	356582
8/4/2045	356582
8/5/2045	356582
8/6/2045	356582
8/7/2045	356582
8/8/2045	356582
8/9/2045	356582
8/10/2045	356582
8/11/2045	356582
8/12/2045	356582
8/13/2045	356582
8/14/2045	356582
8/15/2045	356582
8/16/2045	356582
8/17/2045	356582
8/18/2045	356582
8/19/2045	356582
8/20/2045	356582
8/21/2045	356582
8/22/2045	356582
8/23/2045	356582
8/24/2045	356582
8/25/2045	356582
8/26/2045	356582
8/27/2045	356582
8/28/2045	356582
8/29/2045	356582
8/30/2045	356582
8/31/2045	356582

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	0
7/2/2045	0
7/3/2045	0
7/4/2045	0
7/5/2045	0
7/6/2045	0
7/7/2045	0
7/8/2045	0
7/9/2045	0
7/10/2045	0
7/11/2045	0
7/12/2045	0
7/13/2045	0
7/14/2045	0
7/15/2045	0
7/16/2045	0
7/17/2045	0
7/18/2045	0
7/19/2045	0
7/20/2045	0
7/21/2045	0
7/22/2045	0
7/23/2045	0
7/24/2045	0
7/25/2045	0
7/26/2045	0
7/27/2045	0
7/28/2045	0
7/29/2045	0
7/30/2045	0
7/31/2045	0
8/1/2045	0
8/2/2045	0
8/3/2045	0
8/4/2045	0
8/5/2045	0
8/6/2045	0
8/7/2045	0
8/8/2045	0
8/9/2045	0
8/10/2045	0
8/11/2045	0
8/12/2045	0
8/13/2045	0
8/14/2045	0
8/15/2045	0
8/16/2045	0
8/17/2045	0
8/18/2045	0
8/19/2045	0
8/20/2045	0
8/21/2045	0
8/22/2045	0
8/23/2045	0
8/24/2045	0
8/25/2045	0
8/26/2045	0
8/27/2045	0
8/28/2045	0
8/29/2045	0
8/30/2045	0
8/31/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
9/1/2045	356582
9/2/2045	356582
9/3/2045	356582
9/4/2045	356582
9/5/2045	356582
9/6/2045	356582
9/7/2045	356582
9/8/2045	356582
9/9/2045	356582
9/10/2045	356582
9/11/2045	356582
9/12/2045	356582
9/13/2045	356582
9/14/2045	356582
9/15/2045	356582
9/16/2045	356582
9/17/2045	356582
9/18/2045	356582
9/19/2045	356582
9/20/2045	356582
9/21/2045	356582
9/22/2045	356582
9/23/2045	356582
9/24/2045	356582
9/25/2045	356582
9/26/2045	356582
9/27/2045	356582
9/28/2045	356582
9/29/2045	356582
9/30/2045	356582
10/1/2045	356582
10/2/2045	356582
10/3/2045	356582
10/4/2045	356582
10/5/2045	356582
10/6/2045	356582
10/7/2045	356582
10/8/2045	356582
10/9/2045	356582
10/10/2045	356582
10/11/2045	356582
10/12/2045	356582
10/13/2045	356582
10/14/2045	356582
10/15/2045	356582
10/16/2045	356582
10/17/2045	356582
10/18/2045	356582
10/19/2045	356582
10/20/2045	356582
10/21/2045	356582
10/22/2045	356582
10/23/2045	356582
10/24/2045	356582
10/25/2045	356582
10/26/2045	356582
10/27/2045	356582
10/28/2045	356582
10/29/2045	356582
10/30/2045	356582
10/31/2045	356582

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
9/1/2045	0
9/2/2045	0
9/3/2045	0
9/4/2045	0
9/5/2045	0
9/6/2045	0
9/7/2045	0
9/8/2045	0
9/9/2045	0
9/10/2045	0
9/11/2045	0
9/12/2045	0
9/13/2045	0
9/14/2045	0
9/15/2045	0
9/16/2045	0
9/17/2045	0
9/18/2045	0
9/19/2045	0
9/20/2045	0
9/21/2045	0
9/22/2045	0
9/23/2045	0
9/24/2045	0
9/25/2045	0
9/26/2045	0
9/27/2045	0
9/28/2045	0
9/29/2045	0
9/30/2045	0
10/1/2045	0
10/2/2045	0
10/3/2045	0
10/4/2045	0
10/5/2045	0
10/6/2045	0
10/7/2045	0
10/8/2045	0
10/9/2045	0
10/10/2045	0
10/11/2045	0
10/12/2045	0
10/13/2045	0
10/14/2045	0
10/15/2045	0
10/16/2045	0
10/17/2045	0
10/18/2045	0
10/19/2045	0
10/20/2045	0
10/21/2045	0
10/22/2045	0
10/23/2045	0
10/24/2045	0
10/25/2045	0
10/26/2045	0
10/27/2045	0
10/28/2045	0
10/29/2045	0
10/30/2045	0
10/31/2045	0

TSF1 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	356582
11/2/2045	356582
11/3/2045	356582
11/4/2045	356582
11/5/2045	356582
11/6/2045	356582
11/7/2045	356582
11/8/2045	356582
11/9/2045	356582
11/10/2045	356582
11/11/2045	356582
11/12/2045	356582
11/13/2045	356582
11/14/2045	356582
11/15/2045	356582
11/16/2045	356582
11/17/2045	356582
11/18/2045	356582
11/19/2045	356582
11/20/2045	356582
11/21/2045	356582
11/22/2045	356582
11/23/2045	356582
11/24/2045	356582
11/25/2045	356582
11/26/2045	356582
11/27/2045	356582
11/28/2045	356582
11/29/2045	356582
11/30/2045	356582
12/1/2045	356582
12/2/2045	356582
12/3/2045	356582
12/4/2045	356582
12/5/2045	356582
12/6/2045	356582
12/7/2045	356582
12/8/2045	356582
12/9/2045	356582
12/10/2045	356582
12/11/2045	356582
12/12/2045	356582
12/13/2045	356582
12/14/2045	356582
12/15/2045	356582
12/16/2045	356582
12/17/2045	356582
12/18/2045	356582
12/19/2045	356582
12/20/2045	356582
12/21/2045	356582
12/22/2045	356582
12/23/2045	356582
12/24/2045	356582
12/25/2045	356582
12/26/2045	356582
12/27/2045	356582
12/28/2045	356582
12/29/2045	356582
12/30/2045	356582
12/31/2045	356582
1/1/2046	356582

TSF2 DRY SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	0
11/2/2045	0
11/3/2045	0
11/4/2045	0
11/5/2045	0
11/6/2045	0
11/7/2045	0
11/8/2045	0
11/9/2045	0
11/10/2045	0
11/11/2045	0
11/12/2045	0
11/13/2045	0
11/14/2045	0
11/15/2045	0
11/16/2045	0
11/17/2045	0
11/18/2045	0
11/19/2045	0
11/20/2045	0
11/21/2045	0
11/22/2045	0
11/23/2045	0
11/24/2045	0
11/25/2045	0
11/26/2045	0
11/27/2045	0
11/28/2045	0
11/29/2045	0
11/30/2045	0
12/1/2045	0
12/2/2045	0
12/3/2045	0
12/4/2045	0
12/5/2045	0
12/6/2045	0
12/7/2045	0
12/8/2045	0
12/9/2045	0
12/10/2045	0
12/11/2045	0
12/12/2045	0
12/13/2045	0
12/14/2045	0
12/15/2045	0
12/16/2045	0
12/17/2045	0
12/18/2045	0
12/19/2045	0
12/20/2045	0
12/21/2045	0
12/22/2045	0
12/23/2045	0
12/24/2045	0
12/25/2045	0
12/26/2045	0
12/27/2045	0
12/28/2045	0
12/29/2045	0
12/30/2045	0
12/31/2045	0
1/1/2046	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	0
2/4/2045	0
2/5/2045	0
2/6/2045	0
2/7/2045	0
2/8/2045	0
2/9/2045	0
2/10/2045	0
2/11/2045	0
2/12/2045	0
2/13/2045	0
2/14/2045	0
2/15/2045	0
2/16/2045	0
2/17/2045	0
2/18/2045	31.17
2/19/2045	31.17
2/20/2045	10953
2/21/2045	16485
2/22/2045	33053
2/23/2045	33156
2/24/2045	33156
2/25/2045	33156
2/26/2045	33156
2/27/2045	33156
2/28/2045	51422

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	0
2/4/2045	0
2/5/2045	0
2/6/2045	0
2/7/2045	0
2/8/2045	0
2/9/2045	0
2/10/2045	0
2/11/2045	0
2/12/2045	0
2/13/2045	0
2/14/2045	0
2/15/2045	0
2/16/2045	0
2/17/2045	0
2/18/2045	0
2/19/2045	0
2/20/2045	0
2/21/2045	0
2/22/2045	0
2/23/2045	0
2/24/2045	0
2/25/2045	0
2/26/2045	0
2/27/2045	0
2/28/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	57944
3/2/2045	62659
3/3/2045	62659
3/4/2045	62659
3/5/2045	62659
3/6/2045	62659
3/7/2045	62659
3/8/2045	62659
3/9/2045	62659
3/10/2045	62659
3/11/2045	62659
3/12/2045	62659
3/13/2045	62659
3/14/2045	62659
3/15/2045	62659
3/16/2045	62659
3/17/2045	62659
3/18/2045	62659
3/19/2045	62659
3/20/2045	62659
3/21/2045	62659
3/22/2045	62659
3/23/2045	62659
3/24/2045	62659
3/25/2045	62659
3/26/2045	62659
3/27/2045	62659
3/28/2045	62659
3/29/2045	62659
3/30/2045	62659
3/31/2045	62659
4/1/2045	62659
4/2/2045	62659
4/3/2045	62659
4/4/2045	62659
4/5/2045	62659
4/6/2045	62659
4/7/2045	62659
4/8/2045	62659
4/9/2045	62659
4/10/2045	62659
4/11/2045	62659
4/12/2045	62659
4/13/2045	62659
4/14/2045	62659
4/15/2045	62659
4/16/2045	62659
4/17/2045	62659
4/18/2045	62659
4/19/2045	62659
4/20/2045	62659
4/21/2045	62659
4/22/2045	62659
4/23/2045	62659
4/24/2045	62659
4/25/2045	62659
4/26/2045	62659
4/27/2045	62659
4/28/2045	62659
4/29/2045	62659
4/30/2045	62659

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	0
3/2/2045	0
3/3/2045	0
3/4/2045	0
3/5/2045	0
3/6/2045	0
3/7/2045	0
3/8/2045	0
3/9/2045	0
3/10/2045	0
3/11/2045	0
3/12/2045	0
3/13/2045	0
3/14/2045	0
3/15/2045	0
3/16/2045	0
3/17/2045	0
3/18/2045	0
3/19/2045	0
3/20/2045	0
3/21/2045	0
3/22/2045	0
3/23/2045	0
3/24/2045	0
3/25/2045	0
3/26/2045	0
3/27/2045	0
3/28/2045	0
3/29/2045	0
3/30/2045	0
3/31/2045	0
4/1/2045	0
4/2/2045	0
4/3/2045	0
4/4/2045	0
4/5/2045	0
4/6/2045	0
4/7/2045	0
4/8/2045	0
4/9/2045	0
4/10/2045	0
4/11/2045	0
4/12/2045	0
4/13/2045	0
4/14/2045	0
4/15/2045	0
4/16/2045	0
4/17/2045	0
4/18/2045	0
4/19/2045	0
4/20/2045	0
4/21/2045	0
4/22/2045	0
4/23/2045	0
4/24/2045	0
4/25/2045	0
4/26/2045	0
4/27/2045	0
4/28/2045	0
4/29/2045	0
4/30/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	62659
5/2/2045	62659
5/3/2045	62659
5/4/2045	62659
5/5/2045	62659
5/6/2045	62659
5/7/2045	62659
5/8/2045	62659
5/9/2045	66562
5/10/2045	66562
5/11/2045	66562
5/12/2045	69622
5/13/2045	72250
5/14/2045	80197
5/15/2045	80197
5/16/2045	82163
5/17/2045	84646
5/18/2045	92840
5/19/2045	95305
5/20/2045	122952
5/21/2045	123638
5/22/2045	127649
5/23/2045	127649
5/24/2045	127649
5/25/2045	130953
5/26/2045	130953
5/27/2045	143180
5/28/2045	143180
5/29/2045	143180
5/30/2045	143180
5/31/2045	143180
6/1/2045	143180
6/2/2045	153844
6/3/2045	154051
6/4/2045	154051
6/5/2045	160482
6/6/2045	160482
6/7/2045	160482
6/8/2045	168161
6/9/2045	168161
6/10/2045	168161
6/11/2045	168161
6/12/2045	168161
6/13/2045	185376
6/14/2045	219583
6/15/2045	225090
6/16/2045	225605
6/17/2045	234289
6/18/2045	234342
6/19/2045	234342
6/20/2045	246258
6/21/2045	246258
6/22/2045	246258
6/23/2045	246258
6/24/2045	246258
6/25/2045	247030
6/26/2045	247742
6/27/2045	247742
6/28/2045	251634
6/29/2045	258554
6/30/2045	269906

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	0
5/2/2045	0
5/3/2045	0
5/4/2045	0
5/5/2045	0
5/6/2045	0
5/7/2045	0
5/8/2045	0
5/9/2045	0
5/10/2045	0
5/11/2045	0
5/12/2045	0
5/13/2045	0
5/14/2045	0
5/15/2045	0
5/16/2045	0
5/17/2045	0
5/18/2045	0
5/19/2045	0
5/20/2045	0
5/21/2045	0
5/22/2045	0
5/23/2045	0
5/24/2045	0
5/25/2045	0
5/26/2045	0
5/27/2045	0
5/28/2045	0
5/29/2045	0
5/30/2045	0
5/31/2045	0
6/1/2045	0
6/2/2045	0
6/3/2045	0
6/4/2045	0
6/5/2045	0
6/6/2045	0
6/7/2045	0
6/8/2045	0
6/9/2045	0
6/10/2045	0
6/11/2045	0
6/12/2045	0
6/13/2045	0
6/14/2045	0
6/15/2045	0
6/16/2045	0
6/17/2045	0
6/18/2045	0
6/19/2045	0
6/20/2045	0
6/21/2045	0
6/22/2045	0
6/23/2045	0
6/24/2045	0
6/25/2045	0
6/26/2045	0
6/27/2045	0
6/28/2045	0
6/29/2045	0
6/30/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	270032
7/2/2045	271410
7/3/2045	271410
7/4/2045	271410
7/5/2045	271410
7/6/2045	271410
7/7/2045	271410
7/8/2045	279596
7/9/2045	291160
7/10/2045	291160
7/11/2045	293137
7/12/2045	293137
7/13/2045	293137
7/14/2045	296951
7/15/2045	296951
7/16/2045	296951
7/17/2045	307478
7/18/2045	309440
7/19/2045	309440
7/20/2045	311513
7/21/2045	312271
7/22/2045	315240
7/23/2045	331165
7/24/2045	331165
7/25/2045	331165
7/26/2045	331469
7/27/2045	331469
7/28/2045	331469
7/29/2045	340128
7/30/2045	344484
7/31/2045	344484
8/1/2045	344484
8/2/2045	344484
8/3/2045	344484
8/4/2045	344484
8/5/2045	348984
8/6/2045	348984
8/7/2045	348984
8/8/2045	348984
8/9/2045	353617
8/10/2045	354197
8/11/2045	360814
8/12/2045	361917
8/13/2045	361917
8/14/2045	361917
8/15/2045	364883
8/16/2045	365563
8/17/2045	365563
8/18/2045	365563
8/19/2045	365563
8/20/2045	365563
8/21/2045	365563
8/22/2045	365563
8/23/2045	365563
8/24/2045	365563
8/25/2045	365563
8/26/2045	365563
8/27/2045	365563
8/28/2045	365563
8/29/2045	365563
8/30/2045	365563
8/31/2045	365563

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	0
7/2/2045	0
7/3/2045	0
7/4/2045	0
7/5/2045	0
7/6/2045	0
7/7/2045	0
7/8/2045	0
7/9/2045	0
7/10/2045	0
7/11/2045	0
7/12/2045	0
7/13/2045	0
7/14/2045	0
7/15/2045	0
7/16/2045	0
7/17/2045	0
7/18/2045	0
7/19/2045	0
7/20/2045	0
7/21/2045	0
7/22/2045	0
7/23/2045	0
7/24/2045	0
7/25/2045	0
7/26/2045	0
7/27/2045	0
7/28/2045	0
7/29/2045	0
7/30/2045	0
7/31/2045	0
8/1/2045	0
8/2/2045	0
8/3/2045	0
8/4/2045	0
8/5/2045	0
8/6/2045	0
8/7/2045	0
8/8/2045	0
8/9/2045	0
8/10/2045	0
8/11/2045	0
8/12/2045	0
8/13/2045	0
8/14/2045	0
8/15/2045	0
8/16/2045	0
8/17/2045	0
8/18/2045	0
8/19/2045	0
8/20/2045	0
8/21/2045	0
8/22/2045	0
8/23/2045	0
8/24/2045	0
8/25/2045	0
8/26/2045	0
8/27/2045	0
8/28/2045	0
8/29/2045	0
8/30/2045	0
8/31/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
9/1/2045	365563
9/2/2045	365563
9/3/2045	365563
9/4/2045	365563
9/5/2045	365563
9/6/2045	365563
9/7/2045	365563
9/8/2045	365563
9/9/2045	365563
9/10/2045	365563
9/11/2045	365563
9/12/2045	365563
9/13/2045	365563
9/14/2045	365563
9/15/2045	365563
9/16/2045	365563
9/17/2045	365563
9/18/2045	365563
9/19/2045	365563
9/20/2045	365563
9/21/2045	365563
9/22/2045	365563
9/23/2045	365563
9/24/2045	365563
9/25/2045	365563
9/26/2045	365563
9/27/2045	365563
9/28/2045	365563
9/29/2045	365563
9/30/2045	365563
10/1/2045	365563
10/2/2045	365563
10/3/2045	365563
10/4/2045	365563
10/5/2045	365563
10/6/2045	365563
10/7/2045	365563
10/8/2045	365563
10/9/2045	365563
10/10/2045	365563
10/11/2045	365563
10/12/2045	365563
10/13/2045	365563
10/14/2045	365563
10/15/2045	365563
10/16/2045	365563
10/17/2045	365563
10/18/2045	365563
10/19/2045	365563
10/20/2045	365563
10/21/2045	365563
10/22/2045	365563
10/23/2045	365563
10/24/2045	365563
10/25/2045	365563
10/26/2045	365563
10/27/2045	365563
10/28/2045	365563
10/29/2045	365563
10/30/2045	365563
10/31/2045	365563

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
9/1/2045	0
9/2/2045	0
9/3/2045	0
9/4/2045	0
9/5/2045	0
9/6/2045	0
9/7/2045	0
9/8/2045	0
9/9/2045	0
9/10/2045	0
9/11/2045	0
9/12/2045	0
9/13/2045	0
9/14/2045	0
9/15/2045	0
9/16/2045	0
9/17/2045	0
9/18/2045	0
9/19/2045	0
9/20/2045	0
9/21/2045	0
9/22/2045	0
9/23/2045	0
9/24/2045	0
9/25/2045	0
9/26/2045	0
9/27/2045	0
9/28/2045	0
9/29/2045	0
9/30/2045	0
10/1/2045	0
10/2/2045	0
10/3/2045	0
10/4/2045	0
10/5/2045	0
10/6/2045	0
10/7/2045	0
10/8/2045	0
10/9/2045	0
10/10/2045	0
10/11/2045	0
10/12/2045	0
10/13/2045	0
10/14/2045	0
10/15/2045	0
10/16/2045	0
10/17/2045	0
10/18/2045	0
10/19/2045	0
10/20/2045	0
10/21/2045	0
10/22/2045	0
10/23/2045	0
10/24/2045	0
10/25/2045	0
10/26/2045	0
10/27/2045	0
10/28/2045	0
10/29/2045	0
10/30/2045	0
10/31/2045	0

TSF1 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	365563
11/2/2045	365563
11/3/2045	365563
11/4/2045	365563
11/5/2045	365563
11/6/2045	365563
11/7/2045	365563
11/8/2045	365563
11/9/2045	365563
11/10/2045	365563
11/11/2045	365563
11/12/2045	365563
11/13/2045	365563
11/14/2045	365563
11/15/2045	365563
11/16/2045	365563
11/17/2045	365563
11/18/2045	365563
11/19/2045	365563
11/20/2045	365563
11/21/2045	365563
11/22/2045	365563
11/23/2045	365563
11/24/2045	365563
11/25/2045	365563
11/26/2045	365563
11/27/2045	365563
11/28/2045	365563
11/29/2045	365563
11/30/2045	365563
12/1/2045	365563
12/2/2045	365563
12/3/2045	365563
12/4/2045	365563
12/5/2045	365563
12/6/2045	365563
12/7/2045	365563
12/8/2045	365563
12/9/2045	365563
12/10/2045	365563
12/11/2045	365563
12/12/2045	365563
12/13/2045	365563
12/14/2045	365563
12/15/2045	365563
12/16/2045	365563
12/17/2045	365563
12/18/2045	365563
12/19/2045	365563
12/20/2045	365563
12/21/2045	365563
12/22/2045	365563
12/23/2045	365563
12/24/2045	365563
12/25/2045	365563
12/26/2045	365563
12/27/2045	365563
12/28/2045	365563
12/29/2045	365563
12/30/2045	365563
12/31/2045	365563
1/1/2046	365563

TSF2 AVG SEASON	
Time	Accumulated Overflow
(Date)	m3
11/1/2045	0
11/2/2045	0
11/3/2045	0
11/4/2045	0
11/5/2045	0
11/6/2045	0
11/7/2045	0
11/8/2045	0
11/9/2045	0
11/10/2045	0
11/11/2045	0
11/12/2045	0
11/13/2045	0
11/14/2045	0
11/15/2045	0
11/16/2045	0
11/17/2045	0
11/18/2045	0
11/19/2045	0
11/20/2045	0
11/21/2045	0
11/22/2045	0
11/23/2045	0
11/24/2045	0
11/25/2045	0
11/26/2045	0
11/27/2045	0
11/28/2045	0
11/29/2045	0
11/30/2045	0
12/1/2045	0
12/2/2045	0
12/3/2045	0
12/4/2045	0
12/5/2045	0
12/6/2045	0
12/7/2045	0
12/8/2045	0
12/9/2045	0
12/10/2045	0
12/11/2045	0
12/12/2045	0
12/13/2045	0
12/14/2045	0
12/15/2045	0
12/16/2045	0
12/17/2045	0
12/18/2045	0
12/19/2045	0
12/20/2045	0
12/21/2045	0
12/22/2045	0
12/23/2045	0
12/24/2045	0
12/25/2045	0
12/26/2045	0
12/27/2045	0
12/28/2045	0
12/29/2045	0
12/30/2045	0
12/31/2045	0
1/1/2046	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	2613
1/7/2045	12055
1/8/2045	18676
1/9/2045	18676
1/10/2045	19913
1/11/2045	19913
1/12/2045	19913
1/13/2045	22441
1/14/2045	22441
1/15/2045	22441
1/16/2045	22441
1/17/2045	22441
1/18/2045	22441
1/19/2045	22441
1/20/2045	22441
1/21/2045	22441
1/22/2045	23334
1/23/2045	23334
1/24/2045	26484
1/25/2045	28290
1/26/2045	28290
1/27/2045	28290
1/28/2045	28290
1/29/2045	28290
1/30/2045	28290
1/31/2045	28290
2/1/2045	28290
2/2/2045	28290
2/3/2045	28290
2/4/2045	28290
2/5/2045	28290
2/6/2045	28290
2/7/2045	28290
2/8/2045	28290
2/9/2045	28290
2/10/2045	28290
2/11/2045	28290
2/12/2045	28290
2/13/2045	28290
2/14/2045	28290
2/15/2045	42702
2/16/2045	42702
2/17/2045	42702
2/18/2045	42702
2/19/2045	42702
2/20/2045	42702
2/21/2045	42702
2/22/2045	46054
2/23/2045	60164
2/24/2045	60164
2/25/2045	60164
2/26/2045	60164
2/27/2045	60164
2/28/2045	60164

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
1/1/2045	0
1/2/2045	0
1/3/2045	0
1/4/2045	0
1/5/2045	0
1/6/2045	0
1/7/2045	0
1/8/2045	0
1/9/2045	0
1/10/2045	0
1/11/2045	0
1/12/2045	0
1/13/2045	0
1/14/2045	0
1/15/2045	0
1/16/2045	0
1/17/2045	0
1/18/2045	0
1/19/2045	0
1/20/2045	0
1/21/2045	0
1/22/2045	0
1/23/2045	0
1/24/2045	0
1/25/2045	0
1/26/2045	0
1/27/2045	0
1/28/2045	0
1/29/2045	0
1/30/2045	0
1/31/2045	0
2/1/2045	0
2/2/2045	0
2/3/2045	0
2/4/2045	0
2/5/2045	0
2/6/2045	0
2/7/2045	0
2/8/2045	0
2/9/2045	0
2/10/2045	0
2/11/2045	0
2/12/2045	0
2/13/2045	0
2/14/2045	0
2/15/2045	0
2/16/2045	0
2/17/2045	0
2/18/2045	0
2/19/2045	0
2/20/2045	0
2/21/2045	0
2/22/2045	0
2/23/2045	0
2/24/2045	0
2/25/2045	0
2/26/2045	0
2/27/2045	0
2/28/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	60164
3/2/2045	60164
3/3/2045	60164
3/4/2045	60164
3/5/2045	60164
3/6/2045	60164
3/7/2045	60164
3/8/2045	60164
3/9/2045	60164
3/10/2045	60164
3/11/2045	60164
3/12/2045	60164
3/13/2045	60164
3/14/2045	60164
3/15/2045	60164
3/16/2045	60164
3/17/2045	60164
3/18/2045	60164
3/19/2045	60164
3/20/2045	60164
3/21/2045	60164
3/22/2045	60164
3/23/2045	60164
3/24/2045	62773
3/25/2045	62818
3/26/2045	70338
3/27/2045	70338
3/28/2045	70338
3/29/2045	70338
3/30/2045	70338
3/31/2045	70338
4/1/2045	71709
4/2/2045	71709
4/3/2045	71709
4/4/2045	78344
4/5/2045	80226
4/6/2045	104562
4/7/2045	104562
4/8/2045	104562
4/9/2045	104562
4/10/2045	140969
4/11/2045	140969
4/12/2045	140969
4/13/2045	140969
4/14/2045	140969
4/15/2045	140969
4/16/2045	140969
4/17/2045	140969
4/18/2045	140969
4/19/2045	140969
4/20/2045	140969
4/21/2045	140969
4/22/2045	145623
4/23/2045	145623
4/24/2045	145623
4/25/2045	150883
4/26/2045	152501
4/27/2045	162680
4/28/2045	166173
4/29/2045	168906
4/30/2045	168906

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
3/1/2045	0
3/2/2045	0
3/3/2045	0
3/4/2045	0
3/5/2045	0
3/6/2045	0
3/7/2045	0
3/8/2045	0
3/9/2045	0
3/10/2045	0
3/11/2045	0
3/12/2045	0
3/13/2045	0
3/14/2045	0
3/15/2045	0
3/16/2045	0
3/17/2045	0
3/18/2045	0
3/19/2045	0
3/20/2045	0
3/21/2045	0
3/22/2045	0
3/23/2045	0
3/24/2045	0
3/25/2045	0
3/26/2045	0
3/27/2045	0
3/28/2045	0
3/29/2045	0
3/30/2045	0
3/31/2045	0
4/1/2045	0
4/2/2045	0
4/3/2045	0
4/4/2045	0
4/5/2045	0
4/6/2045	0
4/7/2045	0
4/8/2045	0
4/9/2045	0
4/10/2045	0
4/11/2045	0
4/12/2045	0
4/13/2045	0
4/14/2045	0
4/15/2045	0
4/16/2045	0
4/17/2045	0
4/18/2045	0
4/19/2045	0
4/20/2045	0
4/21/2045	0
4/22/2045	0
4/23/2045	0
4/24/2045	0
4/25/2045	0
4/26/2045	0
4/27/2045	0
4/28/2045	0
4/29/2045	0
4/30/2045	0

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	168906
5/2/2045	176819
5/3/2045	187113
5/4/2045	192944
5/5/2045	210256
5/6/2045	210256
5/7/2045	214666
5/8/2045	214666
5/9/2045	218727
5/10/2045	218936
5/11/2045	226706
5/12/2045	228255
5/13/2045	228255
5/14/2045	232070
5/15/2045	233324
5/16/2045	233324
5/17/2045	236251
5/18/2045	238058
5/19/2045	238058
5/20/2045	238058
5/21/2045	242646
5/22/2045	242646
5/23/2045	255916
5/24/2045	260679
5/25/2045	265757
5/26/2045	265757
5/27/2045	265757
5/28/2045	265757
5/29/2045	268218
5/30/2045	268218
5/31/2045	302269
6/1/2045	311180
6/2/2045	311180
6/3/2045	311761
6/4/2045	311761
6/5/2045	311761
6/6/2045	311761
6/7/2045	321917
6/8/2045	331916
6/9/2045	331916
6/10/2045	331916
6/11/2045	334144
6/12/2045	337489
6/13/2045	337489
6/14/2045	348766
6/15/2045	362682
6/16/2045	368238
6/17/2045	371563
6/18/2045	397035
6/19/2045	401003
6/20/2045	401003
6/21/2045	401003
6/22/2045	401003
6/23/2045	410424
6/24/2045	417485
6/25/2045	426302
6/26/2045	431748
6/27/2045	432893
6/28/2045	437214
6/29/2045	437214
6/30/2045	437214

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
5/1/2045	0
5/2/2045	0
5/3/2045	0
5/4/2045	0
5/5/2045	0
5/6/2045	0
5/7/2045	0
5/8/2045	0
5/9/2045	0
5/10/2045	0
5/11/2045	0
5/12/2045	0
5/13/2045	0
5/14/2045	0
5/15/2045	0
5/16/2045	0
5/17/2045	0
5/18/2045	0
5/19/2045	0
5/20/2045	0
5/21/2045	0
5/22/2045	0
5/23/2045	0
5/24/2045	0
5/25/2045	0
5/26/2045	0
5/27/2045	0
5/28/2045	0
5/29/2045	0
5/30/2045	0
5/31/2045	0
6/1/2045	0
6/2/2045	0
6/3/2045	0
6/4/2045	0
6/5/2045	0
6/6/2045	0
6/7/2045	0
6/8/2045	0
6/9/2045	0
6/10/2045	0
6/11/2045	0
6/12/2045	0
6/13/2045	0
6/14/2045	0
6/15/2045	0
6/16/2045	0
6/17/2045	0
6/18/2045	0
6/19/2045	0
6/20/2045	0
6/21/2045	0
6/22/2045	0
6/23/2045	0
6/24/2045	0
6/25/2045	0
6/26/2045	1831
6/27/2045	1831
6/28/2045	2454
6/29/2045	2454
6/30/2045	2454

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	437214
7/2/2045	437214
7/3/2045	437214
7/4/2045	437214
7/5/2045	437214
7/6/2045	437214
7/7/2045	437214
7/8/2045	437214
7/9/2045	437214
7/10/2045	437214
7/11/2045	437214
7/12/2045	437214
7/13/2045	437214
7/14/2045	437214
7/15/2045	437214
7/16/2045	437214
7/17/2045	437214
7/18/2045	437214
7/19/2045	437214
7/20/2045	437214
7/21/2045	441778
7/22/2045	444951
7/23/2045	444951
7/24/2045	446788
7/25/2045	450449
7/26/2045	450449
7/27/2045	450449
7/28/2045	450449
7/29/2045	450449
7/30/2045	450449
7/31/2045	450449
8/1/2045	450449
8/2/2045	450449
8/3/2045	450449
8/4/2045	450449
8/5/2045	450449
8/6/2045	450449
8/7/2045	450449
8/8/2045	450449
8/9/2045	450449
8/10/2045	450449
8/11/2045	450449
8/12/2045	450449
8/13/2045	450449
8/14/2045	450449
8/15/2045	450449
8/16/2045	450449
8/17/2045	450449
8/18/2045	450449
8/19/2045	450449
8/20/2045	450449
8/21/2045	450449
8/22/2045	450449
8/23/2045	450449
8/24/2045	450449
8/25/2045	450449
8/26/2045	450449
8/27/2045	450449
8/28/2045	450449
8/29/2045	450449
8/30/2045	450449
8/31/2045	450449

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
7/1/2045	2454
7/2/2045	2454
7/3/2045	2454
7/4/2045	2454
7/5/2045	2454
7/6/2045	2454
7/7/2045	2454
7/8/2045	2454
7/9/2045	2454
7/10/2045	2454
7/11/2045	2454
7/12/2045	2454
7/13/2045	2454
7/14/2045	2454
7/15/2045	2454
7/16/2045	2454
7/17/2045	2454
7/18/2045	2454
7/19/2045	2454
7/20/2045	2454
7/21/2045	2454
7/22/2045	2454
7/23/2045	2454
7/24/2045	2454
7/25/2045	2454
7/26/2045	2454
7/27/2045	2454
7/28/2045	2454
7/29/2045	2454
7/30/2045	2454
7/31/2045	2454
8/1/2045	2454
8/2/2045	2454
8/3/2045	2454
8/4/2045	2454
8/5/2045	2454
8/6/2045	2454
8/7/2045	2454
8/8/2045	2454
8/9/2045	2454
8/10/2045	2454
8/11/2045	2454
8/12/2045	2454
8/13/2045	2454
8/14/2045	2454
8/15/2045	2454
8/16/2045	2454
8/17/2045	2454
8/18/2045	2454
8/19/2045	2454
8/20/2045	2454
8/21/2045	2454
8/22/2045	2454
8/23/2045	2454
8/24/2045	2454
8/25/2045	2454
8/26/2045	2454
8/27/2045	2454
8/28/2045	2454
8/29/2045	2454
8/30/2045	2454
8/31/2045	2454

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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9/2/2045	450449
9/3/2045	450449
9/4/2045	450449
9/5/2045	450449
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9/7/2045	450449
9/8/2045	450449
9/9/2045	450449
9/10/2045	450449
9/11/2045	450449
9/12/2045	450449
9/13/2045	450449
9/14/2045	450449
9/15/2045	450449
9/16/2045	450449
9/17/2045	450449
9/18/2045	450449
9/19/2045	450449
9/20/2045	450449
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9/25/2045	450449
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9/30/2045	450449
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10/31/2045	450449

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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10/28/2045	2454
10/29/2045	2454
10/30/2045	2454
10/31/2045	2454

TSF1 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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11/3/2045	450449
11/4/2045	450449
11/5/2045	450449
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12/30/2045	450449
12/31/2045	450449
1/1/2046	450449

TSF2 WET SEASON	
Time	Accumulated Overflow
(Date)	m3
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11/4/2045	2454
11/5/2045	2454
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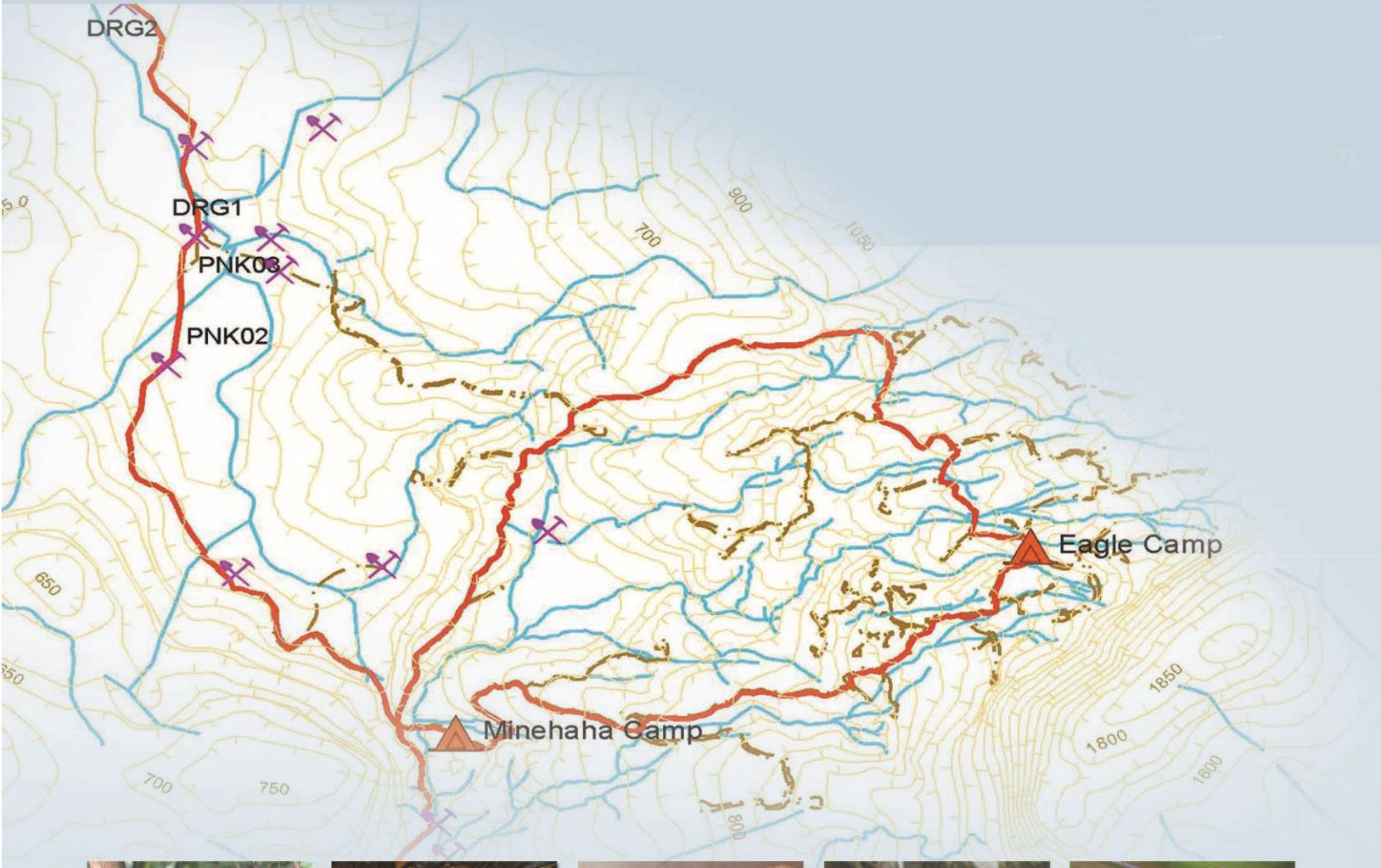
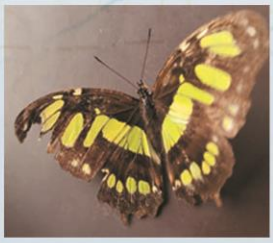
12/28/2045	2454
12/29/2045	2454
12/30/2045	2454
12/31/2045	2454
1/1/2046	2454

BIO

CONSOLIDATED REPORT
BIODIVERSITY BASELINE ASSESSMENT

EAGLE MOUNTAIN, REGION 8, GUYANA





November 2021

Goldsource

Prepared by
Environmental Management Consultants Inc.

1.0 REPORT AT A GLANCE

1.1 Rational

Goldsource Mines Inc. (Stronghold Guyana Inc.) aims to commence gold mining in the near future at its advanced-stage Eagle Mountain gold project in Guyana. Eagle Mountain is located approximately 200 km southwest of Georgetown, as is shown in Figure 1. The extent of the Eagle Mountain Prospecting License is also shown in Figure 1. The company has identified a smaller area of focus within the Prospecting License for which they plan to develop into a mine. This area is defined as the study area, which is also shown in Figure 1. The Mahdia River and the Minnehaha Creek drain the study area. Most of the streams feeding these waterbodies are small, shallow, and sometimes seasonal. The study area itself is highly disturbed. One section, along the Mahdia River and road, was extensively mined by small scale gold miners and is largely deforested. The wet season of the landscape is typically from March to August and the dry season from August to February.

Goldsource Mines Inc. currently has a Prospecting License from the Guyana Geology and Mines Commission which the company intends to convert to a Mining Permit. A biodiversity assessment of the Goldsource Mines Inc. Eagle Mountain Property is required to inform the preparation of an Environmental and Social Impact Assessment Study. An initial wet and dry season survey exercise was undertaken in 2013 to assess the flora and fauna. Given the timeframe elapsed since that survey the company decided to conduct additional wet and dry season surveys in 2021 to update and expand on the baseline data (Table 1).

1.2 Objectives

Environmental Management Consultants Inc. (EMC) was engaged to conduct an assessment of the diversity of plants, macro invertebrates, amphibians & reptiles, mammals, fishes and birds within the study area; identify critical[1] (fauna) habitats; and identify sensitive species.

Sensitive species are *Threatened species* (globally threatened species listed under IUCN Red List[2] categorized as critically endangered, endangered or vulnerable), *Rare species* (endemics, locally rare, and species which may not be globally threatened or listed under the IUCN Red List of Threatened species but are threatened in the region or likely to become threatened, and *Migratory species* (migratory species means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries[3]).

This report presents the consolidated findings of the 2013 and 2021 biodiversity baseline surveys. The location of survey transects and sample sites is provided in Figure 2, the survey methodology is detailed in Appendix A, transects specific biodiversity data is provided in Appendix B, and photographs of methods and threatened species is provided in Appendix C. The same survey approach and

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[1] Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered 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 individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities.

[2] The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species Version 2020-1. https://www.iucnredlist.org was used to conduct this assessment.

[3] Definition of migratory species taken from the UN Convention on the Conservation of Migratory Species – Convention Text S:_Basic_Docs\CMS_Conv_Text\English\CMS-text.en.wpd

methodology was employed in both years but with live mammal traps and camera traps included in 2021.

Table 1: Dates of Biodiversity Survey Exercises

Year	Season	Dates
2013	Wet	May 29 – June 09, 2013
2013	Dry	September 03 – 14, 2013
2021	Wet	July 12 – 25, 2021
2021	Dry	October 04 – 16, 2021

1.3 Summary

The vegetation of the Eagle Mountain study area can be classed as Mixed Forest with sub-classes determined by position on slopes from hilltops and ridges to valley bottoms and gullies. Small waterways and valleys are dominated by a distinctive, low-diversity forest dominated by crabwood (*Carapa guinanensis*) and trysil (*Pentaclethra macroloba*), which transitions to Mixed Forest on the adjacent slopes and hilltops. The dominant trees were trysil (*Pentaclethra macroloba*), black and potaro kakaralli (*Eschweilera* spp.), clump wallaba (*Dicymbe altsonii*), soft wallaba (*Eperua falcata*), maburea (*Maburea trinervis*), mora (*Mora* spp.), and sand baromalli (*Catostemma fragrans*). Forest was most intact at higher elevations on the slopes and summit of Eagle Mountain. At lower elevations, especially near the Mahdia River, the vegetation is heavily disturbed by past and current small-scale gold mining activities and secondary forest dominates with successional 'pioneer' plant species. No endemic, rare or threatened plants or unique habitats were recorded. The forest is well-represented and in a pristine state in many other parts of Guyana.

Although disturbed, the forest is of value as habitat for a diverse assemblage of animals including threatened species. Invertebrate diversity was evidenced by a total of 60 Lepidopteran (butterfly) species observed from five (5) families and 15 sub-families. Most species recorded belonged to the family Nymphalidae (typical nectar-feeders and the largest family of butterflies), typically the most abundant family found in Guyana's forests. The families Pieridae and Riodinidae were also well represented; whereas relatively few species and individuals from the Lycaenidae, Hesperiidae, and Papilionidae were recorded.

Forty-eight (48) species of fish from 17 families were captured. The most abundant families were the Characidae and Cichlidae. *Aequidens potaroensis, Crenicichla wallacii, Anablepsoides (Rivulus) holmiae,* and *Anablepsoides (Rivulus) waimacui* are endemic to Guyana. Additionally*, Lebiasina* species occurring in the study area may have restricted geographical ranges.

A total of 36 amphibian species belonging to six (6) families were detected. All were anurans (frogs and toads). The Hylidae (treefrogs) was the most represented family in terms of numbers of species and individuals recorded, followed by the Bufonidae. Woodley's stefania (*Stefania woodleyi*), Evan's stefania (*Stefania evansi*) (Hemiphractidae) and the Kaie rocket frog (*Anomaloglossus kaiei*) are endemic to Guyana. *Anomaloglossus kaiei* and *Anomaloglossus praderioi* (Aromobatidae) and are listed on the IUCN Red List as Endangered. Both species are only known from a few locations in the region and there is thought to be a decline of the extent and quality of their habitat. Forty-six (46) reptile species were recorded from the study area belonging to 16 families and the reptilian orders; Squamata (lizards and snakes), Testudines (turtles and tortoises) and Crocodylia (caimans, alligators and crocodiles). The yellow-footed tortoise (*Chelonoidis denticulata*) is listed on the IUCN Red List as Vulnerable. Using direct observation, signs (tracks and sound identification), trapping, camera trapping, mist netting, and interviews with local people, a total of 59 mammal species were recorded from the study area.

Thirty-five (35) species were non-volant mammals and 24 species were bats. The overwhelming majority of bats captured were frugivorous Leaf-nosed Bats (Phyllostomidae) from the sub-families Carollinae and Stenodermatinae, with short-tailed fruit bat (*Carollia perspicillata*) the dominant species. Other bat guilds and families were rarerly captured reflecting historical levels of forest disturbance (e.g., Thyropteridae, Emballonuridae, Mormoopidae), and sampling biases (Molossidae). Many of the large mammal species recorded from the study area have economic benefits (primarily as a food source), as well as cultural significance to many local indigenous communities in Guyana. The jaguar (*Panthera onca*) is listed on the IUCN Red List as Near Threatened. The giant anteater (*Myrmecophaga tridactyla)*, lowland tapir (*Tapirus terrestris*), Guiana spider-monkey (*Ateles paniscus*), and white-lipped peccary (*Tayassu pecari*) are listed on the IUCN Red List as Vulnerable.

Two-hundred and forty-four (244) bird species belonging to 47 families were recorded. The most diverse families were the tyrant flycatchers (Tyrannidae), followed by antbirds (Thamnophilidae), tanagers (Thraupidae), hummingbirds (Trochilidae), parrots (Psittacidae), woodcreepers (Furnariidae), hawks (Accipiptridae) and woodpeckers (Picidae). Attributing the great diversity of birds within the area are the innumerable microhabitats which include significant topographic influences such as hilltops and ravines, open and dense forests, disturbed and intact forests, riverine forest, and fruiting and flowering forests. No endemic bird species were recorded. However, a few species are range-restricted to the Guianas and adjacent Venezuela and Brazil. The caica parrot (*Pyrilia caica)*, mealy parrot (*Amazona farinosa),* blue-cheeked parrot *(Amazona dufresniana*)*,* and orange-breasted falcon (*Falco deiroleucus*) are listed on the IUCN Red List as Near Threatened. The channel-billed toucan (*Ramphastos vitellinus*), white-throated toucan (*Ramphastos tucanus*), and Guianan streaked antwren (*Myrmotherula surinamensis*) are listed on the IUCN Red List as Vulnerable. No migratory species occur in the study area.

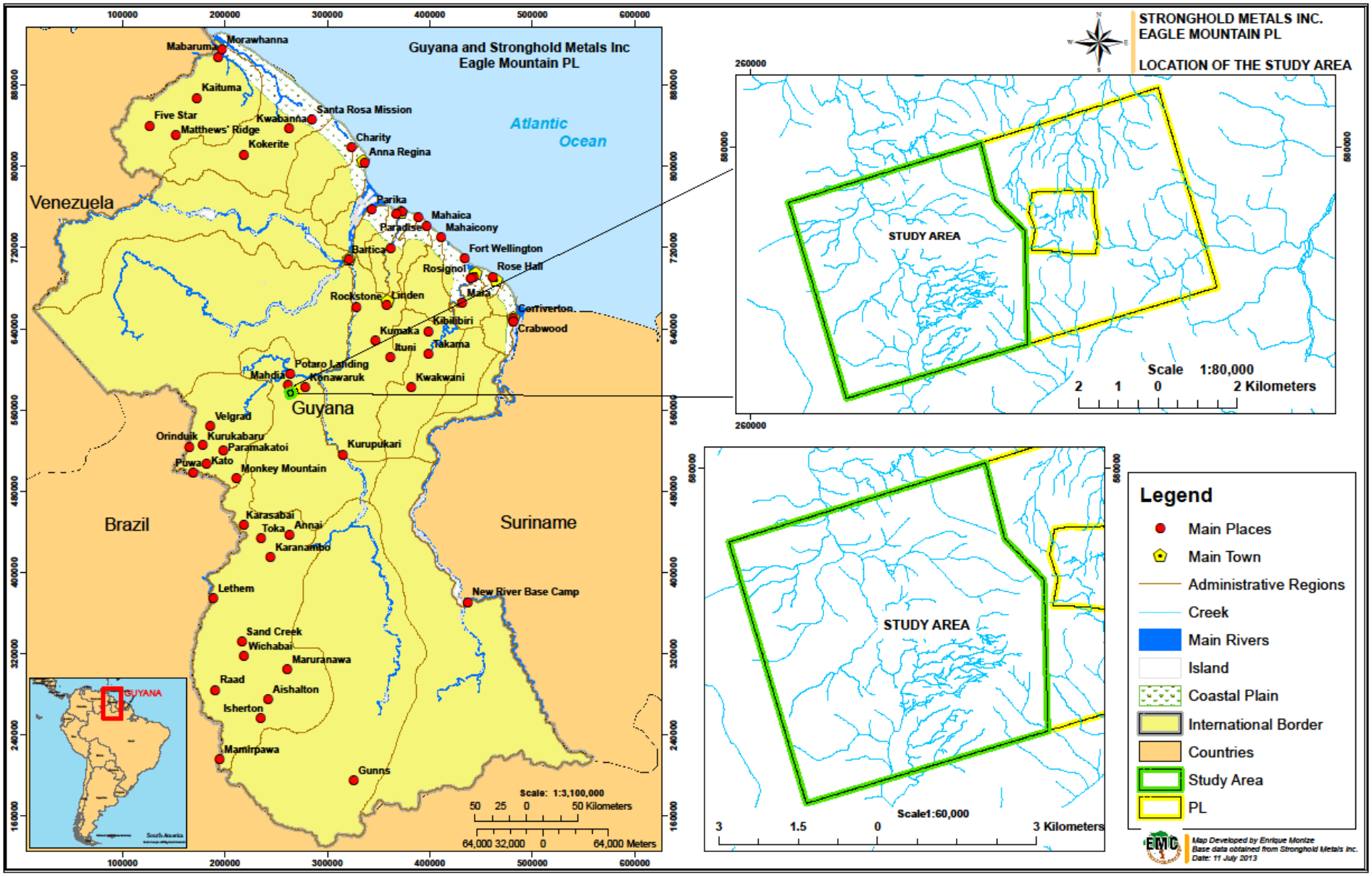

Figure 1: Location of Eagle Mountain Property and Study Area

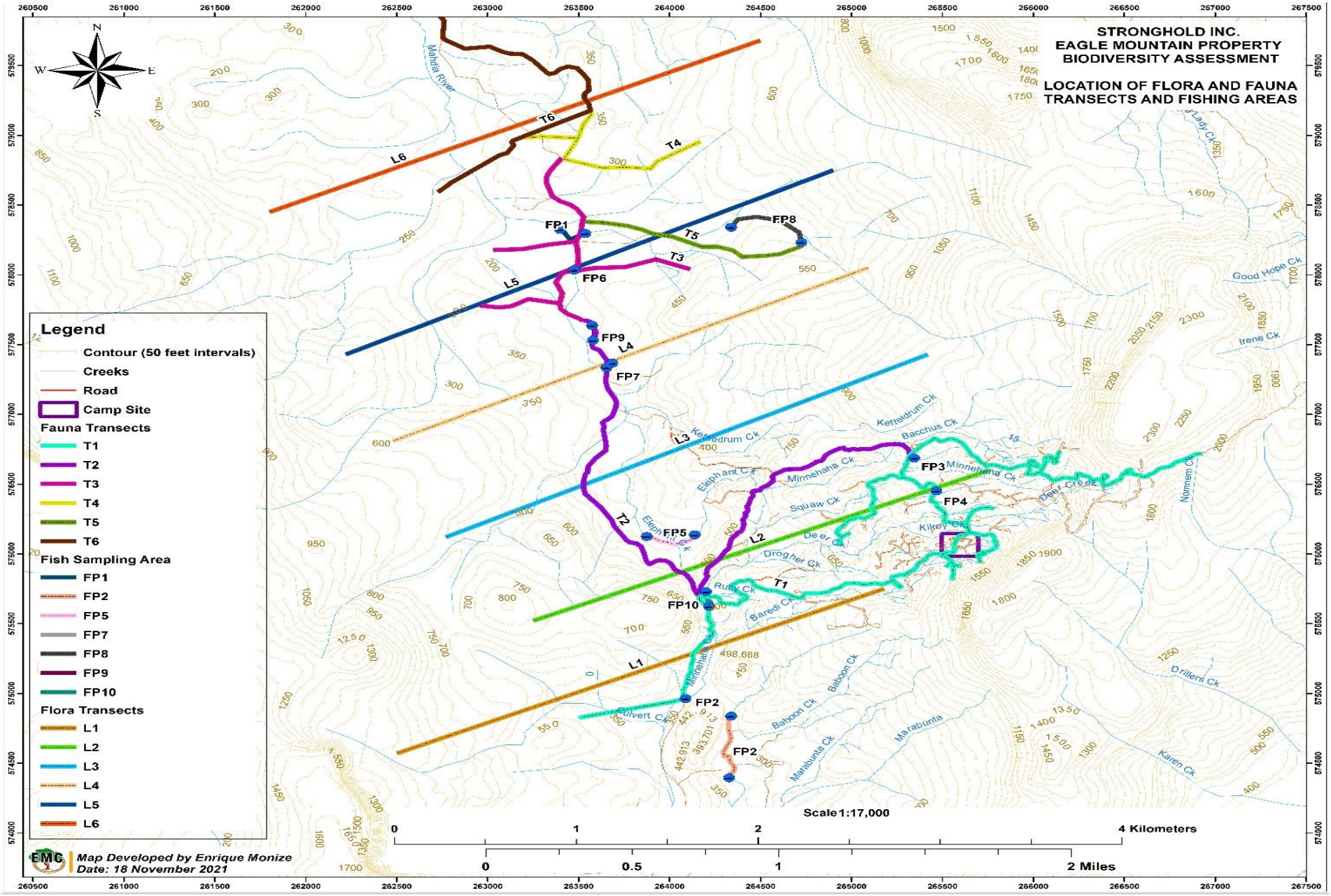

Figure 2: Location of Flora and Fauna Survey Transects and Fishing Points

2.0 PLANTS

The vegetation can be classed as mixed tropical forest with sub-classes determined by position on slopes from hill top and ridges to valley bottoms and gullies. The small waterways and valleys of the area are dominated by a distinctive, low diversity forest dominated by Crabwood *Carapa guinanensis* and Trysil *Pentaclethra macroloba* which transitions to Mixed Forest on the adjacent slopes.

Ninety-seven (97) tree species (woody plants >10cm dbh) from 38 families were recorded from the main sample plots in 2013 and 2021 (Table 2) with an average of 224 individuals/ha recorded. The most frequently woody plant species recorded in the main plots were trysil (*Pentaclethra macroloba*), black and potaro kakaralli (*Eschweilera* spp.), clump wallaba (*Dicymbe altsonii*), soft wallaba (*Eperua falcata*), maburea (*Maburea trinervis*), mora (*Mora* spp.), and sand baromalli (*Catostemma fragrans*). The dominant family was Leguminosae (subfamilies Mimosaceae, Caesalpiniaceae, and Papilionaceae). Leguminosae made up 38.5% of the individuals recorded, followed by Lecythidaceae with 13.3%, Chrysobalanaceae with 4.9%, and Bombacaceae 3.5 %.

Table 2: List of Tree Species (woody plants >10cm dbh) and Families recorded from the Study Area

Scientific Name	Family	Scientific Name	Family
Astronium ulei	Anacardiaceae	*Byrsonima* spp.	Malpighiaceae
Tapirira marchandii	Anacardiaceae	*Miconia lepidota*	Melastomaceae
Guatteria atra	Annonaceae	*Miconia* spp.	Melastomaceae
Guatteria brachypoda	Annonaceae	*Carapa guianensis*	Meliaceae
Allamanda cathartical	Apocynaceae	*Pentaclethra macroloba*	Mimosaceae
Parahancornia fasciculata	Apocynaceae	*Inga laterifolia*	Mimosaceae
Aspidosperma excelsum	Apocynaceae	*Inga stipularis*	Mimosaceae
Aspidosperma album	Apocynaceae	*Pithecellobium fanshawei*	Mimosaceae
Schefflera decaphylla	Araliaceae	*Pithecellobium jupunba*	Mimosaceae
Jacaranda copaia	Bignoniaceae	*Parkia pedula*	Mimosaceae
Tabebuia insignis	Bignoniaceae	*Pithecellobium pedicellare*	Mimosaceae
Catostemma fragrans	Bombacaceae	*Siparuna cusppidata*	Monimiaceae
Catostemma commune	Bombacaceae	*Pourouma guianensis*	Moraceae
Protium decandrum	Burseraceae	*Eugenia* spp.	Myrtaceae
Vouacapoua macropetala	Caesalpiniaceae	*Calycolpus goetheanus*	Myrtaceae
Campsiandra comosa	Caesalpiniaceae	*Maburea trinervis*	Olacaceae
Mora excelsa	Caesalpiniaceae	*Swartzia jenmanii*	Papilionaceae
Mora gongrijppii	Caesalpiniaceae	*Clathrotropis macrocarpa*	Papilionaceae
Eperua falcata	Caesalpiniaceae	*Dipteryx odorata*	Papilionaceae
Dicymbe altsonii	Caesalpiniaceae	*Swartzia benthamiana*	Papilionaceae
Chamaecrista adiantiflia	Caesalpiniaceae	*Clathrotropis* spp.	Papilionaceae
Cecropia obtusifolia	Cecropiaceae	*Alexa imperatricis*	Papilionaceae
Goupia glabra	Celastraceae	*Pterocarpus officinalis*	Papilionaceae
Licania canascens	Chrysobalanaceae	*Diplotripis purpurea*	Papilionaceae
Licania laxiflora	Chrysobalanaceae	*Swartzia leiocalycina*	Papilionaceae
Terminalia amazonia	Combretaceae	*Quiina guianensis*	Quiinaceae
Tapura guianensis	Dichapetalaceae	*Coussarea paniculata*	Rubiaceae
Diospyros dichroa	Ebenaceae	*Duroia eriopila*	Rubiaceae

Scientific Name	Family	Scientific Name	Family
Sloanea guianensis	Elecocarpaceae	*Zanthoxylum apiculata*	Rutaceae
Sloanea schomburgkii	Elecocarpaceae	*Horita regia*	Rutaceae
Hevea pauciflora	Euphorbiaceae	*Matayba oligandra*	Sapindaceae
Heyeronima alchorneoides	Euphorbiaceae	*Matayba opaca*	Sapindaceae
Laetia procera	Flacourtiaceae	*Pouteria cuspidata*	Sapotaceae
Moronobea coccinea	Guttiferae	*Pouteria guianensis*	Sapotaceae
Rheedia benthamiana	Guttiferae	*Sapotace* spp.	Sapotaceae
Symphonia globulifera	Guttiferae	*Micropholis venulosa*	Sapotaceae
Tovomita spp.	Guttiferae	*Manilkara bidentata*	Sapotaceae
Ocotea puberula	Lauraceae	*Pouteria speciosa*	Sapotaceae
Chlorocardium rodiei	Lauraceae	*Sapotace* spp.	Sapotaceae
Aniba hypoglauca	Lauraceae	*Chrysophllum pomiferum*	Sapotaceae
Ocotea spp. 1	Lauraceae	*Ecclinusa guianensis*	Sapotaceae
Ocotea spp. 2	Lauraceae	*Quassia multiflora*	Simaroubaceae
Ocotea oblonga	Lauraceae	*Quassia simarouba*	Simaroubaceae
Laurace spp.	Lauraceae	*Sterculia pruriens*	Sterculiaceae
Eschweilera coriacea	Lecythidaceae	*Xylosterculia rugosa*	Sterculiaceae
Eschweilera sagotiana	Lecythidaceae	*Apeiba membranacea*	Tiliaceae
Eschweilera spp.	Lecythidaceae		
Couratari guianensis	Lecythidaceae		
Eschweilera alala	Lecythidaceae	.	
Lecythis confertiflora	Lecythidaceae		
Lissocarpa guianensis	Lissocarpaceae		

Karallis (*Eschweilera* spp.) and maburia (*Maburea trinervis*) were more dominant at lower altitudes; whereas crabwood (*Carapa guianensis*) and clump wallaba (*Dicymbe* altsonii*)* were more abundant at higher elevations. In general, trees were less abundant in valley bottoms and most abundant in the mid-slope forest between 150-300 m above sea level. The mean diameter of trees showed no consistent pattern with altitude though the upper slopes and hilltops, on average, had larger diameter trees (Table 3).

Table 3: Number of Individuals, mean dbh and five most abundant species in Main Plots by Altitude Class

Altitude (m)	2013		2021		Most Abundant Species
	Individuals/ ha	Mean dbh	Individuals/ ha	Mean dbh	
<75	107	30.83	178	32.87	Trysil, Potaro Kakaralli, Warakairo, Maburia, Sarabebeballi, Black Kakarilli
75-150	201	35.82	972	23.81	Clump Wallaba, Black Kakaralli, Potaro Kakaralli, Smooth-leaf Kakaralli, Trysil
150-225	265	31.48	1400	20.62	Trysil, Sarabebeballi, Clump Wallaba, Smooth-leaf Kakaralli, Parakusan
225-300	255	34.74	233	18.66	Trysil, Clump Wallaba, Apaikara, Sarabebeballi, Crabwood
>300	222	39.78	193	27.44	Sarabebeballi, Trysil, Clump Wallaba, Apaikara, Crabwood

The canopy of Mixed Forest at higher elevations was dominated by families such as Caesalpiniaceae (*Dicymbe, Vouacapoua, Eperua, Campsiandra, Mora),* Lecythidaceae (*Escheweilera* spp., *Aspidosperma* spp.), Rubiaceae (*Coussarea),* Chrysobalanaceae (*Licania, Parinari*), Guttiferae (*Moronobea*), Olacaceae (*Maburea*) and Papilionaceae (*Swartzia* spp*., Dipteryx* spp.). Many aroids (*Philodendron*)*,* epiphytic orchids, Moraceae (ferns), mistletoes and a few bromeliads were also found abundantly in the forest at higher elevations.

The sub-canopy of Mixed Forest was dominated by Burseraceae (*Protium, Trattiinickia*), Annonaceae (*Xylopia*), Sapotaceae (*Pouteria, Micropholis*), Mimosaceae (*Inga, Pentaclethra)*, Chrysobalanaceae (*Licania, Parinari*), Sterculiaceae (*Sterculia, Xylosterculia*), Euphorbiaceae (*Hevea, Heyeronima*) and Caesalpiniaceae (*Dicymbe, Vouacapoua, Eperua, Campsiandra, Mora)*.

The forest floor was dominated by shrubs (Heliconiaceae) and various Melastomataceae species. A relatively 'healthy' juvenile forest exists (composed of seedlings, saplings and poles) of the families: Meliaceae, Chrysobalanaceae, Guttifereae, Annonaceae (*Guatteria, Oxandra),* Caesalpiniaceae, Lecythidaceae (*Escheweilera*) and others.

Forest is most intact at higher elevations on the slopes and summit of Eagle Mountain. At lower elevations, especially near the Mahdia River, the vegetation is heavily disturbed by past and current small-scale gold mining activities. Here secondary forest dominates, with successional ‘pioneer’ plant species. Almost 16% fewer trees were recorded in disturbed plots compared to undisturbed plots (Table 4). Clump wallaba, (*Dicymbe altsonii*), black kakaralli (*Eschweilera sagotiana*), kauta (*Licania laxiflora*), mora (*Mora* spp.), potaro kakaralli (*Eschweilera* spp.), and maburea (*Maburea trinervis)* were more abundant in undisturbed plots and duka (*Tapirira marchandii*) and trysil (*Pentaclethra macroloba*) more abundant in disturbed plots.

Table 4: Comparison of Woody Species between Disturbed and Undisturbed Main Plots

Disturbance State	2013		2021	
	Individuals/ha	Mean dbh	Individuals/ha	Mean dbh
Disturbed Plots	199	34.29	189	28.3
Undisturbed Plots	239	34.99	239	26.9

Guyana and the surrounding frontier forest of the Guiana Shield contain approximately 8,000 documented plant species of which 50% are considered endemic to the region (Parker *et al.,* 1993). There is no evidence to suggest that the study area contains any endemic, rare, threatened or endangered flora species or unique habitats. The forest is well-represented in a pristine state in many other parts of Guyana.

3.0 MACRO-INVERTEBRATES

3.1 Lepidoptera (Butterflies)

In the 2013 wet season survey exercise 31 butterfly species from three (3) families and 10 sub-families were recorded. In the 2013 dry season survey exercise 31 butterfly species from four (3) families and 10 sub-families were recorded.

In the 2021 wet season survey exercise 29 butterfly species from six (6) families and 12 sub-families were recorded. In the 2021 dry season survey exercise 26 butterfly species from five (5) families and 12 sub-families were recorded.

The total number of butterfly species recorded from the study area is 60 from five (5) families and 15 sub-families were recorded (Table 5).

Most species recorded belonged to the family Nymphalidae, the largest family of butterflies. This pattern is typical of butterfly communities in the region. Other studies in Guyana have found the Nymphalidae to be the most abundant family found in all forest habitats surveyed (Devries, 1988; Maharaj, 2007; Sambhu, 2009). The families Pieridae and Riodinidae were also well represented; whereas relatively few species and individuals from the Lycaenidae, Hesperiidae, and Papilionidae were recorded.

Ecologically, butterflies and moths are indicators of a healthy environment and healthy ecosystems (Gillman and Teeuw, 1996). More butterfly species were recorded in undisturbed areas compared to disturbed areas. The main species encountered in disturbed areas were the generalists e.g., *Aphrissa statira, Heliconius erato.* Butterflies that dominated undisturbed areas were habitat-specialist species e.g., *Thyridia psidii aedesia, Siproeta stelenes, Eurema albula.* Elevation appeared to influence the distribution of some butterfly species. For example, *Siproeta stelenes, Paraeuptychia metaleuca* and *Morpho menelaus* were only observed at high elevations.

Gillman and Teeuw (1996) documented 1,100 species of butterflies in Guyana. None of Guyana's butterfly species are listed in the IUCN Red List of Threatened Species as endangered, rare or threatened.

Table 5: List of Butterflies recorded in 2013 and 2021

Species	Family	Sub-Family	2013		2021	
			Wet	Dry	Wet	Dry
Urbanus doryssus	Hesperiidae	Eudaminae		✔		
Astraptes fulgerator	Hesperiidae	Pyrginae			✔	
Theritas spp.	Lycaenidae	Theclinae			✔	
Thestius selina	Lycaenidae	Theclinae			✔	✔
Catonephele acountius	Nymphalidae	Biblidinae	✔	✔		
Dynamine agacles	Nymphalidae	Biblidinae	✔			
Athesis clearista	Nymphalidae	Danainae	✔			
Hypothyris vallonia	Nymphalidae	Danainae	✔	✔		
Lycoria halia	Nymphalidae	Danainae	✔	✔		
Mechanitis polymnia	Nymphalidae	Danainae			✔	✔
Oleria aegle	Nymphalidae	Danainae			✔	✔
Rhodussa cantobrica	Nymphalidae	Danainae			✔	
Scada reckia	Nymphalidae	Danainae	✔	✔		

Species	Family	Sub-Family	2013		2021	
			Wet	Dry	Wet	Dry
Thyridia psidii	Nymphalidae	Danainae	✔			
Heliconius antiochus	Nymphalidae	Heliconiinae		✔		
Dryas iulia	Nymphalidae	Heliconiinae		✔	✔	✔
Heliconius erato	Nymphalidae	Heliconiinae	✔	✔	✔	✔
Heliconius melpomene	Nymphalidae	Heliconiinae			✔	✔
Heliconius sara	Nymphalidae	Heliconiinae			✔	✔
Philaethria dido	Nymphalidae	Heliconiinae			✔	✔
Adelpha cytherea	Nymphalidae	Limenitidinae	✔	✔	✔	✔
Adelpha phylaca	Nymphalidae	Limenitidinae				✔
Caligo brasiliensis	Nymphalidae	Morphinae		✔		
Catoblepia berecynthia	Nymphalidae	Morphinae	✔	✔		
Morpho helenor	Nymphalidae	Morphinae	✔	✔	✔	✔
Morpho menelaus	Nymphalidae	Morphinae	✔		✔	✔
Opsiphanes cassina	Nymphalidae	Morphinae	✔			
Prepona leporin	Nymphalidae	Morphinae	✔			
Anartia jatrophe	Nymphalidae	Nymphalinae	✔	✔	✔	✔
Colobura dirce	Nymphalidae	Nymphalinae		✔		
Dryadula phaetusa	Nymphalidae	Nymphalinae	✔	✔		
Eresia clio	Nymphalidae	Nymphalinae			✔	
Historis odius	Nymphalidae	Nymphalinae		✔		
Junonia evarete	Nymphalidae	Nymphalinae		✔	✔	✔
Siproeta stelenes	Nymphalidae	Nymphalinae	✔	✔	✔	✔
Unidentified nymphalinae species	Nymphalidae	Nymphalinae			✔	
Cissia penelope	Nymphalidae	Satyrinae			✔	✔
Haetera piera	Nymphalidae	Satyrinae		✔	✔	
Paraeuptychia metaleuca	Nymphalidae	Satyrinae	✔	✔		
Pierella lena lena	Nymphalidae	Satyrinae	✔	✔		
Posttaygetis penelea	Nymphalidae	Satyrinae	✔			
Taygetis laches	Nymphalidae	Satyrinae	✔	✔		
Taygetis mermeria	Nymphalidae	Satyrinae	✔	✔		
Battus polydamas	Papilionidae	Papilioninae		✔		
Heraclides thoas	Papilionidae	Papilioninae		✔	✔	✔
Neographium agesilaus	Papilionidae	Papilioninae			✔	✔
Papilio hyppason	Papilionidae	Papilioninae			✔	
Parides aeneas	Papilionidae	Papilioninae	✔	✔		
Parides chabrias	Papilionidae	Papilioninae	✔			
Eurema daira	Peiridae	Coliadinae	✔			
Eurema albula	Pieridae	Coliadinae	✔	✔	✔	✔
Phoebis argante	Pieridae	Coliadinae				✔
Phoebis sennae	Pieridae	Coliadinae	✔	✔	✔	✔
Rhabdodryus trite	Pieridae	Coliadinae	✔			
Aphrissa statira	Pieridae	Pierinae	✔	✔	✔	✔

Species	Family	Sub-Family	2013		2021	
			Wet	Dry	Wet	Dry
Glutophrissa drusilla	Pieridae	Pierinae	✔	✔		
Itaballia demophile	Pieridae	Pierinae	✔	✔	✔	✔
Mesosemia spp.	Riodinidae	Riodininae				✔
Nymphidium cachrus	Riodinidae	Riodininae				✔
Riodina lysippus	Riodinidae	Riodininae			✔	✔

3.2 Other Macro-invertebrates

Terrestrial-macro invertebrates recorded in the surveys were classified to the taxonomic rank of Order, due to the difficulty of identifying and classify invertebrates to lower taxa.

In the 2013 wet season survey exercise 15 macro-invertebrate orders were recorded. In the 2013 dry season survey exercise 25 macro-invertebrate orders were recorded.

In the 2021 wet season survey exercise 16 macro-invertebrate orders were recorded. In the 2021 dry season survey exercise 16 macro-invertebrate orders were recorded.

A total of 26 macro-invertebrate orders have now been recorded from the study area (Table 6).

Macro-invertebrates were fairly common to abundant at all areas surveyed during the surveys, especially the Diptera (true flies), Hymenopteran (wasps, bees, ants), and Odonata (dragonflies and damselflies). The least dominant orders included the Decapoda (crabs), Scorpiones (scorpions), Haplotaxida and Myriapoda.

For stream sampling, mostly mayflies of the order Odonata and freshwater shrimps (Decapoda) were recorded. Overall, there was a poor assemblage of aquatic macro-invertebrates. In the mined-out areas sampled, only generalist insects were observed such as from the orders Hymenoptera, and Diptera.

Table 6: List of Macro-invertebrate Orders Recorded in 2013 and 2021

Order	2013	2021
Diptera	✔	✔
Hymenoptera	✔	✔
Odonata	✔	✔
Lepidoptera (moths)	✔	✔
Isoptera	✔	
Blattaria	✔	✔
Coleoptera	✔	✔
Hemiptera	✔	✔
Orthoptera	✔	✔
Aranaeae	✔	✔
Haplotaxid	✔	✔
Diplopoda	✔	✔
Zygentoma	✔	
Scorpiones	✔	
Decapoda	✔	✔

Order	2013	2021
Dermaptera	✔	
Ephemeroptera	✔	✔
Plecoptera	✔	
Nematoda	✔	
Chilopoda	✔	
Amblypygi	✔	
Mantodea	✔	✔
Phasmida	✔	✔
Isopoda	✔	
Pulmonata	✔	✔
Homoptera	✔	

4.0 FISH

In the 2013 wet season survey exercise 17 fish species representing 8 families were recorded. In the 2013 dry season survey exercise 25 fish species representing 12 families were recorded.

In the 2021 wet season survey exercise 903 individuals of 24 fish species representing 11 families were recorded. In the 2021 dry season survey exercise 1,110 individuals of 27 fish species representing 13 families were recorded.

The total number of fish species recorded from the study area is 48 species belonging to 17 families (Table 7).

More fish were captured in the dry season surveys (compared to the wet seasons) as fish became confined and trapped in smaller pools.

In all seasons and years surveyed the dominant fish families recorded were the Characidae and Cichlidae. *Bryconops affinis* and *Moehkhausia oligolepis* (Characidae) and *Hoplias malabaricus* (Erythrinidae) and *Rhamdia quelen* (Heptapteridae) were captured in all surveys, and appear common in the creeks and waterbodies of the Eagle Mountain area. Members of the Characidae feed on a wide range of plants, animals and other materials including planktonic, crustaceans, insects, some higher plant material, detritus and even fish scales. Their feeding habits probably account for their abundance in the study area.

Sites with the highest species diversity and abundance were the Marshal Clearwater Creek and the site at the Culvert at Minnihaha Creeks Confluence. In contrast, the sites with the fewest fish species and lowest fish abundance were the Creek at Friendly Hill and Turtle Pond.

The species collected are mostly small sized fish species that typically inhabit headwater areas except for *Hoplias macropthalmus*. Commonly known as haimara, *Hoplias macropthalmus* an economically important species known throughout Guyana as an expensive “bush fish” that is considered a delicacy. In unpolluted areas this species is a good source of food but because of the mining activities in the Eagle Mountain area it is not consumed. Some species have some value as aquarium fish (Table 7).

A number of fish recorded from the study area are endemic to Guyana: *Aequidens potaroensis, Crenicichla wallacii, Anablepsoides (Rivulus) holmiae,* and *Anablepsoides (Rivulus) waimacui*. Additionally, the *Lebiasina* species detected may have restricted geographical ranges, though more research is needed on this taxonomically confusing and poorly-studied genus.

None of the fish species occurring within the study area are globally Endangered or Threatened. No migratory fish species were detected. No evidence of Critical [Fish] Habitats were encountered.

Table 7: List of Fish Species recorded within the Study Area in 2013 and 2021

Family	Scientific Name	2013		2021		Human Uses[4]
		Wet	Dry	Wet	Dry	
Acestrorhynchidae	*Acestrorhynchus microlepis*				✔	Aquarium: commercial
Anostomidae	*Leporinus arcus*		✔	✔	✔	Aquarium: commercial
Anostomidae	*Leporinus maculatus*	✔				Aquarium: commercial
Auchenipteridae	*Ageneiosus inermis*				✔	Fisheries: commercial; gamefish; public aquariums
Callichthyidae	*Corydoras adolfoi*	✔	✔			Aquarium: commercial
Cetopsidae	*Helogenes marmoratus*		✔			
Characidae	*Astyanax bimaculatus*			✔	✔	Aquarium: commercial
Characidae	*Brachychalcinus (Poptella) orbicularis*		✔			Aquarium: commercial
Characidae	*Bryconops affinis**	✔	✔	✔	✔	Aquarium: commercial
Characidae	*Bryconops melanurus**			✔	✔	
Characidae	*Characidium cf. zebra***			✔	✔	
Characidae	*Deuterodon potaroensis*				✔	
Characidae	*Hyphessobrycon* spp.		✔			
Characidae	*Jupiaba* spp. 1			✔		
Characidae	*Jupiaba* spp. 2			✔	✔	
Characidae	*Moehkhausia oligolepis*	✔	✔	✔	✔	Aquaculture: commercial; aquarium: commercial
Characidae	*Moenkhausia browni*			✔	✔	
Characidae	*Moenkhausia lepidura*	✔	✔	✔		
Characidae	*Moenkhausia megalops*			✔	✔	
Characidae	*Psalidodon (Astyanax) fasciatus*	✔	✔			Fisheries: minor commercial
Cichlidae	*Aequidens potaroensis*			✔	✔	Endemic to Guyana
Cichlidae	*Apistogramma* spp.	✔	✔		✔	
Cichlidae	*Crenicichla albopunctata*				✔	
Cichlidae	*Crenicichla alta*				✔	
Cichlidae	*Crenicichla lepidota*		✔			Aquarium: commercial
Cichlidae	*Crenicichla wallacii*			✔		Endemic to Guyana

[4] https://www.fishbase.de/

Family	Scientific Name	2013		2021		Human Uses[4]
		Wet	Dry	Wet	Dry	
Cichlidae	*Guianacara (Acarichthys) geayi*	✔	✔			Aquarium: commercial
Cichlidae	*Guianacara dacrya*			✔	✔	
Crenuchidae	*Characidium fasciatum*		✔			Aquarium: commercia
Erythrinidae	*Hoplerythrinus unitaeniatus*	✔	✔	✔		Fisheries: commercial; public aquariums
Erythrinidae	*Hoplias aimara*				✔	Aquarium: commercial
Erythrinidae	*Hoplias macrophthalmus*	✔	✔			Fisheries: commercial
Erythrinidae	*Hoplias malabaricus*	✔	✔	✔	✔	Fisheries: commercial; aquaculture; public aquariums
Hemiodontidae	*Hemiodus quadrimaculatus*		✔	✔	✔	Aquarium: commercial
Heptapteridae	*Rhamdia quelen*	✔	✔	✔	✔	Fisheries: minor commercial; aquaculture: commercial
Lebiasinidae	*Pyrrhulina brevis*	✔	✔			
Lebiasinidae	*Pyrrhulina filamentosa*				✔	Aquarium: commercial
Lebiasininae	*Lebiasina aff uruyensis*			✔	✔	
Lebiasininae	*Lebiasina* spp.1	✔	✔			
Loricariidae	*Ancistrus saudades*			✔	✔	
Loricariidae	*Hypostomus plecostomus*		✔			Fisheries: subsistence; aquarium: highly commercial
Pimelodidae	*Pimelodus ornatus*			✔	✔	Fisheries: commercial; aquarium: commercial
Rivulidae	*Anablepsoides (Rivulus) holmiae*	✔	✔	✔		Endemic to Guyana
Rivulidae	*Anablepsoides (Rivulus) waimacui*	✔	✔	✔	✔	Endemic to Guyana
Rivulidae	*Laimosemion (Rivulus) agilae*	✔	✔			Aquarium: commercial
Sternopygidae	*Eigenmannia lineatus*			✔		
Sternopygidae	*Eigenmannia virescens*		✔			Aquarium: commercial
Synbranchidae	*Synbranchus marmoratus*				✔	Fisheries: commercial; public aquariums

*Sometimes included in family Iguanodectidae; **sometimes included in family Crenuchidae (https://www.fishbase.se/.)

5.0 AMPHIBIANS

In the 2013 wet season survey exercise 260 individuals of 28 amphibian species representing six (6) families were recorded. In the 2013 dry season survey exercise 325 individuals of 23 amphibian species representing six (6) families were recorded.

In the 2021 wet season survey exercise approximately 548 individuals of 21 amphibian species from five (5) families were recorded. In the 2021 dry season survey exercise 359 individuals of 20 amphibian species belonging to four (4) families were recorded.

The total number of amphibian species recorded from the study area is 36 species belonging to six (6) families (Table 8). All amphibians were anurans – frogs and toads.

Within years, more species were detected in the wet season compared to the dry season. Amphibians are more active and easier to detect following rains as their life cycle is tied to water and they typically breed during the rainy season(s).

The Hylidae (treefrogs) were the most represented family in terms of numbers of species and individuals recorded (16 species), followed by the Bufonidae (7 toad species). Transects in close proximity to creeks in swampy areas, and alongside the access roads where there is high surface water runoff from the surrounding inclined forests, were most frequented by adult toads and their tadpoles and juveniles e.g., transects next to Marshall Creek and Culvert Creek.

Treefrogs were most frequently observed vocalizing alongside pools, ponds, and creeks at the forest edge, where there were significant amounts of vegetation overhanging water. *Boana boans* and *Scinax ruber* were the most commonly detected treefrogs; whereas the most commonly detected toad was the ubiquitous *Rhinella marina.*

The white-lined monkey frog (*Phyllomedusa vaillantii*), Troschel's treefrog (*Boana calcarata*), the painted antnest frog (*Lithodytes lineatus*) and members of the Aromobatidae and Pipidae appear rare in the study area (or difficult to detect).

Evan's stefania (*Stefania evansi*) (Hemiphractidae) appears locally abundant and was detected in all surveys and occurred at most transects. Woodley's stefania (*Stefania woodleyi*) was also detected in all surveys though it was less abundant than Evan's stefania*. Stefania evansi* and *Stefania woodleyi* are endemic to Guyana.

The Kaie rocket frog (*Anomaloglossus kaiei*) was detected in 2013 but not 2021. In the 2021 wet season five (5) frogs were observed at transect T1 and six at T2. In the dry season three (3) individuals were observed at T2*. Anomaloglossus kaiei* is endemic to Guyana and listed on the IUCN Red List as Endangered (IUCN SSC Amphibian Specialist Group, 2018). *Anomaloglossus praderioi* was detected in 2021 but not in 2013. Four *Anomaloglossus praderioi* were observed at transecst T1 in the wet season. *Anomaloglossus kaiei* and *Anomaloglossus praderioi* are both listed as Endangered (IUCN SSC Amphibian Specialist Group, 2018 & 2021).

Biogeographically, all other amphibian species documented in the survey are widespread and abundant within Guyana and the wider Amazonian region. They can be found in tropical moist forest and other biogeographic provinces throughout the Guianas (Kok and Kalamandeen, 2008; Starace, 1998; Lescure and Marty, 2000; Smithsonian Institute, 2000; Donnelly *et al*., 1998; Senaris *et al.*, 2005).

No evidence of Critical [Amphibian] Habitats were encountered.

Table 8: List of Amphibian Species recorded within the Study Area in 2013 and 2021

Family	Common Name	Scientific Name	2013		2021	
			Wet	Dry	Wet	Dry
AROMOBATIDAE		*Anomaloglossus praderioi*			✔	
	Kaie Rocket Frog	*Anomaloglossus kaiei*	✔	✔		
BUFONIDAE	Hoogmoed Harlequin Toad	*Atelopus hoogmoedi*	✔	✔	✔	✔
	Spotted Toad	*Rhaebo (Bufo) guttatus*	✔	✔	✔	✔
	Werner's Toad	*Rhaebo (Bufo) nasicus*	✔	✔	✔	✔
		Rhaebo (Bufo) typhonius	✔			
	Giant Toad or Cane Toad	*Rhinella marina*	✔	✔	✔	✔
	South American Common Toad	*Rhinella margaritifera*				✔
		Rhinella martyi			✔	
HEMIPHRACTIDAE	Evan's Stefania	*Stefania evansi*	✔	✔	✔	✔
	Woodley's Stefania	*Stefania woodleyi*	✔	✔	✔	✔
		Stefania scalae cf				✔
HYLIDAE	Marbled Treefrog	*Dendropsophus marmoratus*	✔	✔	✔	✔
	Lesser Treefrog	*Dendropsophus minutus*	✔		✔	
	Giant Gladiator Treefrog	*Boana boans*	✔	✔	✔	✔
	Many-Banded Treefrog	*Boana multifasciatus*	✔	✔		
	Troschel’s Treefrog	*Boana calcarata*			✔	
	Emerald-Eyed Treefrog	*Boana crepitans*	✔	✔	✔	✔
	Demerara Treefrog	*Hypsiboas cinerascens*		✔		
	Slender-legged Treefrog	*Osteocephalus oophagus*	✔	✔	✔	✔
	Manaus Slender-legged Treefrog	*Osteocephalus taurinus*	✔		✔	✔
	Giant Monkey Frog	*Phyllomedusa bicolor*	✔		✔	
	White-Lined Monkey Frog	*Phyllomedusa vaillantii*	✔			
	Paradoxic Frog	*Pseudis paradoxic*	✔	✔		✔
	Boeseman's Snouted Treefrog	*Scinax boesemani*	✔	✔	✔	✔
	Spix's Snouted Treefrog	*Scinax nebulosus*	✔			
	Red-Snouted Treefrog	*Scinax ruber*	✔	✔	✔	✔
	Casque-Headed Treefrog	*Trachycephalus resinitrifix*	✔	✔	✔	✔
LEPTODACTYLIDAE	Knudsen's Thin-Toed Frog	*Leptodactylus knudseni*	✔	✔		

Family	Common Name	Scientific Name	2013		2021	
			Wet	Dry	Wet	Dry
	Long-Snouted Thin-Toed Frog	*Leptodactylus longirostris*	✔	✔		
	Amazonian White-Lipped Frog	*Leptodactylus mystaceus*	✔	✔	✔	✔
	Peter's Thin-Toed Frog	*Leptodactylus petersii*	✔	✔	✔	✔
	Lutz's Thin-Toed Frog	*Leptodactylus lutzi*	✔			
	Painted Antnest Frog	*Lithodytes lineatus*				✔
PIPIDAE	Arrabal's Surinam Toad	*Pipa arrabali*	✔	✔		
	Surinam Toad	*Pipa pipa*		✔		

6.0 REPTILES

In the 2013 wet season survey exercise 225 individuals of 30 reptile species representing 13 families were recorded. In the 2013 dry season survey exercise 360 individuals of 34 reptile species representing 14 families were recorded.

In the 2021 wet season survey exercise approximately 187 individuals of 20 reptile species from 13 families were recorded. In the 2021 dry season survey exercise 310 individuals of 25 reptile species belonging to 13 families were recorded.

Interviews with Goldsource Inc. staff and residents of the area revealed the presence of an additional four species of snakes: the bushmaster *(Lachesis muta*), the rainbow boa (*Epicrates cenchria*), the boa constrictor (*Boa constrictor*), and the green anaconda (*Eunectes murinus*).

The total number of reptile species recorded from the study area is 46 species belonging to 16 families from from the Squamata (lizards and snakes), Testudines (turtles and tortoises) and Crocodylia (caimans, alligators and crocodiles) (Table 9).

The increase in reptile species diversity and abundance recorded during the dry season surveys compared to the wet seasons may be as a direct consequence of the changes in environmental variables such as temperature, moisture, and sunlight intensity leading to enhanced basking opportunities and increased detection.

The most commonly encountered reptiles were Teiid lizards e.g. *Ameiva ameiva* and *Kentropyx calcarata* and the Amazonian skink (*Copeoglossum nigropunctatum*). In the dry seasons these species were commonly detected on transects and around campsites, basking in sunlit patches in the forest floor.

Three (3) of the four (4) species of Caiman that occur in Guyana were recorded in creeks of the study area: *Caiman crocodilus*, *Paleosuchus trigonatus*, and *Paleosuchus palpebrosus*. Four (4) species of freshwater turtles were also recorded from these creeks. Nearly half of the reptile species detected were snakes: with 19 species from six (6) families recorded from the study area.

One (1) yellow-footed tortoise (*Chelonoidis denticulata*) was recorded in the 2021 wet season survey. The IUCN Red List of Threatened species lists this tortoise as Vulnerable (Tortoise & Freshwater Turtle Specialist Group, 1996. It is still commonly encountered in Guyana (Smithsonian Institute, 2000; Donnelly *et al*., 1998); whereas elsewhere in the region they have been unsustainably harvested for their meat and are less frequently encountered. The spectacled caiman (*Caiman crocodilus*), Cuvier's dwarf caiman *(Paleosuchus palpebrosus*)*,* Schneider's dwarf caiman (*Paleosuchus trigonatus*)*,* Amazon tree boa *(Corallus hortulanus*), green anaconda (*Eunectes murinus*), boa constrictor (*Boa constrictor*), and rainbow boa *Epicrates cenchria*, are included in CITES Appendix II.

There is no evidence of Critical [Reptilian] Habitats within the study area.

Table 9: List of Reptiles recorded in the 2013 and 2021 Survey Exercises and Through Interviews

Family	Common name	Scientific Name	2013		2021		
			Wet	Dry	Wet	Dry	INT
ALLIGATORIDAE	Spectacled Caiman	*Caiman crocodilus*	✔	✔	✔		
	Cuvier's Dwarf Caiman	*Paleosuchus palpebrosus*	✔	✔		✔	
	Schneider's Dwarf Caiman	*Paleosuchus trigonatus*	✔	✔	✔	✔	
CHELIDAE	Twist Necked Turtle	*Platemys platycephala*	✔	✔	✔	✔	
	Gibba Toad Head Turtle	*Phrynops gibbus*	✔	✔			
	Geoffrey's Side-neck Turtle*	*Phrynops tuberosus*	✔	✔			
GEOEMYDIDAE	Spot-legged Turtle	*Rhinoclemmys punctularia*	✔	✔		✔	
TESTUDINIDAE	Yellow-footed Tortoise	*Chelonoidis denticulata*			✔		
DACTYLOIDAE	Slender Anole	*Anolis fuscoauratus*	✔	✔	✔	✔	
	Leaf Anole	*Anolis chrysolepis*				✔	
	Goldenscale Anole	*Anolis planiceps*	✔	✔			
TEIIDAE	Striped Forest Whiptail	*Kentropyx calcarata*	✔	✔	✔	✔	
	Gold Tegu	*Tupinambis teguixin*	✔	✔	✔	✔	
	South American Ground Lizard	*Ameiva ameiva*	✔	✔	✔	✔	
	Rainbow Whiptail	*Cnemidophorous lemniscatus*	✔	✔		✔	
GEKKONIDAE	Bridled Forest Gecko	*Gonotodes humeralis*	✔	✔	✔	✔	
	Turnip-tailed Gecko	*Thecadactylus rapicauda*	✔	✔	✔	✔	
	Wood Slave	*Hemidactylus mabouia*	✔	✔	✔	✔	
	Brazilian Pygmy Gecko	*Coleodactylus amazonicus*	✔	✔	✔	✔	
GYMNOPHTHALIMIDAE	Red Neusticurs	*Neusticurus rudis*	✔	✔	✔	✔	
		Leposoma spp.	✔		✔		
	Blunt-scaled Spectacled Lizard	*Cercosaura ocellata*	✔	✔			
		Bachia flavescens		✔			
TROPIDURIDAE	Tree Runner	*Plica plica*		✔		✔	
		Plica umbra	✔	✔			
	Blue-Lipped Tree Lizard	*Uracentron azureum*	✔		✔		
SCINCIDAE	Amazonian Skink**	*Copeoglossum nigropunctatum*	✔	✔	✔	✔	

Family	Common name	Scientific Name	2013		2021		
			Wet	Dry	Wet	Dry	INT
ANOMALEPIDAE	Blind Snake	*Typhlophis squamosus*	✔	✔			
BOIDAE	Amazon Tree Boa	*Corallus hortulanus*		✔		✔	
	Green Anaconda	*Eunectes murinus*					✔
	Rainbow Boa	*Epicrates cenchria*					✔
	Boa Constrictor	*Boa constrictor*					✔
COLUBRIDAE	Black-headed Snake	*Tantilla melanocephala*	✔	✔	✔	✔	
	Brown Sipo	*Chironius fuscus*	✔			✔	
	Wagler's Sipo	*Chironius scurrulus*		✔			
	Common Water Snake	*Erythrolamprus (Liophis) miliaris*		✔			
	Dryad Snake	*Mastigodryas melanolomus*		✔			
	Yellow bellied puffing snake	*Spilotes (Pseustes) sulphureus*	✔	✔		✔	
	Green Vine Snake	*Oxybelis fulgidus*		✔		✔	
DIPSADIDAE	Short Ground Snake	*Erythrolamprus breviceps*			✔		
	Keelback Snake	*Helicops angulatus*		✔			
	Tschudi's False Coral Snake	*Oxyrhopus occipitalis*	✔	✔		✔	
	Blunt-headed Vine Snake	*Imantodes cenchoa*				✔	
ELAPIDAE	Black-back Coral Snake	*Micrurus collaris*	✔				
VIPERIDAE	Common Lancehead	*Bothrops atrox*	✔	✔	✔	✔	
	Bushmaster	*Lachesis muta*					✔

* Formerly *Phrynops geoffroanus;* ** formerly *Mabuya nigropunctata.* INT = Interviews with local people.

7.0 MAMMALS

Using direct observation, signs (tracks and sound identification), trapping, camera trapping, mist netting, and interviews with local people, a total of 59 mammal species were recorded from the study area in 2013 and 2021. These comprised 35 species of non-volant mammals and 24 species of microchiropteran bats.

7.1 Non-volant Mammals

In the 2013 wet season survey exercise 16 non-volant mammal species belonging to 12 families were recorded. In the 2013 dry season survey exercise 18 non-volant mammal species belonging to 13 families were recorded.

In the 2021 wet season survey exercise 17 non-volant mammal species belonging to 15 families were recorded. In the 2021 dry season survey exercise 19 non-volant mammal species belonging to 15 families were recorded.

Interviews with Goldsource Inc. staff and residents of the area revealed the presence of an additional nine (9) species of non-volant mammals. The total number of non-volant mammal species recorded from the study area is 35 species belonging to 21 families (Table 10).

The area, though heavily disturbed in part, harbours a diverse fauna of non-volant mammals. Despite the immediate disturbances caused by small-scale mining activities on the lower elevations of the mountain range; the forests in the higher elevations remain relatively intact; thereby forming suitable habitats for a diversity of non-volant mammal species. Transect T1 exhibited the greatest diversity of mammal species. Despite being subject to ongoing drilling activities, the area around T1 remains a relatively undisturbed location where mammals can refuge from the human active areas.

The most common detected mammals were the agouti (*Dasyprocta leporina*), paca (*Agouti paca*), brocket deer (*Mazama*), howler monkey (*Alouatta macconnellii*) and the Guiana spider monkey (*Ateles paniscus*). Primates were observed and heard foraging at both higher and lower elevations of the mountain range in the early morning and evening hours; whereas many other mammals were only detected via their tracks and scats as many species are secretive, cryptic and difficult to observe. *Eira barbara* and *Tapirus terrestris* were detected via camera traps and *Oecomys bicolor* was captured in a Sherman trap.

All of Guyana's primate species have now been documented within the study area with the exception of the brown-bearded saki (*Chiropotes satanus*) which does not to occur in this part of Guyana. Five out of Guyana's six cat species have now been documented from the study area with the exception of the oncilla (*Lepardus tigrinus).*

Tracks of the lowland tapir (*Tapirus terrestris*) were detected in all surveys. One individual was photographed by a camera trap and another observed in 2021. The Guiana spider-monkey (*Ateles paniscus*) was commonly heard and obseved throughout the study area in groups of up to five (5) individuals. Interviews with local people indicate the presence of the giant anteater *(Myrmecophaga tridactyla*) and white-lipped peccary (*Tayassu pecari*) in the study area. The tracks and scats from an adult Jaguar (*Panthera onca*) were detected in 2013 and 2021.

The IUCN Red List lists the lowland tapir (*Tapirus terrestris*), Guiana spider-monkey (*Ateles paniscus)*, giant anteater *(Myrmecophaga tridactyla*), and white-lipped peccary (*Tayassu pecari*) as Vulnerable (Varela *et al.,* 2019; Mittermeir *et al.* 2021; Keuroghlian *et al.,* 2013). These mammals are known to be vulnerable to habitat loss compounded by hunting. The jaguar (*Panthera onca*) is listed on the IUCN Red List as Near Threatened (Quigley *et al.,* 2017). Jaguar are affected by habitat loss and

fragmentation and by persecution as they come into conflicts with humans and their livestock. All primate species are CITES Appendix II. The jaguar is CITES Appendix I and the Jaguarundi and Oceot are CITES Appendix II.

Table 10: List of Non-volant Mammal Species recorded in 2013 and 2021

Taxon	Common Name	Scientific Name	2013	2021	Interview
MARSUPIALIS					
Didelphidae	Common Opossum	*Didelphis marsupialis*	✔	✔	
XENARTHRA					
Bradypodidae	Three-toed Sloth	*Bradypus tridactylus*	✔	✔	
PILOSA					
Myrmecophagidae	Southern Tamandua	*Tamandua tetradactyla*	✔	✔	
	Giant Anteater	*Myrmecophaga tridactyla*			✔
PRIMATES					
Atelidae	Guianan Howler Monkey	*Alouatta macconnellii*	✔	✔	
	Guiana Spider Monkey	*Ateles paniscus*	✔	✔	
		Cebus apella	✔		
Cebidae	Wedged-capped Capuchin	*Cebus olivaceus*	✔	✔	
	Squirrel Monkey	*Saimiri sciureus*			✔
Callitrichidae	Golden-handed Tamarin	*Saguinus midas*			✔
Pitheciidae	Guianan Saki	*Pithecia pithecia*	✔		
CARNIVORA					
Canidae	Crab-eating fox	*Cerdocyon thous*		✔	
Procyonidae	Coatimundi	*Nasua nasua*	✔	✔	
	Crab-eating Raccoon	*Procyon cancrivorus*	✔		
	Kinkajou	*Potos flavus*	✔	✔	
Felidae	Ocelot	*Leopardus pardalis*	✔	✔	
	Jaguar	*Panthera onca*	✔	✔	
	Puma	*Puma concolor*	✔	✔	
	Jaguarundi	*Herpailurus yagouaroundi*			✔
	Margay	*Leopardus wiedii*			✔
Herpestidae	Small Asian Mongoose	*Herpestes javanicus*			✔
Mustelidae	Tayra	*Eira barbara*	✔	✔	
	Greater Grison	*Galictis vittate*			✔
Artiodactyla					
Cervidae	Red Brocket Deer	*Mazama americana*	✔	✔	
	Gray Brocket Deer	*Mazama gouazoupira*	✔		
Tayassuidae	Collared Peccary	*Tayassu tajacu*			✔
	White-lipped Peccary	*Tayassu pecari*			✔
Perissodactyla					
Tapiridae	Lowland Tapir	*Tapirus terrestris*	✔	✔	
CINGULATA					
Dasypodidae	Nine-banded Armadillo	*Dasypus novemcinctus*	✔		

Taxon	Common Name	Scientific Name	2013	2021	Interview
RODENTIA					
Agoutidae	Labba	*Agouti paca*	✔	✔	
Dasyproctidae	Red Rumped Agouti	*Dasyprocta leporina*	✔	✔	
	Acouchy	*Myoprocta exilis*	✔		
Cricetidae	Bicoloured Arboreal Rice Rat	*Oecomys bicolor*		✔	
Cavidae	Capybara	*Hydrochoerus hydrochaeris*		✔	
Scuiridae	Guianan Red Squirrel	*Sciurus aestuans*	✔		

7.2 Microchiropteran Bats

In the 2013 wet season survey exercise 15 bat species belonging to two (2) families were recorded. the 2013 dry season survey exercise 12 bat species belonging to two (2) families were recorded.

In the 2021 wet season survey exercise 7 bat species belonging to two (2) families were recorded[5]. In the 2021 dry season survey exercise 13 bat species belonging to four (4) families were recorded.

The total number of bat species recorded from the study area is 24 species belonging to five (5) families (Table 11).

Bat species exhibits diverse trophic guilds (Patterson, Willig and Stevens 2004). The overwhelming majority of bats captured were frugivores from the sub-families Carollinae and Stenodermatinae, with the dominant species being the short-tailed fruit bat (*Carollia perspicillata*). These bats feed predominantly on the fruits of disturbance-associated plant species and their abundance indicates that the study area is historically disturbed with a high abundance of pioneer plants belonging to the family Cecropiaceae, Piperaceae, and Solanacea (Patterson, Willig & Stevens 2004). Relatively few phyllostomine bats were captured (gleaning animalivores) reflecting the area's historical-disturbance. Whereas frugivorous bats are known to be significantly more abundant in disturbed forest compared to primary forest, gleaning animalivores are rarely captured in disturbed forest (Clarke *et al.* 2005a,b).

[5] Capture rate was greatly depressed by very heavy rainfall and severe thunderstorms accounting for the few bat species detected.

Table 11: List of Microchiropteran Bat Species recorded in 2013 and 2021

Family/sub-family	Common Name	Species	2013	2021
Thyropteridae	Spix's disc-winged bat	*Thyroptera tricolor*	✔	
Emballonuridae	Chestnut sac-winged bat	*Cormura brevirostris*		✔
Phyllostomidae/ Carollinae	Common short-tailed fruit bat	*Carollia perspicillata*	✔	✔
	Silky short-tailed bat	*Carollia brevicauda*	✔	✔
	Dwarf little fruit bat	*Rhinophylla pumilio*	✔	✔
Phyllostomidae/ Stenodermatinae	Greater fruit-eating bat	*Artibeus lituratus*	✔	✔
	Dark fruit-eating bat	*Artibeus obscurus*	✔	✔
	Flat-faced fruit-eating bat	*Artibeus planirostris*		✔
	Little yellow-shouldered bat	*Sturnira lilium*	✔	✔
	Yellow shouldered bat	*Sturnira tildae*	✔	✔
	Tent-making bat	*Uroderma bilobatum*	✔	✔
	Bidentate yellow-eared bat	*Vampyressa bidens*	✔	
Phyllostomidae/ Glossophaginae	Common long-tongued bat	*Glossophaga soricina*	✔	✔
	Godman's long-tailed bat	*Choeroniscus godmani*	✔	
	Chestnut long-tongued bat	*Lionycteris spurrelli*		✔
Phyllostomidae/ Phyllostominae	Greater spear-nosed bat	*Phyllostomus hastatus*	✔	
	Lesser spear-nosed bat	*Phyllostomus elongatus*	✔	
	Davies's big-eared bat	*Micronycteris daviesi*	✔	
	Stripe-headed round-eared bat	*Tonatia saurophila*	✔	
	Fringe-lipped bat	*Trachops cirrhosus*	✔	
Phyllostomidae/ Desmodontinae	Common vampire bat	*Desmodus rotundus*	✔	
Molossidae	Mastiff bat	*Eumops* spp.		✔
	Mastiff bat	*Molossus molossus*		✔
Mormoopidae	Greater moustached bat	*Pteronotus parnellii*	✔	✔

The Mollosid bats *Eumops* and *Molossus* were only detected during roost searches. Members of this family are high-flying aerial insectivores that appear to easily detect and avoid mist nets set near the ground.

Davie's big-eared bat (*Micronycteris daviesi*) may be rare, though its ecology is poorly known (Clarke & Racey, 2003). *Thyroptera discolor* is also a notable capture. This species is rarely captured, partly due to its small size and slow flight which means that it infrequently gets entangled in mist nets – unless mist nets with very small sized-mesh are used.

That some bat guilds and families were rarely captured reflects historical levels of forest disturbance (e.g., Thyropteridae, Emballonuridae, Mormoopidae), and sampling biases (Molossidae).

At least 222 species of indigenous non-marine mammals that occur in Guyana, half of which are bats (Lim *et al*. 2004). None of the mammal species recorded are endemic to Guyana. No evidence of Critical [Mammal] Habitats was encountered.

8.0 BIRDS

In the 2013 wet season survey exercise 161 bird species belonging to 39 families were recorded.
In the 2013 dry season survey exercise 141 bird species belonging to 40 families were recorded.

In the 2021 wet season survey exercise 147 bird species belonging to 40 families were recorded.
In the 2021 dry season survey exercise 82 species from belonging to 25 families were recorded.

The total number of bird species recorded from the study area is 244 species belonging to 47 families (Table 12).

The most diverse families were the tyrant flycatchers (Tyrannidae, 24 species), followed by antbirds (Thamnophilidae, 23 species), tanagers (Thraupidae, 21 species), hummingbirds (Trochilidae, 16 species), parrots (Psittacidae, 15 species), woodcreepers (Furnariidae, 11 species), hawks (Accipiptridae, 10 species) and the woodpeckers (Picidae, 9 species). Attributing the great diversity of birds within the area are the innumerable microhabitats (despite mining) which included significant topographic influences such as hilltops and ravines, open and dense forests, disturbed and intact forests, riverine forest, and fruiting and flowering forests.

The most commonly observed birds were swifts and swallows (*Chaetura cinereiventris, Streptoprocne zonaris, Hirundo rustica*), green oropendola (*Psarocolius viridis*), silver-beaked tanager (*Ramphocelus carbo*) and brown-throated parakeet (*Aratinga pertinax*). The most commonly heard bird was the screaming piha (*Lipaugus vociferans*).

Opportunistic sightings of birds, especially vultures and hawks, mainly occurred along roadways as the survey teams travelled to and from transects and also around the campsite i.e., king vulture (*Sarcoramphus papa*), plumbeous kite (*Ictinia plumbea*), short-tailed hawk (*Buteo brachyurus*), and orange-breasted falcon (*Falco deiroleucus*).

Species such as roadside hawk (*Buteo magnirostris*), silver-beaked tanager (*Ramphocelus carbo*), blue-gray tanager (*Thraupis episcopus*) and common ground-dove (*Columbina passerina*), were almost always observed in disturbed forest and at forest edges. Other species that appeared to prefer forest edges and secondary growth shrubby habitats in the study area included the tropical kingbird (*Tyrannus melanocholicus*), yellow-bellied elaenia (*Elaenia flavogaster*), dusky antbird (*Cercomacra tyrannia*) and southern house-wren (*Troglodytes aedon*). Other studies have found similar habitat preferences (Restall, 2006).

A few species are restricted to the Guianas and adjacent Venezuela and Brazil: The caica parrot (*Pionopsitta caica*), rufous-bellied antwren (*Myrmotherula guttata*), Todd's antwren (*Herpsilochmus stictocephalus*), orange-bellied manakin (*Lepidothrix suavissima*) and waved woodpecker (*Celeus undatus*).

Twelve species are further known to be exclusively distributed north of the Amazon: black curassow (*Crax alector*), blue-cheeked parrot (*Amazona dufresniana*), fiery-shouldered parakeet (*Pyrrhura egregia*), black-headed parrot (*Pionites melanocephala*), Guianan toucanet (*Selenidera culik*), black nunbird (*Monasa atra*), cayenne jay (*Cyanocorax cayanus*), Guianan puffbird (*Notharchus macrorhynchos*), spot-tailed antwren (*Herpsilochmus sticturus*), Guianan streaked-antwren (*Myrmotherula surinamensis*), Guianan warbling antbird (*Hypocnemis cantator*) and yellow-throated flycatcher (*Conopias parva*).

Two (2) orange-breasted falcons (*Falco deiroleucus)* were observed in 2013. *Falco deiroleucus* can be considered to be rare in many areas since mountainous areas with exposed cliffs is important habitat for this species. The varied topography of the Eagle Mountain area appears ideal for this

species. In 2013, three (3) caica parrots (*Pyrilia (Gypopsitta) caica*) and six (6) blue-cheeked parrots *(Amazona dufresniana*) were observed. Nine (9) mealy parrots (*Amazona farinosa*) were detected in 2021. The caica parrot (*Pyrilia caica*), mealy parrot (*Amazona farinosa),* blue-cheeked parrot *(Amazona dufresniana*), and orange-breasted falcon *(Falco deiroleucus*), are listed on the IUCN Red List as Near Threatened.

Channel-billed toucans (*Ramphastos vitellinus*) and white-throated toucans (*Ramphastos tucanus)* were commonly observed and heard throughout the study area (at all transects) in all surveys, with the former more commonly encountered than the latter. A small number of Guianan streaked antwrens (*Myrmotherula surinamensis*) (between 2 and 4 individuals) were detected in 2013 and 2021. All three species are listed on the IUCN Red List as Vulnerable (BirdLife International 2016a,b,c). All psitticines and toucans recorded in this study are listed as CITES Appendix II species. No migratory birds were recorded. No evidence of Critical [Bird] Habitats were encountered.

Table 12: List of Birds recorded within the Study Area in 2013 and 2021

Family	Common Name	Scientific Name	2013	2021
Accipitridae	Short-tailed Hawk	*Buteo brachyurus*	✔	
Accipitridae	Gray-lined Hawk	*Buteo nitidus*		✔
Accipitridae	Common-black Hawk	*Buteogallus anthracinus*		✔
Accipitridae	Great Black Hawk	*Buteogallus urubitinga*	✔	✔
Accipitridae	Swallow-tailed Kite	*Elanoides forficatus*	✔	✔
Accipitridae	Plumbeous Kite	*Ictinia plumbea*	✔	✔
Accipitridae	Barred Forest Falcon	*Micrastur ruficollis*		✔
Accipitridae	White Hawk	*Pseudastur albicollis*	✔	✔
Accipitridae	Roadside Hawk	*Rupornis magnirostris*		✔
Accipitridae	Black Hawk-eagle	*Spizaetus tyrannus*	✔	
Alcedinidae	American Pygmy-Kingfisher	*Chloroceryle aenea*	✔	✔
Alcedinidae	Amazon Kingfisher	*Chloroceryle amazona*	✔	✔
Alcedinidae	Green Kingfisher	*Chloroceryle americana*	✔	✔
Alcedinidae	Green-and-Rufous Kingfisher	*Chloroceryle inda*	✔	
Alcedinidae	Ringed Kingfisher	*Megaceryle torquata*	✔	✔
Apodidae	Grey-rumped Swift	*Chaetura cinereiventris*		✔
Apodidae	Band-rumped Swift	*Chaetura spinicaudus*	✔	✔
Apodidae	Lesser- Swallow-tailed Swift	*Panyptila cayennensis*		✔
Apodidae	White-collared Swift	*Streptoprocne zonaris*	✔	✔
Ardeidae	Striated Heron	*Butorides striata*	✔	
Ardeidae	Rufescent Tiger-Heron	*Tigrisoma lineatum*	✔	
Bucconidae	Swallow-winged Puffbird	*Chelidoptera tenebrosa*	✔	✔
Bucconidae	Black Nunbird	*Monasa atra*	✔	✔
Bucconidae	Unidentified Puffbird	*Nonnula* spp.		✔
Bucconidae	White-necked Puffbird	*Notharchus hyperrhynchus*		✔

Family	Common Name	Scientific Name	2013	2021
Bucconidae	Guianan Puffbird	*Notharchus macrorhynchos*	✔	✔
Capitonidae	Black-spotted Barbet	*Capito niger*	✔	
Caprimulgidae	Common Paraque	*Nyctidromus albicollis*	✔	
Caprimulgidae	Blackish Nightjar	*Nyctipolus nigrescens*		✔
Cardinalidae	Yellow-green Grosbeak	*Caryothraustes canadensis*	✔	✔
Cardinalidae	Amazonian Grosbeak	*Cyanoloxia rothschildii*		✔
Cardinalidae	Grayish Saltator	*Saltator coerulescens*	✔	
Cathartidae	Lesser Yellow-headed Vulture	*Cathartes burrovianus*		✔
Cathartidae	Greater Yellow-headed Vulture	*Cathartes melambrotus*	✔	✔
Cathartidae	King Vulture	*Sarcoramphus papa*	✔	✔
Columbidae	Plain-breasted Ground-Dove	*Columbina minuta*		✔
Columbidae	Common Ground-Dove	*Columbina passerine*	✔	✔
Columbidae	Ruddy Ground Dove	*Columbina talpacoti*		✔
Columbidae	White-tipped Dove	*Leptotila verreauxi*	✔	✔
Columbidae	Plumbeous Pigeon	*Patagioenas plumbea*	✔	✔
Columbidae	Ruddy Pigeon	*Patagioenas subvinacea*	✔	
Corvidae	Cayenne Jay	*Cyanacorax cayanus*	✔	✔
Cotingidae	Screaming Piha	*Lipaugus vociferans*	✔	✔
Cotingidae	Capuchin Bird	*Perissocephalus tricolor*	✔	
Cotingidae	Guianan Red-Cotinga	*Phoenicircus carnifex*	✔	✔
Cotingidae	Purple-throated Fruit-crow	*Querula purpurata*	✔	✔
Cotingidae	Guianan Cock-of-the-Rock	*Rupicola rupicola*	✔	✔
Cotingidae	Pompadour Cotinga	*Xipholena punicea*	✔	✔
Cracidae	Black Curassow	*Crax alector*	✔	✔
Cracidae	Variable Chachalaca	*Ortalis motmot*		✔
Cracidae	Spix's Guan	*Penelope jacquacu*	✔	✔
Cracidae	Marail Guan	*Penelope marail*	✔	
Cuculidae	Little Cuckoo	*Coccycua minuta*		✔
Cuculidae	Smooth-billed Ani	*Crotophaga ani*	✔	✔
Cuculidae	Greater Ani	*Crotophaga major*	✔	✔
Cuculidae	Squirrel Cuckoo	*Piaya cayana*	✔	✔
Cuculidae	Black-bellied Cuckoo	*Piaya melanogaster*	✔	
Eurypygidae	Sunbittern	*Eurypyga Helias*	✔	
Falconidae	Black Caracara	*Daptrius ater*	✔	
Falconidae	Orange-breasted Falcon	*Falco deiroleucus*	✔	
Falconidae	Bat Falcon	*Falco rufigularis*	✔	✔
Falconidae	Laughing Falcon	*Herpetotheres cachinnans*	✔	✔

Family	Common Name	Scientific Name	2013	2021
Falconidae	Red-throated Caracara	*Ibycter americanus*	✔	✔
Falconidae	Slaty-backed Forest-Falcon	*Micrastur mirandollei*	✔	
Formicariidae	Black-faced Antthrush	*Formacarius analis*	✔	
Formicariidae	Rufous-capped Antthrush	*Formicarius colma*	✔	
Fringillidae	Unidentified Foliage-gleaner	*Automolus* spp.	✔	
Fringillidae	Golden-sided Euphonia	*Euphonia cayennensis*	✔	
Fringillidae	Violaceous Euphonia	*Euphonia violacea*	✔	✔
Fringillidae	Orange-bellied Euphonia	*Euphonia xanthogaster*		✔
Furnariidae	Cinnamon-throated Woodcreeper	*Dendrexetastes rufigula*		✔
Furnariidae	Unidentified Woodcreeper	*Dendrocincla* spp.	✔	
Furnariidae	Amazon-barred Woodcreeper	*Dendrocolaptes certhia*	✔	
Furnariidae	Wedge-billed Woodcreeper	*Glyphorynchus spirurus*	✔	✔
Furnariidae	Olivaceous Woodcreeper	*Sittasomus griseicapillus*	✔	✔
Furnariidae	Plain-crowned Spinetail	*Synallaxis gujanensis*	✔	✔
Furnariidae	Plain Xenops	*Xenops minutus*	✔	✔
Furnariidae	Buff-throated Woodcreeper	*Xiphorhynchus guttatus*	✔	✔
Furnariidae	Striped Woodcreeper	*Xiphorhynchus obsoletus*		✔
Furnariidae	Chestnut-rumped Woodcreeper	*Xiphorhynchus pardalotus*	✔	✔
Furnariidae	Straight-billed Woodcreeper	*Xiphorhynchus picus*		✔
Galbulidae	Yellow-billed Jacamar	*Galbula albirostris*	✔	
Galbulidae	Paradise Jacamar	*Galbula dea*		✔
Grallariidae	Spotted Antpitta	*Hylopezus macularius*	✔	
Grallariidae	Thrush-like Antpitta	*Myrmothera campanisona*	✔	
Hirundinidae	White-banded Swallow	*Atticora fasciata*	✔	✔
Hirundinidae	Barn Swallow	*Hirundo rustica*		✔
Hirundinidae	Gray-breasted Martin	*Progne chalybea*	✔	✔
Hirundinidae	White-winged Swallow	*Tachycineta albiventer*	✔	✔
Icteridae	Yellow-rumped Cacique	*Cacicus cela*	✔	✔
Icteridae	Red-rumped Cacique	*Cacicus haemorrhous*	✔	
Icteridae	Yellow Oriole	*Icterus nigrogularis*		✔
Icteridae	Crested Oropendola	*Psarocolius decumanus*	✔	✔
Icteridae	Green Oropendola	*Psarocolius viridis*	✔	✔
Mimidae	Tropical Mockingbird	*Mimus gilvus*		✔
Momotidae	Blue-crowned Motmot	*Momotus motmot*	✔	

Family	Common Name	Scientific Name	2013	2021
Odontophoridae	Marbled Wood-quail	*Odontophorus gujanensis*	✔	
Parulidae	Rose-breasted Chat	*Granatellus pelzeini*	✔	
Parulidae	Riverside Warbler	*Phaeothlypis rivularis*	✔	
Passerellidae	Pectoral Sparrow	*Arremon taciturnus*	✔	
Picidae	Crimson-crested Woodpecker	*Campephilus melanoleucos*	✔	✔
Picidae	Red-necked Woodpecker	*Campephilus rubricollis*	✔	✔
Picidae	Chestnut Woodpecker	*Celeus elegans*	✔	✔
Picidae	Waved Woodpecker	*Celeus undulatus*	✔	
Picidae	Lineated Woodpecker	*Dryocopus lineatus*	✔	✔
Picidae	Yellow-tufted Woodpecker	*Melanerpes cruentatus*	✔	
Picidae	Yellow-throated Woodpecker	*Piculus flavigula*	✔	
Picidae	Golden-olive Woodpecker	*Piculus rubiginosus*	✔	
Picidae	Verniliornis woodpecker	*Verniliornis* spp.	✔	
Pipridae	Golden-headed Manakin	*Ceratopipra erythrocephala*	✔	✔
Pipridae	White-throated Manakin	*Corapipo gutturalis*	✔	✔
Pipridae	Orange-bellied Manakin	*Lepidothrix suavissima*	✔	✔
Pipridae	White-bearded Manakin	*Manacus manacus*	✔	✔
Pipridae	White-crowned Manakin	*Pseudopipra (Pipra) pipra*	✔	✔
Polioptilidae	Trilling Gnatwren	*Ramphocaenus melanurus*	✔	✔
Psittacidae	Orange-winged Parrot	*Amazona amazonica*	✔	✔
Psittacidae	Blue-cheeked Parrot	*Amazona dufresniana*	✔	
Psittacidae	Mealy Parrot	*Amazona farinosa*		✔
Psittacidae	Blue and yellow Macaw	*Ara ararauna*		✔
Psittacidae	Red-and-Green Macaw	*Ara chloropterus*	✔	✔
Psittacidae	Scarlet Macaw	*Ara macao*		✔
Psittacidae	Brown-throated Parakeet	*Aratinga pertinax*		✔
Psittacidae	Red-fan Parrot	*Deroptyus accipitrinus*	✔	✔
Psittacidae	Caica Parrot	*Pyrilia caica*	✔	
Psittacidae	Black-headed Parrot	*Pionites melanocephalus*	✔	✔
Psittacidae	Dusky Parrot	*Pionus fuscus*	✔	✔
Psittacidae	Blue-headed Parrot	*Pionus menstruus*	✔	✔
Psittacidae	Fiery-shouldered Parakeet	*Pyrrhura egregia*	✔	
Psittacidae	Painted Parakeet	*Pyrrhura picta*		✔
Psittacidae	Lilac-tailed Parrotlet	*Touit batavica*	✔	✔
Rallidae	Rufous-necked wood-rail	*Aramides axillaries*		✔
Rallidae	Gray-cowled Wood-rail	*Aramides cajaneus*		✔
Ramphastidae	Black-necked Aracari	*Pteroglossus aracari*	✔	✔
Ramphastidae	Green Aracari	*Pteroglossus viridis*		✔

Family	Common Name	Scientific Name	2013	2021
Ramphastidae	White-throated Toucan	*Ramphastos tucanus*	✔	✔
Ramphastidae	Channel-billed Toucan	*Ramphastos vitellinus*	✔	✔
Ramphastidae	Guianan Toucanet	*Selenidera culik*	✔	
Scolopacidae	Solitary Sandpiper	*Tringa solitaria*		✔
Strigidae	Spectacled owl	*Pulsatrix perspicillata*	✔	
Thamnophilidae	Gray Antbird	*Cercomacra cinerascens*	✔	
Thamnophilidae	Dusky Antbird	*Cercomacroides tyrannina*	✔	✔
Thamnophilidae	Fasciated Antshrike	*Cymbilaimus lineatus*	✔	
Thamnophilidae	Rufous-throated Antbird	*Gymnopithys rufigula*		✔
Thamnophilidae	Todd's Antwren	*Herpsilochmus stictocephalus*	✔	
Thamnophilidae	Spot-tailed Antwren	*Herpsilochmus sticturus*	✔	
Thamnophilidae	Scaled-back Antbird	*Hylophylax poecilinotus*	✔	
Thamnophilidae	Guianan Warbling Antbird	*Hypocnemis cantator*	✔	✔
Thamnophilidae	Black-throated Antbird	*Myrmeciza atrothorax*	✔	
Thamnophilidae	Ferruginous-backed Antbird	*Myrmoderus ferrugineus*	✔	✔
Thamnophilidae	White-flanked Antwren	*Myrmotherula axillaris*	✔	
Thamnophilidae	Plain-winged Antwren	*Myrmotherula behni*	✔	
Thamnophilidae	Pygmy Antwren	*Myrmotherula brachyura*	✔	
Thamnophilidae	Gray Antwren	*Myrmotherula menetriesii*	✔	✔
Thamnophilidae	Guianan Streaked-Antwren	*Myrmotherula surinamensis*	✔	✔
Thamnophilidae	White-plumed Antbird	*Pithys albifrons*		✔
Thamnophilidae	Silvered Antbird	*Sclateria naevia*	✔	
Thamnophilidae	Great Antshrike	*Taraba major*	✔	
Thamnophilidae	Dusky-throated Antshrike	*Thamnomanes ardesiacus*	✔	✔
Thamnophilidae	Cinereous Antshrike	*Thamnomanes caesius*	✔	✔
Thamnophilidae	Barred Antshrike	*Thamnophilus doliatus*		✔
Thamnophilidae	Mouse-colored Antshrike	*Thamnophilus murinus*	✔	✔
Thamnophilidae	Scale-backed Antbird	*Willisornis poecilinotus*		✔
Thraupidae	Green Honeycreeper	*Chlorophanes spiza*	✔	✔
Thraupidae	Bananaquit	*Coereba flaveola*	✔	✔
Thraupidae	Purple Honeycreeper	*Cyanerpes caeruleus*	✔	✔
Thraupidae	Red-legged Honeycreeper	*Cyanerpes cyaneus*	✔	
Thraupidae	Blue Dacnis	*Dacnis cayana*	✔	✔
Thraupidae	Guira Tanager	*Hemithraupis guira*	✔	
Thraupidae	Fulvous-crested Tanager	*Maschalethraupis surinama*		✔
Thraupidae	Red-capped Cardinal	*Paroaria gularis*	✔	✔

Family	Common Name	Scientific Name	2013	2021
Thraupidae	Silvered-beaked Tanager	*Ramphocelus carbo*	✔	✔
Thraupidae	Grayish Saltator	*Saltator coerulescens*	✔	
Thraupidae	Wing-barred seedeater	*Sporophila americana*		✔
Thraupidae	Chestnut-bellied Seedeater	*Sporophila castaneiventris*	✔	✔
Thraupidae	Yellow-bellied Seedeater	*Sporophila nigricollis*		✔
Thraupidae	Fulvous-crested Tanager	*Tachyphonus cristatus*	✔	
Thraupidae	White-shouldered Tanager	*Tachyphonus luctuosus*		✔
Thraupidae	Blue-grey Tanager	*Tangara episcopus*	✔	✔
Thraupidae	Bay-headed Tanager	*Tangara gyrola*	✔	✔
Thraupidae	Turquoise Tanager	*Tangara mexicana*	✔	✔
Thraupidae	Opal-rumped Tanager	*Tangara velia*	✔	
Thraupidae	Palm Tanager	*Thraupis palmarum*	✔	✔
Thraupidae	Blue-black Grassquit	*Volatinia jacarina*	✔	✔
Threskiornithidae	Green Ibis	*Mesembrinibis cayennensis*	✔	✔
Tinamidae	Variegated Tinamou	*Crypturellus variegatus*	✔	✔
Tinamidae	Great Tinamou	*Tinamus major*	✔	✔
Tityridae	Amazonian Royal-Flycatcher	*Onychorhynchus coronatus*		✔
Tityridae	Black-tailed Tityra	*Tityra cayana*	✔	
Trochilidae	Black-throated Mango	*Anthracothorax nigricollis*		✔
Trochilidae	Gray-breasted Sabre-wing	*Campylopterus largipennis*	✔	✔
Trochilidae	Blue-chinned Sapphire	*Chlorostilbon notata*		✔
Trochilidae	Blue-tailed Emerald	*Chlorostilbon mellisugus*		✔
Trochilidae	White-chested Emerald	*Chrysuronia brevirostris*		✔
Trochilidae	Rufous-breasted Hermit	*Glaucis hirsutus*	✔	✔
Trochilidae	Black-eared Fairy	*Heliothryx auritus*	✔	
Trochilidae	Sooty-capped Hermit	*Phaethornis augusti*		✔
Trochilidae	Straight-billed Hermit	*Phaethornis bourcieri*	✔	✔
Trochilidae	Grey-chinned Hermit	*Phaethornis griseogularis*		✔
Trochilidae	Reddish Hermit	*Phaethornis ruber*	✔	✔
Trochilidae	Eastern Long-tailed Hermit	*Phaethornis superciliosus*	✔	✔
Trochilidae	White-tailed Golden-throat	*Polytmus guainumbi*		✔
Trochilidae	Green-tailed Golden-throat	*Polytmus theresiae*		✔
Trochilidae	Fork-tailed Woodnymph	*Thalurania furcata*	✔	
Trochilidae	Pale-tailed Barb-throat	*Threnetes leucurus*	✔	✔
Troglodytidae	Coraya Wren	*Thryothorus coraya*	✔	
Troglodytidae	Buff-breasted Wren	*Thryothorus leucotis*	✔	

Family	Common Name	Scientific Name	2013	2021
Troglodytidae	House Wren	*Troglodytes aedon*	✔	✔
Trogonidae	Black-tailed Trogon	*Trogon melanurus*	✔	✔
Trogonidae	Black-throated Trogon	*Trogon rufus*	✔	
Trogonidae	Violaceous Trogon	*Trogon violaceus*	✔	
Trogonidae	White-tailed Trogon	*Trogon viridis*	✔	
Turdidae	White-necked Thrush	*Turdus albicollis*		✔
Turdidae	Black-billed Thrush	*Turdus ignobilis*		✔
Turdidae	Spectacled Thrush	*Turdus nudigenis*		✔
Tyrannidae	Cinnamon Attila	*Attila cinnamomeus*	✔	
Tyrannidae	Bright-rumped Attila	*Attila spadiceus*	✔	
Tyrannidae	Yellow-throated Flycatcher	*Conopias parva*	✔	✔
Tyrannidae	Yellow-bellied Elaenia	*Elaenia flavogaster*	✔	✔
Tyrannidae	Slaty-capped Flycatcher	*Leptopogon superciliaris*	✔	
Tyrannidae	Helmeted Pygmy Tyrant	*Lophotriccus galeatus*	✔	✔
Tyrannidae	Boat-billed Flycatcher	*Megarynchus pitangua*		✔
Tyrannidae	McConnell's Flycatcher	*Mionectes macconnelli*	✔	
Tyrannidae	Ochre-bellied Flycatcher	*Mionectes oleagineus*	✔	✔
Tyrannidae	Short-crested Flycatcher	*Myiarchus ferox*	✔	✔
Tyrannidae	Swainson's Flycatcher	*Myiarchus swainsoni*		✔
Tyrannidae	Forest Elaenia	*Myiopagis gaimardii*		✔
Tyrannidae	Short-tailed Pygmy-Tyrant	*Myiornis ecaudatus*	✔	✔
Tyrannidae	Rusty-margined Flycatcher	*Myiozetetes cayanensis*	✔	✔
Tyrannidae	Northern Royal Flycatcher	*Onychorhynchus coronatus*	✔	
Tyrannidae	Mouse-colored Tyrannulet	*Phaeomyias murina*	✔	
Tyrannidae	Lesser Kisskadee	*Philohydor lictor*	✔	✔
Tyrannidae	Great Kiskadee	*Pitangus sulphuratus*		✔
Tyrannidae	Grayish Mourner	*Rhytipterna simplex*	✔	
Tyrannidae	Common Tody-Flycatcher	*Todirostrum cinereum*	✔	✔
Tyrannidae	Yellow-margined Flycatcher	*Tolmomyias assimilis*	✔	✔
Tyrannidae	Sulphury Flycatcher	*Tyrannopsis sulphurea*		✔
Tyrannidae	Yellow-crowned Tyrannulet	*Tyrannulus elatus*	✔	✔
Tyrannidae	Tropical Kingbird	*Tyrannus melancholicus*	✔	✔
Vireonidae	Buff-cheeked Greenlet	*Hylophilus musicicapinus*	✔	
Vireonidae	Ashy-headed Greenlet	*Hylophilus pectoralis*	✔	
Vireonidae	Lemon-chested Greenlet	*Hylophilus thoracicus*	✔	✔
Vireonidae	Slaty-capped Shrike-vireo	*Vireolanius leucotis*	✔	

9.0 SENSITIVE SPECIES

The biodiversity baseline data compiled was examined to assess whether there are critical[6] (fauna) habitats and sensitive species. Sensitive species are *Threatened species* (globally threatened species listed under IUCN Red List[7] categorized as critically endangered, endangered or vulnerable), *Rare species* (endemics, locally rare, and species which may not be globally threatened or listed under the IUCN Red List of Threatened species but are threatened in the region or likely to become threatened), and *Migratory species* (migratory species means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries[8]).

The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species Version 2021-3. https://www.iucnredlist.org (Accessed – December 2021) was used to conduct this assessment. The criteria used for the classification of the IUCN Red List of threatened species are provided in Table 13. The globally Threatened categories are species listed as Vulnerable, Endangered or Critically Endangered. The full list of Threatened species occurring in the study area is given in Table 14.

Table 13: Classification Criteria of the IUCN Red List of Threatened Species

IUCN Category	Classification
Critically Endangered	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened	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	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	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

[6] Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered 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 individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities.

[7] The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species Version 2021-3. https://www.iucnredlist.org was used to conduct this assessment.

[8] Definition of migratory species taken from the UN Convention on the Conservation of Migratory Species – Convention Text S:_Basic_Docs\CMS_Conv_Text\English\CMS-text.en.wpd

IUCN Category	Classification
	known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.
Not Evaluated	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Table 14: IUCN Red List and CITES listings of species occurring in the Study Area

Common Name	Scientific Name	Status
	Anomaloglossus praderioi	IUCN Endangered.
Kaie rocket frog	*Anomaloglossus kaiei*	IUCN Endangered.
Yellow-footed tortoise	*Chelonoidis denticulata*	IUCN Vulnerable. CITES Appendix II.
Spectacled caiman	*Caiman crocodilus*	CITES Appendix II.
Cuvier's dwarf caiman	*Paleosuchus palpebrosus*	CITES Appendix II.
Schneider's dwarf caiman	*Paleosuchus trigonatus*	CITES Appendix II.
Amazon tree boa	*Corallus hortulanus*	CITES Appendix II.
Green anaconda	*Eunectes murinus*	CITES Appendix II.
Rainbow boa	*Epicrates cenchria*	CITES Appendix II.
Boa constrictor	*Boa constrictor*	CITES Appendix II.
Lowland tapir	*Tapirus terrestris*	IUCN Vulnerable.
Giant anteater	*Myrmecophaga tridactyla*	IUCN Vulnerable.
Guiana spider monkey	*Ateles paniscus*	IUCN Vulnerable. CITES Appendix II.
White-lipped peccary	*Tayassu pecari*	IUCN Vulnerable.
Jaguar	*Panthera onca*	IUCN Near Threatened. CITES Appendix I
Jaguarundi	*Herpailurus yagouaroundi*	CITES Appendix II.
Ocelot	*Leopardus pardalis*	CITES Appendix II.
Howler monkey	*Alouatta macconnellii**	CITES Appendix II.
Wedged-capped capuchin	*Cebus olivaceus*	CITES Appendix II.
Squirrel monkey	*Saimiri sciureus*	CITES Appendix II.
Golden-handed tamarin	*Saguinus midas*	CITES Appendix II.
Guianan saki	*Pithecia pithecia*	CITES Appendix II.
Channel-billed toucan	*Ramphastos vitellinus*	IUCN Vulnerable. CITES Appendix II.
White-throated toucan	*Ramphastos tucanus*	IUCN Vulnerable. CITES Appendix II.
Guianan streaked-antwren	*Myrmotherula surinamensis*	IUCN Vulnerable.
Caica parrot	*Pyrilia (Gypopsitta) caica*	IUCN Near Threatened. CITES Appendix II.
Mealy parrot	*Amazona farinosa*	IUCN Near Threatened. CITES Appendix II.
Blue-cheeked parrot	*Amazona dufresniana*	IUCN Near Threatened. CITES Appendix II.
Orange-breasted falcon	*Falco deiroleucus*	IUCN Near Threatened.

*CITES Appendix I - includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances; CITES Appendix II - includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival; CITES Appendix III - contains species that are protected in at least one country, which has asked other CITES Parties for assistance in controlling the trade. * Synonymous with Alouatta seniculus.*

9.1 Threatened Species

Plants

No threatened flora species were detected in surveys. The only EN or CE plant species listed by the IUCN Red List that are known to occur in Guyana are: *Trichilia surinamenis* (EN), *Aniba rosiodora* (EN), *Virola surinamensis* (EN), and *Vouacapoua americana* (CR). These species are widespread within their ranges in forest lands of Guyana. *Aniba rosiodora*, *Virola surinamensis*, the genus *Vouacapoua* are known to have ranges that include the lowland and lower montane forest of the Pakaraimas uplands.

Amphibians

Two species of frogs recorded from the study area are Threatened. The Kaei rocket frog (*Anomaloglossus kaiei*) and *Anomaloglossus praderioi* are listed by IUCN Red List as Endangered. Because *Anomaloglossus* is a poorly-studied genus, more research and DNA identification may be required to verify the occurrence of *Anomaloglossus kaiei* and *Anomaloglossus praderioi* within the study area.

Anomaloglossus kaiei is a terrestrial, diurnal species, found mainly in primary and disturbed forest but not closely associated with bodies of water. *Anomaloglossus kaiei* is known from Kaieteur National Park to the slopes of Maringma Tepui, Guyana (Kok *et al*. 2006). It is also present on the slopes of Mt. Wokomung and can be found along the Guyana-Brazil border. It is may be present in adjacent Brazil. It occurs between 150–1,060 m asl and is considered to be locally abundant (Kok *et al*. 2006; Kok, 2010). It is listed as Endangered because its extent of occurrence (EOO) is 3,605 km^2, it occurs in fewer than five threat-defined locations, and there is ongoing decline in the extent and quality of habitat (IUCN SSC Amphibian Specialist Group, 2018).

Anomaloglossus praderioi is a terrestrial, duirnal species that is known to occur in undisturbed montane medium-canopy forest with abundant epiphytes and mosses and rich undergrowth. *Anomaloglossus praderioi* is listed as Endangered as it is known only from a few sites in the region and there is a continued decline in its habitat from mining and other human-induced impacts (IUCN SSC Amphibian Specialist Group, 2021). It is previously known from two localities in eastern Venezuela: 1) the slopes of Mt. Roraima (type locality; La Marca 1997) between 1,800-1,950 m asl, and 2) Sierra de Lema (currently the westernmost and northernmost known locality) at 1,374 m asl; and two localities in Guyana: 1) the slopes of Mt. Roraima at 1,310 m asl and 2) the slopes of Maringma Tepui at 1,376 m asl (currently the easternmost and southernmost known locality). All localities are between 1,310–1,950 m asl.

Reptiles

One (1) Threatened species of reptile was recorded from the study area. The yellow-footed tortoise (*Chelonoidis denticulata*) is listed by IUCN Red List as Vulnerable (Tortoise & Freshwater Turtle Specialist Group, 1996). It occurs in Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, Trinidad & Tobago, Venezuela, and Bolivia. The yellow-footed tortoise is a food source for the local people and indigenous communities in the region. It is still commonly encountered in Guyana (Smithsonian Institute, 2000; Donnelly *et al*., 1998); whereas elsewhere in the region they have been unsustainably harvested for their meat and are less frequently encountered. The spectacled caiman (*Caiman crocodilus*), Cuvier's dwarf caiman *(Paleosuchus palpebrosus*)*,* Schneider's dwarf caiman (*Paleosuchus trigonatus*)*,* and the Amazon tree boa (*Corallus hortulanus*) are CITES Appendix II.

Mammals

A number of mammals recorded from the study area are Threatened. The IUCN Red List lists the lowland tapir (*Tapirus terrestris*), Guiana spider-monkey (*Ateles paniscus*), giant anteater (*Myrmecophaga tridactyla*), and white-lipped peccary (*Tayassu pecari*) as Vulnerable (Miranda *et al.,* 2014, Varela *et al.,* 2019; Mittermeir *et al.* 2021; Keuroghlian *et al.,* 2013). The jaguar (*Panthera onca*) is listed by IUCN as Near Threatened (Quigley *et al.,* 2017). All primate species are CITES Appendix II. The Jaguar is CITES Appendix I and the Jaguarundi and Ocelot are CITES Appendix II.
The 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. *Tapirus terrestris* is considered to be Vulnerable due to habitat loss, illegal hunting, road-kill and competition with livestock. In Guyana this species appears to be widely distributed and inhabits

swamp forests, dry and moist shrublands and grasslands and a wide variety of wetlands (Montambault and Missa, 2002; Lim and Engstrom, 2004; Rapid Assessment Program, 2008).

The giant anteater is native to Argentina; Brazil; Colombia; Ecuador; French Guiana; Guyana; Honduras; Nicaragua; Panama; Paraguay; Peru and Suriname. It is listed as Vulnerable to extinction due to to habitat degredation. The dietary specificity, low reproductive rates, large body size, along with threats to habitat degradation in many parts of its range, have proved to be significant factors in its decline (Miranda *et al.,* 2014).

The Guiana spider Monkey occurs in Brazil (Amapá, Pará, Roraima); French Guiana; Guyana; and Suriname. *Ateles paniscus* is listed as Vulnerable due to habitat loss caused by expanding agriculture, ranching, mining, hydroelectric and associated road construction, which contributes to heavy hunting pressure (Mittermeier *et al*., 2021). It occurs in primary high forest, and is seldom found in edge or degraded forest. In Guyana, it is known from the far south and from the east of the Essequibo River.

The white-lipped peccary occurs from south-eastern Mexico in the north, through Central America and northern and central South America, as far south as northern Argentina and southern Brazil (Keuroghlian *et al.,* 2013). *Tayassu pecari* is considered Vulnerable due to habitat loss, illegal hunting, competition with livestock, and epidemics. In Guyana this species is widely distributed and occurs in a wide diversity of habitats including evergreen forest, seasonal forests, savannah, swamp forest and coastal mangroves (Montambault and Missa, 2002; Lim and Engstrom, 2004).

<u>Birds</u>

A number of birds recorded from the study area are listed on the IUCN Red List as Threatened. The channel-billed toucan (*Ramphastos vitellinus*), white-throated toucan (*Ramphastos tucanus*), and Guianan streaked antwren (*Myrmotherula surinamensis*), are listed by the IUCN as Vulnerable; whereas the mealy parrot (*Amazona farinosa),* blue-cheeked parrot (*Amazona dufresniana*)*,* and orange-breasted falcon (*Falco deiroleucus)* are listed as Near Threatened (NT)(BirdLife International, 2016). All psitticines and toucans recorded in this study are listed as CITES Appendix II species.

The channel-billed toucan (*Ramphastos vitellinus*) occurs in Brazil, Colombia, French Guiana, Guyana, Suriname, Trinidad and Tobago and Venezuela. It is 'fairly common' within its range and inhabits forested lowlands, most often near water, forest edge, swamp forest, clearings, riverine forest, patches in savannas and much less common in secondary and selectively cut forest. The primary threat to this species is accelerating deforestation in the Amazon basin and hunting pressure (BirdLife International, 2016a).

The white-throated toucan (*Ramphastos tucanus*) occurs in Brazil, French Guiana, Guyana, Suriname and Venezuela. It is 'common' within its range and inhabits lowland tropical forest, especially old riverbeds, late-stage successional forest, and mature forest near water. Also forages in secondary forest, edges, clearings, forest patches, pasture trees, plantations, gardens, mangroves in Guyana. *Ramphastos tucanus* is listed as Vulnerable based on a model of deforestation in the Amazon basin, and the species' susceptibility to hunting (BirdLife International, 2016b).

Myrmotherula surinamensis is an understorey and middle-storey species of Amazonian lowland seasonally flooded forest, permanently flooded forest and shrubby secondary growth, occurring up to 550m. The primary threat to *Myrmotherula surinamensis* is accelerating deforestation in the Amazon basin as land is cleared for cattle ranching and soy production, facilitated by expansion of the road network (BirdLife International, 2016c). This bird has a large range in the Guyana Shield region: Brazil, French Guiana, Guyana, Suriname, and Venezuela.

9.2 Near Threatened and Rare Species

One mammal and three bird species recorded from the study area can be considered Rare and are listed on the IUCN Red List as Near Threatened: jaguar (*Panthera onca*), caica parrot (*Pyrilia (Gypopsitta) caica*), mealy parrot (*Amazona farinosa*), blue-cheeked parrot *(Amazona dufresniana),* and orange-breasted falcon *(Falco deiroleucus*).

The jaguar (*Panthera onca*) has a very large geographical range, ranging throughout the tropical Americas into the USA in the north and Argentina in the south of its distribution. Jaguars mainly inhabit tropical lowland forest, typically characterized by dense forest cover (mainly primary and secondary forest) and the presence of water bodies and a sufficient prey base. Jaguar home ranges vary in size across their geographic range, often according to the season and availability of resources. The Jaguar is classified as Near Threatened, due to a suspected 20-25% decline over the past three generations (21 years) in area of occupancy, extent of occurrence, and habitat quality, along with actual or potential levels of exploitation. Jaguars often suffer from human impacts such as illegal hunting (Quigley *et al,* 2017).

The caica parrot (*Pyrilia caica*) occurs in Velezuela, Brazil, Guyana, Suriname and French Guiana, although not really numerous in any parts of its range. This species is restricted to tall, primary "terra firme" forest (with no flooding), up to 1,100 m. Based on a model of future deforestation in the Amazon basin, and its susceptibility to hunting, it is suspected that the population of this species will decline by 25-30% over the next three generations, and it has therefore been uplisted to Near Threatened (BirdLife International, 2016d).

The mealy parrot (*Amazona farinosa*) occurs in tropical Central America and South America. This parrot inhabits extensive tracts of lowland tropical evergreen forest, also occurring in palm stands, deciduous and gallery woodland and secondary growth near forest. Based on a model of future deforestation in the Amazon basin, and the susceptibility of this newly split to hunting and trapping, it is suspected that its population will undergo a moderately rapid decline over three generations from 2002, and it is therefore listed as Near Threatened (BirdLife International, 2016e).

The blue-cheeked parrot *(Amazona dufresniana*) occurs in south-east Venezuela, Guyana, north-east Suriname, French Guiana, and northern Brazil. This parrot inhabits humid forest up to 560m elevation in Guyana. Most birds have been reported from gallery forest. This species is classified as Near Threatened because it has a moderately small population that is suspected to be in slow decline owing to habitat loss and trade (BirdLife International, 2016f).

Orange-breasted falcon *(Falco deiroleucus*) has a range covering much of Latin America, though in Guyana it is scarce. This species occurs in a range of habitats, including lowland forest and in human-modified landscapes, but only if mature forest is the dominant habitat. It is found mostly up to 1,100m, and mountainous areas with exposed cliffs appears important habitat for this species. The nest is built on a cliff face, or rarely in a tree, often near water. It is a highly specialised hunter of flying prey. Based on a model of future deforestation in the Amazon basin, as well as evidence of declines elsewhere within its extensive range, it is suspected that the total population of this species is undergoing ongoing declines at the rate of 25-30% over three generations, and it has therefore been uplisted to Near Threatened (BirdLife International, 2016g).

9.3 Range-restricted and Endemic Species

<u>Plants</u>

There is no clear picture of plant endemism in Guyana. Guyana is no phytogeographic entity in itself but is part of the Guiana Shield region. *Dicymbe altsonii* was recorded from the study area. It is

endemic to Guyana, occurring in the lowland and lower montane forests of the Pakaraima Mountain and central Guyana upland region. Common Baromalli *Catostemma commune* was recorded from the study area and is endemic to the Guiana Shield region. *Catostemma commune* is frequent to abundant in Mixed Forest and Mora Forest and occurs principally in the Essequibo and Cuyuni River Basins (Steyermark, 1987). *Catostemma commune* is found abundantly in almost every dry land forest type in the Northwest District region of Guyana (Huber, 1995).

Macro-invertebrates

No endemic species of invertebrates were recorded from the study area. However, the invertebrate fauna of Guyana and levels of endemism are poor known. The invertebrate Orders Hymenoptera (Family-Formicidae, ants); Lepidoptera (butterflies); and Opisthopora (earthworms) are estimated to have high endemism within the Guiana Shield region (Lavelle, 2003).

Fish

The following fish recorded from the study area are endemic to the rivers of Guyana: *Aequidens potaroensis, Crenicichla wallacii, Anablepsoides (Rivulus) holmiae,* and *Anablepsoides (Rivulus) waimacui*. Additionally, species in the genus *Lebiasina* were recorded from the study area and may have restricted ranges, though more research is needed on this taxonomically confusing and poorly-studied genus.

Amphibians

The following frogs recorded from the study area are endemic to Guyana: Woodley's stefania (*Stefania woodleyi*), Evan's stefania (*Stefania evansi*), and the Kaie rocket frog *(Anomaloglossus kaiei*). *Anomaloglossus praderioi,* also recorded, is a range-restricted species, occurring in two localities in Venezula and two in Guyana. Most of the Guiana's endemic amphibians are largely restricted to the Guyana Shield Highlands, generally strongly associated with the Tepui formations (Senaris and Mac Culloch, 2005).

Evan's stefania (*Stefania evansi*) was previously reported from the lowlands of west-central Guyana, including the base of Mount Wokomung between 680-698 m asl in the Pakaraima Mountains, as well as Mount Ayanganna, Kaieteur National Park and Iwokrama Forest Reserve, up to 900 m asl. It is now only known with certainty from its type locality of Groete Creek in Guyana and Pakatau Creek, Iwokrama Forest Reserve (sps. 1 and 2 in Kok et al. 2017), at around 100 m asl. It is likely to occur between known localities, however further surveys are required to verify this.

Woodley's stefania (*Stefania woodleyi*) was recorded from the study area. It is endemic to the eastern part of the Pakaraima Mountains in Guyana. *Stefania woodleyi* was previously reported from Mount Kanaima (type locality), Tukeit (near the base of Kaieteur Falls), Mount Paramakatoi, Mount Ayanganna, as well as Mount Wokomung, between 100–870 m asl. It is now only known from certainty from its type locality of Mount Kanaima and Kaieteur National Park, between 205-580 m asl (IUCN Specialist Amphibian Group, 2019).

The Kaie rocket frog *(Anomaloglossus kaiei*) is known from Kaieteur National Park to the slopes of Maringma Tepui, Guyana. It is also present on the slopes of Mt. Wokomung and can be found along the Guyana-Brazil border. It is may be present in adjacent Brazil (IUCN Specialist Amphibian Group, 2017).

Anomaloglossus praderioi is a range-restricted species, previously known from two localities in eastern Venezuela: 1) the slopes of Mt. Roraima (type locality; La Marca 1997) between 1,800-1,950 m asl, and 2) Sierra de Lema (currently the westernmost and northernmost known locality) at 1,374 m

asl; and two localities in Guyana: 1) the slopes of Mt. Roraima at 1,310 m asl and 2) the slopes of Maringma Tepui at 1,376 m asl (currently the easternmost and southernmost known locality)(IUCN Specialist Amphibian Group, 2021).

Reptiles

None of the reptiles recorded from the study area are known to be endemic to Guyana. As is the case with other vertebrate fauna, most of the endemic reptiles are restricted to highland areas (Senaris and MacCulloch, 2005).

Mammals

None of the mammals recorded from the study area are known to be endemic to Guyana. However, the Guianan saki monkey (*Pithecia Pithecia*) and Guiana spider monkey (*Ateles paniscus*) are endemic to the Guiana Shield region, where they are widely distributed (Hollowell and Reynolds, 2005).

Birds

None of the mammals recorded from the study area are known to be endemic to Guyana. However, based on Braun's (2000) endemism classification system, a number of birds recorded from the study area are restricted to the Guiana Shield region: the Guianan toucanet (*Selenidera culik*), the cayenne jay (*Cyanocorax cayanus*), the Guianan puffbird (*Notharchus macrorhynchos*), the Guianan warbling antbird (*Hypocnemis cantator)*, the yellow-throated flycatcher (*Conopias parva*), the Guianan red-cotinga *(Phoenicircus carnifex*), and the Guianan cock-of-the-rock *(Rupicola rupicola*).

The following birds recorded from the study area are restricted to the Guiana Shield region and adjacent Venezuela and Brazil: the caica parrot (*Pionopsitta caica*), rufous-bellied antwren (*Myrmotherula guttata*), Todd's antwren (*Herpsilochmus stictocephalus*), orange-bellied manakin (*Lepidothrix suavissima*) and waved woodpecker (*Celeus undatus*).

The following twelve (12) bird species recorded from the study area are known to be exclusively distributed north of the Amazon: black curassow (*Crax alector*), blue-cheeked parrot (*Amazona dufresniana*), fiery-shouldered parakeet (*Pyrrhura egregia)*, black-headed parrot (*Pionites melanocephala)*, Guianan toucanet (*Selenidera culik*), black nunbird (*Monasa atra*), cayenne jay (*Cyanocorax cayanus)*, Guianan puffbird (*Notharchus macrorhynchos*), spot-tailed antwren (*Herpsilochmus sticturus)*, Guianan streaked-antwren (*Myrmotherula surinamensis*), Guianan warbling antbird (*Hypocnemis cantator*) and yellow-throated flycatcher (*Conopias parva*).

9.4 Migratory Species

No migratory species were recorded from the study area. The interior lowlands of Guyana are not known to be critical habitats for migratory species. However, the forests and rivers of the Eagle Mountain study area are linked to those of the Amazon Basin, serving as biological corridors for animal movements. The Mahdia and Potaro Rivers serve as the major rivers draining the landscape of Eagle Mountain. These rivers form part of the river system that drains the lower Potaro River Basin of Guyana. The Potaro River is linked to the Essequibo River drainage basin, which is known to serve as a major biological corridor for aquatic species. The Essequibo River 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 Potaro River basin is connected to the Amazonia aquatic systems via the Essequibo River, thereby serving as biological corridors for aquatic species linking to the Amazon Basin. Regarding forests, the landscape of Eagle Mountain forms part of the lowland and low montane forest ecosystems typical of

the lowland and lower montane forest habitats of the national forest regions and by extension, the lowland and lower montane forests of the Guyana Shield Region and the Amazon Basin.

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APPENDIX A: BIODIVERSITY BASELINE METHODOLOGY

FLORA

A modified stratified-random sampling system was utilized based on a grid of transects. Transects were laid out over the study area from W to E crossing the main N-S trail; they were oriented in the same way as the drill lines crossing the trail (approximately on a 73° grid bearing) and coincided with them where possible. Transects avoided obvious areas of complete vegetation clearance (determined with high resolution satellite imagery).

Plots were placed along six transects and measured 100 m by 20 m (i.e., 10 m from the center transect line). A central plot was established every 300 m along the main transects, and a sub-plot (5 m × 5 m) was typically set every 650 m along the transects. The transect lines' plot start and end positions were marked with numbered tape. The distance between transect lines was measured at 100 m intervals, and plot start points were recorded. The same six transects sampled in 2013 were re-sampled in 2021, though some plots and sub-plots had to be moved due to their inaccessibility.

Number of plots and sub-plots per transect in 2013 and 2021

2013			2021		
Transect	**Plots**	**Sub-plots**	**Transect**	**Plots**	**Sub-plots**
1	13	3	1	9	4
2	11	3	2	9	3
3	8	3	3	9	5
4	9	1	4	8	2
5	10	2	5	7	2
6	4	1	6	7	3

Data Collection

In the main plots all woody plants (dicot trees, palms and lianas) down to 10 cm diameter at breast height (DBH) were enumerated. DBH was recorded plus species. In the sub-plots, in addition to main plot data, all trees and lianas less than 10 cm diameter plus flowering plants (e.g., shrubs, heliconia, bromeliads, and aroids) and ferns were identified and enumerated. Woody species were categorized as poles (5-14 cm DBH), saplings (<5 cm DBH taller than 1 m) and seedlings (less than 1 m tall). The disturbance state and soil type of the plots was also recorded.

GPS Location of Flora Sample Plots at Transects in 2013

X	Y	Line	Plot	Sub-plot	Soil Type	State
262620	573998	1	1		Brown sand/rock	Undisturbed
262926	574064	1	2		Brown sand/rock	Undisturbed
263212	574115	1	3		Brown sand/rock	Undisturbed
263500	574208	1	4		Brown sand/rock	Undisturbed
263787	574272	1	5		Brown sand	Disturbed
264079	574338	1	6		Brown sand	Disturbed
264658	574497	1	7		Brown sand	Disturbed
264944	574588	1	8		Brown sand	Disturbed
265232	574696	1	9		Brown sand/rock	Undisturbed
265513	574775	1	10		Brown sand/rock	Undisturbed
265809	574869	1	11		Brown sand/rock	Undisturbed
266088	574958	1	12		Brown sand/rock	Undisturbed
266374	575054	1	13		Brown sand/rock	Undisturbed

X	Y	Line	Plot	Sub-plot	Soil Type	State
263250	574141	1		1	Brown sand/rock	Undisturbed
264990	574608	1		2	Brown sand/rock	Undisturbed
265567	574791	1		3	Brown sand/rock	Undisturbed
262504	574587	2	1		Brown sand/rock	Undisturbed
262772	574638	2	2		Brown sand/rock	Undisturbed
263074	574720	2	3		Brown sand/rock	Undisturbed
263358	574803	2	4		Brown sand/rock	Undisturbed
263657	574865	2	5		Brown sand	Disturbed
263945	574945	2	6		Brown sand	Disturbed
264237	575026	2	7		Brown sand	Disturbed
264517	575112	2	8		Brown sand/rock	Undisturbed
264800	575219	2	9		Brown sand/rock	Undisturbed
265090	575303	2	10		Brown sand/rock	Undisturbed
265365	575386	2	11		Brown sand/rock	Undisturbed
263127	574734	2		1	Brown sand/rock	Undisturbed
264281	575040	2		2	Brown sand/rock	Undisturbed
264856	575225	2		3	Brown sand/rock	Undisturbed
263508	575733	3	1		Brown sand	Undisturbed
263756	575837	3	2		Brown sand	Undisturbed
264019	575947	3	3		Brown sand	Undisturbed
264310	576026	3	4		Brown sand	Undisturbed
264887	576211	3	5		Brown sand	Disturbed
265449	576388	3	6		Brown sand	Disturbed
265741	576480	3	7		Brown sand	Disturbed
266302	576637	3	8		Brown sand	Undisturbed
264078	575955	3		1	Brown sand	Undisturbed
265216	576323	3		2	Brown sand	Undisturbed
265785	576515	3		3	Brown sand/rock	Undisturbed
262432	576999	4	1		Brown sand/rock	Undisturbed
262127	576939	4	2		Brown sand/rock	Undisturbed
262716	577045	4	3		Brown sand	Disturbed
263008	577123	4	4		Brown sand	Disturbed
263335	577146	4	5		Brown sand	Disturbed
264458	577521	4	6		Brown sand	Disturbed
264761	577608	4	7		Brown sand/rock	Undisturbed
265033	577680	4	8		Brown sand/rock	Undisturbed
		4	9		Brown sand/rock	Undisturbed
264504	577530	4		1	Brown sand/rock	Undisturbed
261784	577716	5	1		Brown sand	Disturbed
262081	577774	5	2		Brown sand	Disturbed
262374	577830	5	3		Brown sand	Disturbed
263060	577976	5	4		Brown sand	Disturbed
262667	577893	5	5		Brown sand/rock	Undisturbed
263351	578044	5	6		Brown sand/rock	Undisturbed
263924	578203	5	7		Brown sand/rock	Undisturbed
264211	578295	5	8		Brown sand	Disturbed
264493	578386	5	9		Brown sand/rock	Undisturbed

X	Y	Line	Plot	Sub-plot	Soil Type	State
264793	578438	5	10		Brown sand/rock	Undisturbed
262421	577841	5		1	Brown sand/rock	Undisturbed
264850	578443	5		2	Brown sand/rock	Undisturbed
262035	578697	6	1		Brown sand/rock	Undisturbed
262328	578793	6	2		Brown sand/rock	Undisturbed
264052	579307	6	3		Brown sand	Disturbed
264334	579397	6	4		Brown sand	Disturbed
264383	579485	6		1	Brown sand/rock	Undisturbed

GPS Location of Flora Sample Plots at Transects in 2021

Latitude	Longitude	Elevation	Line	Plot	Sub-plot	State
5.200583	-59.122899	241	1	1		Undisturbed
5.199136	-59.125212	201	1	2		Undisturbed
5.199070	-59.12566	195	1	3		Undisturbed
5.197987	-59.12900	139	1		1	Undisturbed
5.197521	-59.130334	159	1	4		Undisturbed
5.197409	-59.131265	149	1	5		Undisturbed
5.196268	-59.133706	166	1		2	Undisturbed
5.195497	-59.135528	173	1	6		Undisturbed
5.195187	-59.136200	157	1	7		Undisturbed
5.191185	-59.143936	157	1		3	Undisturbed
5.194498	-59.137884	189	1	8		Undisturbed
5.193461	-59.140382	216	1	9		Undisturbed
5.192842	-59.141712	248	1		4	Undisturbed
5.210450	-59.114604	342	2	1		Disturbed
5.209367	-59.117090	350	2	2		Disturbed
5.207903	-59.120078	313	2		1	Disturbed
5.206784	-59.121893	253	2	3		Disturbed
5.205315	-59.125437	180	2		2	Undisturbed
5.204866	-59.126904	172	2	4		Undisturbed
5.203873	-59.129305	124	2	5		Undisturbed
5.203312	-59.130268	120	2		3	Undisturbed
5.202534	-59.131925	148	2	6		Undisturbed
5.201366	-59.134172	187	2	7		Undisturbed
5.200163	-59.136305	228	2	8		Undisturbed
5.200042	-59.136470	229	2	9		Undisturbed
5.199683	-59.137348	238	2	10		Undisturbed
5.217130	-59.117692	118	3	1		Undisturbed
5.215867	-59.120031	327	3	2		Undisturbed
5.214515	-59.122941	266	3		1	Undisturbed
5.214689	-59.122511	271	3	3		Undisturbed
5.213603	-59.124959	203	3	4		Undisturbed
5.212413	-59.127387	171	3	5		Undisturbed
5.211935	-59.128159	155	3		2	Undisturbed
5.211485	-59.129023	136	3	6		Undisturbed
5.210017	-59.132117	108	3		3	Undisturbed

Latitude	Longitude	Elevation	Line	Plot	Sub-plot	State
5.207879	-59.136645	153	3	7		Undisturbed
5.20645	-59.139118	159	3	8		Undisturbed
5.205206	-59.141549	172	3	9		Undisturbed
5.222725	-59.120597	84	4	1		Undisturbed
5.221520	-59.123022	201	4	2		Undisturbed
5.220249	-59.125845	198	4		1	Undisturbed
5.220089	-59.126318	185	4	3		Undisturbed
5.219139	-59.127875	155	4	4		Disturbed
5.218124	-59.130259	115	4	5		Undisturbed
5.217610	-59.131203	100	4		2	Disturbed
5.215421	-59.135803	104	4	6		Disturbed
5.213787	-59.139346	104	4	7		Undisturbed
5.215216	-59.136252	101	4		3	Undisturbed
5.212583	-59.141639	154	4	8		Undisturbed
5.211435	-59.144095	103	4	9		Undisturbed
5.228957	-59.122331	59	5	1		Undisturbed
5.227411	-59.124718	145	5	2		Undisturbed
5.226405	-59.127203	113	5	3		Undisturbed
5.226128	-59.127641	111	5		1	Disturbed
5.220650	-59.138812	88	5	4		Disturbed
5.220389	-59.139258	104	5	5		Disturbed
5.221790	-59.136763	82	5		2	Disturbed
5.217032	-59.146639	107	5	6		Undisturbed
5.216486	-59.147184	118	6	1		Undisturbed
5.237714	-59.126058	109	6	2		Undisturbed
5.236329	-59.128528	151	6	3		Undisturbed
5.235415	-59.131063	113	6	4		Undisturbed
5.234170	-59.133358	110	6	5		Undisturbed
5.228253	-59.145648	85	6	6		Undisturbed
5.227099	-59.148008	97	6	7		Undisturbed
5.225858	-59.150471	138	6	8		Undisturbed

FAUNA

Animals were surveyed at six main transects. The location and description of the fauna transects is given below.

Transect	GPS Coordinates and Elevation	Habitat Description
T1	21 N 0266126 0576719, Elev. 573 m 21 N 0265638 0576147, Elev. 368 m 21 N 0265496 0576226, Elev. 344 m	Transects include areas of mixed forests (mostly undisturbed but with some disturbed forest) on rocky and brown sands/loam soils. Transect runs from access road at high elevations on Eagle Mountain to base of mountain. Crosses small access lines, drill pads, the creek at the main campsite, sections of Minihaha Creek, and part of the main access road to Minihaha.
T2	21 N 0263513 0574829, Elev. 350 m 21 N 0264077 0574961, Elev. 352 m 21 N 0264025 0574942, Elev. 352 m	Includes areas of intact mixed forest and disturbed forest on rocky and brown sands/loam soils. Transects run from road behind campsite to main access road and includes areas of open shrub, grassland and creeks.
T3	21 N 0263500 0578083, Elev. 127 m 21 N 0264195 0576176, Elev. 105 m 21 N 0263589 0577567, Elev. 127 m 21 N 0263476 0578018, Elev. 90 m	Includes sections of mixed forests with primary and secondary growth. Runs from end of T2 to the main road along forest trails through small area of savannah-like habitat.
T4	21 N 0263812 0577232, Elev.97 m	Includes approximately 1.2 km of secondary road characterized by mixed forest, drill pads, flooded pools, and a section of the main road with secondary forest bisected by several fast-flowing creeks. Sampling areas also included Marshall's Farming area, with rocky, red loam and sandy soils
T5	21 N 0263497 0578240, Elev.100 m 21 N 0264735 0578253, Elev.136 m	Includes lower elevations of study area, a fast-flowing clearwater creek (the Mahdia Town water source), a forested trail running to the top of the creek's waterfall, and the access road to the water source. Transect is characterised by primary and secondary vegetation and an open reclaimed mined area.
T6	21 N 0262831 0578805, Elev.70 m 21 N 0262948 0578848, Elev.74 m 21 N 0263414 0578830, Elev.153 m 21 N 0263201 0578891, Elev.104 m	Includes a small access road with secondary vegetation leading to Mahdia Creek, reclaimed mining areas, active mining areas, and a section of main road running to end of Goldsource property and continuing for about 800 m out of the property, with mixed lowland forests, on red loam, rocks, clay soils.

Lepidoptera and other macro-invertabrates

Methods employed to sample the Lepidoptera included baited butterfly traps and butterfly nets. The bait included fermented banana, and plantain in beer. Other fruits such as mango and watermelon were added to the mixture. The butterflies that were caught were placed in separate envelopes and photographed to aid in identification.

The principal method used to sample terrestrial macro-invertebrates was to conduct daily Visual Encounter Surveys (VES) along each of the six fauna transects. Flying and crawling insects were caught using a long-handled insect sweep net along each transect. The sweep net was randomly

dragged when insects were present. Captured insects were removed, photograph and identified. VES was typically conducted between 8:30 and 11:30h and 13:30 to 16:00h. Night sampling was also done randomly using a white light to attract and a sheet to collect macro-invertebrates.

Each night a light trap was set to sample nocturnal flying insects, such as moths and beetles, bearing in mind that most insect sampling methods are biased towards certain groups of insects and that many variables (e.g., moonlight, wind, temperature) can affect the success of insect trapping. The light trap, fitted with a double lamp, emitting ultra-violet and white light, was hung from a tree branch 1-2 m above the ground in front of a vertical white sheet. The white sheet placed behind the light helped with collecting since it gives the flying insects a place to land and fewer escape routes. The traps were not situated so that the light source is not heavily shaded by the surrounding vegetation, because this reduces the area over which the light The light trap was switched on for three 10-minute periods each night: 1 hour after sunset, 2 hours after sunset and 3 hours after sunset, and insects attracted by the light trap were identified and counted.

Pitfall traps were set to capture ground-dwelling insects were sampled along a single 200m transect. A hole was dug to 8cm in depth and a plastic container was placed in the ground at ground level with water and a squirt of detergent to capture the ground-dwelling insects.

For aquatic macro-invertebrates all fishing points were surveyed. At each site, a D-net was used to capture surface and bottom-dwelling invertebrates. The net was rubbed against different substrates (rocks, woods, etc.) which are ideal habits for macroinvertebrates. The area was vigorously kicked to stir up any invertebrates we may have missed. After sampling was completed, the net was lifted and the specimens were removed for identification. Specimens were placed in a sorting tray where they were counted and photographed.

Geographical coordinates of sites used to sample macro invertebrates

ID	Nearest Transect	Coordinates
Along access road	T1	21N 0264025 0574302 21N 0264031 0574305
Along access road	T1	21N 0264304 0574413 21N 0263585 0574220
Along access road	T2	21N 0263282 0574824 21N 0263508 0574832 21N 0263520 0574831
Clearing near intersection	T3	21N 0264092 0574959
Near Camp	T3	21N 0265125 0575889 21N 0265736 0576125
Savannah	T3	21N 0264073 0576133 21N 0263940 0576094
Along access road	T3	21N 0266156 0576469 21N 0266106 0576522
Along access road	T3	21N 0265976 0576321 21N 0266010 0576326
Cock of the rock cave	T3	21N 0265940 0576734
Highest Drill pad	T3	21N 0266039 0576753 21N 0266174 0576762 21N 0266222 0576751
Near Friendly turn	T4	21N 0265641 0576607 21N 0265682 0576672

ID	Nearest Transect	Coordinates
Along access road	T4	21N 0265474 0576336 21N 0265466 0576395
Along access road	T4	21N 0263518 0578926 21N 0263498 0578918
Along access road	T4	21N 0263627 0577515 21N 0263588 0577438
Along access road[9]	T4	21N 0265958 0576390 21N 0265967 0576395 21N 0265970 0576398
Along access road	T4	21N 0265325 0576721 21N 0265328 0576715
Along access road	T5	21N 0265735 0576435 21N 0265717 0576433
Along access road	T5	21N 0263543 0576577 21N 0263538 0576561
Road Intersection	T5	21N 0263418 0578753 21N 0262843 0578753 21N 0264735 0578255
Top of Hill	T6	21N 0263207 0578898 21N 0262843 0578753 21N 0262590 0577983

FISH

A total of ten sites were sampled in both seasons with sites chosen based on their location, habitat type and accessibility. To ensure that the sites were exhaustively sampled, different sampling gears were used to capture fishes of various sizes. The gears used at the sampling sites differ based on the local environment and the width and depth of the water body. In larger channels, gillnets and hook and line were used. The shallow sites only facilitated the use of smaller gears such as the dip net and drag nets. All of the sites were either congested or too shallow and rocky to facilitate the used of cast nets.

The following are the different sampling gears used at the different sampling sites:

- **FP1 -** Hook and line, gillnet, visual observation and drag seine.
- **FP2 -** Gillnets, hook and line, drag seine and visual observation.
- **FP3 -** Gillnets, hook and line, visual observation, drag seine and dip net.
- **FP4 -** Hook and line and visual observation.
- **FP5 -** Visual observation, hook and line, gillnet and drag seine.
- **FP6 -** Hook and line, visual observation and interview(s) with locals.
- **FP7 -** Drag seine and dip net.
- **FP8 -** Hook and line, visual observation and drag seine.
- **FP9 -** Hook and line, gillnet and visual observation.
- **FP10 -** Drag net, visual observation and dip net.

[9] Coordinates are for points where baited fruit traps were placed and areas where VES took place.

Approximately 24 hours were spent at each of the sampling sites, including the evenings and early mornings. The following methods were used:

- Gillnets were set out based on the depth, width and velocity of the water body. In areas where gillnets were used, these nets were checked every morning at 08:00 hrs and afternoon at 17:00 hrs. Gillnets were used to target nocturnal fishes. However, according to Kirk Winemiller (Personal Communication, February 2021) the usage of drag nets targets all aquatic species found in the water body.

- Dip nets and drag seine were used at most of the sampling sites. These methods were used to capture small fish species.

- Hook and line fishing was undertaken where possible depending on the velocity of the water and the depth. Hooks were baited either using earthworms dug from the sample areas or with small fish that had been captured with dip nets and/or gillnets.

- In areas where the stream has clear/brackish water, visual encounter surveys were used to record fish that are surface oriented or dwell in shallow waters.

- Interviews were conducted with miners and employees of Goldsource Inc. a who live in the area to gather information on fish commonly caught within the study area.

All the different species collected were photographed and were classified following the taxonomic classification of Watkins *et al*. (2004).

Habitat Descriptions of the Fishing Points. Map datum is Prov South America '56'. Position format is UTM

Fishing Points	GPS Coordinates	Habitat Description and Elevation (m)
FP1	Start 21 N 0263582 0578145 End 21 N 0236456 0578170	Elev. 102 m. Marshall clear-water creek. Site located along access road of the Mahdia Town water supply reservoir. Channel depth approx. 0.3m and width approx. 3.3m. Human disturbance along the bank and channel estimated to be negligible. Channel estimated to be 40% woody debris, 15% sand, 30% leaf litter, 5% pebbles, and 10% clay; whereas the bank was estimated to be 50% shrubs, 25% trees and 25% grass. No human disturbance. Weather during sampling was sunny with little rainfall.
FP2	Start 21 N 0264089 0574963 End 21 N 0264328 0574395	Elev. 118m. Minnihaha Creek. Site located at southern border of Eagle Mountain property. Channel depth 0.3m at shallowest and 1.5m at deepest. Channel width approx. 3m. Channel estimated to be 20% woody debris, 20% sand, 10% leaf litter, 15% pebbles, 15% gravel and 20% silt; whereas bank estimated to be 50% shrubs, 25% trees and 25% grass. Human disturbance was high i.e., secondary growth, domestic garbage, and mining.
FP3	Start 21 N 0265345 End 0576687	Pond at Friendly Hill. Fishing point at access road to Goldsource Camp. Water murky, channel depth approx. 1.8m deep and 30m wide. Channel estimated to be 50% clay, 20% woody debris, 20% leaf litter, 5% rocks and 5% sand; whereas bank estimated to be 25% trees, 55% shrubs and 15% grass. Canopy cover was 25% and human disturbance was relatively high due to presence of exploration drilling activities.

Fishing Points	GPS Coordinates	Habitat Description and Elevation (m)
FP4	Start 21 N 0265467 End 0576451	Turtle Pond. Fishing point located close to Goldsource Camp. Channel estimated to be 10% clay, 40% woody debris, 40% leaf litter, 10% pebbles; whereas the bank was 80% trees, 10% shrubs and 10% shrubs. Human disturbance was negligible. The pond was approximately 3m wide and 0.6m deep.
FP5	Start 21 N 0264139 0576138 End 21 N 0263875 0576125	Elephant Pond. Fishing point located at shrub area. Channel estimated to be 40% clay, 15% woody debris, 20% leaf litter, 15% sand and 10% cobbles; whereas the bank was 40% trees, 30% shrubs and 20% shrubs. Human disturbance negligible. Pond approx. 10m wide and 1.8m deep. Length of area sampled was 50m. The water was clear. Pond drains into a fast-flowing stream.
FP6	Start 21 N 0263476 End 0578034	Mahdia Creek. Channel here like a murky pond, about 10m wide and >4m deep. Channel estimated to be 30% clay, 30% woody debris, 20% leaf litter and 20% leaf litter; whereas the bank was 70% trees, 10% shrubs and 20% grass. Canopy cover estimated as 75%. Human disturbance at site low.
FP7	Start 21 N 0263685 0577368 End 21 N 0263654 0577336	Elev. 103m. Unnamed creek. The channel was considered as a clear water stream about 4 ft wide and not more than 2 ft deep. The channel was estimated to be 30% clay, 30%woody debris, 10%pebbles, 10% cobbles and 20% leaf litter, while the bank was 70% trees, 10% shrubs and 20% grass. The level of canopy cover was estimated to be 95% while the level of human disturbance was negligible.
FP8	Start 21 N 0264726 0578233 End 21 N 0264339 0578342	Elev. 178m. Mahdia water supply creek. Channel shallow, rocky, with clear water. Width approx. 5m and depth from 0.3-1.5m. Channel estimated to be 5 % woody debris, 20% sand, 10% pebbles, 10% cobbles, 55% rocks; whereas bank was 5 % grass, 90 % trees and 5% shrubs. Human disturbance was estimated low to moderate due the presence of the water reservoir.
FP9	Start 21 N 0263574 0577638 End 21 N 0263579 0577531	Elev. 90m. Unnamed creek. Fishing point was a murky pond approx. 5m wide and 0.3-1.5m deep. The channel was estimated to be 10% woody debris, 20% sand, 20% pebbles, 50% clay; whereas the banks were estimated to be 50 % grass, 10 % trees and 40% shrubs. Human disturbance was low.
FP10	Start 21 N 0264201 0575729 End 21 N 0264217 0575625	Elev. 138m. Minnihaha Creek. Site at entrance of Goldsource compound. The channel estimated to be 5% clay, 10% sand, 5% silt, 10% cobbles, 5% woody debris, 5% litter and 5% pebbles and 55% rocks; whereas the bank was 20% grass, 10% shrubs and 70% trees. Canopy cover was 100% and human disturbance was high due to access road passing across creek. Channel was fast flowing and murky at some points due to heavy rainfall.

Amphibians and Reptiles

Amphibian surveys within the study area were undertaken in lowland forest, upland forest, savanna-like open areas including old mining areas, access roads, swamps, and creeks, and other waterbodies that are now closely associated with the natural drainage system of the area. Sites were mainly characterized by undulating terrain with mixed forest, and secondary growth in previously mined areas. At each of the six fauna transects, three sub-sites were identified to sample amphibians, **A** – being 3-5, approx.100 m transects in a forested area, **B**- transects alongside or around swamps, creeks and other water bodies, and **C** – 3-5, 100 m transects in open areas, including savannas, access roads and abandoned mining areas.

Diurnal and nocturnal visual encounter surveys (VES) and auditory encounter surveys (AES) were conducted each day along transects to determine species presence, distribution and relative abundance. Patch sampling of habitats was also done during this time. Searches were also done after heavy rainfall, to record explosive breeders that use the heavy rainfall and subsequent run off for breeding and laying eggs.

Three (3) pit fall stations were also set up at T1 and T2. The Zion tunnels/caves that were surveyed in previous studies were filled with debris and unsafe for exploration during this survey period.

Additional information on species presence was documented from local ecological knowledge interviews with workers of the company, local miners and local residents in the area. Photographs were taken of most of the species that were observed.

Non-volant Mammals
The following methods were utilized to assess the non-volant mammal fauna at transects:

- Visual encounter surveys (for animal presence/ or signs of presence) were conducted in the morning (approx. 07:00 hrs – 10:30 hrs) as well as at night (approx.19:00 hrs – 23:00 hrs) to document diurnal and nocturnal mammals. Transects T2, T3, T4, T5 and T6 were each surveyed over a two-day period; whereas T1 was surveyed over a three-day period because of the greater diversity of habitats at T1. Direct sightings and indirect evidence such as tracks, scats, prey remains, burrows, animal markings and scent were used to document the presence of species.

- In 2021 (but not 2013), 10 small Sherman traps baited with sunflower seeds and sardines were placed along the edge of the primary campsite near transect T1 for eight days. Traps were not set in all of the sampling areas because of the logistics of accessing each site every morning as all traps had to be checked each morning and rebaited if necessary.

- In 2021 (but not 2013), three camera traps were set up at transects T2 (one camera set in a relatively open area) and at T1 (one camera alongside the forest edge on a hill and a second set at the campsite next to the garbage pit). Each camera trap was set to record for six days.

- Multiple interviews were conducted with those Goldsource Inc. staff who have been working in the area for at least two years to further document the mammal fauna of the study area. Interviews were conducted by showing persons photographs of mammals of Guyana and recording whether they have been seen within the study area. Interviews are regarded as extremely useful in rapid biodiversity assessments (Camino *et al*, 2020).

Microchiropteran Bats
At each of the six transects, three 12m x 2.6m and three 6m x 3m mist nets (38mm mesh size nets made by Avinet, Drysden, NY, USA) were erected at ground level (0-3m). Nets were placed in a perpendicular manner to each other to optimize the sample effort in the area.

Nets were opened before sunset each night for a total of two consecutive nights per site since bats quickly learn the position of mist-nets and are able to evade them. Heavy rainfall and thunderstorms delayed the opening and forced the closure of mist nets on most nights. Nets were left opened for up to 7 hours after sunset since bat activity and capture rates tend to peak between two to five hours after sunset (Frank Clarke personal communication).

Mist-nets were checked every thirty minutes. Captured bats were identified using the field key to the bat fauna of Guianan sub region provided by Lim and Engsrom (2001) and Lopez-Baucells *et al.*

(2016) Field Guide to Amazonian Bats. Captured bats were then immediately released at the site of capture. Capture effort was calculated as the number of hours of net surface-area deployed. Due to low capture rates during the initial part of the survey due to very heavy rainfall (bats are less active during rainfall and can more easily detect nets), roost searches and opportunistic sampling was undertaken in areas where bat roosts are likely to occur.

Birds

Along each of the fauna transects, the bird fauna was assessed using Visual Encounter Surveys and Auditory Encounter Surveys (namely Point Counts), to determine bird species presence, distribution and relative abundance. Vocal identifications of many of the cryptic and canopy species were verified by using playback of pre-recorded bird songs.

Mist-netting was also conducted at all transects. To capture birds, mist-nets were positioned to in all microhabitats present at the six study sites: near streams, flat well-drained ground, and swampy areas, on mountain slopes, under closed canopy or in tree-fall gaps. A total of six (6) nets were set along trails with the orientation of the mist-nets varying since the landscape throughout the concession varied in topography and structure. Captured birds were photographed, identified to species with reference to field guides (Braun *et al*. 2000; Hilty, 2003), the fifth primary was marked to determine recaptures, and then they were immediately released at the site of capture. Each transect was surveyed for two days. VES and AES were undertaken on day one; whereas mist-netting was undertaken on day two.

APPENDIX B: TRANSECT SPECIFIC DATA FOR STUDY AREA

Appendix B-1: Flora

List of Trees (>10cm dbh) recorded from Main Plots

Common name	Scientific name	Family
Bauwaua	*Astronium ulei*	Anacardiaceae
Duka	*Tapirira marchandii*	Anacardiaceae
Arara	*Guatteria atra*	Annonaceae
Smooth skin arara	*Guatteria brachypoda*	Annonaceae
Allamanda	*Allamanda cathartical*	Apocynaceae
Dukali	*Parahancornia fasciculata*	Apocynaceae
Yarula	*Aspidosperma excelsum*	Apocynaceae
Shibadan	*Aspidosperma album*	Apocynaceae
Karahoro	*Schefflera decaphylla*	Araliaceae
Futui	*Jacaranda copaia*	Bignoniaceae
White cedar	*Tabebuia insignis*	Bignoniaceae
Sand baromalli	*Catostemma fragrans*	Bombacaceae
Common baromalli	*Catostemma commune*	Bombacaceae
Kurokai	*Protium decandrum*	Burseraceae
Sarabebeballi	*Vouacapoua macropetala*	Caesalpiniaceae
Apaikara	*Campsiandra comosa*	Caesalpiniaceae
Mora	*Mora excelsa*	Caesalpiniaceae
Morabukea	*Mora gongrijppii*	Caesalpiniaceae
Soft wallaba	*Eperua falcata*	Caesalpiniaceae
Clump wallaba	*Dicymbe altsonii*	Caesalpiniaceae
Apokaito	*Chamaecrista adiantiflia*	Caesalpiniaceae
Congo pump	*Cecropia obtusifolia*	Cecropiaceae
Kabukalli	*Goupia glabra*	Celastraceae
Marishiballi	*Licania canascens*	Chrysobalanaceae
Kauta	*Licania laxiflora*	Chrysobalanaceae
Fukadi	*Terminalia amazonia*	Combretaceae
Waiaball	*Tapura guianensis*	Dichapetalaceae
Barabara	*Diospyros dichroa*	Ebenaceae
Aruadan	*Sloanea guianensis*	Elecocarpaceae
Ubudiballi	*Sloanea schomburgkii*	Elecocarpaceae
Hatti	*Hevea pauciflora*	Euphorbiaceae
Surada	*Heyeronima alchorneoides*	Euphorbiaceae
Warakaioro	*Laetia procera*	Flacourtiaceae
Manniballi	*Moronobea coccinea*	Guttiferae
Asashi	*Rheedia benthamiana*	Guttiferae
Manni	*Symphonia globulifera*	Guttiferae
Awasokule	*Tovomita* spp.	Guttiferae
Kereti silverballi	*Ocotea puberula*	Lauraceae
Greenheart	*Chlorocardium rodiei*	Lauraceae

Common name	Scientific name	Family
Yellow silverballi	*Aniba hypoglauca*	Lauraceae
Pear leaf silverballi	*Ocotea* spp. 1	Lauraceae
Silverballi	*Ocotea* spp. 2	Lauraceae
Poor kereti	*Ocotea oblonga*	Lauraceae
Laurace species	*Laurace* spp.	Lauraceae
Smooth leaf kakaralli	*Eschweilera coriacea*	Lecythidaceae
Black kakaralli	*Eschweilera sagotiana*	Lecythidaceae
Potaro Kakaralli	*Eschweilera* spp.	Lecythidaceae
Wadara	*Couratari guianensis*	Lecythidaceae
Gava skin kakaralli	*Eschweilera alala*	Lecythidaceae
Wimiri kakaralli	*Lecythis confertiflora*	Lecythidaceae
Barabara charcoal	*Lissocarpa guianensis*	Lissocarpaceae
Arikadako	*Byrsonima* spp.	Malpighiaceae
Waraia	*Miconia lepidota*	Melastomaceae
Unidentified Waraia (almond)	*Miconia* spp.	Melastomaceae
Crabwood	*Carapa guianensis*	Meliaceae
Trysil	*Pentaclethra macroloba*	Mimosaceae
Warakosa	*Inga laterifolia*	Mimosaceae
Maporokon	*Inga stipularis*	Mimosaceae
Manariballi	*Pithecellobium fanshawei*	Mimosaceae
Huruasa	*Pithecellobium jupunba*	Mimosaceae
Darina	*Parkia pedula*	Mimosaceae
Manariballi red	*Pithecellobium pedicellare*	Mimosaceae
Muniridan	*Siparuna cusppidata*	Monimiaceae
Buruma	*Pourouma guianensis*	Moraceae
Banya	*Eugenia* spp.	Myrtaceae
Wild guava	*Calycolpus goetheanus*	Myrtaceae
Maburea	*Maburea trinervis*	Olacaceae
Parakusan	*Swartzia jenmanii*	Papilionaceae
Aromata	*Clathrotropis macrocarpa*	Papilionaceae
Tonka bean	*Dipteryx odorata*	Papilionaceae
Itikiboroballi	*Swartzia benthamiana*	Papilionaceae
Adallidan	*Clathrotropis* spp.	Papilionaceae
Haiariballi	*Alexa imperatricis*	Papilionaceae
Hill cork wood	*Pterocarpus officinalis*	Papilionaceae
Tatabu	*Diplotripis purpurea*	Papilionaceae
Wamara	*Swartzia leiocalycina*	Papilionaceae
Okokonshi	*Quiina guianensis*	Quiinaceae
Kumakaballi	*Coussarea paniculata*	Rubiaceae
Komaramara	*Duroia eriopila*	Rubiaceae
Silk cotton	*Zanthoxylum apiculata*	Rutaceae
Wild orange	*Horita regia*	Rutaceae
Kulishiri	*Matayba oligandra*	Sapindaceae
Kulishiri red	*Matayba opaca*	Sapindaceae
Kokoritiballi	*Pouteria cuspidata*	Sapotaceae

Common name	Scientific name	Family
Asepoko	*Pouteria guianensis*	Sapotaceae
Sapotace species	*Sapotace* spp.	Sapotaceae
Kudibiushi	*Micropholis venulosa*	Sapotaceae
Bulletwood	*Manilkara bidentata*	Sapotaceae
Suya	*Pouteria speciosa*	Sapotaceae
Birdhead	*Sapotace* spp.	Sapotaceae
Paripiballi	*Chrysophllum pomiferum*	Sapotaceae
Barataballi	*Ecclinusa guianensis*	Sapotaceae
Hachiballi	*Quassia multiflora*	Simaroubaceae
Simarupa	*Quassia simarouba*	Simaroubaceae
Maho	*Sterculia pruriens*	Sterculiaceae
Kuyama black	*Xylosterculia rugosa*	Sterculiaceae
Duru	*Apeiba membranacea*	Tiliaceae

Woody Plant Species recorded in Main Plots in 2013 (Ewart Smith, Linsford Lagoudou & Gary Clarke)

Species	Individuals recorded	Species	Individuals recorded	Species	Individuals recorded
Trysil	303	warakairo	9	Bignon sp	2
Clump wallaba	237	Shirada black	9	Simarupa	2
Sarabebeballi	228	Yellow silverballi	8	Monkey Ladder	2
Smooth leaf kakaralli	112	Adalidan (like aromata)	8	Unknown (1M)	2
Black kakaralli	105	Swartia	7	Imirmiaballi	2
Potaro Kakaralli	99	Barabara chalk coal	7	Manariballi red	2
Apaikara (Clump wallaba)	94	Asepoko	7	Poor kereti	2
Maburia	91	Hachiballi	6	Asashi	2
Warakosa	89	Gauavaballi	6	Bullet wood	2
Parakusan	87	Wairai	5	Paripiballi	2
Soft wallaba	80	Hairiballi	5	Almond	2
Crabwood	62	Buruma	5	Pear leaf silverballi	2
Marishiballi	60	Kumakaballi	5	Muniridan	1
Hatti	55	Manariballi	5	white cedar	1
Maho	37	Sapatace sp	5	Wamara	1
Duka	37	Huruasa	5	Brown silverballi	1
Kauta	32	Allamanda	5	Sawari nut	1
Banya	31	Darina	5	Common baromalli	1
Comgo pump	31	Kabukalli	4	Awasokule	1
Kurokai	28	Silverballi	4	Awati	1
Barabara	27	Dukalli	4	Bauwaua	1
Arara	25	Okokonshi	4	Purpleheart	1
Duru	25	Fukadi	4	Winiri kakaralli	1
Sand baramalli	20	Kudibiushi	4	Luraceae sp	1

Species	Individuals recorded	Species	Individuals recorded	Species	Individuals recorded
Mora	20	Unknown (2M)	4	Unknown (3M)	1
Morabukea	19	Sada	4	Asepokoballi	1
Smooth skin arara	17	Shibidan	4	Karahoro	1
Arudan	17	Ulu	3	Tatabu	1
Kairiballi	17	Kautaballi	3	Wallaba sp	1
Tonka bean	16	Wadara	3	Aiomorakushi	1
Futui	16	Red Kulishiri	3	Komaramara	1
Kereti silverballi	15	Kaditiri	3	Barataballi	1
Aromata	15	Hill cork wood	3	Silverballi pear leaf	1
waiaballi	14	Kulishiri	3	ubudiballi	1
Itikiboroballi	14	Water wallaba	3	Wild orange	1
Apiketo	11	Gauava skin kakaralli	3	Birdhead	1
Maporokon	11	Suradan	3	Manni	1
Greenheart	10	Suya	3	Arikadako	1
Kokoritiballi	10	Yarula	3	Kuyama	1
Manniballi	9	Silk cotton	2	Kuyama black	1

Woody Plant Species recorded in Sub-Plots in 2013 (Ewart Smith, Linsford Lagoudou & Gary Clarke)

Common Name	Scientific Name	Family	Plants	Pole	Sapling	Seedling	Vine	Total
Fern	*Epiphylls*	Moraceae	171					**171**
Rubia sp	*Palicouria sp*	Rubiaceae	32					**32**
Sarebebeballi	*Vouacapoua macropetala*	Caesalpiniaceae			1	30		**31**
Aroids	*Philodendron*	Araceaea				22		**22**
Trysil	*Pentaclethra macroloba*	Mimosaceae		6	1	15		**22**
Mokhru	*Ischnosiphon sp*	Marantaceae	20					**20**
Melastoma	*Melastoma sp*	Melastomataceae				20		**20**
Bignon	*Bauhinia sp*	Bignoniaceae					19	**19**
Heliconia	*Heliconia sp*	Heliconiaceae	19					**19**
Congo pump	*Cecropia sciadophylla*	Cecropiaceae		13		1		**14**
Piper	*Piper sp*	Piperaceae				14		**14**
Blood wood	*Vismia macrophylla*	Clusiaceae (Guttifereae)		12		1		**13**
Crabwood	*Carapa guianensis*	Meliaceae				11		**11**
Marishiballi	*Licania canescens*	Chrysobalanaceae		1		5		**6**
Hatti	*Hevea pauciflora*	Euphorbiaceae				6		**6**
Kulishiri	*Matayba oligandra*	Sapindaceae				6		**6**
Arara	*Guatteria atra*	Annonaceae		4		1		**5**
Smooth leaf kakaralli	*Eschweilera coriacea*	Lecythidaceae		1		4		**5**
Black Kakaralli	*Eschweilera sagotiana*	Lecythidaceae		1		4		**5**
Potaro kakaralli	*Eschweilera sp*	Lecythidaceae		1		4		**5**
Sand Baromalli	*Catostemma fragrans*	Bombacaceae				4		**4**
Kauta	*Licania laxiflora*	Chrysobalanaceae				4		**4**
Black sage	*Cordia candidula*	Boraginaceae	3					**3**
Soft wallaba	*Eperua falcata*	Caesalpiniaceae				3		**3**
Warakosa	*Inga laterifolia*	Mimosaceae				3		**3**
Line leaf arara	*Guatteria sp*	Annonaceae		2				**2**
Karishiri	*Oxandra asbeckii*	Annonaceae		1		1		**2**
Clump wallaba	*Dicymbe altsonii*	Caesalpiniaceae				2		**2**
Mora	*Mora excelsa*	Caesalpiniaceae		1		1		**2**

Common Name	Scientific Name	Family	Plants	Pole	Sapling	Seedling	Vine	Total
Aromata	*Cfathrotropis macrocarpa*	Papilionaceae				2		**2**
Adallidan	*Clathropis sp*	Papilionaceae				2		**2**
Kokoritiballi	*Pouteria cuspidata*	Sapotaceae				2		**2**
Duka	*Tapirira marchandii*	Anacardiaceae		1				**1**
Yari yari	*Duguetia neglecta*	Annonaceae				1		**1**
Granny cherry	*Cordia tetrandra*	Boraginaceae	1					**1**
Apikara	*Campsiandra comosa*	Caesalpiniaceae				1		**1**
Imirimiaballi	*Chamaecrista adiantifolia*	Caesalpiniaceae			1			**1**
Morabukea	*Mora gonggrippi*	Caesalpiniaceae				1		**1**
Kabukalli	*Goupia glabra*	Celastraceae		1				**1**
Like dalli	*Vismia sp*	Clusiaceae (Guttifereae)		1				**1**
Barabara	*Diospyros dichroa*	Ebenaceae		1				**1**
Maburea	*Maburea trinervis*	Olacaceae		1				**1**
Itikiboroballi	*Swartzia benthamiana*	Papilionaceae				1		**1**
Wild coffee	*Lxora aluminicola*	Rubiaceae		1				**1**
Wild soursap	*Chrysophyllum auratum*	Sapotaceae		1				**1**
Duru	*Apeiba petoumo*	Tiliaceae				1		**1**
Batris palm	*Pouteria durlandii*	Palmae				1		**1**
Buba bua palm	*Socratea exorrhiza*	Palmae				1		**1**

Woody plant species recorded in main plots in 2021 (Ewart Smith and Raeburn Jones)

Species	Individuals Recorded	Species	Individuals Recorded
Adalidan (like aromata)	1	Kereti silverballi	9
Adebero	4	Kokoritiballi	5
Aiomorakushi	10	Komaramara	23
Alomond gale silverballi	19	Kudibiushi	1
Apiketo	3	Kulishiri	3
Arara	27	Kurokai	1
Aromata	24	Kuyama	4

Species	Individuals Recorded	Species	Individuals Recorded
Awati	6	Limonaballi	2
Arudan	37	Maburia	143
Asepoko	4	Maho	45
Awasokule	5	Manariballi	1
Bactris palm	24	Mani	3
Banya	7	Maporokon	30
Barabara	34	Marishiballi	38
Black kakaralli	234	Mokhru	28
Blood wood	7	Monkey ladder	3
Brown Silverballi	1	Mora	104
Buba bua palm	33	Morabukea	3
Bullet wood	1	Itikiboroballi	5
Bullet wood	2	Parakusan	58
Burada	2	Pipper	57
Clump wallaba	204	Potaro Kakaralli	143
Comgo pump	5	Purpleheart	3
congo pump	8	Royal Palm	25
Crabwood	88	Ruba species	121
Duka	49	Sand baramalli	104
Dukalli	2	Sarabebeballi	193
Asepokoballi	10	Sawari	2
Fern	157	Shibidan	4
Fukadi	1	Simarupa	6
Futui	10	Smooth leaf kakaralli	13
Gauava skin kakaralli	4	Soft Wallaba	101
Greenheart	8	Tonka bean	4
Hairariballi	5	Trysil	350
Aroids		Turu palm	2
Hatti	42	Unknown	5
Helicona	55	waiaballi	1
Hill cork wood	13	Wairai	22
Huruasa	5	Warakosa	15
Kabukalli	3	White cedar	1
Kaditiri	14	Yari yari	1
Kairiballi	32	Yarula	3
Kauta	72	Yellow Siverballi	4
		Bignon	15

Woody plant species recorded in sub-plots in 2021 (Ewart Smith and Raeburn Jones)

Common Name	Scientific Name	Family	Understory vegetation					Total
			Plants	Pole	Sapling	Seedling	Vine	
Adebero	*Paypayrola guianensis* Aubl.	Violaceae	3					3
Alomond gale silverballi	*Aniba citrifolia*	Lauraceae				17		17
Arara	*Guatteria atra*	Annonaceae	1					1
Aromata	*Cfathrotropis macrocarpa*	Papilionaceae				8		8
Arudan	*Sloanea guianensis*	Elecocarpaceae				2		2
bactris palm	*Pouteria durlandii*	Palmae	12			12		24
Barabara	*Diospyros dichroa*	Ebenaceae				21		21
Bignon	*Bauhinia* spp.	Bignoniaceae					15	15
Black kakaralli	*Escheweilera sagotiana*	Lecythidaceae			8	20		28
Blood wood	*Cordia candidula*	Boraginaceae			1	3		4
Buba bua palm	*Socratea exorrhiza*	Palmae			15	17		32
Clump wallaba	*Dicymbe altsonii*	Fabaceae				3		3
Crabwood	*Carapa guianensis*	Meliaceae				31		31
Duka	*Tapirira obtusa*	Anacardiaceae				13		13
Fern	Unidentified species.		129					129
Gauava skin kakaralli	*Escheweilera alala*	Lecythidaceae		1				29
Hatti	*Hevea paciflora*	Euphorbiaceae		2				2
Helicona	*Helicona* spp.	Heliconiaceae		20	20	15		55
Itikiboroballi	*Swartzia benthamiana*	Papilionaceae	1					1
Kairiballi	*Licania heteromorpha*	Chrysobalanaceae		1				1
Kauta	*Licania laxiflora*	Chrysobalanaceae			11			11
Komaramara	*Duroia eriopila*	Rubiaceae				2		2
Maburia	*Maburea trinervis*	Olacaceae		11	11			22
Mokhru	*Ischnosiphon* spp.	Marantaceae		20		8		28
Monkey ladder	*Bauhinia cinnanomea*	Caesalpiniaceae					2	2
Mora	*Mora excelsa*	Caesalpiniaceae			32	34		66
Pipper	*Piper* spp.	Piperaceae				57		57
Potaro Kakaralli	*Escheweilera* spp.	Lecythidaceae				3		3
Royal Palm	Unidentified species.	Palmae				25		25
Ruba species	*Palicouria* spp.	Rubiaceae	121					121
Sand baramalli	*Catostemma fragrans*	Bombacaceae				16		16
Sarabebeballi	*Vouacapoua macropetala*	Caesalpiniaceae				10		10

Common Name	Scientific Name	Family	Understory vegetation					Total
			Plants	Pole	Sapling	Seedling	Vine	
Soft Wallaba	*Eperua falcata*	Caesalpiniaceae			3	2		5
Trysil	*Pentaclethra macroloba*	Mimosaceae		40	10	91		141
Wairai	*Melastoma* spp.	Melastomaceae			22			22
Warakosa	*Inga laterifolia*	Mimosaceae	2			2		2
Grand Total								**952**

Appendix B-2: Lepidoptera (Butterfly)

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Kristine Erskine)

Species	Family	Subfamily	T1	T2	T3	T4	T5	T6	Total
Itaballia demophile niphates	Pieridae	Pierinae		4	22	35	7	4	72
Parides aeneas aeneas	Papilionidae	Papilioninae	1	4	21	4	25	10	65
Adelpha cytherea cytherea	Nymphalidae	Coliadinae		7	19	18	6	10	60
Morpho menelaus	Nymphalidae	Morphinae	6	9	13	12	6	10	56
Pierella lena lena	Nymphalidae	Satyrinae		6	5	17	13	11	52
Lycoria halia halia	Nymphalidae	Danainae		7	6	18	6	10	47
Prepona leporin amesia	Nymphalidae	Morphinae	5	4	3	15	1		28
Catonephele a. acoutius	Nymphalidae	Biblidinae			20			8	28
Hypothyris vallonia glycon	Nymphalidae	Danainae		4	9	3	3	5	24
Morpho helenor extremus	Nymphalidae	Morphinae			9	1	9		19
Siproeta stelenes meridionalis	Nymphalidae	Nymphalinae		3	1	5	5	3	17
Paraeuptychia metaleuca	Nymphalidae	Satyrinae			2	1	4	8	15
Eurema daira	Peiridae	Coliadinae	2		4			4	10
Glutophrissa drusilla	Pieridae	Pierinae	3		4	1			8
Taygetis mermeria	Nymphalidae	Satyrinae				2	3	3	8
Adelpha cytherea despoliata	Nymphalidae	Coliadinae			1	4	1		6
Phoebis sennae marcellina	Pieridae	Coliadinae				1	2	1	4
Catoblepia berecynthia halli	Nymphalidae	Morphinae					4		4
Athesis clearista clearista	Nymphalidae	Danainae			1	1	1	1	4
Eurema albula	Pieridae	Coliadinae					1	2	3
Parides chabrias mithras	Papilionidae	Papilioninae			1	1	1		3
Dryadula phaetusa	Nymphalidae	Nymphalinae-heliconiinae			1	1			2
Rhabdodryus trite	Pieridae	Coliadinae				1	1		2
Scada reckia bernhardii	Nymphalidae	Danainae				2			2
Dynamine agacles core	Nymphalidae	Biblidinae				1		1	2
Aphrissa statira statira	Pieridae	Pierinae			1				1
Posttaygetis penelea	Nymphalidae	Satyrinae			1				1
Heliconius erato	Nymphalidae	Heliconiinae			1				1

Species	Family	Subfamily	T1	T2	T3	T4	T5	T6	Total
Thyridia psidii aedesia	Nymphalidae	Danainae						1	1
Taygetis laches	Nymphalidae	Satyrinae			1				1
Opsiphanes cassina merianae	Nymphalidae	Morphinae			1				1
Anartia jatrophae	Nymphalidae	Nymphalinae				1			1
		Total number of records	**17**	**48**	**147**	**145**	**99**	**92**	**548**
		Total number of species	**5**	**9**	**23**	**22**	**19**	**17**	**32**

2013 DRY SEASON: SEPTEMBER 03 - 14, 2013 (Kristine Erskine)

Scientific Name	Family	Subfamily	T1	T2	T3	T4	T5	T6	Total
Heliconius erato	Nymphalidae	Heliconiinae			32	30	1	12	75
Pierella lena lena	Nymphalidae	Satyrinae		6		10	2		18
Dryas iulia moderata	Nymphalidae	Heliconiinae	2		13	2			17
Heraclides thoas	Papilionidae	Papilioninae			12	4			16
Dryadula phaetus	Nymphalidae	Nymphalinae-heliconiinae			6	4	2	1	13
Siproeta stelenes meridionalis	Nymphalidae	Nymphalinae			5		2	6	13
Junonia evarete zonalis	Nymphalidae	Nymphalinae			1			10	11
Adelpha cytherea cytherea	Nymphalidae	Coliadinae	4		5				9
Anartia jatrophae	Nymphalidae	Nymphalinae				2		7	9
Lycorea halia halia	Nymphalidae	Danainae			3		5		8
Phoebis sennae marcellina	Pieridae	Coliadinae	3			3		2	8
Catoblepia berecynthia halli	Nymphalidae	Morphinae			2			4	6
Morpho helenor extremus	Nymphalidae	Morphinae	1	1		2	2		6
Itaballia demophile niphates	Pieridae	Pierinae			1		4		5
Eurema albula	Peiridae	Coliadinae			3		1	1	5
Taygetis laches	Nymphalidae	Satyrinae			4				4
Haetera piera	Nymphalidae	Satyrinae		3	1				4
Heliconius antiochus	Nymphalidae	Heliconiinae				4			4
Pareuptychia metaleuca	Nymphalidae	Satyrinae			4				4
Hypothyris vallonia glycon	Nymphalidae	Danainae		3					3
Glutophrissa drusilla	Pieridae	Pierinae			1			2	3
Parides aeneas aeneas	Papilionidae	Papilioninae			2				2
Urbanus doryssus	Hesperiidae	Eudaminae			2				2

Scientific Name	Family	Subfamily	T1	T2	T3	T4	T5	T6	Total
Taygetis mermeria	Nymphalidae	Satyrinae			2				2
Battus polydamas polydamas	Papilionidae	Papilioninae			1			1	2
Caligo brasiliensis sulanus	Nymphalidae	Morphinae			1			1	2
Catonephele acontius acontius	Nymphalidae	Biblidinae				1		1	2
Colobura dirce	Nymphalidae	Nymphalinae			2				2
Historis odius odius	Nymphalidae	Nymphalinae						1	1
Scada reckia bernhardii	Nymphalidae	Danainae					1		1
Aphrissa statira statira	Pieridae	Pierinae			1				1
Total Number of Individuals			**10**	**13**	**104**	**62**	**20**	**49**	**258**
Total Number of Species			**4**	**4**	**22**	**10**	**9**	**13**	**32**

2021 WET SEASON: JULY 12 – 25, 2021 (Mark Ram)

Species	Family	Sub-Family	T1	T2	T3	T4	T5	T6	Total
Adelpha cytherea	Nymphalidae	Limenitidinae	6		2	2	3	2	**15**
Adelpha phylaca	Nymphalidae	Limenitidinae	9						**9**
Anartia jatrophe	Nymphalidae	Nymphalinae	4	3	10	1		5	**23**
Junonia evarete	Nymphalidae	Nymphalinae	20	10	11	6	8	4	**59**
Siproeta stelenes	Nymphalidae	Nymphalinae	2		1				**3**
Cissia Penelope	Nymphalidae	Satyrinae					3		**3**
Dryas iulia	Nymphalidae	Heliconiini	14	1	3	3		1	**22**
Heliconius erato	Nymphalidae	Heliconiini	3			1			**4**
Heliconius melpomene	Nymphalidae	Heliconiini	29	4	5	1	1	9	**49**
Heliconius sara	Nymphalidae	Heliconiini	6		1		5	7	**19**
Philaethria dido	Nymphalidae	Heliconiini					2		**2**
Mechanitis polymnia	Nymphalidae	Ithomiini	5						**5**
Morpho helenor	Nymphalidae	Morphinae	10				8		**18**
Morpho menelaus	Nymphalidae	Morphinae	6	3					**9**
Oleria aegle	Nymphalidae	Danainae					5		**5**
Itaballia demophile	Pieridae	Pierinae	1		3	1			**5**
Aphrissa statira	Pieridae	Pierinae	2		5		9		**16**
Eurema albula	Pieridae	Coliadinae	10	1	1	3	2	1	**18**
Phoebis argante	Pieridae	Coliadinae	6	3	11		4	6	**30**
Phoebis sennae	Pieridae	Coliadinae	31	1	8		1	4	**45**
Heraclides thoas	Papilionidae	Papilioninae					1		**1**
Neographium agesilaus	Papilionidae	Papilioninae	1		1				**2**
Nymphidium cachrus	Riodinidae	Riodininae	73	7					**80**

Species	Family	Sub-Family	T1	T2	T3	T4	T5	T6	Total
Riodina lysippus	Riodinidae	Riodininae	7		2	1	3	2	**15**
Mesosemia spp.	Riodinidae	Riodininae	26			4			**30**
Thestius selina	Lycaenidae	Theclinae	1						**1**
Total Number of Individuals			**272**	**33**	**64**	**23**	**55**	**41**	**488**
Total Number of Species			**22**	**9**	**14**	**10**	**14**	**10**	**26**

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Mark Ram)

Species	Family	Sub-Family	T1	T2	T3	T4	T5	T6	Total
Astraptes fulgerator	Hesperiidae	Pyrginae		1					**1**
Theritas spp.	Lycaenidae	Theclinae		1					**1**
Thestius selina	Lycaenidae	Theclinae					1		**1**
Adelpha cytherea	Nymphalidae	Limenitidinae	9	8					**17**
Anartia jatrophae	Nymphalidae	Nymphalinae	9	3	1				**13**
Eresia clio	Nymphalidae	Nymphalinae	5						**5**
Junonia evarete	Nymphalidae	Nymphalinae	8	2	1		3	3	**17**
Siproeta stelenes	Nymphalidae	Nymphalinae	1	1		2			**4**
Unidentified species	Nymphalidae	Nymphalinae	1	1	1				**3**
Cissia penelope	Nymphalidae	Satyrinae	2	4			8		**14**
Dryas iulia	Nymphalidae	Heliconiinae	20	2	3		3		**28**
Heliconius erato	Nymphalidae	Heliconiinae	4			4	3		**11**
Heliconius melpomene	Nymphalidae	Heliconiinae	40	21	7	3	4		**75**
Heliconius sara	Nymphalidae	Heliconiinae	7	7			4		**18**
Philaethria dido	Nymphalidae	Heliconiinae	1						**1**
Haetera piera	Nymphalidae	Satyrinae	3						**3**
Mechanitis polymnia	Nymphalidae	Danainae	1	4		2			**7**
Oleria aegle	Nymphalidae	Danainae	6						**6**
Rhodussa cantobrica	Nymphalidae	Danainae		3					**3**
Morpho helenor	Nymphalidae	Morphinae	12	3	1		2		**18**
Morpho menelaus	Nymphalidae	Morphinae	3		1				**4**
Phoebis sennae	Pieridae	Coliadinae	3	3					**6**
Itaballia demophile	Pieridae	Pierinae	3		5				**8**
Aphrissa statira	Pieridae	Pierinae	2	8	2				**12**
Eurema albula	Pieridae	Coliadinae	15	5	6		2		**28**
Heraclides thoas	Papilionidae	Papilioninae	1						**1**
Neographium agesilaus	Papilionidae	Papilioninae	22	7	1				**30**
Papilio hyppason	Papilionidae	Papilioninae	1						**1**
Riodina lysippus	Riodinidae	Riodininae	1				1		**2**
TOTAL NUMBER OF SPECIES			**25**	**18**	**11**	**4**	**10**	**1**	**29**

Appendix B-3: Other Macro-Invertabrate Orders

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Kristine Erskine)

Macro Invertebrates Order/Family	Description	Method(s)	Locations
Odonata (Dragon-flies, Damselfly)			
Species /Morph 1(*Erythemis peruviana*)	Dragonfly with red abdomen	VES	T3, T4
Species/Morph 2 (*Erythrodiplax* spp.)	Small blue dragonfly	VES	T2, T3,T4
Species/Morph 3 (*Oligoclada* spp.)	Small black damselfly	VES	T3
Species/Morph 4 (*Erythrodiplax fusca)*	Black dragonfly with grey abdomen	VES	T3, T4, T5
Species/Morph 5 (*Uracis imbuta*)	Grey Dragonfly	VES	T3, T4
Species/Morph6 (*Uracis* spp.)	Brown dragonfly	VES	T3, T5
Blattaria (Roaches)			
Unidentified roach spp. 1 (Family: Ectobiidae)	Small brown forest cockroach	VES	T3, T4, T5, T6
Mantodea (Mantids)			
Species/Morph 1 (*Sphodromantis* sp.?)	Brown/Camouflaged mantid	VES/Light trap	T5
Coleoptera (Beetles, Diving Beetles)			
Species/Morph 1 (Family: Chrysomelidae)	Leaf beetle: black beetle	VES/Light trap	T3, T4
Species/Morph 2 (*Stenolophus* spp.?)	- Black abdomen and orange thorax beetle	VES/Light trap	All sites
Species/Morph 3 (Family: Lampyridae)	Brown and black beetle (Ground beetle) Firefly/Candle fly	VES/Light trap	All sites
Diptera (True Flies)			

Macro Invertebrates Order/Family	Description	Method(s)	Locations
Species/Morph 1 (family: Tephritidae?) Species/Morph 2 (Family: Ceratopogonidae) Species/Morph 3 (Family: Drosophilidae)	- ~1cm, black-bodied, iridescent greenish eyes and wings mottled brown or black - Small sand flies: 1-4mm body length - Small black flies: <1cm body length,	VES VES VES	All sites All sites All sites
Hymenoptera (Ants, Bees and Wasps) Africanised honey bee *Apis melifera* (Apidae) Small brown wasp (Family Vespidae) Small black wasp (Family Polistinae) Leaf cutter ant *Atta* spp. (Family: Formicidae) Large black bee (Family: Apidae)	Small golden brown wasp: ~1-2cm, clear wings Small black wasp: 2-3cm, shiny black clear wing Metallic black bee	VES, light trap VES, light trap VES VES, leaf litter VES	All sites All sites T3, T4, T5, T6 T3, T4 T3, T4, T5, T6
Isoptera (Termite Family: Termitidae) Species 1.	- colony of workers and a queen	VES, leaf litter	All sites
Araneae (Spiders) Grey spider (Family : Araneidae) Pink Toed Tarantula (Family: Theraphosidae)	- Small grey spider - Black to grey tarantula. Pink toe tips	VES VES	All sites T3

Macro Invertebrates Order/Family	Description	Method(s)	Locations
Hemiptera (Stink bugs)			
Brown grass bug (Family: Miridae)	- 2-3cm, brown to green colour, strong scent	VES/Light trap	All sites
Greenish-white bug (Family: Aleyrodidae)	- 2-3 cm, Small hemipteran bug	VES/light trap	All sites
Green grass bug (Family: Rhopalidae)	- 2-3 com, green colouration, strong scent	VES/light trap	All sites
Water Striders (Family: Gerridae)	- Strides on water bodies on long fragile legs	VES	T1, T2, T3
Orthoptera (Grasshoppers)			
Large green grasshopper (Tettigonidae)	- 9-10 cm, bright grass green colouration	VES	T4, T5, T6
Tiny brown grasshopper (Acrididae)	- 1-2 cm, dark brown colour, short horned	VES/light trap	All sites
Common field grass hopper (Acrididae)	- 5-6 cm, bright grass green colouration	VES	All sites
Lepidoptera (moths)			
Inch worm caterpillar (Geometridae)	- 8-9 com, bright green colouration	VES	T3
Brown and black moth (Noctuiidae)	- black and brown colour, wing span ~3cm.	VES, light trap	All sites
Army moth (Noctuidae)		VES, light trap	T3, T4, T5
Brown and white moth (Geometridae)	- mottled brown colouration	VES, light trap	T4, T5, T6
Small dark brown moth (Sphingidae)		VES	T3, T4
Large black moth (Noctuidae)	- Wing span ~4-5cm, white colour usually speckled with brown for camouflage	VES/light trap	T3, T4

Macro Invertebrates Order/Family	Description	Method(s)	Locations
Small grey and white moth (Cosmopterigidae) Small brown moth (Gelechiidae) Small orange and black moth (Arctiidae/ Aganaidae) Small silver moth (Tineidae) Spp 1. Small black and white moth (Cosmopterigidae) Spp 2 Small brown and white moth (Cosmopterigidae) Spp 3.Small white moth (Cosmopterigidae)	- Narrow wings and streamlined abdomens for adaptations for rapid flight - Large bat shaped, dark colour, wing span to 16cm - Very small to small in size, Usually black, grey to white in colour, wings are long and narrow - Very small to small in size, They have dull colours with narrow wings - Usually bright orange, yellow, white and black warning colours, - Wing span of 10-20mm, more or less brownish in colour but often with a gold or silver sheen. - Very small to small in size, Usually black, grey to white in colour, wings long narrow	VES/light trap VES/light trap VES/light trap VES/light trap VES/light trap	All sites All sites All sites T3, T4, T5 All sites
Chordeumida (Millipedes) Unidentified millipede #1 (Family: Julidae?) *Harpaphe haydeniana* (Family: Polydesmida)	- Smooth black millipede, ~18-20cm long - Length up to 4-5cm. Body black & distinctively marked along sides with patches of yellow.	VES VES	T3, T4 T2, T3, T4
Thysanura (Silverfish) Unidentified silverfish spp. 1 (Family: Lepismatidae)	- Typical silverfish appearance/behaviour	VES/soil	T3, T4, T5, T6
Haplotaxida (Earthworms)			

Macro Invertebrates Order/Family	Description	Method(s)	Locations
Unidentified worm spp. #1. (Family: Lumbricidae)	- Typical earthworms observed in moist forest soil	VES/soil	T3, T4, T5, T6
Decapoda (crabs) Unidentified freshwater crab species #1	- Freshwater crab	streams	Undisturbed streams

2013 DRY SEASON: SEPTEMBER 03 14, 2013 (Kristine Erskine)

Order	Species Description	Method(s)*	Location
Amblypygi	Tailless Whipscorpions	VES	T3
Aranaeae	black and white spider	VES	T3
Aranaeae	black spider	OPP	T4
Aranaeae	black spider with green abdomen " black face"	OPP	T4
Aranaeae	black spider with two white spots on sides of abdomen	VES	T4
Aranaeae	brown and cream spider	OPP	T3
Aranaeae	cream spider with gold and silver abdomen	OPP	T3
Aranaeae	daddy long leg spider	VES	T3/T4
Aranaeae	large brown spider with gold raised lines across abdomen	VES/OPP	T3
Aranaeae	medium orange and brown spider	OPP	T4
Aranaeae	small brown and black spider	VES	T3
Aranaeae	small red spiders (nest)	VES/OPP	T4
Aranaeae	spider white with gold abdomen	VES	T4
Aranaeae	tarantula jumping brown	VES	T2
Aranaeae	white spider	VES	T4
Aranaeae	white spider with reddish brown spikes	VES	T6
Aranaeae	large orange spider	OPP	T3
Aranaeae	red spider with spikes on abdomen	OPP	T3
Blattaria	speckled cockroach	LT	T3
Blattaria	fine cockroach	LT	T3

Order	Species Description	Method(s)*	Location
Blattaria	cock roach	LT	T3
Chilopoda	centipede	H	T5
Coleoptera	black with white line across back beetles (long antenna)	Bait	T3
Coleoptera	black beetle	VES	T3
Coleoptera	click beetle (black and white striped)	VES	T3
Coleoptera	green head black abdomen beetle	VES	T3
Coleoptera	grub	VES	T3
Coleoptera	long antennae beetle	OPP	T4
Coleoptera	rhino beetle	OPP	T4
Coleoptera	tan beetle with black spots	OPP	T4
Coleoptera	tiny black water beetles	VES	T4
Coleoptera	yellow and black beetle	VES	T5
Coleoptera	yellow and black long horn beetle	Bait	T2
Coleoptera	yellow beetle	VES	T3
Coleoptera	medium black beetle	H	T5
Coleoptera	white insect larva	H	T5
Coleoptera	medium black beetle	H	T3 B
Coleoptera	lightening bugs	LT	T3
Coleoptera	black beetle with white spots	LT	T3
Coleoptera	oval golden-brown black beetle	LT	T3
Coleoptera	lightening bugs	OPP	T3,T4
Coleoptera	brown hairy beetle	LT	T3
Coleoptera	golden brown beetle	LT	T3
Coleoptera	lighting bugs	LT	T3
Crustacean (Decapoda)	red crabs	OPP	T4
Crustacean (Decapoda)	large dark crab	OPP	T4
Crustacean (Decapoda)	shrimp	OPP	T3
Crustacean	wood lice (crustacean)	H	T5
Crustacean (Isopoda)	wood lice (crustacean)	VES	T2

Order	Species Description	Method(s)*	Location
Dermaptera	earwig (red head black abdomen)	VES	T2
Diplopoda	giant millipede with white margin on segments	VES	T3
Diplopoda	large brown millipede	OPP	T3
Diplopoda	millipede (dark segments)	VES	T3
Diplopoda	smooth millipede	VES	T3
Diplopoda	slender light brown millipede	HOLE	T4,
Diplopoda	slender millipede	Holes	T4
Diplopoda	pink millipede with long white legs	H	T2
Diplopoda	small black millepede like pill	H	T4, T5,T2
Diptera	black cowfly	VES	T3
Diptera	brown cowfly	VES	T2
Diptera	flies	Bait	T2
Diptera	large black fly	VES	T3
Diptera	long slender mosquito	OPP	T4
Diptera	normal mosquito	T2, T4	T4, T5
Diptera	caburi small black biting fly	VES/OPP	T2, T4
Diptera	orange and black fly	VES	T3
Diptera	orange and black fly	OPP	T3
Diptera	flies	LT	T3
Ephemeroptera	mayfly	LT	T3
Haplotaxid	earthworm and eggs	H	T6,T1,T2,T5,T3,T4
Hemiptera	brown stink bug with yellow spots	OPP	T2
Hemiptera	Hemiptera with modified leg	VES	T3
Hemiptera	plant bug	VES	T3
Hemiptera	plant bug	VES	T4
Hemiptera	water skimmers	VES	T3
Hemiptera	plant bug	LT	T3
Hemiptera	Hemiptera	LT	T3
Hemiptera	red and black Hemiptera	LT	T3
Homoptera	large black cicada (immature)	OPP	T3
Homoptera	small clear wing cicada	OPP	T3
Homoptera	small black cicada with blue wing base	OPP	T3

Order	Species Description	Method(s)*	Location
Hymenoptera	black and yellow bee	VES	T3
Hymenoptera	black and yellow bees	VES	T3
Hymenoptera	black ant	VES	T3
Hymenoptera	black ants (1/2")	VES	T3
Hymenoptera	brown wasp with orange wings	VES	T3
Hymenoptera	honey bee	VES	T3
Hymenoptera	honey bees (yellow with black stripe)	VES	T4
Hymenoptera	inch long black ant (big head)	VES	T3
Hymenoptera	large ant	VES	T3
Hymenoptera	large black bee	VES	T3
Hymenoptera	large black bumble bee	VES	T4
Hymenoptera	large black wasp	OPP	T5
Hymenoptera	red brown ant	OPP	T3
Hymenoptera	small black and yellow wasp	VES	T3
Hymenoptera	tiny brown ants	VES	T3
Hymenoptera	wasp	VES	T3
Hymenoptera	small golden-brown bee	VES	T6
Hymenoptera	wasp	VES	T3
Hymenoptera	yellow thorax bee with black abdomen	VES	T3
Hymenoptera	wasp	LT	T3
Plecoptera	ant with wing	LT	T3
Isoptera	wood ants	H	T5
isoptera	termite queen with wings	LT	T3
Lepidoptera	orange and silver moth	LT	T3
Lepidoptera	small cream moth	LT	T3
Lepidoptera	small yellow and silver moth with silver dots on hind wing	LT	T3
Lepidoptera	small white moth with black line running down wings	LT	T3
Lepidoptera	small white moth with black line across back	LT	T3
Lepidoptera	small cream moth with dark brown spots & wings with fringe	LT	T3
Lepidoptera	small brown black and cream speckled moth	LT	T3
Lepidoptera	small cream moth with thick black line across lower wings	LT	T3

Order	Species Description	Method(s)*	Location
Lepidoptera	small arrow shaped oranged moth	LT	T3
Lepidoptera	small orange and silver moth with silver dots on hind wing	LT	T3
Lepidoptera	small cream moth with black spots on wings	LT	T3
Lepidoptera	small cream moth with thin black lines across wings	LT	T3
Lepidoptera	light brown moth with dark brown line across wings	LT	T3
Lepidoptera	black and white moth	LT	T3
Lepidoptera	white moth wing black circumference	LT	T3
Lepidoptera	small brown moth with netty lines crisscrossing wings	LT	T3
Lepidoptera	white long abdomen moths with black circumference wings	LT	T3
Lepidoptera	brown shiny moth	LT	T3
Lepidoptera	large brown leaf shape moth	OPP	T3
Lepidoptera	medium brownish green moth with white spots on wings	OPP	T3
Lepidoptera	large purple and brown ripples moth	OPP	T3
Lepidoptera	small brown moth	LT	T3
Lepidoptera	medium size green moth	LT	T3
Lepidoptera	white moth brown circumference	LT	T3
Lepidoptera	orange moth	LT	T3
Lepidoptera	red and black fly with black wing white stripe	LT	T3
Lepidoptera	orange hairy caterpillar with white spots	VES	T3
Lepidoptera	fuzzy white caterpillar	VES	T3
Lepidoptera	orange and black caterpillar	OPP	T3
Lepidoptera	day moth	VES, OPP	T3
Lepidoptera	large black moth with white spot on the forewing	OPP	T3
Mantodea	brown praying mantis	OPP	T4
Mantodea	small green and black mantid	VES	T3
Mantodea	green praying mantis	VES	T4
Molluscs	snail	OPP	T3
Molluscs	snail (stripe shell)	OPP	T3
Molluscs	snails with conical shells	VES	T2
Molluscs	brown conical snail	OPP	T5

Order	Species Description	Method(s)*	Location
Nematoda	black worm	H	T5
Odonata	black and white dragonfly	VES	T4
Odonata	blue black damsel fly	VES	T2
Odonata	blue dragon fly with black wings circle close to body	VES	T3
Odonata	blue body dragon fly	VES	T3
Odonata	brown body brown tipped wing dragonfly	VES	T3
Odonata	brown bodied stiped (dark brown) dragonfly	VES	T3
Odonata	brown body black tipped wing dragonfly	VES	T3
Odonata	brown body blue wings dragon fly	VES	T3
Odonata	large dragon fly	VES	T3
Odonata	large green dragonfly	VES	T4
Odonata	light blue dragon fly	VES	T4
Odonata	light brown dragonfly	VES	T4
Odonata	purple or burgundy dragonfly	VES	T4
Odonata	pygmy dragonfly	VES	T6
Odonata	yellow dragonfly with black wing circle close to body	VES	T3
Odonata	nymph dragonfly	OPP	T3
Orthoptera	brown cave cricket	VES	T3
Orthoptera	brown grasshopper	VES	T2
Orthoptera	brown grasshopper	OPP	T3
Orthoptera	brown grasshopper with stripe down back	VES	T3
Orthoptera	large brown locust	OPP	T3
Orthoptera	large leaf looking grasshopper	VES	T3
Orthoptera	small black and white grasshopper	VES	T3
Orthoptera	small black and white grasshoppers	VES	T3
Orthoptera	small black and white grasshoppers	VES	T4
Orthoptera	two grasshoppers (stripe down back)	VES	T3
Orthoptera	little brown cricket	OPP	T3
Orthoptera	large red cricket	OPP	T3
Orthoptera	small weird black grasshopper	OPP	T3
Orthoptera	black and white cricket	LT	T3
Orthoptera	small brown cricket	LT	T3
Orthoptera	cricket	LT	T3

Order	Species Description	Method(s)*	Location
Orthoptera	large green grasshopper	LT	T3
Phasmida	giant stick insect	VES	T3
Phasmida	green/ brown stick insect	VES	T3
Phasmida	light brown stick insect	OPP	T3
Scorpiones	large black scorpion	OPP	T3

Opp: Opportunistically observed, VES = Visual Encounter Survey, LT = Light Trap

2021 WET SEASON: JULY 12 – 25, 2021 (Mark Ram)

Order	TRANSECT					
	T1	T2	T3	T4	T5	T6
Diptera	F	U	-	U	-	U
Hymenoptera	A	A	A	U	-	U
Odonata	A	C	F	C	-	F
Lepidoptera (moths)	C	F	F	C	-	A
Blattaria	U	-	-	F	-	-
Coleoptera	F	F	-	F	-	-
Hemiptera	C	C	-	F	U	-
Orthoptera	A	A		U	U	-
Araneae	U	F	-	U	U	-
Haplotaxid	U	F	-	U	-	-
Diplopoda	U	F	-	U	U	
Decapoda	U	-	-	-	-	-
Ephemeroptera	U	-	-	U	-	-
Mantodea	U	-	-	-	-	-
Phasmida	U	-	-	-	-	-
Pulmonata	U	-	U	-	-	-

2021 DRY SEASON: October 04 – 16, 2021 (Mark Ram)

Order	TRANSECT					
	T1	T2	T3	T4	T5	T6
Diptera	**F**	**U**	**C**	**U**	**C**	**U**
Hymenoptera	**A**	**A**	**A**	**A**	**C**	**C**
Odonata	**A**	**A**	**C**	**C**	**C**	**F**

Order	TRANSECT					
	T1	T2	T3	T4	T5	T6
Lepidoptera (moths)	C	F	F	C	-	A
Blattaria	U	-	-	F	-	-
Coleoptera	F	F	-	F	-	-
Hemiptera	C	C	-	F	U	-
Orthoptera	A	A		U	U	-
Aranaeae	U	F	-	U	U	-
Haplotaxid	U	F	-	U	-	-
Diplopoda	U	F	-	U	U	
Decapoda	U	-	-	-	-	-
Ephemeroptera	U	-	-	U	-	-
Mantodea	U	-	-	-	-	-
Phasmida	U	-	-	-	-	-
Pulmonata	U	-	U	-	-	-

Key
U (Uncommon) – Small numbers recorded, within proximity to transect
F (Fairly common) – Observer between two to four individuals daily
C (Common) – Observed between five to ten individuals daily
A (Abundant) – Observed more than ten individuals daily

Appendix B-4: Fish Fauna

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Bibi Khan)

Taxon	Common Name	Locations/Fishing Points Sampled									
		1	2	3	4	5	6	7	8	9	10
Anostomidae											
Leporinus maculatus		obs	-	-	-	-	-	-	-	-	-
Belonidae											
Corydoras adolfoi	needle fish	6	-	-	-	-	-	-	-	-	
Characidae											
Astyanax fasciatus	tetra	23	10	-	-	18	6	27	3	31	5
Bryconops affinis		13	12	obs	obs	obs	1	3	obs	2	obs
Moenkhausia spp.		7	24	obs	obs	37	16	22	obs	29	4
Moenkhausia lepidura		49	15	obs	obs	10	18	11	5	23	37
Moenkhausia oligolepis	glass tetra	31	11	-	-	2	1	-	16	22	36
Cichlidae											
Apistogramma spp.		5	35	-	-	26	7	6	-	13	-
Acarichthys geayi		2	14	-		6	4	14	-	15	-
Crenicichla lepidota	pike cichlid	-	1	-	-	-	-	-	-	-	-
Erythrinidae											
Hoplerythrinus unitaeniatus	yarrow	-	1	-	-	-	-	-	-	-	-
Hoplias malabaricus	huri	2	8	-	-	-	-	-	-	-	-
Hoplias macrophthalmus	haimara	PC	-	-	-	-	PC	-	-	-	-
Heptapteridae											
Rhamdia quelen	kassie	PC	-	-	-	-	PC	-	-	-	-
Lebiasinidae											
Pyrrhulina brevis	short pencil-fish	-	-	-	-	-	-	2	-	-	-
Lebiasina spp.1	opp. obs. at transect										
Rivulidae											
Rivulus waimacui		3	2	1	4	1	3	2	17	4	1
Rivulus agilae		5	3	2	2	3	6	5	38	7	2
Rivulus holmiae		-	-	-	11	-	-	-	-	-	-

2013 DRY SEASON: SEPTEMBER 03 – 14, 2013 (Bibi Khan)

Taxon	Common Name	Locations/Fishing Points Sampled									
		1	2	3	4	5	6	7	8	9	10
Anostomidae											
Leporinus arcus	daray	1	-	-	-	-	-	-	5	-	-
Belonidae						-					
Corydoras adolfoi	needle fish	15	-	-	-	-	-	-	-	-	
Cetopsidae											
Helogenes marmoratus		1	1	-	-	-	-	-	-	-	-
Characidae											
Astyanax fasciatus	tetra	21	11	-	-	5	2	1	3	2	17
Bryconops affinis		4	5	1	obs	11	3	2	obs	1	13
Charicidium fasciatum		-	-	-	-	-	-	-	4		-
Hyphessobrycon spp.		-	1	-	-	-	-	-	-	-	-
Moenkhausia spp.		12	2	-	-	-		-	obs	-	2
Moenkhausia lepidura		27	9	-	-	7	1	obs	5	2	57
Moenkhausia oligolepis	glass tetra	39	11	-	-	1	3	-	16	-	12
Poptella orbicularis		3	-	-	-	-	3	-		-	-
Cichlidae											
Apistogramma spp.		3	1	-	-	-	-	obs	6	-	5
Acarichthys geayi		7	15	-		35	2	-	8	1	27
Crenicichla lepidota	pike cichlid	1	-	-	-	4	-	-	-	-	obs
Erythrinidae											
Hoplerythrinus unitaeniatus	yarrow	-	obs	-	-	-	-	-	-	-	obs
Hoplias malabaricus	huri	1	obs	-	-	2	-	-	1	-	2
Hoplias macrophthalmus	haimara	PC	-	-	-	-	PC	-	-	-	-
Hemiodontidae											
Hemiodus quadrimaculatus	Barred hemiodus	1	-	-	-	-	1				-
Heptapteridae											
Rhamdia quelen	kassie	PC	-	-	-	-	PC	-	-	-	-
Lebiasinidae											
Pyrrhulina brevis	short pencil-fish	2	3	-	-	-	-	-	1	-	-
Lebiasina spp.1		-	2						-		
Loricaridae											
Ancistrus spp.		1	4						9		-
Hypostomus plecostomus	Smoke hassar	1							1		-
Rivulidae											
Rivulus waimacui		-	-	3	2	-	-	obs	31	1	-
Rivulus agilae		-	-	-	-	-	-	-	44	3	-

Taxon	Common Name	Locations/Fishing Points Sampled									
		1	2	3	4	5	6	7	8	9	10
Rivulus holmiae		-	-	-	2	-	-	-	-	-	-
Sternopygidae											
Eigenmannia virescens	Knife fish	-	-	-	-	-	-	-	2		-

2021 WET SEASON: JULY 12 – 25, 2021 (Devya Hemraj)

Family	Genus	Species	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8	FP9	FP10	TOTAL
Anostomidae	*Leporinus*	*arcus*							1				**1**
Characidae	*Bryconops*	*affinis*							4	8			**12**
Characidae	*Characidium*	*cf. zebra*							1	2			**3**
Characidae	*Jupiaba*	spp. 1								56			**56**
Characidae	*Jupiaba*	spp. 2	22				2		37	44	4		**109**
Characidae	*Moenkhausia*	spp. 1 (lepidura?)		1									**1**
Characidae	*Astyanax*	*bimaculatus*	2	13			3		15	8		56	**97**
Characidae	*Moenkhausia*	*browni*	12						25	150			**187**
Characidae	*Moehkhausia*	*oligolepis*	14				48	12	28		4		**106**
Characidae	*Moenkhausia*	*megalops*							26				**26**
Characidae	*Bryconops*	*melanurus*	2										**2**
Cichlidae	*Aequidens*	*potaroensis*		15			5	12	13	6	10		**61**
Cichlidae	*Guianacara*	*dacrya*					8	8	17		2		**35**
Cichlidae	*Crenicichla*	*wallacii*		8			8	2					**18**
Erythrinidae	*Hoplias*	*malabaricus*		2			6	4			2		**14**
Erythrinidae	*Hoplerythrinus*	*unitaeniatus*					3						**3**
Hemiodontidae	*Hemiodus*	*quadrimaculatus*	1						2				**3**
Heptapteridae	*Rhamdia*	*quelen*										4	**4**
Lebiasininae	*Lebiasina*	*aff uruyensis*					1			1			**2**
Loricariidae	*Ancistrus*	*saudades*								32		2	**34**
Pimelodidae	*Pimelodus*	*ornatus*								1			**1**
Rivulidae	*Ananblepsoides (Rivulus)*	*waimacui*				83				12			**95**
Rivulidae	*Ananblepsoides (Rivulus)*	spp. 1 (holmiae?)				26			6				**32**
Sternopygidae	*Eigenmannia*	*lineatus*							1				**1**
TOTAL NUMBER OF INDIVIDUALS			**53**	**39**	**0**	**109**	**84**	**38**	**176**	**320**	**22**	**62**	**903**
TOTAL NUMBER OF SPECIES			**6**	**5**	**0**	**2**	**9**	**5**	**13**	**11**	**5**	**3**	**24**

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Devya Hemraj)

Family	Scientific Name	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8	FP9	FP10	Subtotal
Acestrorhynchidae	*Acestrorhynchus microlepis*									1		**1**
Anostomidae	*Leporinus arcus*	5						2				**7**
Auchenipteridae	*Ageneiosus inermis*	1										**1**
Characidae	*Bryconops affinis*	23							19			**42**
Characidae	*Characidium cf. zebra*	10							8			**18**
Characidae	*Deutrodon potaronensis*								2			**2**
Characidae	*Jupiaba* spp. 2	4				3						**7**
Characidae	*Moenkhausia browni*	58							208		3	**269**
Characidae	*Astyanax bimaculatus*	25	20					7	145	1	20	**218**
Characidae	*Moehkhausia oligolepis*	13	50			19	15	34		1		**132**
Characidae	*Bryconops melanurus*	19						7	122			**148**
Characidae	*Moenkhausia megalops*		23									**23**
Cichlidae	*Aequidens potaroensis*	1	1			25	5	29		17	3	**79**
Cichlidae	*Guianacara dacrya*	13				7	3	3	20			**46**
Cichlidae	*Crenicichla alta*					4			17			**21**
Cichlidae	*Crenicichla albopuntata*	1	1				2					**4**
Cichlidae	*Apistogramma* spp.								2			**2**
Erythrinidae	*Hoplias malabaricus*	4	1				2	1		2	1	**11**
Erythrinidae	*Hoplias aimara*		1									**1**
Hemiodontidae	*Hemiodus quadrimaculatus*	15										**15**
Heptapteridae	*Rhamdia quelen*						2				18	**20**
Lebiasinidae	*Pyrrhulina filamentosa*								2		1	**3**
Lebiasininae	*Lebiasina aff uruyensis*								3		1	**4**

Family	Scientific Name	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8	FP9	FP10	Subtotal
Loricariidae	*Ancistrus saudades*								17		1	**18**
Pimelodidae	*Pimelodus ornatus*	7										**7**
Rivulidae	*Anablepsoides (Rivulus) waimacui*	3			1				4			**8**
Synbranchidae	*Synbranchus marmoratus*			1								**1**
TOTAL NUMBER OF SPECIES		**16**	**7**	**1**	**1**	**5**	**6**	**7**	**13**	**5**	**8**	**27**

Appendix B-5: Amphibian

2013 WET SEASON: MAY 29 – JUNE 09, 2013. (Indranee Roopsind)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
AROMOBATIDAE																						
Anomaloglossus kaiei Kaie Rocket Frog	2	3		2	4																	**11**
BUFONIDAE																						
Atelopus hoogmoedi Hoogmoed Harlequin Toad		2		1	2	1		3			3	1		1								**14**
Rhaebo (Bufo) guttatus Spotted Toad	1	1	2	1		2	1	1	4	1		2	1	3	1		3			5	4	**33**
Rhaebo (Bufo) nasicus Werner's Toad		2		1		2	2	3	4	2		1	4	1	2		4				1	**29**
Rhaebo (Bufo) typhonius					2																1	**3**
Rhinella marina Giant Toad or Cane Toad						1			2			1	1		2	2	1	3		2		**15**
HEMIPHRACTIDAE																						
Stefania evansi Evan's Stefania		1			2		1	1	1	1		2		2			1			2		**14**
Stefania woodleyi Woodley's Stefania																			9			**9**
HYLIDAE																						
Dendropsophus minutus Lesser Treefrog		1			1	2								1								**5**
Dendropsophus marmoratus Marbled Treefrog														2								**2**
Hypsiboas boans Giant Gladiator Treefrog	1			2		1	1	1	2		1	2		1		1				1	1	**15**
Hypsiboas multifasciatus Many-Banded Treefrog								1						1								**2**
Hypsiboas crepitans Emerald-Eyed Treefrog												1										**1**

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
Osteocephalus oophagus Slender-legged Treefrog		1						1			1			2			1				1	**7**
Osteocephalus taurinus Manaus Slender-Legged Treefrog							1	2		1												**4**
Pseudis paradoxic Paradoxic Frog					2									1								**3**
Phyllomedusa bicolor Giant Monkey Frog	1							1												1	1	**4**
Phyllomedusa vaillantii White-Lined Monkey Frog														1								**1**
Scinax boesemani Boeseman's Snouted Treefrog								11					22		3							**36**
Scinax nebulosus Spix's Snouted Treefrog													4									**4**
Scinax ruber Red-Snouted Treefrog		1		1	1		2	1		1	2			1			7	1	1	2	1	**22**
Trachycephalus resinitrifix Casque-Headed Treefrog														2								**2**
LEPTODACTYLIDAE																						
Leptodactylus knudseni Knudsen's Thin-Toed Frog		1									1			1							1	**4**
Leptodactylus longirostris Long-Snouted Thin-Toed Frog	1								1		1				1			2				**6**
Leptodactylus lutzi Lutz's Thin-Toed Frog										2		1										**3**
Leptodactylus mystaceus Amazonian White-Lipped Frog								1														**1**
Leptodactylus petersii Peter's Thin-Toed Frog	2		1		2	1				2	3			1				1				**13**
PIPIDAE																						

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
Pipa arrabali Arrabal's Surinam Toad												1										**1**
Number of Individuals	**8**	**13**	**3**	**8**	**16**	**10**	**8**	**25**	**14**	**9**	**12**	**12**	**32**	**21**	**9**	**3**	**17**	**7**	**10**	**13**	**11**	**260**
Number of Species	**6**	**9**	**2**	**6**	**8**	**7**	**6**	**12**	**6**	**7**	**7**	**9**	**5**	**16**	**5**	**2**	**6**	**4**	**2**	**6**	**8**	**28**

2013 DRY SEASON: SEPTEMBER 03 – 14, 2013. (Indranee Roopsind)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
AROMOBATIDAE																						
Anomaloglossus kaiei Kaie Rocket Frog				2	1																	**3**
BUFONIDAE																						
Atelopus hoogmoedi Hoogmoed Harlequin Toad				2	1	2		1	1			2	2	1								**12**
Rhaebo (Bufo) guttatus Spotted Toad		1	1	1		2	1	1	2			1		2	1		2			4	3	**22**
Rhaebo (Bufo) nasicus Werner's Toad	1			10	3	6	1	4	3	1		1	3		1		3				4	**41**
Rhinella marina Giant Toad or Cane Toad	5				3		1	2	4	8	5	1	2	1	1	2	2	1		5		**43**
HEMIPHRACTIDAE																						
Stefania evansi Evan's Stefania		1			1		3	1	1					1						3		**11**
Stefania woodleyi Woodley's Stefania																			8	2		**10**
HYLIDAE																						
Dendropsophus marmoratus Marbled Treefrog														1								**1**
Hypsiboas boans Giant Gladiator Treefrog	4			16	10	8	5	2	8		2	3	6	11	7	2				3	1	**88**
Hypsiboas multifasciatus Many-Banded Treefrog					1								1							1	1	**4**

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
Hypsiboas crepitans Emerald-Eyed Treefrog									2						1							**3**
Hypsiboas cinerascens Demerara Treefrog					2		1								1	2						**6**
Osteocephalus oophagus Slender-legged Treefrog				1				1					2		1	1					1	**7**
Pseudis paradoxic Paradoxic Frog				1	4						1		1							2	3	**12**
Scinax boesemani Boeseman's Snouted Treefrog									2			1				1					1	**5**
Scinax ruber Red-Snouted Treefrog				2			3		4		1				7			2		4		**23**
Trachycephalus resinitrifix Casque-Headed Treefrog							2		1				1								1	**5**
LEPTODACTYLIDAE																						
Leptodactylus knudseni Knudsen's Thin-Toed Frog				1	1				1		1		2									**6**
Leptodactylus longirostris Long-Snouted Thin-Toed Frog						1			1						2							**4**
Leptodactylus mystaceus Amazonian White-Lipped Frog				1						1				1							2	**5**
Leptodactylus petersii Peter's Thin-Toed Frog				2				2					3									**7**
PIPIDAE																						
Pipa arrabali Arrabal's Surinam Toad							2						1									**3**
Pipa pipa Surinam Toad			2										4									**6**
Number of Individuals	**10**	**2**	**3**	**39**	**27**	**19**	**19**	**14**	**30**	**10**	**10**	**9**	**28**	**18**	**22**	**8**	**7**	**3**	**8**	**24**	**17**	**323**
Number of Species	**3**	**2**	**2**	**11**	**10**	**5**	**9**	**8**	**12**	**3**	**5**	**6**	**12**	**7**	**9**	**5**	**3**	**2**	**1**	**8**	**10**	**23**

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Indranee Roopsind and Ovid Cyril)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
BUFONIDAE																				
Atelopus hoogmoedi Hoogmoed Harlequin Toad	1							1								1				3
Rhaebo (Bufo) guttatus Spotted Toad				1			1							1						3
Rhaebo (Bufo) nasicus Werner's Toad		1	2				2			2					2	2				11
Rhinella margaritifera S. Amer. Common Toad	4		2	1		1														8
Rhinella marina Giant Toad or Cane Toad	5			1	2	9			2	4		9			2	2	1	3		40
HEMIPHRACTIDAE																				
Stefania evansi Evan's Stefania	3	1	2											5						11
Stefania woodleyi Woodley's Stefania	1	7																		8
Stefania scalae cf														2						2
HYLIDAE																				
Dendropsophus marmoratus Marbled Treefrog	1		2	1		13						4	1		5					27
Boana boans Giant Gladiator Treefrog	3		1	2		1	2	2		3	1			2		3				20
Boana crepitans Emerald-Eyed Treefrog			22			5	7		2	3		5			13		2			59
Osteocephalus oophagus	1			2		1				1		1		2	1					9

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
Slender-legged Treefrog																				
Osteocephalus taurinus Manaus Slender-Legged Treefrog					2			3				2								7
Scinax boesemani Boeseman's Snouted Treefrog			2		14						7	3					5			31
Scinax ruber Red-Snouted Treefrog			6	1	7	21	5	5	7	10		7	3		21	3		7	3	106
Trachycephalus resinitrifix Casque-Headed Treefrog			1											1						2
Pseudis paradoxic Paradoxic Frog																1				1
LEPTODACTYLIDAE																				
Leptodactylus mystaceus Amazonian White-Lipped Frog												1		1		3			1	6
Leptodactylus petersii Peter's Thin-Toed Frog																1				1
Lithodytes lineatus Painted Antnest Frog						4														4
Number of Individuals	**19**	**9**	**40**	**9**	**25**	**55**	**17**	**11**	**11**	**23**	**8**	**32**	**4**	**14**	**44**	**16**	**8**	**10**	**4**	**359**
Number of Species	**8**	**3**	**9**	**7**	**4**	**8**	**5**	**4**	**3**	**6**	**2**	**8**	**2**	**7**	**6**	**8**	**3**	**2**	**9**	**20**
Number of Species	**13**			**11**			**8**			**10**			**12**			**10**			**3**	**20**

2021 WET SEASON: OCTOBER 04 – 16, 2021 (Indranee Roopsind and Ovid Cyril)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
AROMOBATIDAE																				
Anomaloglossus praderioi Rocket Frog	1		3																	4
BUFONIDAE																				
Atelopus hoogmoedi Hoogmoed Harlequin Toad	3			2				3					1							9
Rhaebo (Bufo) guttatus Spotted Toad			2	2		1	1			2				3	1	1			1	14
Rhaebo (Bufo) nasicus Werner's Toad	3	2	1			3	3			4				1	2		4		2	25
Rhinella martyi	1		2	1	2	1			1											8
Rhinella marina Giant Toad or Cane Toad	10			2	>40	9			>30	4		9			2	2	5	7		>120
HEMIPHRACTIDAE																				
Stefania evansi Evan's Stefania		3	2											2						7
Stefania woodleyi Woodley's Stefania	1	7	1																	9
HYLIDAE																				
Dendropsophus minutus Lesser Treefrog	11		9		1	2			13	12		7	2	4		5			7	73
Dendropsophus marmoratus Marbled Treefrog	3	1		2									1	3						10
Boana boans Giant Gladiator Treefrog	3		6	6		1	2	6	9	9	2			2			3		8	57
Boana calcarata	1			2				1						1					2	7

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
Many-Banded Treefrog																				
Boana crepitans Emerald-Eyed Treefrog			7			11	3		9	7		5			8		5			55
Osteocephalus oophagus Slender-legged Treefrog	2		1	3		4			1	7		2		2					3	25
Osteocephalus taurinus Manaus Slender-Legged Treefrog					2			2				1								5
Phyllomedusa bicolor Giant Monkey Frog						1		1		1								1	2	6
Scinax boesemani Boeseman's Snouted Treefrog			6		>25				2			5			3		>11			>52
Scinax ruber Red-Snouted Treefrog	1		9	1	1	5	2		1	10		8		2				7	2	49
Trachycephalus resinitrifix Casque-Headed Treefrog	1		4	2										1						8
LEPTODACTYLIDAE																				
Leptodactylus mystaceus Amazonian White-Lipped Frog								1											1	1
Leptodactylus petersii Peter's Thin-Toed Frog			2											1				1		4
Number of Individuals	**41**	**13**	**55**	**23**	**>71**	**38**	**11**	**14**	**>66**	**56**	**2**	**37**	**4**	**22**	**16**	**8**	**17**	**16**	**28**	**>548**
Number of Species	**13**	**4**	**14**	**10**	**6**	**10**	**5**	**6**	**8**	**9**	**1**	**7**	**3**	**11**	**5**	**3**	**5**	**4**	**9**	**21**

Appendix B-6: Reptile

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Indranee Roopsind)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
ALLIGATORIDAE																						
Caiman crocodilus Spectacled Caiman					1			1														**2**
Paleosuchus palpebrosus Cuvier's Dwarf Caiman								2						1								**3**
Paleosuchus trigonatus Schneider's Dwarf Caiman								4														**4**
CHELIDAE																						
Phrynops gibbus Gibba Toad Head Turtle														2								**2**
*Phrynops tuberosus** Geoffrey's Side-neck Turtle														2								**2**
Platemys platycephala Twist-Necked Turtle														3								**3**
GEOEMYDIDAE																						
Rhinoclemmys punctularia Spot-legged Turtle				1						1												**2**
POLYCHORITDAE																						
Anolis fuscoauratus Slender Anole	1						1			2												**4**
Anolis planiceps										1												**1**
TEIIDAE																						
Kentropyx calcarata Striped Forest Whiptail	2		1	4	1	1	6	1		2	1	1	2	1	2	3	4	1		14	2	**49**
Tupinambis teguixin Gold Tegu															1						2	**3**
Ameiva ameiva	1	1	2	3	2	2	4	2	6	1	2	1	1		1	2		1		21		**53**

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
South American Ground Lizard																						
Cnemidophorus lemniscatus Rainbow Whiptail		2				1	1			2	1	1								7		**15**
GEKKONIDAE																						
Gonotodes humeralis Bridled-Forest Gecko	1						2		1	1			1							11		**17**
Thecadactylus rapicauda Turnip-tailed Gecko	1						1													9		**11**
Hemidactylus mabouia Wood Slave															2					8		**10**
Coleodactylus amazonicus Brazilian Pygmy Gecko	1			2																		**3**
GYMNOPHTHALIMIDAE																						
Cercosaura ocellata Blunt-scaled Spectacled Lizard										3												**3**
Leposoma spp						1																**1**
Neusticurus rudis Red Neusticurs										1										2		**3**
TROPIDURIDAE																						
Plica umbra				1																		**1**
Uracentron azureum Blue-Lipped Tree Lizard							1															**1**
SCINCIDAE																						
Mabuya nigropunctata Black-spotted Skink	1						2	1	1	1	2			2	1					5		**16**
ANOMALEPIDAE																						
Typhlophis squamosus Blind Snake				1																		**1**
COLUBRIDAE																						
Tantilla melanocephala Black-headed Snake												1										**1**

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	TZ 1	Camp	MiniH	TOTAL
Chironius fuscus Brown Sipo									1													**1**
Pseustes sulphureus Yellow-Bellied Puffing Snake									1													**1**
Oxyrhopus occipitalis Tschudi's False Coral Snake				1						1										2		**4**
ELAPIDAE																						
Micrurus collaris Black-back Coral Snake								1					1									**2**
VIPERIDAE																						
Bothrops atrox Fer de lance	1			3			1						1									**6**
Number of Individuals	**9**	**3**	**3**	**16**	**4**	**5**	**19**	**12**	**10**	**16**	**6**	**4**	**6**	**11**	**7**	**5**	**4**	**2**	**0**	**79**	**4**	**225**
Number of Species	**8**	**2**	**2**	**8**	**3**	**4**	**9**	**7**	**5**	**11**	**4**	**4**	**5**	**6**	**5**	**2**	**1**	**2**	**0**	**9**	**2**	**30**

* Formerly *Phrynops geoffroanus*

2013 DRY SEASON: 03 – 14 SEPTEMBER, 2013 (Indranee Roopsind)

Scientific Name	T1 a	T 1 b	T 1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T 3 c	T 4 a	T 4 b	T 4 c	T 5 a	T 5 b	T 5 c	T 6 a	T 6 b	T 6 c	T Z 1	Ca mp	Min iH	TO T
ALLIGATORIDAE																						
Caiman crocodilus Spectacled Caiman								1														**1**
Paleosuchus palpebrosus Cuvier's Dwarf Caiman								2						1								**3**
Paleosuchus trigonatus Schneider's Dwarf Caiman								1														**1**
CHELIDAE																						
Phrynops gibbus Gibba Toad Head Turtle *											1		4									**5**
Phyrnops tuberosus Geoffrey's Sideneck Turtle					1							1	2									**4**

Scientific Name	T1a	T1b	T1c	T2a	T2b	T2c	T3a	T3b	T3c	T4a	T4b	T4c	T5a	T5b	T5c	T6a	T6b	T6c	TZ1	Camp	MiniH	TOT
Platemys platycephala Twist-Necked Turtle													1									**1**
GEOEMYDIDAE																						
Rhinoclemmys punctularia Spot-legged Turtle				1						1				1								**3**
POLYCHORITDAE																						
Anolis fuscoauratus Slender Anole				1			2			1		1		1								**6**
Anolis planiceps Leaf Anole														1								**1**
TEIIDAE																						
Kentropyx calcarata Striped Forest Whiptail	4	2	2	7	4	5	9	3	2	1	2	4	3	5	2	2	3	4		18	10	**92**
Tupinambis teguixin Gold Tegu		2			1						1			1						2		**7**
Ameiva ameiva South American Ground Lizard	2	1	6	5	1	4	9	4	7	2	5	3	1		4	3		1		32	4	**94**
Cnemidophorus lemniastus Rainbow Whiptail		3				1	2			1		1								4		**12**
GEKKONIDAE																						
Gonotodes humeralis Bridled-Forest Gecko				1	2		5		3	1			2							14		**28**
Thecadactylus rapicauda Turnip-tailed Gecko				1									1							16		**18**
Hemidactylus mabouia Wood Slave															3					11		**14**
Coleodactylus amazonicus Brazilian Pgymy Gecko	3			1																		**4**
GYMNOPHTHALIMIDAE																						
Cercosaura ocellata Blunt-scaled Spectacled Lizard				1	2									1								**4**
Neusticurus rudis Red Neusticurs				1																1		**2**

Scientific Name	T1a	T1b	T1c	T2a	T2b	T2c	T3a	T3b	T3c	T4a	T4b	T4c	T5a	T5b	T5c	T6a	T6b	T6c	TZ1	Camp	MiniH	TOT
Bachia flavescens													2									**2**
TROPIDURIDAE																						
Plica plica Tree Runner				1									1									**2**
Plica umbra Blue-lipped Tree Lizard				1										1								**2**
SCINCIDAE																						
Mabuya nigropunctata Amazonian Skink	1	1		2		1	4	2	7		1		2	1	3	1		1		7	2	**36**
ANOMALEPIDAE																						
Typhlophis squamosus Blind Snake													1									**1**
BOIDAE																						
Corallus hortulanus Amazon Tree Boa																					1	**1**
COLUBRIDAE																						
Tantilla melanocephala Black-headed Snake													1									**1**
Liophis miliaris Common Water Snake								2	1												1	**4**
Mastigodryas melanolomus Dryad Snake									1				1								1	**3**
Pseutes sulphureus Yellow-Bellied Puffing Snake																		1				**1**
Oxyrhopus occipitalis Tschudi's False Coral Snake								1														**1**
Chironius scurrulus Wagler's Sipo													1									**1**
Oxybelis fulgidus Green Vine Snake						1																**1**
DIPSADIDAE																						
Helicops angulatus Brown Banded Water Snake									1													**1**

Scientific Name	T1a	T1b	T1c	T2a	T2b	T2c	T3a	T3b	T3c	T4a	T4b	T4c	T5a	T5b	T5c	T6a	T6b	T6c	TZ1	Camp	MiniH	TOT
VIPERIDAE																						
Bothrops atrox Common Lancehead							1		1												1	**3**
Number of Individuals	**10**	**9**	**8**	**23**	**11**	**12**	**32**	**16**	**23**	**7**	**10**	**10**	**23**	**13**	**12**	**6**	**3**	**7**	**0**	**105**	**20**	**360**
Number of Species	**4**	**5**	**2**	**12**	**6**	**5**	**7**	**8**	**8**	**6**	**5**	**5**	**14**	**9**	**4**	**3**	**1**	**4**	**0**	**9**	**7**	**34**

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Indranee Roopsind and Ovid Cyril)

Scientific Name	T1a	T1b	T1c	T2a	T2b	T2c	T3a	T3b	T3c	T4a	T4b	T4c	T5a	T5b	T5c	T6a	T6b	T6c	MiniH	TOTAL
ALLIGATORIDAE																				
Paleosuchus palpebrosus Cuvier's Dwarf Caiman	3			1							2								1	**7**
Paleosuchus trigonatus Schneider's Dwarf Caiman								3		1			1			1				**6**
CHELIDAE																				
Platemys platycephala Twist-Necked Turtle								1												**1**
GEOEMYDIDAE																				
Rhinoclemmys punctularia Spot-legged Turtle															1					**1**
DACTYLOIDAE																				
Anolis fuscoauratus Slender Anole	2			3												1				**6**
Anolis chrysolepis																				

Scientific Name	T1 a	T1 b	T1 c	T2a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5c	T6 a	T6 b	T6 c	Mini H	TOTAL
Leaf Anole	1			1						1			1			5				**9**
TEIIDAE																				
Kentropyx calcarata Striped Forest Whiptail	17		11	6		16	3	2	7	1		5			7	5		9		**89**
Tupinambis teguixin Gold Tegu	3		2													2				**7**
Ameiva ameiva South American Ground Lizard	13		4	15	2	8	9		5	5		2	1			4		3		**71**
Cnemidophorus lemniscatus Whiptail Lizard				5			3			11						1				**20**
GEKKONIDAE																				
Gonotodes humeralis Bridled-Forest Gecko	11						3													**14**
Thecadactylus rapicauda Turnip-tailed Gecko	3			2			1													**6**
Hemidactylus mabouia Wood Slave	1			1			1									1				**4**
Coleodactylus amazonicus Brazilian Pygmy Gecko	3												1			2				**6**
GYMNOPHTHALIMIDAE																				
Neusticurus rudis Red Neusticurs	2	3			4		2							4			2			**17**
TROPIDURIDAE																				
Plica plica Collared Tree Runner	1									1						1				**3**
SCINCIDAE																				
Copeoglossum nigropunctatum *				12						10			7			2				**31**

Scientific Name	T1 a	T1 b	T1 c	T2a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5c	T6 a	T6 b	T6 c	Mini H	TOTAL
Black-spotted Skink																				
COLUBRIDAE																				
Tantilla melanocephala Black-headed Snake	1																			**1**
Chironius fuscus Brown Sipo							1													**1**
Spilotes (Pseustes) sulphureus Yellow-bellied puffing snake													1							**1**
Oxybelis fulgidus Green Vine Snake						1						1								**2**
DIPSADIDAE																				
Imantodes cenchoa Blunt-headed Vine Snake						1														**1**
Oxyrhopus occipitalis Brown Capped False Coral Snake																1				**1**
VIPERIDAE																				
Bothrops atrox Fer de lance				1	3															**4**
BOIDAE																				
Corallus hortulanus Amazon Tree Boa										1										**1**
Number of Individuals	**61**	**3**	**17**	**47**	**9**	**26**	**23**	**6**	**12**	**31**	**2**	**8**	**12**	**4**	**8**	**26**	**2**	**12**	**1**	**310**
Number of Species	**13**	**1**	**3**	**10**	**3**	**4**	**8**	**3**	**2**	**8**	**1**	**3**	**6**	**1**	**2**	**12**	**1**	**2**	**1**	**25**
Number of Species	**13**			**13**			**10**			**9**			**9**			**13**			**1**	**25**

** formerly *Mabuya nigropunctata*

2021 WET SEASON: OCTOBER 04 – 16, 2021 (Indranee Roopsind and Ovid Cyril)

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
ALLIGATORIDAE																				
Caiman crocodilus Spectacled Caiman								2							1					**3**
Paleosuchus trigonatus Schneider's Dwarf Caiman			1																	**1**
CHELIDAE																				
Platemys platycephala Twist-Necked Turtle				1									1							**2**
GEOEMYDIDAE																				
Rhinoclemmys punctularía Spot-legged Turtle								1		1										**2**
POLYCHORITDAE																				
Anolis fuscoauratus Slender Anole	1						1			2										**4**
TESTUDINIDAE																				
Chelonoidis denticulata Yellow-footed Tortoise				1																**1**
TEIIDAE																				
Kentropyx calcarata Striped Forest Whiptail	1		5	14	7	5	9		11	2		1			16	3		11	7	**92**
Tupinambis teguixin Gold Tegu			2									1			1				1	**5**
Ameiva ameiva South American Ground Lizard			4	4	1	1	2		7	1		1			8	1		9	2	**41**
GEKKONIDAE																				

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
Gonotodes humeralis Bridled-Forest Gecko	1						1			1										**3**
Thecadactylus rapicauda Turnip-tailed Gecko	4		3																	**7**
Hemidactylus mabouia Wood Slave			1												2					**3**
Coleodactylus amazonicus Brazilian Pygmy Gecko			1																	**1**
GYMNOPHTHALIMIDAE																				
Leposoma spp.						1														**1**
Neusticurus rudis Red Neusticurs														1						**1**
TROPIDURIDAE																				
Uracentron azureum Blue-Lipped Tree Lizard									1											**1**
SCINCIDAE																				
*Copeoglossum nigropunctata** Black-spotted Skink	1		3			2			1	3		1	1		2				1	**15**
COLUBRIDAE																				
Tantilla melanocephala Black-headed Snake												1								**1**
DIPSIDAE																				
Erythrolamprus breviceps Short Ground Snake			1																	**1**
VIPERIDAE																				
Bothrops atrox Fer de lance			2																	**2**
Number of Individuals	**8**	**0**	**23**	**20**	**8**	**9**	**13**	**3**	**20**	**10**	**0**	**5**	**2**	**1**	**30**	**4**	**0**	**20**	**11**	**187**

Scientific Name	T1 a	T1 b	T1 c	T2 a	T2 b	T2 c	T3 a	T3 b	T3 c	T4 a	T4 b	T4 c	T5 a	T5 b	T5 c	T6 a	T6 b	T6 c	Mini H	TOTAL
Number of Species	**5**	**0**	**10**	**4**	**2**	**4**	**4**	**2**	**4**	**6**	**0**	**4**	**2**	**1**	**6**	**2**	**0**	**2**	**4**	**20**

* Formerly *Mabuya nigropunctata*

Appendix B-7: Non-volant Mammal Species Diversity and Abundance at Transects

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Annalise Bayney and Anita Ramlochan)

Taxon	Common Name	Transect							
		T1	T2	T3	T4	T5	T6	Opp.	Interview
XENARTHRA									
Bradypodidae									
Bradypus tridactylus	Three-toed sloth							Obs (1)	
Myrmecophagidae									
Myrmecophaga tridactyla	Giant anteater*								X
Tamandua tetradactyla	Tamandua	Skeleton							
Dasypodidae									
Dasypus novemcinctus	Nine-banded armadillo	Track (1)			Track (1)	Track (1)			
PRIMATES									
Cebidae									
Alouatta seniculus	Red howler monkey		Obs (2)	Obs (5)				AES (≥4)	
Ateles paniscus	Black spider monkey	AES (≥3)	Obs (2)	Obs (5)	Obs (8)		Obs (4)	AES (≥5)	
Cebus apella	Brown capuchin								X
Saimiri sciureus	Squirrel monkey								X
CARNIVORA									
Procyonidae									
Procyon cancrivorus	Crab eating raccoon			Scat (1)					
Felidae									
Herpailurus yaguarondi	Jaguarundi								X
Leopardus pardalis	Ocelot		Track (1)						
Leopardus wiedii	Margay								X
Panthera onca	Jaguar			Scat (1)					
Puma concolor	Puma		Track (1)				Track (1)		
Herpestidae									
Herpestes javanicus	Small Asian mongoose								X
Mustelidae									

Taxon	Common Name	Transect							
		T1	T2	T3	T4	T5	T6	Opp.	Interview
Eira barbara	Tyra		Track (1)						
Galictis vittata	Grison								X
ARTIODACTYLA									
Cervidae									
Mazama gouazoupira	Grey brocket deer	Scat (1)		Track (2)	Track (1)	Track (1)			
Mazama americana	Red brocket deer	Track (1)	Track (1)		Track (1)			Track (1)	
Tayassuidae									
Tayassu tajacu	Collared peccary								X
Tayassu pecari	White lipped peccary								X
PERISSODACTYLA									
Tapiridae									
Tapirus terrestris	Lowland tapir	Track (1)	Track (1)	Track (1)					
RODENTIA									
Scuiridae									
Sciurus aestuans	Guianan squirrel							Obs (2)	
Agoutidae									
Agouti paca	Paca/Labba	Track (1)		Obs (1) Track (5)	Track (3)	Track (2)	Track (2)	Obs (1)	
Dasyproctidae									
Dasyprocta leporina[10]	Red-rumped agouti	Obs (2)	Obs (5)	Obs (5) Track (1)	Track (2)			Obs (1)	
Myoprocta exilis	Acouchi								X

*Two mining camps report haven caught an eaten this species within the month preceding our surveys.

[10] May be synonymous with *Dasyprocta cristata*

2013 DRY SEASON SEPTEMBER 03 – 14, 2013 (Annalise Bayney and Anita Ramlochan)

Taxon	Common Name	Transect						
		T1	T2	T3	T4	T5	T6	Opp.
MARSUPIALIS								
Didelphidae								
Didelphis marsupialis	Common Opposum			Track (1)				
XENARTHRA								
Bradypodidae								
Bradypus tridactylus	Three-toed sloth							Obs (1) Dead (1)
Dasypodidae								
Dasypus novemcinctus	Nine-banded armadillo			Track (2)				
PRIMATES								
Cebidae								
Alouatta seniculus	Red howler monkey			Obs (5)				AES (>4)
Ateles paniscus	Black spider monkey	Obs (4)	Obs (3)					Obs (3)
Cebus olivaceus	Wedge-capped capuchin		Obs (3)					
Pithecia pithecia	Guianan saki							Obs (2)
CARNIVORA								
Procyonidae								
Nasua nasua	South American coati				Tracks			
Procyon cancrivorus	Crab-eating raccoon			Scat (1)		Track (1)		
Potos flavus	Kinkajou			Obs (1)				
Felidae								
Leopardus pardalis	Ocelot		Tracks	Tracks				
Panthera onca	Jaguar			Scat (2)				Scent
Mustelidae								
Eira barbara	Tyra	Obs (1)	Obs (1)					
ARTIODACTYLA								
Cervidae								
Mazama gouazoupira	Grey brocket deer	Track (1)	Track (1)	Track (2)				

Taxon	Common Name	Transect						
		T1	T2	T3	T4	T5	T6	Opp.
Mazama americana	Red brocket deer	Track (3)		Track (>10)	Track (3)	Track (1)		
PERISSODACTYLA								
Tapiridae								
Tapirus terrestris	Lowland tapir	Track (1)						
RODENTIA								
Agoutidae								
Agouti paca	Pacca/labba	Track (3)		Obs (2) Track (>10)	Obs (2) Track (10)	Track (1)		
Dasyproctidae								
Dasyprocta leporina[11]	Red-rumped agouti	Track (3)		Obs (3) Track (>20)	Obs (2) Track (>10)	Track (3)	Track (2)	

2021 WET SEASON: JULY 12 – 25, 2021 (Indranee Roopsind, Ovid Cyril & Anita Ramlochan)

Taxon	Common Name	Transect						
		T1	T2	T3	T4	T5	T6	Interviews
MARSUPIALIS								
Didelphidae								
Didelphis marsupialis	Common Opposum	Tracks (1)						
XENARTHRA								
Bradypodidae								
Bradypus tridactylus	Three-toed sloth	Obs (2)						
PILOSA								
Myrmecophagidae								

[11] May be synonymous with *Dasyprocta cristata*

Taxon	Common Name	Transect						Interviews
		T1	T2	T3	T4	T5	T6	
Tamandua tetradactyla	Southern Tamandua	Obs (1)						
PRIMATES								
Atelidae								
Alouatta macconnelli	Guiana howler monkey	AES (5)	AES (3)	AES			AES (2)	
Ateles paniscus	Black spider monkey	AES (4)	AES (2)					
Cebidae								
Cebus olivaceus	Wedge-capped capuchin	Obs (7)						
Callitrichidae								
Saguinus midas	Golden-handed tamarin monkey							X
Pithecidae								
Pithecia pithecia	White-faced or Guianan saki monkey							X
CARNIVORA								
Canidae								
Cerdocyon thous	Crab-eating fox	Obs (1)	Obs (4)	Obs (5)	Obs (2)	Tracks (1)		
Procyonidae								
Nasua nasua	South American coati	Obs (1)			Tracks			
Felidae								
Herpailurus yagouaroundi	Jaguarundi							X
Leopardus pardalis	Ocelot	Tracks (1)	Tracks (1)		Tracks/Scat			
Panthera onca	Jaguar				Tracks			
Puma concolor	Puma							X

Taxon	Common Name	Transect						
		T1	T2	T3	T4	T5	T6	Interviews
Mustelidae								
Eira barbara	Tyra	Obs (4) CT (2)						
Artiodactyla								
Cervidae								
Mazama americana	Red brocket deer	Tracks (1)		Tracks (1)	Tracks (2)			
Perissodactyla								
Tapiridae								
Tapirus terrestris	Lowland tapir	CT (1)		Track (1)				
CINGULATA								
Dasypodidae								
Dasypus novemcinctus	Nine-banded armadillo							X
Dasyproctidae								
Dasyprocta leporina	Red-rumped agouti	Tracks			Tracks (2)	Tracks (3)		
RODENTIA								
Agoutidae								
Agouti paca	Paca/labba		Tracks		Tracks (2)			
Cricetidae								
Oecomys bicolor	Bicolored Arboreal Rice Rat	TR (2)						
Cavidae								
Hydrochoerus hydrochaeris	Capybara						Tracks (4)	
TOTAL NUMBER SPECIES		**14**	**5**	**4**	**7**	**2**	**2**	

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Indranee Roopsind, Ovid Cyril & Anita Ramlochan)

Taxon	Common Name	Transect Location						Interviews
		T1	T2	T3	T4	T5	T6	
MARSUPIALIS								
Didelphis marsupialis	Common Opossum	Obs (1)						X
XENARTHRA								
Bradypodidae								
Bradypus tridactylus	Three-toed Sloth	Obs (1)						X
Dasypodidae								
Dasypus novemcinctus	Nine-banded Armadillo		Tracks (1)		Obs (1)			X
PILOSA								
Myrmecophagidae								
Tamandua tetradactyl a	Southern Tamandua							X
Myrmecophaga tridactyla	Giant Anteater							X
PRIMATES								
Atelidae								
Alouatta macconnelli	Guiana Howler Monkey	AES (3)	AES (2)		AES (3)	AES (2)	AES (4)	X
Ateles paniscus	Black Spider Monkey	Obs (1)						X
Cebidae								
Cebus olivaceus	Wedged-capped Capuchin		Obs (4)					X
Saimiri sciureus	Squirrel Monkey							X
Pithecia pithecia	Guianan Saki							X
CARNIVORA								
Canidae								

Taxon	Common Name	Transect Location						Interviews
		T1	T2	T3	T4	T5	T6	
Cerdocyon thous	Crab-eating fox	Obs (5)	Obs (3)	Obs (1)	Tracks (1)	Tracks (3)		X
Procyonidae								
Nasua nasua	Coatimundi		Track (1)					X
Potos flavus	Kinkajou		Obs (3)					X
Felidae								
Leopardus pardalis	Ocelot	Obs (1), CT (1)			Obs (1)	Tracks (1)		X
Panthera onca	Jaguar	Tracks (1)		Tracks (1)		Tracks (1)	Tracks (1)	X
Puma concolor	Puma		Tracks (1)	Obs (1)			Tracks (1)	X
Herpailurus yagouaroundi	Jaguarundi							X
Leopardus wiedii	Margay							X
Mustelidae								
Eira barbara	Tayra	Obs (3)	Tracks (1)					X
Artiodactyla								
Cervidae								
Mazama americana	Red Brocket Deer	Tracks (2)	Tracks (3)		Tracks (2)	Obs (1)	Tracks (1)	X
Mazama gouazoupira	Gray Brocket Deer							X
Tayassuidae								
Tayassu tajacu	Collared Peccary							X
Tayassu pecari	White-lipped Peccary							X
Perissodactyla								
Tapiridae								

Taxon	Common Name	Transect Location						Interviews
		T1	T2	T3	T4	T5	T6	
Tapirus terrestris	Lowland Tapir					Obs (1) Tracks (1)	Tracks (1)	X
RODENTIA								
Agoutidae								
Agouti paca	Labba	Tracks (1)			Tracks (1)		Tracks (1)	X
Dasyproctidae								
Dasyprocta leporina	Red Rumped Agouti	Obs (1)	Tracks (2)	Tracks (3)	Tracks (1)		Obs (1)	X
Myoprocta exilis	Acouchy							X
Cricetidae								
Oecomys bicolor	Bicoloured Arboreal Rice Rat	Trapped (2)						
Cavidae								
Hydrochoerus hydrochaeris	Capybara		Tracks (2)		Obs (1)			X
Scuiridae								
Sciurus aestuans	Guianan Red Squirrel							X
Number of Species		**12**	**11**	**4**	**8**	**6**	**7**	**10**

Appendix B-8: Bats

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Anita Ramlochan)

Taxon	Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Totals
Mormoopodae							
Pteronotus parnellii	Greater moustached bat	2	1				3
Phyllostomidae							
Phyllostominae							
Phyllostomus hastatus	Greater spear-nosed bat			1			1
Micronycteris daviesi	Bartica bat					1	1
Tonatia saurophila	Stripe-headed round-eared bat			3			3
Trachops cirrhosus	Fringe-lipped bat or frog eating bat		1				1
Carollinae							
Carollia perspicillata	Common short-tailed fruit bat	9	8	16	9	11	53
Rhinophylla pumilio	Dwarf little fruit bat	6	8	4		1	19
Stenodermatinae							
Artibeus lituratus	Greater fruit-eating bat	1	2				3
Artibeus obscurus	Sooty fruit-eating bat		4		1		5
Artibeus planirostris	Flat-faced fruit-eating bat				1		1
Sturnira lilium	Little yellow-shouldered bat	7	2	3	6	6	24
Uroderma bilobatum	Tent-making bat			1	1		2
Vampyressa bidens	Yellow-eared bat		1				1
Glossophaginae							
Choeroniscus godmani	Godman's long-tailed bat	1		1			1
Glossophaga soricina	Common long-tongued bat	1	1	1			3

2013 DRY SEASON: SEPTEMBER 03-14, 2013 (Anita Ramlochan)

Taxon	Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Totals
Thyropteridae							
Thyroptera tricolor	Disc-winged bat			1			1
Phyllostomidae							
Phyllostominae							
Phyllostomus elongatus	Dark spear-nosed bat			1		1	2
Trachops cirrhosus	Fringe-lipped bat or frog eating bat		1		1		2

Taxon	Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Totals
Carollinae							
Carollia perspicillata	Common short-tailed fruit bat	4	18	5	5	4	36
Rhinophylla pumilio	Dwarf little fruit bat	6	7	2	3	3	21
Desmondontinae							
Desmodus rotundus	Common vampire bat			1			1
Stenodermatinae							
Artibeus lituratus	Greater fruit-eating bat	1	1		1		3
Artibeus obscurus	Sooty fruit-eating bat			1			1
Sturnira lilium	Little yellow-shouldered bat	4		1	1	1	7
Sturnira tildae	Yellow shouldered bat	4		1	1	1	7
Uroderma bilobatum	Tent-making bat	1		1			2
Glossophaginae							
Glossophaga soricina	Common long-tongued bat				1		1
Total captures		**20**	**27**	**14**	**13**	**10**	**84**
Mist-netting effort (M^2h)		**4,680**	**4,493**	**4,306**	**4,493**	**4,306**	**22,277**
Captures per unit effort		**0.004**	**0.006**	**0.003**	**0.003**	**0.002**	**0.004**

2021 DRY SEASON: OCTOBER 04 – 16, 2021 (Anita Ramlochan)

Vernacular Name	Family – Sub Family	Scientific Name	Mist Netting Sites						Opportunitic Surveys	Roost Searches	Trophic Guild
			1	2	3	4	5	6			
Mastif Bat	Molossidae	*Eumops* spp.								✔	AI
Mastif Bat	Molossidae	*Molossus molossus*		3							AI
Common Mustached Bat	Mormoopidae	*Pteronotus parnellii*						1			AI
Chestnut sac-winged bat	Emballonuridae	*Cormura brevirostris*	1								AI
Seba's Short-tailed bat	Phyllostomidae - Carolliinae	*Carollia perspicillata*	5		20	2	4		✔	✔	F
Silky Short-tailed Bat	Phyllostomidae - Carolliinae	*Carollia brevicauda*	3	2	11	4	5	1	✔		F
Dwarf Little Fruit Bat	Phyllostomidae - Carolliinae	*Rhinophylla pumilio*	5			2		1	✔		F

Vernacular Name	Family – Sub Family	Scientific Name	Mist Netting Sites						Opportunitic Surveys	Roost Searches	Trophic Guild
			1	2	3	4	5	6			
Tent-making Bat	Phyllostomidae - Stenodermatinae	*Uroderma bilobatum*				2					F
Tilda's Yellow-Shouldered Bat	Phyllostomidae - Stenodermatinae	*Sturnira tildae*	5	3	5		2		✔		F
Little Yellow-Shouldered Bat	Phyllostomidae - Stenodermatinae	*Sturnira lilium*		6	2		2		✔		F
Great Fruit-Eating Bat	Phyllostomidae - Stenodermatinae	*Artibeus lituratus*	1			1	1		✔		F
Flat-faced Fruit-eating Bat	Phyllostomidae - Stenodermatinae	*Artibeus planirostris*					2				F
Common Long-tongued Bat	Phyllostomidae - Glossophaginae	*Glossophaga soricina*	1		5						N
		Number of Individuals	**21**	**14**	**43**	**11**	**16**	**3**			
		Number of Species	**7**	**4**	**5**	**5**	**6**	**3**	**6**	**2**	

2021 WET SEASON: JULY 12 – 25, 2021 (Anita Ramlochan)

Family – Sub Family	Scientific Name	Sites						Opportunitic Survey	Roost Searches	Trophic Guild
		1	2	3	4	5	6			
Molossidae	*Eumops* spp. (Mastif Bat)								✔	AI
Phyllostomidae - Carolliinae	*Carollia perspicillata* (Seba's short-tailed bat)	1		9	1	3	5	✔	✔	F
Phyllostomidae - Carolliinae	*Carollia brevicauda* (Silky short-tailed bat)			4			2	✔		F
Phyllostomidae - Stenodermatinae	*Uroderma bilobatum* (Tent-making bat)			5		2	1			F
Phyllostomidae – Stenodermatinae	*Sturnira tildae* (Tilda's yellow-shouldered bat)			9						F
Phyllostomidae - Glossophaginae	*Glossophaga soricina* (Common long-tongued bat)			3						N
Phyllostomidae - Glossophaginae	*Lionycteris spurrelli* (Chestnut long-tongued bat)		1							N
	SPECIES TOTALS	**1**	**1**	**5**	**1**	**2**	**3**			

Appendix B-9: Birds

2013 WET SEASON: MAY 29 – JUNE 09, 2013 (Waldyke Prince)

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Tinamidae (2)								
Tinamus major	Great Tinamou **							1
Crypturellus spp	Tinamou species			1				1
Cracidae (3)								
Crax alector	Black Curassow **							7
Penelope jacquacu	Spix's Guan			2				2
Penelope marail	Marail Guan		3					
Rallidae (1)								
Aramides spp.	Rail species				1			
Eurypygidae (1)								
Eurypyga helias	Sun bittern **							1
Ardeidae (2)								
Tigrisoma lineatum	Rufescent Tiger-Heron		1					
Butorides striata	Striated Heron **							1
Cathartidae (2)								
Sarcoramphus papa	King Vulture **							3
Cathartes melambrotus	Greater Yellow-headed Vulture	1				2		3
Accipiptridae (7)								
Buteo magnirostris	Roadside Hawk					1		1
Spizaetus tyrannus	Black Hawk-eagle		1					1
Buteo brachyurus	Short-tailed Hawk **							2
Buteogallus urubitinga	Great Black Hawk				1			
Ictinia plumbea	Plumbeous Kite			1				
Elanoides forficatus	Swallow-tailed Kite **							2
Falconidae (5)								
Falco deiroleucus	Orange-breasted Falcon **							2
Herpetptheres cachinnans	Laughing Falcon **							1
Micrastur mirandollei	Slaty-backed Forest-Falcon **							1
Ibycter americanus	Red-throated Caracara			3				

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Daptrius ater	Black Caracara						3	
Threskiornithidae (1)								
Mesembrinibis cayennensis	Green Ibis					3		
Columbidae (4)								
Columba plumbea	Plumbeous Pigeon			1	2	1	1	
Patagioenas subvinacea	Ruddy Pigeon	1				1	3	
Columbina passerina	Common Ground-Dove			5			6	5
Leptotila verreauxi	White-tipped Dove	2	2	1	2			
Psittacidae (7)								
Ara chloropterus	Red-and-Green Macaw			2				2
Amazona amazonica	Orange-winged Parrot				2		6	
Amazona dufresniana	Blue-cheeked Parrot			4			2	
Pionus menstruus	Blue-headed Parrot	14	4	3				
Deroptyus accipitrinus	Red-fan Parrot			4			4	
Pyrrhura egregia	Fiery-shouldered Parakeet			15	4			
Pionites melanocephalus	Black-headed Parrot		3				3	
Cuculidae (4)								
Piaya melanogaster	Black-bellied Cuckoo	2						
Piaya cayana	Squirrel Cuckoo			1		2		
Crotophaga major	Greater Ani					5		
Crotophaga ani	Smooth-billed Ani						7	
Apodidae (2)								
Streptoprocne zonaris	White-collared Swifts						100	
Chaetura spinicaudus	Band-rumped Swifts			60			3	
Caprimulgidae (1)								
Nyctidromus albicollis	Common Paraque **							3
Trochilidae (8)								
Phaethornis superciliosus	Eastern Long-tailed Hermit	2	1	5	2			
Glaucis hirsutus	Rufous-breasted Hermit			3				
Threnetes leucurus	Pale-tailed Barb-throat		1	3		1		
Anthracothorax nigricollis	Black-throated Mango		2					
Phaethornis ruber	Reddish Hermit		1	3	1	2		
Heliothryx auritus	Black-eared Fairy			4				

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Campylopterus largipennis	Gray-breasted Sabre-wing			1				
Thalurania furcata	Fork-tailed Woodnymph			2		1		5
Trogonidae (2)								
Trogon viridis	White-tailed Trogon	1		2				
Trogon melanurus	Black-tailed Trogon	1	1					
Alcedinidae (5)								
Megaceryle torquata	Ringed Kingfisher **							1
Chloroceryle amazona	Amazon Kingfisher					1	1	
Chloroceryle inda	Green-and-Rufous Kingfisher					1		
Chloroceryle americana	Green Kingfisher				1	1		1
Chloroceryle aenea	American Pygmy-Kingfisher		1					
Momotidae (1)								
Momotus motmot	Blue-crowned Motmot			3				1
Bucconidae (3)								
Notharchus macrorhynchos	Guianan Puffbird				2			
Monasa atra	Black Nunbird	2						
Chelidoptera tenebrosa	Swallow-winged Puffbird			5				
Ramphastidae (4)								
Ramphastos tucanus	White-throated Toucan		2	6	3		2	
Ramphastos vitellinus	Channel-billed Toucan				2	2		
Selenidera culik	Guianan Toucanet				2			
Pteroglossus aracari	Black-necked Aracari		2				7	
Furnariidae (2)								
Automolus spp.	Foliage-gleaner **							1
Synallaxis gujanensis	Plain-crowned Spinetail	2		1		4	4	
Dendrocolaptidae (5)								
Sittasomus griseicapillus	Olivaceous Woodcreeper				2			
Glyphorynchus spirurus	Wedge-billed Woodcreeper	2	2	6	3			
Xiphorhynchus pardalotus	Chestnut-rumped Woodcreeper	2	4	2	3			
Dendrocolaptes certhia	Amazon-barred Woodcreeper			4	2		2	
Xiphorhynchus guttatus	Buff-throated Woodcreeper			1	3	1	3	
Dendrocincla spp.	Unidentified Woodcreeper					1		
Picidae (8)								

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Dryocopus lineatus	Lineated Woodpecker			2		1	2	
Campephilus melanoleucos	Crimson-crested Woodpecker				1			
Campephilus rubricollis	Red-necked Woodpecker			2		2		
Celeus elegans	Chestnut Woodpecker	1						
Piculus flavigula	Yellow-throated Woodpecker		2	1	2			
Melanerpes cruentatus	Yellow-tufted Woodpecker				1	2	2	
Celeus undulatus	Waved Woodpecker			4	2			
Piculus rubiginosus	Golden-olive Woodpecker			2	2			
Thamnophilidae (18)								
Thamnophilus murinus	Mouse-colored Antshrike			4	3			
Taraba major	Great Antshrike				2			
Thamnomanes ardesiacus	Dusky-throated Antshrike	2		4	1			
Thamnomanes caesius	Cinereous Antshrike		3		1			
Cymbilaimus lineatus	Fasciated Antshrike	1						
Myrmotherula surinamensis	Guianan Streaked-Antwren			4	3			
Myrmotherula axillaris	White-flanked Antwren		1	2	4			2
Myrmotherula menetriesii	Gray Antwren			4	2			
Myrmotherula brachyura	Pygmy Antwren					4		
Herpsilochmus stictocephalus	Todd's Antwren	4		2	2			
Herpsilochmus sticturus	Spot-tailed Antwren			2	2			
Cercomacra cinerascens	Gray Antbird			2	4			
Hypocnemis cantator	Guianan Warbling Antbird			6	4			
Cercomacra tyrannia	Dusky Antbird			6		6		
Myrmeciza atrothorax	Black-throated Antbird		1					
Sclateria naevia	Silvered Antbird	1				2		
Myrmeciza ferruginea	Ferruginous-backed Antbird		2	2				
Hylophylax poecilinotus	Scaled-back Antbird					2		
Formicariidae (1)								
Hylopezus macularius	Spotted Antpitta		1					
Tyrannidae (18)								
Elaenia flavogaster	Yellow-bellied Elaenia					2		
Philohydor lictor	Lesser Kisskadee	2		1	3			
Myiozetetes cayanensis	Rusty-margined Flycatcher			1		2		

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Tolmomyias assimilis	Zimmer's Flycatcher	4		7				
Conopias parvus	Yellow-throated Flycatcher	2						
Leptopogon superciliaris	Slaty-capped Flycatcher	1		2				
Myiarchus ferox	Short-crested Flycatcher					2		
Tyrannus melanocholicus	Tropical Kingbird				1		3	
Onychorhynchus coronatus	Northern Royal Flycatcher *		1					
Mionectes oleagineus	Ochre-bellied Flycatcher *		1					
Lophotriccus galeatus	Helmeted Pygmy-Tyrant			2	3		1	
Myiornis ecaudatus	Short-tailed Pygmy-Tyrant		1				1	
Tyrannulus elatus	Yellow-crowned Tyrannulet						2	
Phaeomyias murina	Mouse-colored Tyrannulet				1			
Todirostrum cinereum	Common Tody-flycatcher						1	
Attila cinnamomeus	Cinnamon Attila					2	1	
Attila spadiceus	Bright-rumped Attila			1		1		1
Tityra cayana	Black-tailed Tityra					1		1
Cotingidae (5)								
Lipaugus vociferans	Screaming Pia	1	3	7				
Querula purpurata	Purple-throated Fruitcrow		4	4				
Rupicola rupicola	Guianan Cock-of-the-Rock			1				1
Xipholena punicea	Pompadour Cotinga			1				
Phoenicircus carnifex	Guianan Red-Cotinga			1	2			
Pipridae (4)								
Lepidothrix suavissima	Orange-bellied Manakin	3	1					
Pipra pipra	White-crowned Manakin *		3		3			
Corapipo gutturalis	White-throated Manakin				7			
Manacus manacus	White-bearded Manakin				2	2	1	
Polioptilidae (1)								
Ramphocaenus melanurus	Long-billed Gnatwren			3	2			
Vireonidae (3)								
Hylophilus thoracicus	Lemon-chested Greenlet	2	2	2	2	4		
Hylophilus musicicapinus	Buff-cheeked Greenlet	4		2	2			
Vireolanius leucotis	Slaty-capped Shrike-vireo			2	1			
Hirundinidae (3)								

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Tachycineta albiventer	White-winged Swallow **							1
Atticora fasciata	White-banded Swallow					3	1	
Progne chalybea	Grey-breasted Martin						3	
Corvidae (1)								
Cyanocorax cayanus	Cayenne Jay		2	2	5			
Troglotidae (1)								
Thryothorus leucotis	Buff-breasted Wren		1	3				
Thryothorus coraya	Coraya Wren					1		
Troglodytes aedon	Southern House-Wren						2	
Thraupidae (12)								
Tangara mexicana	Turquoise Tanager	3		9				
Ramphocelus carbo	Silvered-beaked Tanager	15	3	7	8	17	11	5
Tachyphonus cristatus	Fulvous-crested Tanager	3		4	6			
Thraupis episcopus	Blue-grey Tanager			2			6	
Tangara gyrola	Bay-headed Tanager				5			
Hemithraupis guira	Guira Tanager			3				
Thraupis palmarum	Palm Tanager					4		
Dacnis cayana	Blue Dacnis **							1
Cyanerpes caeruleus	Purple Honeycreeper			2	4		2	
Cyanerpes cyaneus	Red-legged Honeycreeper			4				
Chlorophanes spiza	Green Honeycreeper			8	3			
Coereba flaveola	Bananaquit				1			
Parulidae (2)								
Phaeothlypis rivularis	Riverside Warbler				2		1	
Granatellus pelzeini	Rose-breasted Chat			2				
Cardinalidae (2)								
Caryothraustes canadensis	Yellow-green Grosbeak			5				
Saltator coerulescens	Grayish Saltator			1				
Emberizidae (4)								
Volatinia jacarina	Blue-black Grassquit			1			4	
Sporophila castaneiventris	Chestnut-bellied Seedeater			5			5	
Sporophila spp.	Unidentified Yellowish Seedeater					5		
Paroaria gularis	Red-capped Cardinal						2	

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Icteridae (2)								
Psarocolius decumanus	Crested Oropendola			40			3	
Psarocolius viridis	Green Oropendola						1	9
Fringillidae (2)								
Euphonia violacea	Violaceous Euphonia			2				
Euphonia cayennensis	Golden-sided Euphonia				4			
	Number of Individuals	**81**	**63**	**340**	**141**	**95**	**212**	**69**

**Birds that were recorded exclusively via mist-netting; ** Birds that was recorded exclusively via Opportunistic sighting.*

2013 DRY SEASON: SEPTEMBER 03 – 14, 2013 (Waldyke Prince)

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Tinamidae								
Tinamus major	Great Tinamou			1				
Crypturellus variegatus	Variegated Tinamou***	1						
Crypturellus spp.	Tinamou species ***							1
Cracidae								
Crax alector	Black Curassow **							2
Penelope marail	Marail Guan **							2
Ardeidae								
Tigrisoma lineatum	Rufescent Tiger-Heron	1						
Odontophoridae								
Odontophorus gujanensis	Marbled Wood Quail***			3				
Threskiornithidae								
Mesembrinibis cayennensis	Green Ibis					4		2
Cathartidae								
Sarcoramphus papa	King Vulture **							1
Cathartes melambrotus	Greater Yellow-headed Vulture			2				
Accipiptridae								
Buteo brachyurus	Short-tailed Hawk						1	2
Buteogallus urubitinga	Great Black Hawk		1					
Leucopternis albicollis	White Hawk ***			1				
Ictinia plumbea	Plumbeous Kite							1

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Elanoides forficatus	Swallow-tailed Kite **							1
Falconidae								
Falco rufigularis	Bat Falcon ***					2		
Falco deiroleucus	Orange-breasted Falcon **							2
Ibycter americanus	Red-throated Caracara		2					3
Strigidae								
Pulsatrix perspicillata	Spectacled owl ***							1
Columbidae								
Patagioenas subvinacea	Ruddy Pigeon				1		1	
Columbina passerina	Common Ground-Dove						2	
Leptotila verreauxi	White-tipped Dove			3		1	1	1
Psittacidae								
Ara chloropterus	Red-and-Green Macaw			2				
Amazona amazonica	Orange-winged Parrot **							2
Pionus menstruus	Blue-headed Parrot					7		
Pionus fuscus	Dusky Parrot ***					3		
Deroptyus accipitrinus	Red-fan Parrot					4		
Pyrrhura egregia	Fiery-shouldered Parakeet			5				
Pionites melanocephalus	Black-headed Parrot		6				3	
Gypopsitta caica	Caica Parrot ***	2		1				
Touit batavica	Lilac-tailed Parrotlet ***		23					
Cuculidae								
Piaya cayana	Squirrel Cuckoo			1	1	3	1	2
Crotophaga ani	Smooth-billed Ani					4	2	
Apodidae								
Chaetura spinicaudus	Band-rumped Swifts			12			11	
Caprimulgidae								
Nyctidromus albicollis	Common Paraque **							1
Trochilidae								
Phaethornis superciliosus	Eastern Long-tailed Hermit	2		2	1	2	1	
Phaethornis bourcieri	Straight-billed Hermit *		1					
Glaucis hirsutus	Rufous-breasted Hermit			1				
Threnetes leucurus	White-tailed Barb-throat				1			

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Phaethornis ruber	Reddish Hermit			3	2	1	1	
Heliothryx auritus	Black-eared Fairy		2					
Campylopterus largipennis	Gray-breasted Sabre-wing *							1
Thalurania furcata	Fork-tailed Woodnymph			3				
Trogonidae								
Trogon viridis	White-tailed Trogon			2	1	1	1	
Trogon melanurus	Black-tailed Trogon	1	1				1	
Trogon violaceus	Violaceous Trogon ***			1				
Trogon rufus	Black-throated Trogon ***			1				
Alcedinidae								
Chloroceryle amazona	Amazon Kingfisher						1	
Chloroceryle americana	Green Kingfisher		1					
Chloroceryle aenea	American Pygmy-Kingfisher		1					
Momotidae								
Momotus motmot	Blue-crowned Motmot **							1
Galbulidae								
Galbula albirostris	Yellow-billed Jacamar *						1	
Bucconidae								
Chelidoptera tenebrosa	Swallow-winged Puffbird			2	1	4	3	
Ramphastidae								
Ramphastos tucanus	White-throated Toucan		2	2		1		
Ramphastos vitellinus	Channel-billed Toucan						1	
Selenidera culik	Guianan Toucanet						1	
Pteroglossus aracari	Black-necked Aracari			3			2	22
Capitonidae								
Capito niger	Black-spotted Barbet ***						2	
Furnariidae								
Xenops minutus	Plain Xenops *	1						
Synallaxis gujanensis	Plain-crowned Spintetail			4	1	4	1	
Dendrocolaptidae								
Glyphorynchus spirurus	Wedge-billed Woodcreeper	2		3			2	
Xiphorhynchus pardalotus	Chestnut-rumped woodcreeper		2	2			2	
Dendrocolaptes certhia	Amazon-barred Woodcreeper	1		1	1		2	

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Xiphorhynchus guttatus	Buff-throated Woodcreeper	2			1		1	
Picidae								
Dryocopus lineatus	Lineated Woodpecker		1			1	1	1
Campephilus rubricollis	Red-necked Woodpecker	1	1					
Celeus elegans	Chestnut Woodpecker			2				
Piculus flavigula	Yellow-throated Woodpecker	1	2					
Verniliornis spp.	Verniliornis woodpecker			1				
Melanerpes cruentatus	Yellow-tufted Woodpecker	2				2	1	
Celeus undulatus	Waved Woodpecker	1		1			3	
Thamnophilidae								
Thamnophilus murinus	Mouse-colored Antshrike			2	2			
Thamnomanes ardesiacus	Dusky-throated Antshrike	2					2	
Thamnomanes caesius	Cinereous Antshrike						2	
Cymbilaimus lineatus	Fasciated Antshrike	1						
Myrmotherula surinamensis	Guianan Streaked-Antwren				2			
Myrmotherula axillaris	White-flanked Antwren			3				
Myrmotherula brachyura	Pygmy Antwren					3		
Herpsilochmus stictocephalus	Todd's Antwren			2			2	
Myrmotherula behni	Plain-winged Antwren ***				2			
Cercomacra cinerascens	Gray Antbird			3			4	
Hypocnemis cantator	Guianan Warbling Antbird	2					4	
Cercomacra tyrannia	Dusky Antbird	2		2	2	2	2	
Sclateria naevia	Silvered Antbird					2		
Myrmeciza ferruginea	Ferruginous-backed Antbird						1	
Formicariidae								
Hylopezus macularius	Spotted Antpitta	1						
Myrmothera campanisona	Thrush-like Antpitta ***						1	
Formacarius colma	Rufous-capped Antthrush ***		1					
Formacarius analis	Black-faced Antthrush **							1
Tyrannidae								
Philohydor lictor	Lesser Kisskadee					1	2	
Myiozetetes cayanensis	Rusty-margined Flycatcher				5	2		
Tolmomyias assimilis	Zimmer's Flycathcer	2	2	2	2		2	

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Conopias parvus	Yellow-throated Flycatcher						2	
Myiarchus ferox	Short-crested Flycatcher						2	
Tyrannus melanocholicus	Tropical Kingbird				1		2	
Mionectes oleagineus	Ochre-bellied Flycatcher *					1		
Mionectes macconnelli	McConnell's Flycatcher ***			1				
Lophotriccus galeatus	Helmented Pygmy-Tyrant	2		2			1	
Myiornis ecaudatus	Short-tailed Pygmy-Tyrant						1	
Tyrannulus elatus	Yellow-crowned Tyrannulet						1	
Phaeomyias murina	Mouse-colored Tyrannulet	1						
Tityra cayana	Black-tailed Tityra	1				1		
Rhytipterna simplex	Grayish Mourner ***						1	
Cotingidae								
Lipaugus vociferans	Screaming Pha	1	3	6			2	3
Perissocephalus tricolor	Capuchin Bird ***	1	1					
Rupicola rupicola	Guianan Cock-of-the-Rock			2				2
Phoenicircus carnifex	Guianan Red-Cotinga			1				
Pipridae								
Lepidothrix suavissima	Orange-bellied Manakin			2				
Pipra erythrocephala	Golden-headed Manakin ***			2		2	2	
Pipra pipra	White-crowned Manakin				1		2	
Corapipo gutturalis	White-throated Manakin	3						
Manacus manacus	White-bearded Manakin	2		2	2	1	2	
Polioptilidae								
Ramphocaenus melanurus	Long-billed Gnatwren	1	2	2			2	
Vireonidae								
Hylophilus thoracicus	Lemon-chested Greenlet			3		2		
Hylophilus musicicapinus	Buff-cheeked Greenlet			2	2		2	
Hylophilus pectoralis	Ashy-headed Greenlet ***			1				
Hirundinidae								
Atticora fasciata	White-banded Swallow						2	2
Corvidae								
Cyanacorax cayanus	Cayenne Jay	9						
Troglotidae								

TAXON	Common name	T1	T2	T3	T4	T5	T6	Opp. Obs
Thryothorus leucotis	Buff-breasted Wren						2	
Thryothorus coraya	Coraya Wren			3				
Troglodytes aedon	Southern House-Wren					1	1	
Thraupidae								
Tangara mexicana	Turquoise Tanager						2	
Ramphocelus carbo	Silvered-beaked Tanager	5	3	10	7	12	8	
Tachyphonus cristatus	Flame-crested Tanager	2		3				
Thraupis episcopus	Blue-grey Tanager					4		
Tangara velia	Opal-rumped Tanager ***			4				2
Thraupis palmarum	Palm Tanager					2		
Dacnis cayana	Blue Dacnis			4				
Cyanerpes caeruleus	Purple Honeycreeper			4	3			
Chlorophanes spiza	Green Honeycreeper	2	4	5				
Parulidae								
Phaeothlypis rivularis	Riverside Warbler	2			1	1		
Cardinalidae								
Paroaria gularis	Red-capped Cardinal					2		
Saltator coerulescens	Grayish Saltator			2			2	
Emberizidae								
Arremon taciturnus	Pectoral Sparrow ***						2	
Sporophila castaneiventris	Chestnut-bellied Seedeater					4	3	2
Icteridae								
Psarocolius decumanus	Crested Oropendola					6	5	
Psarocolius viridis	Green Oropendola		2	1			2	
Cacicus haemorrhous	Red-rumped Cacique ***	2						
Cacicus cela	Yellow-rumped Cacique ***					3	2	
Fringillidae								
Euphonia violacea	Violaceous Euphonia				2	2	4	
Euphonia cayennensis	Golden-sided Euphonia			1				
	Number of individuals	**62**	**64**	**142**	**45**	**98**	**129**	**61**

**Birds that were recorded exclusively via mist-netting, **Birds that was recorded exclusively via Opportunistic sightings, ***New species seen in second survey phase.*

2021 WET SEASON JULY 12 – 25, 2021 (Tameka King)

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
1	Accipitridae	Plumbeous Kite	*Ictinia plumbea*							1	1
2	Accipitridae	Swallow-tailed Kite	*Elanoides forficatus*		1		2	1		1	5
3	Accipitridae	Gray-lined Hawk*	*Buteo nitidus*				1			1	2
4	Accipitridae	Roadside Hawk*	*Rupornis (Buteo) magnirostris*			1					1
5	Accipitridae	White Hawk	*Pseudastur (Leucopternis) albicollis*	2						1	3
6	Accipitridae	Barred Forest Falcon*	*Micrastur ruficollis*	1						1	2
7	Accipitridae	Great Black Hawk	*Buteogallus urubitinga*	1	1						2
8	Alcedinidae	Amazon Kingfisher	*Chloroceryle amazona*			1		1		1	3
9	Alcedinidae	Ringed Kingfisher	*Megaceryle torquata*			2			1		3
10	Alcedinidae	American Pygmy Kingfisher	*Chloroceryle aenea*				1				1
11	Apodidae	Grey-rumped Swift*	*Chaetura cinereiventris*							8	8
12	Apodidae	White-collared Swift	*Streptoprocne zonaris*							29	29
13	Apodidae	Band-rumped Swift	*Chaetura spinicaudus*					7			7
14	Bucconidae	Swallow-winged Puffbird	*Chelidoptera tenebrosa*				2			4	6
15	Bucconidae	White-necked Puffbird*	*Notharchus hyperrhynchus*	1							1
16	Bucconidae	Guianan Puffbird	*Notharchus macrorhynchos*							1	1
17	Bucconidae	Unidentified Pufbird species*	*Nonnula* spp.	1							1
18	Caprimulgidae	Blackish Nightjar*	*Nyctipolus nigrescens*				1				1
19	Cardinalidae	Amazonian Grosbeak*	*Cyanoloxia rothschildii*					1			1
20	Cardinalidae	Yellow-green Grosbeak	*Caryothraustes canadensis*				1		1		2
21	Cathartidae	King Vulture	*Sarcoramphus papa*		3					3	6
22	Cathartidae	Greater Yellow-headed Vulture	*Cathartes melambrotus*	2			3			6	11
23	Cathartidae	Lesser Yellow-headed Vulture *	*Cathartes burrovianus*		3		2				5
24	Columbidae	Ruddy Ground Dove*	*Columbina talpacoti*		1						1
25	Columbidae	Plain-breasted Ground-Dove*	*Columbina minuta*							5	5
26	Columbidae	White-tipped Dove	*Leptotila verreauxi*							2	2
27	Columbidae	Common Ground-Dove	*Columbina passerina*			4	2		4		10

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
28	Columbidae	Plumbeous Pigeon	*Patagioenas plumbea*							1	1
29	Corvidae	Cayenne Jay	*Cyanocorax cayanus*			4					4
30	Cotingidae	Guianan Cock-of-the-Rock	*Rupicola rupicola*				1				1
31	Cotingidae	Pompadour Cotinga	*Xipholena punicea*			1					1
32	Cotingidae	Guianan Red Cotinga	*Phoenicircus carnifex*				2				2
33	Cotingidae	Screaming Piha	*Lipaugus vociferans*	13	12					16	41
34	Cracidae	Spix's Guan	*Penelope jacquacu*				4	2			6
35	Cracidae	Variable Chachalaca*	*Ortalis motmot*	1					6	3	10
36	Cracidae	Black Curassow	*Crax alector*							3	3
37	Cuculidae	Little Cuckoo*	*Coccycua minuta*			1		5	1		7
38	Cuculidae	Squirrel Cuckoo	*Piaya cayana*			1	2				3
39	Cuculidae	Greater Ani	*Crotophaga major*				2		4	2	8
40	Cuculidae	Smooth-billed Ani	*Crotophaga ani*			5		6	6	4	21
41	Falconidae	Red-throated Caracara	*Ibycter americanus*		6		4				10
42	Falconidae	Bat Falcon	*Falco rufigularis*				2				2
43	Falconidae	Laughing Falcon*	*Herpetotheres cachinnans*							1	1
44	Fringillidae	Violaceous Euphonia	*Euphonia violacea*							2	2
45	Fringillidae	Orange-bellied Euphonia*	*Euphonia xanthogaster*						1		1
46	Furnariidae	Buff-throated Woodcreeper	*Xiphorhynchus guttatus*			1					1
47	Furnariidae	Cinnamon-throated Woodcreeper*	*Dendrexetastes rufigula*				1	1			2
48	Furnariidae	Wedge-billed Woodcreeper	*Glyphorynchus spirurus*		1		2				3
49	Furnariidae	Chestnut-rumped Woodcreeper	*Xiphorhynchus pardalotus*				1		1		2
50	Furnariidae	Striped Woodcreeper*	*Xiphorhynchus obsoletus*							4	4
51	Furnariidae	Plain-crowned Spinetail	*Synallaxis gujanensis*					1			1
52	Furnariidae	Unidentified Woodcreeper	*Xiphorhynchus* spp.					1			1
53	Furnariidae	Plain Xenops	*Xenops minutus*	1							1
54	Galbulidae	Paradise Jacamar	*Galbula dea*		1	1					2
55	Hirundinidae	Gray-breasted Martin	*Progne chalybea*							9	9
56	Hirundinidae	White-winged Swallow	*Tachycineta albiventer*		1					2	3
57	Hirundinidae	White-banded Swallow	*Atticora fasciata*		3						3
58	Icteridae	Green Oropendola	*Psarocolius viridis*		4						4

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
59	Icteridae	Crested Oropendola	*Psarocolius decumanus*		12	70	40	79	2		203
60	Mimidae	Tropical Mockingbird*	*Mimus gilvus*							2	2
61	Picidae	Lineated Woodpecker	*Dryocopus lineatus*			1	2				3
62	Picidae	Crimson-crested Woodpecker	*Campephilus melanoleucos*	2		3	1				6
63	Picidae	Red-necked Woodpecker	*Campephilus rubricollis*	3							3
64	Pipridae	Golden-headed Manakin	*Ceratopipra (Pipra) erythrocephala*		1	9	6				16
65	Pipridae	White-bearded Manakin	*Manacus manacus*		1	4	4	3	1		13
66	Pipridae	White-throated Manakin	*Corapipo gutturalis*			1		1		1	3
67	Pipridae	Orange-bellied Manakin	*Lepidothrix suavissima*		6						6
68	Pipridae	White-crowned Manakin	*Pseudopipra (Pipra) pipra*				1				1
69	Polioptilidae	Trilling Gnatwren	*Ramphocaenus melanurus*	1							1
70	Psittacidae	Lilac-tailed Parrotlet	*Touit batavica*							8	8
71	Psittacidae	Red-and-green Macaw	*Ara chloroptera*	2	5		12		2		21
72	Psittacidae	Orange-winged Parrot	*Amazona amazonica*				2			6	8
73	Psittacidae	Blue-headed Parrot	*Pionus menstruus*	4		1				2	7
74	Psittacidae	Dusky Parrot	*Pionus fuscus*				4				4
75	Psittacidae	Black-headed Parrot	*Pionites melanocephalus*	2							2
76	Psittacidae	Scarlet Macaw*	*Ara macao*	2							2
77	Psittacidae	Red-fan Parrot	*Deroptyus accipitrinus*	4							4
78	Rallidae	Gray-cowled Wood-rail	*Aramides cajaneus*			4					4
79	Ramphastidae	Black-necked Aracari	*Pteroglossus aracari*			3	3	7			13
80	Ramphastidae	White-throated Toucan	*Ramphastos tucanus*	5	2		3	3		4	17
81	Ramphastidae	Channel-billed Toucan	*Ramphastos vitellinus*			2	8	1			11
82	Scolopacidae	Solitary Sandpiper*	*Tringa solitaria*				1				1
83	Thamnophilidae	Ferruginous-backed Antbird	*Myrmoderus ferrugineus (Myrmeciza ferruginea)*		1						1
84	Thamnophilidae	White-plumed Antbird*	*Pithys albifrons*		1						1
85	Thamnophilidae	Scale-backed Antbird	*Willisornis (Hylophylax) poecilinotus*				1			2	3
86	Thamnophilidae	Guianan Warbling Antbird	*Hypocnemis cantator*				1			1	2
87	Thamnophilidae	Cinereous Antshrike	*Thamnomanes caesius*			1					1

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
88	Thamnophilidae	Dusky-throated Antshrike	*Thamnomanes ardesiacus*	1							1
89	Thamnophilidae	Barred Antshrike*	*Thamnophilus doliatus*			2				2	4
90	Thamnophilidae	Guianan Streaked-Antwren	*Myrmotherula surinamensis*				2				2
91	Thamnophilidae	Dusky Antbird	*Cercomacroides tyrannina (Cercomacra tyrannia)*	1	1						2
92	Thraupidae	Blue-gray Tanager	*Tangara (Thraupis) episcopus*			1	4	8			13
93	Thraupidae	Green Honeycreeper	*Chlorophanes spiza*		2						2
94	Thraupidae	Purple Honeycreeper	*Cyanerpes caeruleus*		2					4	6
95	Thraupidae	Wing-barred seedeater*	*Sporophila americana*						2		2
96	Thraupidae	Chestnut-bellied Seedeater	*Sporophila castaneiventris*				7			2	9
97	Thraupidae	Yellow-bellied Seedeater*	*Sporophila nigricollis*						1		1
98	Thraupidae	Silver-beaked Tanager	*Ramphocelus carbo*	7	47	16	30	34	6	12	152
99	Thraupidae	Opal-rumped Tanager	*Tangara velia*		10						10
100	Thraupidae	Turquoise Tanager	*Tangara mexicana*	1			10				11
101	Thraupidae	Fulvous-crested Tanager*	*Maschalethraupis surinama (Tachyphonus surinamus)*	3							3
102	Thraupidae	Bay-headed Tanager	*Tangara gyrola*	2							2
103	Thraupidae	Bananaquit	*Coereba flaveola*				4				4
104	Thraupidae	Blue-black Grassquit	*Volatinia jacarina*		1		1				2
105	Thraupidae	Red-capped Cardinal	*Paroaria gularis*					2			2
106	Thraupidae	Blue Dacnis	*Dacnis cayana*	4							4
107	Thraupidae	Palm Tanager	*Thraupis (Tangara) palmarum*							2	2
108	Threskiornithidae	Green Ibis	*Mesembrinibis cayennensis*			3					3
109	Tinamidae	Variegated Tinamou	*Crypturellus variegatus*							8	8
110	Tityridae	Amazonian Royal-Flycatcher	*Onychorhynchus coronatus*			3					3
111	Trochilidae	Gray-breasted Sabrewing	*Campylopterus largipennis*			3	1	1		1	6
112	Trochilidae	Eastern Long-tailed Hermit	*Phaethornis superciliosus*	4	5	1	2			1	13
113	Trochilidae	Grey-chinned Hermit*	*Phaethornis griseogularis*	1			1				2

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
114	Trochilidae	White-chested Emerald*	*Chrysuronia brevirostris*	1							1
115	Trochilidae	Reddish Hermit	*Phaethornis ruber*	2	2		2				6
116	Trochilidae	Rufous-breasted Hermit	*Glaucis hirsutus*					1		1	2
117	Trochilidae	White-tailed Goldenthroat*	*Polytmus guainumbi*	1							1
118	Trochilidae	Green-tailed Goldenthroat*	*Polytmus theresiae*						1		1
119	Trochilidae	Pale-tailed Barbthroat	*Threnetes leucurus*			2		1			3
120	Trochilidae	Blue-chinned Sapphire*	*Chlorostilbon (Chlorestes) notata*					2			2
121	Trochilidae	Blue-tailed Emerald*	*Chlorostilbon mellisugus*			1					1
122	Troglodytidae	House Wren	*Troglodytes aedon*	1				2		4	7
123	Trogonidae	Black-tailed Trogon	*Trogon melanurus*							2	2
124	Turdidae	White-necked Thrush*	*Turdus albicollis*	1							1
125	Turdidae	Black-billed Thrush*	*Turdus ignobilis*	1							1
126	Turdidae	Unidentified Turdus species*	*Turdus* spp.						1		1
127	Turdidae	Spectacled Thrush*	*Turdus nudigenis*				1				1
128	Tyrannidae	Great Kiskadee*	*Pitangus sulphuratus*	2				1		3	6
129	Tyrannidae	Lesser Kiskadee	*Philohydor lictor*			3	4	1			8
130	Tyrannidae	Rusty-margined Flycatcher	*Myiozetetes cayanensis*			2	4		3		9
131	Tyrannidae	Sulphury Flycatcher*	*Tyrannopsis sulphurea*							2	2
132	Tyrannidae	Swainson's Flycatcher*	*Myiarchus swainsoni*			1					1
133	Tyrannidae	Common Tody-Flycatcher	*Todirostrum cinereum*						1		1
134	Tyrannidae	Ochre-bellied Flycatcher	*Mionectes oleagineus*	1	2		1				4
135	Tyrannidae	Short-crested Flycatcher	*Myiarchus ferox*							1	1
136	Tyrannidae	Tropical Kingbird	*Tyrannus melancholicus*			4	2	1			7
137	Tyrannidae	Yellow-throated Flycatcher	*Conopias parvus*				4				4
138	Tyrannidae	Helmeted Pygmy Tyrant	*Lophotriccus galeatus*		1	1					2
139	Tyrannidae	Short-tailed Pygmy-Tyrant	*Myiornis ecaudatus*							1	1
140	Tyrannidae	Boat-billed Flycatcher*	*Megarynchus pitangua*						1		1
141	Tyrannidae	Forest Elaenia*	*Myiopagis gaimardii*					1			1
142	Tyrannidae	Yellow-bellied Elaenia	*Elaenia flavogaster*				1				1
143	Tyrannidae	Yellow-crowned Tyrannulet	*Tyrannulus elatus*				1				1
144	Vireonidae	Lemon-chested Greenlet	*Hylophilus thoracicus*					1			1
145	Vireonidae	Ashy-headed Greenlet	*Hylophilus pectoralis*					1		1	2

TAXA				Area of Study-SGI-EM						Opp. Obs.	Total
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6		
			Number of Individuals	**82**	**139**	**164**	**207**	**177**	**46**	**184**	**999**
			Number of Species	**35**	**30**	**36**	**53**	**30**	**20**	**49**	**145**

2021 DRY SEASON OCTOBER 04 – 16, 2021 (Paulette Torres and Anita Ramlochan)

	Taxa			Area of Study-SGI-EM							
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6	Opp. Obs.	Total
1	Accipitridae	Roadside Hawk	*Rupornis (Buteo) magnirostris*	1	1	1		1		2	6
2	Accipitridae	Plumbeous Kite	*Ictinia plumbea*					1	1	2	4
3	Accipitridae	Swallow-tailed Kite	*Elanoides forficatus*	1						1	2
4	Accipitridae	White Hawk	*Pseudastur (Leucopternis) albicollis*	1						1	2
5	Accipitridae	Common-black Hawk	*Buteogallus anthracinus*		1					1	2
6	Alcedinidae	Amazon Kingfisher	*Chloroceryle amazona*			1				1	2
7	Alcedinidae	Green Kingfisher	*Chloroceryle americana*			1				1	2
8	Alcedinidae	American Pygmy-Kingfisher	*Chloroceryle aenea*			1				1	2
9	Apodidae	Lesser- Swallow-tailed Swift	*Panyptila cayennensis*		6			6	8	10	30
10	Bucconidae	Black Nunbird	*Monasa atra*			1					1
11	Cathartidae	King Vulture	*Sarcoramphus papa*	10						8	18
12	Cathartidae	Greater Yellow-headed Vulture	*Cathartes melambrotus*	10						10	20
13	Cathartidae	Lesser Yellow-headed Vulture	*Cathartes burrovianus*	10						10	20
14	Columbidae	Plumbeous Pigeon	*Patagioenas plumbea*	1	2					2	5
15	Columbidae	Common Ground-Dove	*Columbina passerina*			2		2	2	2	8
16	Columbidae	Ruddy Ground Dove	*Columbina talpacoti*			2				4	6
17	Columbidae	White-tipped Dove	*Leptotila verreauxi*			1				1	2
18	Corvidae	Cayenne Jay	*Cyanacorax cayanus*			2				2	4
19	Cotingidae	Screaming Piha	*Lipaugus vociferans*		2	2	2	2	2	12	22
20	Cotingidae	Purple-throated Fruitcrow	*Querula purpurata*			2		2		2	6

#	Taxa			Area of Study-SGI-EM							
	Family	**Common Name**	**Scientific Name**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Opp. Obs.**	**Total**
21	Cotingidae	Guianan Cock-of-the-Rock	*Rupicola rupicola*	1						1	2
22	Cotingidae	Guianan Red-Cotinga	*Phoenicircus carnifex*	1						1	2
23	Cracidae	Black Curassow	*Crax alector*	2						2	4
24	Cracidae	Spix's Guan	*Penelope jacquacu*	2		2				2	6
25	Cracidae	Variable Chachalaca	*Ortalis motmot*				4			4	8
26	Cuculidae	Squirrel Cuckoo	*Piaya cayana*	1	1	1	1	1		2	7
27	Cuculidae	Greater Ani	*Crotophaga major*			5	4	4		5	18
28	Falconidae	Red-throated Caracara	*Ibycter americanus*	8	2	2	2	2		6	22
29	Falconidae	Bat Falcon	*Falco rufigularis*			1	1	1	1	3	7
30	Furnariidae	Olivaceous Woodcreeper	*Sittasomus griseicapillus*				1				1
31	Furnariidae	Straight-billed Woodcreeper	*Xiphorhynchus picus*	1							1
32	Furnariidae	Wedge-billed Woodcreeper	*Glyphorynchus spirurus*	8	1		1	1			11
33	Galbulidae	Paradise Jacamar	*Galbula dea*			1				1	2
34	Hirundinidae	Barn Swallow	*Hirundo rustica*	8	12	5	6	10	10	22	73
35	Icteridae	Crested Oropendola	*Psarocolius decumanus*	6	4	2	8	2			22
36	Icteridae	Green Oropendola	*Psarocolius viridis*	4	40			6		40	90
37	Icteridae	Yellow-rumped Cacique	*Cacicus cela*			5	6	6	2	5	22
38	Icteridae	Yellow Oriole	*Icterus nigrogularis*			1		2		2	5
39	Picidae	Lineated Woodpecker	*Dryocopus lineatus*	1		4	3	2		6	16
40	Picidae	Crimson-crested Woodpecker	*Campephilus melanoleucos*	2						2	4
41	Picidae	Red-necked Woodpecker	*Campephilus rubricollis*	2	2	2	1			5	12
42	Picidae	Chestnut Woodpecker	*Celeus elegans*	2						2	4
43	Pipridae	Orange-bellied Manakin	*Lepidothrix suavissima*	5	4	2					11
44	Pipridae	White-crowned Manakin	*Pseudopipra (Pipra) pipra*			1					1
45	Pipridae	White-bearded Manakin	*Manacus manacus*		1			2	1		4
46	Pipridae	Golden-headed Manakin	*Ceratopipra (Pipra) erythrocephala*	1		2					3
47	Psittacidae	Red-and-Green Macaw	*Ara chloropterus*	8	6	2	2	2	2	2	24
48	Psittacidae	Blue-headed Parrot	*Pionus menstruus*	4	5	2	2	2		4	19
49	Psittacidae	Red-fan Parrot	*Deroptyus accipitrinus*	2				2		2	6

#	Taxa			Area of Study-SGI-EM							
	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6	Opp. Obs.	Total
50	Psittacidae	Blue and yellow Macaw	*Ara ararauna*	8						8	16
51	Psittacidae	Mealy Parrot	*Amazona farinosa*	2	3		2			2	9
52	Psittacidae	Brown-throated Parakeet	*Aratinga pertinax*	10	12	4	4	6	5	10	51
53	Psittacidae	Scarlet Macaw	*Ara macao*	2							2
54	Psittacidae	Painted Parakeet	*Pyrrhura picta*		6			6		6	18
55	Rallidae	Rufous-necked wood-rail	*Aramides axillaries*		2				2	2	6
56	Ramphastidae	White-throated Toucan	*Ramphastos tucanus*	4	6	4	4	4	2		24
57	Ramphastidae	Channel-billed Toucan	*Ramphastos vitellinus*	6	4	1	2	2	2	2	19
58	Ramphastidae	Black-necked Aracari	*Pteroglossus aracari*			6	2			6	14
59	Ramphastidae	Green Aracari	*Pteroglossus viridis*		2	4	2			4	12
60	Tinamidae	Great Tinamou	*Tinamus major*						1		1
61	Thamnophilidae	Mouse-colored Antshrike	*Thamnophilus murinus*	1	1	1			1	4	8
62	Thamnophilidae	Cinereous Antshrike	*Thamnomanes caesius*	1							1
63	Thamnophilidae	Gray Antwren	*Myrmotherula menetriesii*	4	2						6
64	Thamnophilidae	Rufous-throated Antbird	*Gymnopithys rufigula*	1							1
65	Thamnophilidae	Guianan Warbling Antbird	*Hypocnemis cantator*	1					1		2
66	Thamnophilidae	Dusky Antbird	*Cercomacra tyrannia*			1					1
67	Thraupidae	Silvered-beaked Tanager	*Ramphocelus carbo*	6	27	10	14	6	18		81
68	Thraupidae	Blue-grey Tanager	*Tangara (Thraupis) episcopus*			4		4		4	12
69	Thraupidae	Opal-rumped Tanager	*Tangara velia*		2						2
70	Thraupidae	Fulvous-crested Tanager	*Maschalethraupis surinama (Tachyphonus surinamus)*		1				2		3
71	Thraupidae	Red-capped Cardinal	*Paroaria gularis*			2				2	4
72	Thraupidae	White-shouldered Tanager	*Tachyphonus luctuosus*		2					2	4
73	Trochilidae	Eastern Long-tailed Hermit	*Phaethornis superciliosus*		2						2
74	Trochilidae	Straight-billed Hermit	*Phaethornis bourcieri*	2							2
75	Trochilidae	Rufous-breasted Hermit	*Glaucis hirsutus*	2							2
76	Trochilidae	Reddish Hermit	*Phaethornis ruber*			1	1	1			3
77	Trochilidae	Gray-breasted Sabre-wing	*Campylopterus largipennis*		1		1				2
78	Trochilidae	Sooty-capped Hermit	*Phaethornis augusti*				1				1

	Taxa			Area of Study-SGI-EM							
#	Family	Common Name	Scientific Name	T1	T2	T3	T4	T5	T6	Opp. Obs.	Total
79	Tyrannidae	Lesser Kisskadee	*Philohydor lictor*	4	6	4	4	4	4		26
80	Tyrannidae	Yellow-margined Flycatcher	*Tolmomyias assimilis*			4			4		8
81	Tyrannidae	Yellow-throated Flycatcher	*Conopias parvus*	4	4	4	4	4	4		24
82	Tyrannidae	Ochre-bellied Flycatcher	*Mionectes oleagineus*	1	1	2		1			5
			Total Number of Individuals	**162**	**174**	**108**	**85**	**97**	**75**	**346**	**943**
			Total Number of Species	**44**	**34**	**43**	**27**	**31**	**21**	**52**	**82**

Opp. obs. – Opportunistic observations

APPENDIX C: PHOTOGRAPHS OF METHODOLOGY AND FLORA AND FAUNA

Area previously disturbed by mining

Secondary growth forest in area previously disturbed by small-scale gold mining

Area of mature forest disturbed by ongoing exploration drilling activities

Use of butterfly net

Use of white light to traps insects

Pit fall trap with drift fence

Leaf-litter sampling for small animals

Hook and line fishing

Dip-netting for aquatic invertebrates and fish

Mist net set in understorey to catch bats

Weighing a captured bat in cloth bag

Anablepsoides (Rivulus) waimacui

Lebiasina aff. uruyensis (captured 2013)

Deuterodon potaroensis

Lebiasina aff. uruyensis (captured 2021)

Aequiden potaroensis

Lebiasina spp.1 (captured 2013)

Stefania evansi

Stefania woodleyi with offspring

Anamoglossus praderioi

Anomologlossus kaiei

Erythrolamprus breviceps

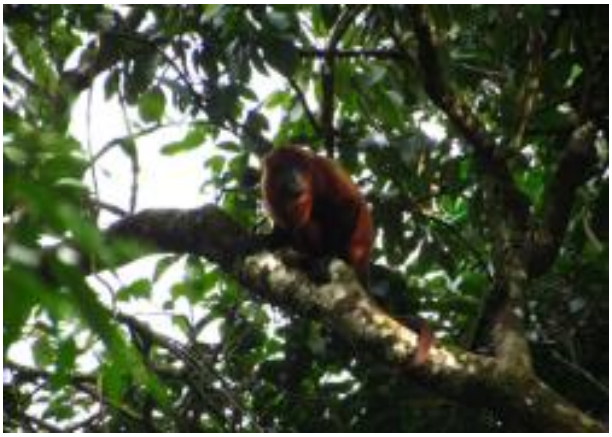
Tantilla melanocephala

Corallus hortulanus

Paleosuchus palpebrosus

Paleosuchus trigonatus

Track from adult Jaguar *Panthera onca*



Red howler monkey *Alouatta macconnellii*

Cameratrap photo of Ocelot *Leopardus pardalis*

Cormura brevirostris

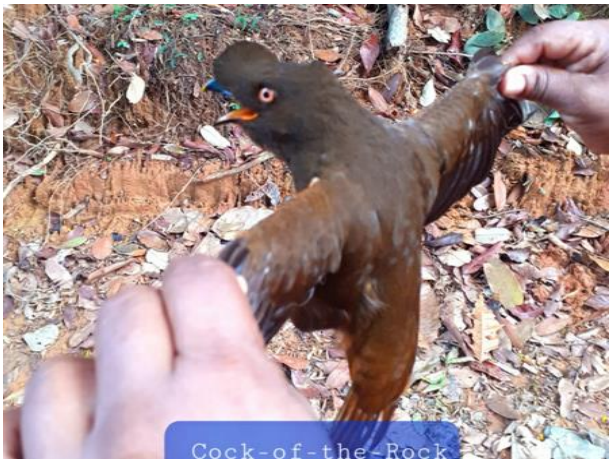
Carollia brevicauda

Molossus molossus

Artibeus lituratus

Tracks of *Hydrochaeris hydrochaeris*

Oecomys bicolor captured in Sherman trap



Guianan cock-of-the-rock (*Rupicola rupicola*)

Guianan warbling antbird (*Hypocnemis cantator*)

NATURE METRICS
DNA-BASED MONITORING

Thank you for choosing NatureMetrics

Please read the following information to help you understand the data in this file. For more information on how to interpret your results please see our Report Interpretation Guide. This file contains four tables: Species Data Table Percentages, Species Data Table Read Counts, Metrics by Sample Table, Quality Control Table

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Species Data Table Percentages

This table provides a list of all the species detected in each of your samples. Where a species was detected in a sample, the percentage of DNA sequences assigned to that species is provided. A dash indicates that the species was not detected in the sample. Additionally, for each species the following is included:

- The OTU DNA sequence
- The taxonomic identification: Kingdom, Phylum, Class, Order, Family, Genus, Species
- The Common Name*
- CHEGD Fungal Group
- IUCN Red List Threat Status^
- Invasive status: A Yes/No status indicating whether the species is listed as invasive in the country the sample was taken from**
- Target Status: Our tests are targeted to detect certain groups of species, but species outside these

* Only available for species named at the species level. Provided for vertebrates, fish and mammals.
** Only available for species named at the species level. Not available for bacteria, eukaryotes and fungi.

Fauna Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

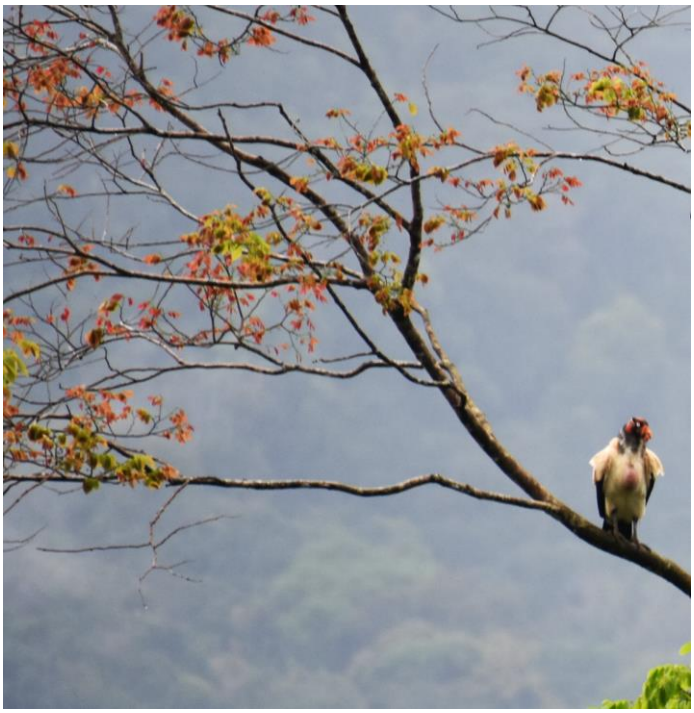

PHOTO 1
King Vulture *Sarcoramphus papa*

PHOTO 2
Squirrel Cuckoo *Piaya cayana*

Fauna Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

PHOTO 3
South American Common Toad *Rhinella margaritifera cf*

PHOTO 4
Knudsen's Thin-Toed Frog *Leptodactylus knudseni* (juvenile individual)

PHOTO 5
White Lipped Thin-Toed Frog *Leptodactylus mystaceus*

PHOTO 6
Woodley's Stefania *Stefania woodleyi*. This individual was recorded from the eastern portion of the project site. This species is endemic to eastern Guyana.

PHOTO 7
This Stefania woodleyi was recorded at the fast-flowing creek closest to camp, where the species would have been recorded in earlier surveys. The past observations of the species at this site included reproductive behavior, with the juveniles being carried on the back of females.

PHOTO 8
Cane Toad *Rhinella marina*

PHOTO 9

Arrabal's Suriname toad *Pipa arrabali* recorded from the eastern project site. This species lacks a free-swimming tadpole. The eggs develop into juvenile frogs in the dermal pockets of the female.

PHOTO 10

Giant Ameiva *Ameiva ameiva*

Fauna Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

PHOTO 11

Cuvier's Dwarf Caiman *Paleosuchus palpebrosus*

Flora Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

PHOTO 1
Trail showing signs of regeneration.

PHOTO 2
Mora excelsa with *Clusia grandiflora.*

Flora Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

PHOTO 3
Parinari campestris seed

PHOTO 4
Licania guianensis seeds

Flora Photographic Log

CLIENT: Mako Mining Corporation	SITE LOCATION: Eagle Mountain, Region 8	PROJECT NO.: 0763224

PHOTO 5
Chlorocardium rodiei

PHOTO 6
Clusia grandiflora seedling

PHOTO 7
Clusia grandiflora flower

PHOTO 8
Mora excelsa

PHOTO 9
Chlorocardium rodiei seed

PHOTO 10
Pityrogramma spp.

PHOTO 11
Pentaclethra macroloba seed pod

PHOTO 12
Heliconia bihai

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SPECIES LIST

FLORA

Common Name	Scientific Name	Family Name	IUCN Rankings	CITES Status
Adebero	*Paypayrola longifolia*	Violaceae	LC	Not Listed
Ants bush	*Cordia nodosa*	Boraginaceae	LC	Not Listed
Arara broad leaf	*Unonopsis spp.*	Annonaceae	LC	Not Listed
Batrics palms	*Bactris oligoclada*	Palmae	NE	Not Listed
Bird seed grass	*Echinochola colona*	Poaceae	NE	Not Listed
Bisi-bisi-grass	*Cyperus ligularis L.*	Poaceae	NE	Not Listed
Black Kakaralli*	*Eshweilera sagotiana*	Lecythidaceae	NE	Not Listed
Black Yari Yari	*Guatteria punctata*	Annonaceae	NE	Not Listed
Blood wood	*Vismia guianemsis*	Guttiferae	NE	Not listed
Buba	*Socratea exorrhiza*	Palmae	LC	Not Listed
Burada*	*Parinari campestris*	Chrysobalanaceae	LC	Not Listed
Buru buru	*Solanum subinerme*	Solanaceae	LC	Not Listed
Climbing Furn	*Lygodium microphyllum*	Schizaeaceae	LC	Not Listed
Clump Wallaba	*Dicymbe corymbosa*	Caesalpionoiceae	LC	Not Listed
Coffee mortar*	*Terminalia dichotama*	Combretaceae	LC	Not Listed
Common Baromalli*	*Catostemma commune*	Bombacaceae	LC	Not Listed
Conga Pong/Cecropia	*Cecropia angulata*	Cecropiaceae	NE	Not Listed
Dalli hill*	*Virola sebifera*	Myristicaceae	LC	Not Listed
Dandelion	*Erechtites hieracifolia*	Compositae	NE	Not Listed
Dog stone	*Tabenaemontana undulata*	Apocynaceae	LC	Not Listed

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Common Name	Scientific Name	Family Name	IUCN Rankings	CITES Status
Dove weed	*Murdannia nudiflora*	Commelinaceae	NE	Not Listed
Face to the east	*Philodendron scandens*	Araceae	NE	Not Listed
Fern	*Pityrogramma spp.*	Adiantiaceae	LC	Not listed
Foxtail	*Andropogon bicornis*	Poaceae	NE	Not Listed
Fukadi*	*Terminalia amazonia*	Combretaceae	LC	Not listed
Futi*	*Jacaranda copaia*	Bignoniaceae	LC	Not Listed
Greenheart*	*Chlorocardium rodiei*	Lauraceae	DD	Not Listed
Hold-me-back	*Desmoncus orthacanthos*	Areacaceae	NE	Not Listed
Iron Mary	*Chaetocarpus schomburgkianus*	Euphorbiaceae	LC	Not Listed
Iron weed	*Vernonia spp.*	Asteraceae	NE	Not Listed
Jamun	*Syzygium cumini*	Myrtaceae	LC	Not Listed
Kabukalli*	*Goupia glabra*	Celastraceae	LC	Not Listed
Kauta*	*Licania guianensis*	Chrysobalanaceae	LC	Not Listed
Komaramara	*Duroia eriopila l.f. var. eriopila*	Rubiaceae	NE	Not Listed
Kufa	*Clusia grandiflora*	Clusiaceae	LC	Not Listed
Kurokai*	*Protium heptaphyllum*	Burseraceae	LC	Not Listed
Macaw-flower	*Heliconia bihai*	Heliconiaceae	NE	Not Listed
Mokru	*Ischnosiphon arouma*	Marantaceae	NE	Not Listed
Monkey Ladder	*Bauhinia scala-simiae*	Leguminosae-caesalp	LC	Not Listed
Mora*	*Mora excelsa*	Caesalpiniaceae	LC	Not Listed
Morabukea*	*Mora gongrijpii*	Caesalpionoiceae	LC	Not Listed
Nibi	*Heteropsis flexuosa*	Areacaceae	LC	Not Listed
Parakasana	*Swartzia schomburgkii*	Leguminosae-papil	LC	Not Listed

Common Name	Scientific Name	Family Name	IUCN Rankings	CITES Status
Purpleheart*	*Peltogyne venosa*	Leguminosae-caesalp	NE	Not listed
Silk Cotton	*Ceiba spp.*	Malvaceae	NE	Not listed
Soft Wallaba*	*Eperua falcatae*	Caesalpionoiceae	NE	Not listed
Soldier's cap	*Psychotria poeppigiana*	Rubiaceae	NE	Not Listed
Sour grass	*Paspalum conjugatum*	Poaceae	NE	Not Listed
Striker	*Scleria microcarpa*	Cyperaceae	NE	Not Listed
Swamp Flatseddge	*Cyperus ligularis*	Cyperaceae	NE	Not Listed
Trysil	*Pentaclethra macroloba*	Leguminosae-Mimos	LC	Not Listed
Turu	*Jessenia bataua*	Arecaceae	NE	Not listed
Understorey palm	*Bactris spp*	Areacaceae	NE	Not Listed
Warakosa	*Inga thibaudiana*	Leguminosae - Mimos	LC	Not listed
White seed	*Bactris oligoclada*	Palmae	LC	Not Listed
White Yari Yari	*Duguetia pauciflora*	Annonaceae	LC	Not Listed
Wild Guava	*Myrcaria ibibianaro*	Myrtaceae	NE	Not listed
Yarula	*Swartzia jenmani*	Apocynaceae	LC	Not Listed

FAUNA

AMPHIBIANS

Family	Species	Common Name	IUCN Status
BUFONIDAE	*Rhinella marina*	Cane Toad	Least Concern
	Rhinella margaritifera cf	South American Common Toad	Least Concern
HYLIDAE	*Scinax ruber*	Red-Eyed Snouted Treefrog	Least Concern
	Boana boans	Gladiator Treefrog	Least Concern
	Boana crepitans	Emerald Eyed Treefrog	Least Concern

Family	Species	Common Name	IUCN Status
	Osteocephalus oophagus	Oophagus Slender-Legged Treefrog	Least Concern
	Dendropsophus minutus	Lesser Treefrog	Least Concern
	Dendropsophus marmoratus	Marbled Treefrog	Least Concern
PIPIDAE	*Pipa arrabali*	Arrabal's Suriname toad	Least Concern
LEPTODACTYLIDAE	*Leptodactylus knudseni*	Knudsen's Thin-Toed Frog	Least Concern
	Leptodactylus mystaceus	White-Lipped Thin-Toed Frog	Least Concern
HEMIPHRACTIDAE	Stefania woodleyi	Stefania's Woodleyi	Data Deficient, Endemic to Guyana
AROMOBATIDAE	*Anomalglossus sp*		

REPTILES

Family	Species	Common Name	IUCN Status
ALLIGATORIDAE	*Paleosuchus palpebrosus*	Cuvier's Dwarf Caiman	Least Concern
TEIIDAE	*Ameiva ameiva*	Giant Ameiva	Least Concern
GEKKONIDAE	*Thecadactylus rapicauda*	Turnip-tailed Gecko	Least Concern
GYMNOPHTHALIMIDAE	*Lepasoma sp*		
	Neusticurus rudis	Red Neusticurus	Least Concern
VIPERIDAE	*Bothrops atrox*	Common Lancehead	Least Concern
COLUBRIDAE	*Chironius fuscus*	Brown Sipo	Least Concern

BIRDS

Family	Species	Common Name	IUCN Status
CATHARTIDAE	*Sarcoramphus papa*	King Vulture	Least Concern
	Cathartes melambrotus	Greater- Yellow headed Vulture	Least Concern
CRACIDAE	*Crax alector*	Black Currasow	Least Concern
THRAUPIDAE	*Thraupis episcopus*	Blue-Gray tanager	Least Concern
	Rhamphocelus carbo	Silver-Beaked Tanager	Least Concern
FALCONIDAE	*Ibycter americanus*	Red-throated Caracara	Least Concern
TROGLODYTIDAE	*Cyphorhinus arada*	Musician Wren	Least Concern
		Ruddy Ground Dove	Least Concern
COLUMBIDAE	*Celeus elegans*	Chestnut Woodpecker	Least Concern
CUCULIDAE	*Piaya cayana*	Squirrel Cuckoo	Least Concern
PSITTACIDAE	*Ara ararauna*	Blue and Yellow Macaw	Least Concern
RHAMPHASTIDAE	*Ramphastos tucanus*	White-throated Toucan	Least Concern
TYRANNIDAE	*Pitangus sulphuratus*	Great Kiskadee	Least Concern

SOCIAL

Eagle Mountain Gold Project, Guyana

Environmental Impact Assessment Report: Appendix F - Social Baseline

PREPARED FOR
Stronghold Guyana Inc.
(subsidiary of Mako Mining Corp.)

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1. SOCIOECONOMIC BASELINE

1.1 INTRODUCTION

This section describes the socioeconomic baseline conditions for the Project, sets out the relevant criteria, describes the methodology for the baseline survey, and summarises the socio-economic survey data.

This chapter includes information related to governance, demographics, education, employment, livelihoods, community health, land use, Indigenous (Amerindian) peoples, and ecosystems services, as well as other related topics, at the country level to supplement the information provided in the Social Baseline of the EIA.

1.2 DATA SOURCES

Data sources include a combination of primary data collected through fieldwork in 2025 and secondary data, including census data[1], recent media sources, and published academic and/or research data where available.

1.2.1 EXISTING SOCIOECONOMIC CONDITIONS IN GUYANA

1.2.1.1 GOVERNANCE

Guyana has a semi-presidential parliamentary style government with a constitution and multi-party system. The President is the Head of State and elected by popular vote; the Prime Minister is the Head of Government and is appointed by the President. The National Assembly is the single legislative chamber (United Nations, Undated). There are two primary political parties - the People's National Congress (PNC) and the People's Progressive Party (PPP) - with the PPP currently in power under President Irfaan Ali.

Guyana is divided into ten administrative regions, which are overseen by Regional Democratic Councils (RDCs). These are led by a Regional Chairperson who is elected every five years. These regions are further subdivided into 70 Neighbourhood Democratic Councils (NDCs) and nine town councils (TCs). Within the regions, there is a mixture of community development councils (CDCs) for some villages, and village councils (VCs) for titled Amerindian villages (Guyana Country Profile 2017).

Georgetown is the capital city of Guyana, with nine other townships (or municipalities) (GLSC, Undated). In 2015, three of these townships were gazetted[2] as new townships by the Ministry of Communities as part of an administrative decentralisation effort. Decentralisation continued in 2018 when Mahdia (in Region 8 and in the Social AoI) was gazetted as a township. Georgetown, like other townships, is administered by a Mayor and City Council. Georgetown and the nine townships serve as an administrative hub for government services. They also provide utilities and public services, such as water, sanitation, and banking (Commonwealth Governance, 2024).

[1] Preliminary results for the 2022 Guyana Population and Housing Census are now available, however full and final datasets have not yet been released. As such, this report uses 2022 data where possible, and in cases where detailed information is not yet published, the 2012 census figures are used as substitutes and may therefore be considered outdated.
[2] To announce or publish information in an official gazette.

1.2.1.2 POPULATION

The estimated population density of Guyana is 4.09 people per square kilometre (km^2), or approximately 11 people per square mile (mi^2). Most of the country's population is concentrated in the coastland areas, which cover about 4 percent of the total land area and about 90 percent of the country's population. Georgetown has a population density of 155.81 people per km^2, compared with the six coastal regions (which have a combined population density of 9.6 people per km^2). The four interior regions[3] (Regions 1, 7, 8 and 9) have a combined population density of less than one person per km^2 (IDB 2016). Table 1.1 summarises the distribution of population across the 10 regions.

TABLE 1.1 REGIONAL POPULATION DISTRIBUTION IN GUYANA

Region		Population 2012	Population 2022	% change	% of total population
1	Barima Waini	27,643	38,956	40.93%	4.43%
2	Pomeroon–Supenaam	46,810	56,469	20.63%	6.43%
3	Essequibo Islands-West Demerara	107,785	143,884	33.49%	16.38%
4	Demerara Mahaica	311,563	347,759	11.62%	39.58%
5	Mahaica-Berbice	49,820	57,667	15.75%	6.56%
6	East Berbice-Corentyne	109,652	114,574	4.49%	13.04%
7	Cuyuni-Mazaruni	18,375	30,324	65.03%	3.45%
8	Potaro-Siparuni	11,077	13,598	22.76%	1.55%
9	Upper Takutu-Upper Essequibo	24,238	29,944	23.54%	3.41%
10	Upper Demerara-Berbice	39,992	45,499	13.77%	5.18%
	Guyana	**746,955**	**878,674**	**17.63%**	**100.00%**

Sources: BSG 2012, 2022

Note: Each region's change in population should be weighted based on that region's percent of the total population; therefore, the sum of percentage population changes in each region do not add up to the total national percentage population change.

Approximately half of Guyanese people in the world live outside Guyana's borders due to steady emigration from the country since the 1970s, and an estimated 30,000 people emigrate from Guyana annually, one of the highest emigration rates in the world (Matera et al. 2020). Also known as the Guyana diaspora, the emigrating populations mostly go to the United States, Canada, and the United Kingdom, although Venezuela, France, South Africa, Suriname, and others also have notable Guyanese populations. The consistent nature of emigration from Guyana has implications for the country's functioning, as many departing Guyanese are educated and skilled. However, with the anticipation of significant economic and social transformation due to the recent oil and gas activity, the country is hopeful it will attract—and keep—its population. Retention of Guyanese people who would otherwise emigrate is expected

[3] Referred to as areas outside the coastal plain. These areas are remote areas, difficult to reach by road, and in many cases, only accessible by boat.

to have positive implications for population growth and overall socioeconomic development in the country (Matera et al. 2020).

1.2.1.3 EDUCATION

Education in Guyana is governed by constitutional provisions that mandate compulsory school attendance up to the age of 15. Both primary and secondary education are provided free of charge, with oversight and administration managed by the Ministry of Education. The country is divided into 11 education districts—10 aligned with administrative regions and one dedicated to Georgetown. Historically, education has been a priority in national budgeting, consistently receiving approximately 15 percent of the total annual budget. Notable allocations include GYD $74.4 billion in 2022 (USD $356 million), GYD $105 billion in 2023 (USD $502 million), GYD $135.2 billion in 2024 (USD $645 million), and GYD $100 billion in 2025 (USD $478.9 million), reflecting sustained investment in infrastructure, programs, and sectoral development (Ministry of Education, 2024; DPI, 2025).

Despite progress toward universal primary education, challenges persist in access and quality, particularly at the secondary level. Census data from 2012 revealed that most adults had not advanced beyond secondary education, with only 24.9 percent of the working-age population attaining that level (BSG, 2021). Secondary school attendance was estimated at 84.5 percent in 2014 (World Bank, 2016), yet over half of the population had only completed primary education or had limited formal schooling.

The adult literacy rate (defined as the percent of population age 15 and above that can read and write) increased by 2.5 percent between the 2002 and 2012 censuses. During that timeframe, most regions showed a minor improvement in literacy rates. Gender differences in literacy are minimal among the regions, with the female population showing a slightly higher rate of literacy than males across the country as a whole.

Indigenous communities face distinct educational barriers when compared to non-Indigenous groups. Primary school attendance among Amerindian populations is relatively higher than secondary school attendance (Garnett, 2021). Data from UNICEF Multiple Indicator Cluster Survey (MICS) show that approximately 69.9 percent of children in the interior regions (predominantly populated by Indigenous communities) complete primary education, while only about 53 percent of students in Indigenous communities complete secondary school (UNICEF 2017; UNICEF, 2023). Contributing factors include inadequate infrastructure, limited access to utilities, a shortage of qualified teachers, financial constraints, and curricula misaligned with Indigenous cultural values (Ministry of Education, 2014; UNICEF 2017). In response, the government has planned to implement targeted interventions such as smart classrooms, internet access, remote teacher training, and pilot programs in Indigenous languages (DPI, 2021; Newsroom, 2021).

In addition to initiatives to promote education among Indigenous peoples in Guyana, the country has a number of regulatory undertakings aimed at improving inclusivity in the education system, including disability, gender, rural location, and poverty. In the 2010 Persons with Disabilities Act, the 2014 Education Bill, and the 2014–2018 education sector plan, promoting inclusivity for people with disabilities centred around providing substantive and high-quality special education in an unrestrictive and enabling environment (UNESCO, 2021). Gender, location, and poverty disparities have been similarly addressed at the regulatory levels. The National Policy on Women 2006, the 2014 Education Bill, and the 2008–2013 Education Strategic Plan all focus on reducing gender stereotyping in education material and

offering males and females the same access to teacher training programs (UNESCO, 2021). Specifically, the 2014 Education Bill and the 2014–2018 Education Sector Plan allow for flexible schooling options, such as remote learning, for students in remote or sparsely populated areas. The latter is also significant for minimising absenteeism due to rainy seasons, low water levels that prevents travel by boat, and times when students must stay home to help harvest crops (UNESCO, 2021). Additionally, poverty, which is often linked to rural living, was addressed in the 2014–2018 Education Sector Plan by aiming to reduce the costs of education for poor families to enable them to keep their children in school. The Ministry of Education offered measures, including providing free textbooks and uniforms and implementing school feeding programs, as a way to alleviate the financial stressors of education (UNESCO, 2021).

1.2.2 ECONOMIC

1.2.2.1 ECONOMIC OVERVIEW

Guyana was reclassified by the World Bank from a lower middle-income country to an upper middle-income country in 2016 (World Bank 2016), was promoted to a high-income country in 2023, and continues to hold that status (World Bank 2024a). However, there are inconsistencies in the distribution of income among the population, often linked to race-based and class-based disparities (Constantine 2023). Guyana's high poverty rate reflects challenges faced in meeting basic needs. World Bank data indicates Guyana's Gini coefficient, a measure of income inequality, has ranged between 0.45 to 0.5 since 1998, where a score of 0 indicates perfect equality (World Bank 2020), indicating consistently unequal distribution of wealth. High levels of income inequality are rooted in systemic issues related to inadequate infrastructure, educational inequalities, and uneven development across regions. Urban areas experience higher levels of economic activities and better services than rural and interior regions, as well as people in remote areas often struggle with fewer economic opportunities and lower standard of living.

Guyana's gross domestic product (GDP) growth rate (year-on-year) marked 43.5 percent in 2020, 20.1 percent in 2021, 63.4 percent in 2022, and 33.0 percent in 2023 (World Bank 2024b). Most of this growth is attributed to oil exports, although the non-oil GDP also expanded by 11.7 percent over the prior year (Bank of Guyana 2024). The growth in non-oil GDP was attributed to the increased output in all the major sectors, especially construction (26.8 percent), manufacturing (25.0 percent), services (10.3 percent), and agriculture (7.0 percent) (Bank of Guyana 2024).

Guyana's main sectors by contribution to GDP from 2021 to 2024 are summarised in Table 1.2.

TABLE 1.2 GROSS DOMESTIC PRODUCT GROWTH RATES BY ECONOMIC SECTORS IN 2021 - 2024

Item	2021	2022	2023	2024
Agriculture, Fishing and Forestry	**14.0**	**11.8**	**7.7**	**5.6**
Sugar	0.2	0.1	0.1	0.0
Rice	3.5	2.0	1.3	1.0
Other crops	7.7	7.5	4.9	3.6
Livestock	1.6	1.3	0.9	0.5

Item	2021	2022	2023	2024
Fishing	0.6	0.7	0.4	0.3
Forestry	0.4	0.3	0.2	0.2
Mining and Quarrying	**5.8**	**5.0**	**3.2**	**2.2**
Bauxite	0.3	0.3	0.2	0.1
Gold	5.1	3.8	2.1	1.3
Other mining and quarrying	0.7	0.9	0.9	0.8
Petroleum, gas, and support services	**40.8**	**54.9**	**68.1**	**76.0**
Manufacturing	**3.5**	**2.3**	**1.7**	**1.5**
Sugar	0.2	0.1	0.0	0.0
Rice	1.1	0.7	0.5	0.4
Other manufacturing	2.2	1.5	1.2	1.1
Services	**26.7**	**19.0**	**13.2**	**9.5**
Wholesale and retail trade and repairs	3.5	3.3	2.4	1.7
Transportation and storage	2.0	1.6	1.1	0.8
Accommodation and food services	0.2	0.2	0.1	0.1
Information and communication	1.5	1.2	0.8	0.6
Financial and insurance activities	3.1	2.4	1.6	1.2
Real estate activities	4.7	3.6	2.3	1.6
Professional, scientific, and technical services	0.2	0.2	0.2	0.2
Administrative and support services	3.7	3.0	2.3	1.7
Public administration	4.4	1.7	1.1	0.8
Education	2.0	1.0	0.6	0.5
Human health and social work	1.1	0.6	0.4	0.2
Arts, entertainment, and recreation	0.1	0.1	0.1	0.1
Other service activities	0.1	0.1	0.1	0.1
Other	**5.7**	**4.5**	**4.1**	**3.8**
Electricity supply	0.3	0.2	0.2	0.1
Water supply and sewerage	0.2	0.1	0.1	0.1
Construction	5.2	4.2	3.8	3.6

Source: Ministry of Finance 2024

Guyana's economy remains heavily reliant on trade, with exports playing a central role in national revenue generation. The composition of Guyana's exports has evolved, with traditional commodities such as sugar, rice, bauxite, gold, and forest products now complemented by crude oil, which became a major export product starting in 2020 (Bank of Guyana 2024). The

country has experienced significant growth in export earnings over recent years, driven largely by the emergence of the oil and gas sector.

The investment climate and financial infrastructure in Guyana is still maturing, and the country has faced challenges in attracting investments and diversifying the economy. According to the World Bank, the overall business regulatory framework remains complex and cumbersome. A challenging regulatory environment for businesses particularly affects micro, small, and medium sized enterprises, which account for most businesses in Guyana (IDB 2018). In 2020, as in recent prior years, Guyana ranked 134 out of 190 world economies for ease of doing business (World Bank 2020).

Petroleum, Gas and Support Services

Oil production in Guyana commenced in December 2019, and Guyana became an oil exporting nation in 2020. The oil reserves of Guyana are estimated at 9 billion barrels (1.4 billion m^3) of oil equivalent resource, with still unexplored and potentially undiscovered additional reserves; offshore oil exploration activities are ongoing.

Categorised as part of the Mining and Quarrying sector, the "Petroleum & Gas & Support Services" sector expanded substantially in 2020 (Bank of Guyana 2021). This was the first full year of crude oil production, amounting to over 27 million barrels (4.3 million m^3) in 2020, compared to just over 427,000 barrels (68,320 m^3) in 2019. Oil production averaged 74,300 barrels (11,888 m^3) per day over the year, peaking at 120,000 barrels (19,000 m^3) per day in December 2020. Overall, the sector contributed more than $180.39 billion GYD ($901.95 million USD) to the national GDP in 2020, representing 17 percent of total GDP at basic prices, compared to 1.9 percent in 2019.

Production increased to 6.8 million m^3 in 2021, and - with the commissioning of the Liza Unity FPSO - production more than doubled to 16.2 million m^3 in 2022. Overall, the sector contributed more than $1,774.5 billion GYD (approximately $8,496.4 million USD) to the national GDP in 2022, representing 59.5 percent of total GDP at basic prices (Bank of Guyana 2023). In 2023, the sector expanded by 45.9 percent, and production of crude oil grew by 40.8 percent to 142.8 million barrels, when compared with 101.4 million barrels the previous year, and in 2024, the sector further expanded by 57.9 percent, recording a production of 225.4 million barrels (Bank of Guyana 2025).

Agriculture

Guyana has a relatively strong agriculture sector when compared to other countries in Latin America and the Caribbean. In 2022, the agriculture sector's contribution to GDP (including sugarcane, rice, other crops, and livestock) grew by 39 percent over the prior year, with the most significant growth in the livestock and other crops categories (Bank of Guyana 2023). In 2023, the agriculture sector experienced a 7.0 percent growth, which was attributed to higher outputs of sugarcane, rice, and other crops (Bank of Guyana 2024), and in 2024, the sector grew by 11.0 percent, which was attributed to the increase in production of rice and the 'other crops' sector (predominantly non-traditional crops) (Bank of Guyana 2025).

Nontraditional crops (i.e., crops other than sugar cane and rice) grown in Guyana include tubers such as cassava, sweet potato, and eddo; vegetables such as bora, eggplant, cabbage, cucumber, pumpkin, plantains, squash, tomatoes, and okra; spices such as hot peppers, eschalot, and ginger; and fruits such as avocado, banana, cherry, lime, orange, papaya, mango, passionfruit, watermelon, and pineapple. Growth in root vegetables and

spices/seasonings has been more modest, whereas fruits and non-traditional crops have shown more substantial increases in production. In 2023, production of crops (other than sugarcane and rice) grew by 7.2 percent. Coconut production increased by 50.4 percent, mainly due to increased acreage cultivated. Beans and cereals production increased by 22.7 percent while cole crops[4] and root crops production increased by 7.2 percent and 7.0 percent (Bank of Guyana 2024). Fruits and vegetables production increased by 3.9 percent and 3.1 percent. The Ministry of Agriculture noted that the country is currently producing about 60 percent of the food consumed by its population but is aiming to increase the number and even produce enough to export (Ministry of Agriculture 2023).

Fisheries and Aquaculture

The fisheries sector is of critical importance to the economy and wellbeing across Guyana, contributing 1.9 percent of total GDP in 2012, and formally employing 8,386 people across marine and freshwater fisheries (FAO 2019). Throughout the country, people depend to varying degrees on fisheries as a key livelihood activity and source of food, with average annual consumption of fish at 29.5kg (down from 40 kg in 2003) (FAO 2019).

In addition to four types of marine fisheries that are largely based in the shallow waters of the continental shelf, Guyana's freshwater fish species are highly diverse and found in various habitats including rivers, lakes, swamps, and flooded plains. The Essequibo basin is particularly abundant in freshwater fish. Freshwater fishing is primarily conducted for subsistence use, and some small-scale commercial fishing, particularly 'scale and skin' fish like including haimara (*Hoplias macrophthalmus*), basha (*Cynoscion acoupa*), and pacu (*Colossoma macropomum*) using small, flat-bottomed dory-type vessels and cast nets, seines, or individual handlines (FAO 2019). Compared to marine fisheries, comprehensive data on contribution to GDP and household incomes from freshwater fisheries are not widely available, though total production is estimated at 700 tons (700,000 kg) per year. The only large-scale commercial fisheries inland are for ornamental fish, and there are limited to no management measures in place for inland fisheries.

Aquaculture is a relatively small industry in Guyana, although has been characterised as having strong economic potential due to substantial areas of flat lands and with suitable soil types and access to large quantities of freshwater. Several attempts have been made over the years to develop freshwater and brackish water aquaculture, especially since local consumer demand for freshwater fish is high (FAO 2025). The Fisheries Department of the Ministry of Agriculture and the National Drainage and Irrigation Authority started the brackish water shrimp project on the Corentyne coast of Region 6, aiming to increase the production of brackish water shrimp significantly by 2025 (Ministry of Agriculture 2023; Guyana Chronicle 2024). Farmed species using semi-intensive pond rearing approaches include various species of tilapia, catfish, and giant river prawn (*Macrobrachium rosenbergii*). Pacu (Colossoma macropomum) farming now also represents about half of aquaculture production annually, or 350,000 kg per year (FAO 2019).

Mining and Quarrying

Mining has been a crucial part of the Guyanese economy since the pre-Colombian period, with artisanal and small-scale mining (ASM) pre-dating colonial contact. Mining and quarrying, including gold, diamonds, bauxite, loam, manganese, oil, and sand, accounted for

[4] Cole crops include broccoli, cauliflower, and purple cabbage.

approximately 13 to 15 percent of the national GDP from 2017 to 2020 (Bank of Guyana 2021). The sector includes ASM as well as medium-and larger-scale operations. Currently, one large-scale foreign company, Guyana Gold Fields Inc. (a subsidiary of Zijin Mining Co.), is operating in Guyana. Another operation, the Oko West Project (a subsidiary of G Mining Ventures), is anticipated to begin production in 2026.

Artisanal and small-scale gold mining (ASM) has been and continues to be a key engine for economic growth, a key source of foreign exchange, and a critical source of employment and/or income across the country (Laing et al. 2021). The rapid expansion of ASM has also led to environmental issues due to prominent use of mercury (an estimated 2.39 kg of mercury estimated to be used for every kg of gold extracted in 2013), contamination of water sources, and as a direct and indirect driver of deforestation (see Land Use Section 10.6) (McRae 2014).

In 2020, faced with the challenges of operating during the COVID-19 pandemic, the mining and quarrying sector contributed $128.8 billion GYD ($640 million USD) to GDP at basic prices (12.2 percent of GDP), representing a decline from $142.7 billion GYD ($713.5 million USD, or 14.8 percent of GDP) in 2019. Mining was severely affected by flooding in 2021, with over 50 percent of ASM operations affected. With mining areas cut off due to infrastructural damages, estimating that lost production amounted to approximately $23 billion GYD ($115 million USD) and $1 billion GYD ($5 million USD) in damages to mining infrastructure (Kaieteur News 2021). However, by 2022, the sector had rebounded to $139.7 billion GYD ($668.8 million USD), with bauxite production expanding but gold production being lower than expected due to the impacts of inclement weather (Bank of Guyana 2023).

In 2023, bauxite and gold production declined by 25.6 percent and 11.2 percent, respectively. Bauxite decline was attributed to developments in the external market, which have affected prices and demand for the product, and gold decline was due to small- and medium-scale miners (which represents approximately 74.6 percent of total declarations) experiencing a decline of 16.2 percent (Bank of Guyana 2024).

In 2024, bauxite output grew by 48.4 percent, primarily on account of higher production of Metallurgical Grade Bauxite (MAZ). Gold production increased by 0.5 percent, reflecting an increase in production by the sole large scale operating foreign company by 30.9 percent. However, small and medium scale miners, who represented 67 percent of the total declarations recorded a 9.9 percent decline. The diamond subsector's output also declined by 17.0 percent (Bank of Guyana 2025).

Other Sectors

Wholesale and retail trade sector represented 3.3 percent of GDP in 2022. In 2022, the sector grew by 15.6 percent, primarily from the lifting of the COVID-19 restrictions (Bank of Guyana 2023). In 2023, the sector increased by 9.0 percent, as consumer goods continue to be in high demand (Bank of Guyana 2024); and in 2024, the sector increased by 7.1 percent, again, due to the continued demand for consumer goods (Bank of Guyana 2025).

The **manufacturing** sector experienced growth of 25.0 percent in 2023. Sugar manufacturing increased by 28.0 percent, other manufacturing by 31.8 percent and rice manufacturing by 8.3 percent (Bank of Guyana 2024). The expansion in rice and sugar manufacturing correlates with higher output achieved, increased cultivation and harvesting. Other manufacturing that witnessed a robust growth include butter, pharmaceutical ointments, paints, sweets, ice cream, mineral/distilled water, cereal, aerated beverages, putty and biscuits (Bank of Guyana 2024).

Guyana's manufacturing sector also benefited from increased demand as a result of the COVID-19 pandemic, most notably for the country's production of plastic sinks, pharmaceuticals, tablets, nitrogen gas, oxygen, and detergents (Bank of Guyana 2021). This subsequently fell by 2023 – oxygen production by 4.0 percent, detergents by 4.2 percent, pharmaceutical tablets 17.8 percent and liquids by 6.4 percent. There have also been production reductions in wine, shandy & vita malt, and rum by 17.5 percent, 11.2 percent and 9.4 percent respectively (Bank of Guyana 2024). In 2024, the manufacturing sector a 13.5 percent growth, owing to increased production of rice, and 'other manufacturing' (Bank of Guyana 2025).

According to the World Travel and Tourism Council (2023), **tourism** directly contributed 9.1 percent to the global GDP; an increase of 23.2 percent from 2022 and only 4.1 percent below the 2019 level. Although most tourism infrastructure (e.g., hotels) is located in the more populated townships such as Georgetown, Linden, and Berbice, many of Guyana's tourist attractions are located in the country's interior. These attractions offer nature, culture, and adventure-based experiences such as trips to waterfalls and Amerindian villages.

Regarding specific economic sectors in Guyana, domestic workers (i.e., people who work within the scope of a residence) are considered to work in the **informal economy**. When surveying sector employment, it can be difficult to access domestic workers, so reliable statistics about the rate of domestic work in Guyana is uncommon. However, it is known that many Guyanese domestic workers also engage in other income-generating activities. To help address the challenges faced by domestic workers and by Guyana trying to account for that subset of the population, the country ratified International Labour Organisation (ILO) Convention No. 189 in 2013, creating decent work for domestic workers. In the Convention, domestic workers are to be covered by labour legislation, minimum wage, overtime, paid leave, and social security (ILO 2017). Despite ratification of the ILO Convention No. 189, domestic workers often work without pay or protections, resulting in their roles being considered nonwage activities.

Indigenous peoples may also engage in livelihood activities outside of wage-based employment. The majority of Indigenous peoples in Guyana work in a range of income-generating activities, including processing crops, fishing, producing crafts, small-scale trading and bartering, and day labour. However, on average in Guyana, less than 10 percent of households in Amerindian communities are documented to have members with a fulltime, salaried job. As such, Indigenous land use and customary Indigenous livelihood activities may be considered a non-wage activity (Griffiths and Anselmo 2010).

Labour Force Profile

The most recent iteration of the Guyana Labour Force Survey provides data for the third quarter of 2021 (BSG 2021). Results indicate that as of the first quarter of 2021, the unemployment rate was 15.6 percent (46,480 persons), compared to 14.5 percent (41,992) at the end of the third quarter. As of the third quarter of 2021, Guyana's working age population (aged 15 and above) was 582,571 persons, of which approximately 72.3 percent were based in rural areas. Women accounted for 51.6 percent, and men represented approximately 48.4 percent of the working age population. However, men represented 60.6 percent of the total labour force (the sum of employed and unemployed persons).

Among the working age population, participation in the labour force (a percentage of the working age population) was higher among men than women (62.1 percent versus 37.8 percent) and slightly higher in urban areas (49.6 percent) compared to rural areas (49.1

percent). The employment to population ratio (the proportion of a country's working age population that is employed) was 42.4 percent, with a substantial difference between the rate of men (54.6 percent) and women (30.9 percent) (BSG 2021). In the third quarter of 2021, about 35.7 percent of youth (aged 15 to 24) were not in education, employment, or training; this percentage has seen a slight increase from the first quarter of 2020 where 34.0 percent of youth was not in education.

According to the Guyana Labour Force Survey data (Table 1.3), there was a 1.2 percent increase in employment from first quarter 2020 (3.4 percent) to third quarter 2021 (5.0 percent) for the economic sector of Mining and Quarrying (in which oil and gas and support services are captured). This amounted to a $40,323 GYD ($202 USD) increase in labour-related income (gross remuneration in cash and in kind) for the sector.

The private sector accounts for 65 percent of employment, with the public sector and not-for-profit organisations accounting for 23 percent and 12 percent, respectively. More women than men are employed in the public sector. As of the first quarter of 2021, the majority of employed persons worked in either the wholesale and retail trade sector (16 percent), or the public administration and defence sector (13.4 percent). Recent growth in the public administration and defence sector has been offset by a 35 percent decrease in employment in agriculture, forestry, and fishing, which has dropped from the largest single employment sector in Guyana's economy in 2017 to the third largest employment sector. This shift was attributed to the downsizing of the sugar industry, compounded by broader economic diversification and growth of other sectors which shifted national employment away from agriculture. As of the third quarter of 2021, approximately 48.0 percent of workers were classified as informally employed. Of this total, approximately 60 percent were men and 40 percent were women; and approximately 57 percent and 42 percent identified as rural and urban residents, respectively (BSG 2021). Informal employment is characterised by a low level of organisation, and labour relations have no contractual arrangements or formal guarantees.

TABLE 1.3 EMPLOYMENT IN GUYANA BY ECONOMIC SECTOR

Economic Sectors	2012 (%)	2017 [a] (%)	2021 (%)
Agriculture, forestry, and fishing	17.5	18.9	13.8
Wholesale and retail trade	15.4	16.1	16.8
Public administration and defence	7.2	9.3	8.7
Construction	10.4	7.7	9.0
Manufacturing	8.6	8.4	8.8
Transportation and storage	7.7	7.3	7.0
Education	5.3	6.3	5.4
Mining and quarrying	8.2	4.2	5.0
Administrative and support services	3.7	4.3	5.0
Accommodation and food service activities	2.8	4.4	4.3
Human health and social work activities	2.7	1.2	4.1
Activities of households as employers	2.3	2.8	3.3
Other service activities	2.7	2.6	2.1

Economic Sectors	2012 (%)	2017 [a] (%)	2021 (%)
Financial and insurance activities	1.3	1.2	1.3
Professional, scientific, and technical services	1	0.97	1.1
Water supply, sewerage, and waste management	0.5	1.24	1.4
Information and communication	1	0.84	1.1
Electricity, gas, steam, and air conditioning	1	0.82	1.1
Activities of extraterritorial organisations	0.2	0.8	0.2
Arts, entertainment, and recreation	0.6	0.5	0.5
Real estate activities	0.1	<0.1	0.0
Not classifiable by economic activity	0.3	<0.1	0.0

Source: BSG 2016, 2018, 2021

[a] Results from the Guyana Labour Force Survey for the final quarter of 2017
[b] Results from the Guyana Labour Force Survey for the third quarter of 2021

1.2.3 COMMUNITY HEALTH, SAFETY, AND WELLBEING IN GUYANA

1.2.3.1 HEALTHCARE INFRASTRUCTURE

Guyana's healthcare infrastructure includes a mixture of public and private systems, with the public sector being the primary provider of healthcare across the country. The Ministry of Health is responsible for setting national policy, regulation, and standards; building and refurbishing healthcare facilities; financing the employment of doctors, nurses, and emergency response workers; and providing free healthcare in public hospitals/clinics/health posts. The private sector offers paid services, often with shorter waiting times and more advanced facilities, including hospitals, clinics, and pharmacies. At the regional level, the Regional Health Authorities have the autonomy to assess, plan, and implement health services and manage the facilities for a defined population in a defined geographic area, including day-to-day management of the facilities and employment of all other staff working in the health sector. The country's main framework for health is the PAHO/WHO Country Cooperation Strategy, implemented to support the Ministry of Health with the overall planning and outlining of strategic priorities for the Guyanese health sector to achieve its Health Vision 2030 (PAHO/WHO 2023).

Guyana's government health spending is relatively low compared to other Latin American and Caribbean countries, representing 4.9 percent of gross domestic product (GDP) in 2021, a successive increase from 5.5 percent in 2020. This is one of the lowest proportions in the region and contrasts to neighbouring Suriname (5.7 percent), Trinidad and Tobago (7.0 percent), Colombia (9.0 percent) and Brazil (10.0 percent; WHO 2023). The country's healthcare infrastructure has been undergoing transformation in recent years, driven by investments to modernise and enhance the delivery of services. In 2025, $143.2 billion GYD (approximately $680 million USD) was expended to improve the health sector, with focus on expanding and modernising healthcare facilities across the country (Ministry of Health, 2025). This represents approximately 11.03 percent of the budgetary allocations.

In 2022, the Ministry of Health announced a package of essential primary healthcare services including support for training and deployment of human resources to all Guyana regions (PAHO 2022c). The package provides a basis for expansion of facilities, medicines, health services, and medical equipment across the country, working toward the Ministry's vision to achieve universal healthcare in Guyana. International doner organisations like PAHO and WHO also support funding, training and technical aid. Guyana also has an ongoing collaborative effort with Mount Sainai Health System and Hess Corporation since 2022 to transform the Public Health system by 2030, focused on the delivery of high-quality healthcare for all citizens (Government of Guyana 2025).

Healthcare Facilities

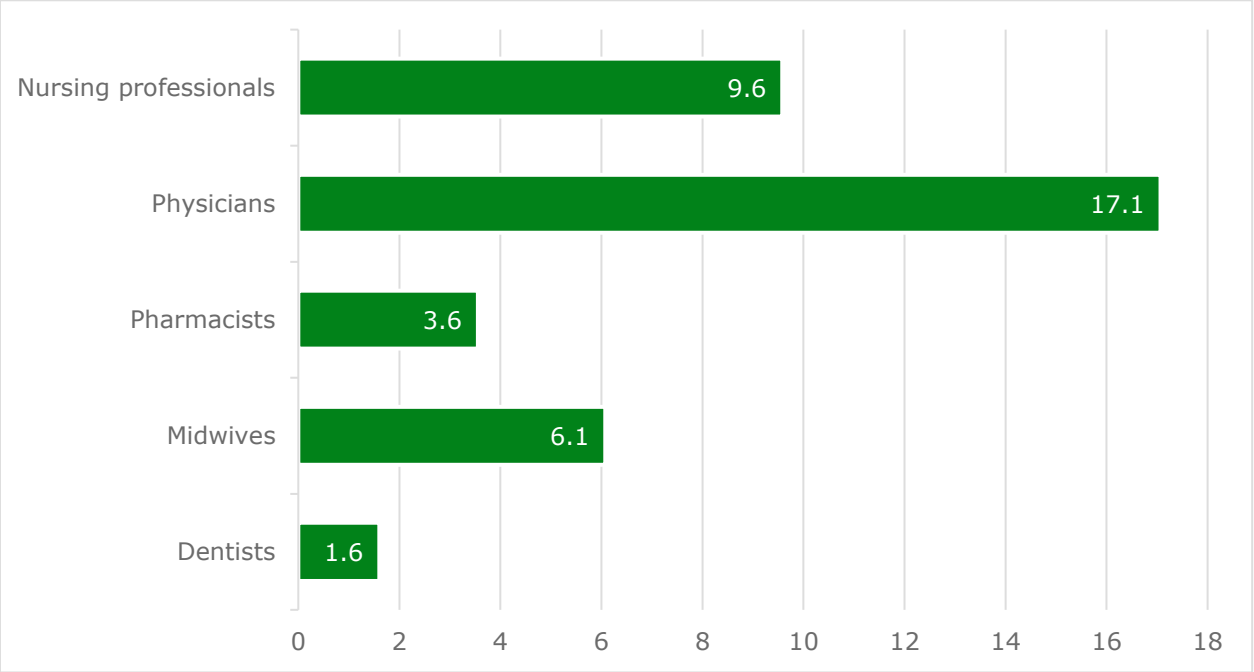
According to Guyana's Chief Medical Officer, one of the biggest health system shortfalls for Guyana is unreliable emergency care services. This includes the lack of a functioning air ambulance system, which is needed to adequately respond to mining injuries in the country's interior and to the large number of vehicle accident-related injuries. These challenges persists largely due to logistical and infrastructural barriers, as Guyana's vast and remote terrain makes rapid emergency transport difficult, and the system currently lacks an air ambulance service. At a national level, the most common reasons for clinic visits include hypertension, diabetes, antenatal care, and family planning. Medical supplies, including medicines, have also been in short supply or found expired, due in part to procurement delays, storage constraints and distribution challenges (Stabroek News, 2023). However, efforts have been made to address these issues, and most essential medicines have since been restocked (News Room 2022).

The public hospital in Georgetown currently has 600 beds (LAU Undated). The Infectious Diseases Hospital was commissioned at Liliendaal, Georgetown, in July 2020 to serve as the premier institution for the quarantining and isolation of persons infected with COVID-19 and other infectious diseases (News Room 2021b). The hospital has a capacity of 200 beds and an Intensive Care Unit capacity of 40 beds. As the COVID-19 caseload has declined, the facility has been used to treat patients with other communicable diseases, including tuberculosis (TB), and for ongoing vaccination campaigns (Guyana Chronical 2023b).

Healthcare Professionals

Retention of healthcare professionals in Guyana is a challenge. The most recently available statistics indicate that there were 17.1 physicians and 9.6 nursing professionals per 10,000 people in Guyana in 2021 (PAHO 2022a; Figure 1.1). The numbers healthcare professionals as a proportion of the population are lower in Guyana than other Caribbean countries, particularly for nursing professionals, where other non-Latin Caribbean countries report between 24.7 and 54 nurses per 10,000.

FIGURE 1.1 HEALTHCARE PROFESSIONALS IN GUYANA (PER 10,000 POPULATION), 2021



Source: PAHO 2022a

Note: Data derived from PAHO Core Indicators Open Data portal. Healthcare human resources are based on reports from the Guyana Medical Council Register, Nursing Council, Pharmacy Council, and Dental Council.

1.2.3.2 HEALTH AND WELLBEING STATUS

According to the Ministry of Health, health outcomes in Guyana have steadily improved over recent decades (PAHO, 2023). Between 2019 and 2021, the Global Health Security Index rated Guyana's healthcare access[5] as relatively stable (score of 58.8 and 58.7, respectively); and the country ranked 18 out of 34 countries in Latin America and the Caribbean (GHS Index 2021). Life expectancy for all births increased from 62.6 years in 2000 to 70.3 years in 2024, though still lower than the average for the rest of the Americas region[6] (PAHO 2024).

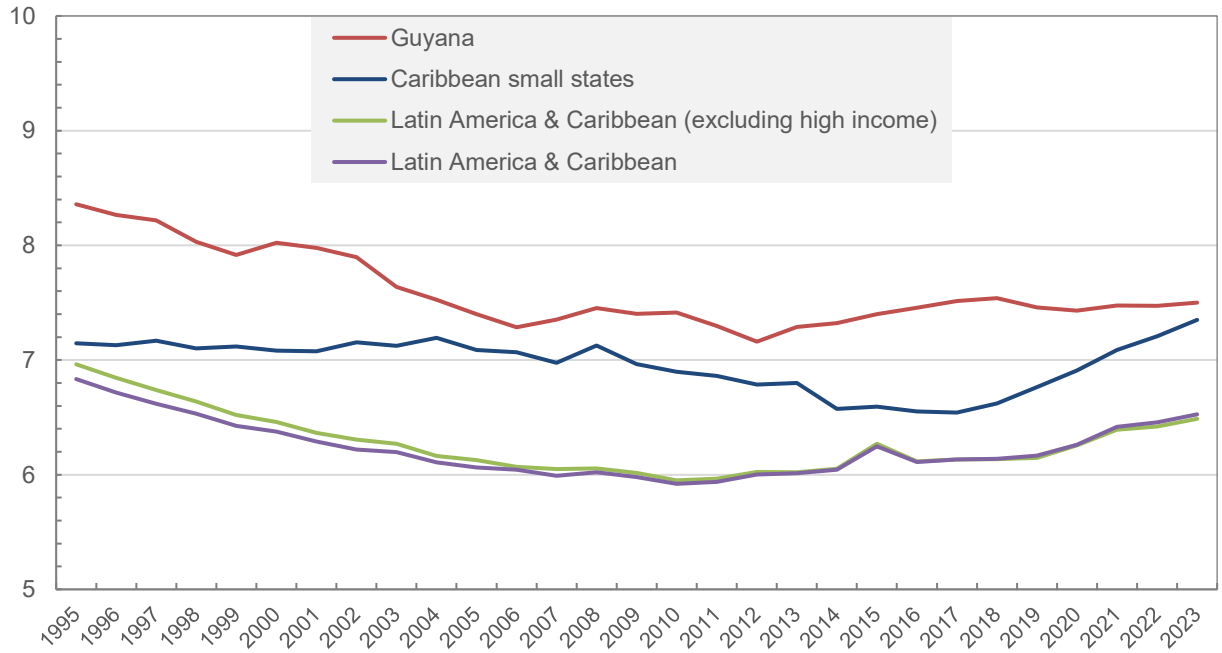
In 2023, the crude death rate[7] in Guyana was 7.32 deaths per 1,000 persons (World Bank 2025). Prior to 2020, the crude death rate had largely stabilised, with an average of 7.4 between 2000 and 2019. However, as exhibited in other countries in the region, the crude death rate increased slightly with the spread of the COVID-19 global pandemic in 2020 (Figure 1.2).

In 2021, the leading cause of death in Guyana was COVID-19, followed by ischemic heart disease (also known as coronary artery disease), stroke, and diabetes (Figure 1.3). Over the preceding 10 years (2011 through 2021), Guyana saw increases in some causes of death (notably chronic kidney disease and hypertensive heart disease) and a decrease in human

[5] The score for "healthcare access" is a function of citizens' right to medical care, access to skilled birth attendants, out-of-pocket health expenditures per capita, paid medical leave, and prioritisation of healthcare access for healthcare workers.
[6] Including North America, South America, Central America, and the Caribbean.
[7] The crude death rate is the number of deaths occurring among the population of a given geographical area during a given year, per 1,000 mid-year total population of the given geographical area during the same year (UN 2001).

immunodeficiency virus (HIV) / acquired immunodeficiency syndrome (AIDS) and lower respiratory infections as a cause of death.

FIGURE 1.2 CRUDE DEATH RATE: REGIONAL TRENDS IN LATIN AMERICA AND THE CARIBBEAN



Source: World Bank 2023

FIGURE 1.3 TOP TEN CAUSES OF DEATHS (ALL AGES), GUYANA 2021

Communicable, maternal, neonatal, and nutritional diseases
Non-communicable diseases
Injuries

Cause	2011 rank	2021 rank	Change in deaths per 100k, 2011-2021
COVID-19	-	1	↑ +216.3
Ischemic heart disease	1	2	↓ −2.7
Stroke	2	3	↓ −2.0
Diabetes	3	4	↑ +5.2
Chronic kidney disease	6	5	↑ +10.5
Hypertensive heart disease	4	6	↑ +7.4
Self-harm	9	7	↑ +0.6
Cirrhosis liver	10	8	↑ +2.4
Lower respiratory infect	8	9	↓ −6.2
HIV/AIDS	7	10	↓ −8.1

Source: IHME 2024

Note: The 5th ranked cause of death in 2011 was neonatal death. Neonatal deaths decreased significantly relative to other causes in subsequent years and were not in the top ten causes of death in 2021.

Non-Communicable Disease

Non communicable diseases are a major health concern in Guyana, accounting for approximately 74 percent of all deaths, with over 23 percent being premature deaths (before the age of 70) (Stabroek News 2023).

Obesity is a major health issue in the country, along with other forms of malnutrition. In 2021, the Minister of Health noted that 41 percent of the male population and 56.5 percent of females were obese, and these percentages are increasing (Guyana Times 2021a). Obesity is recognised as a risk factor for several chronic, non-communicable diseases such as diabetes, high blood pressure, cardiovascular, and heart diseases (DPI 2023a). Although Guyana is considered self-sufficient for food, the population's access to and utilisation of the right types of food to maintain good health are of concern. This led the Ministry of Agriculture to develop the Guyana Food and Nutrition Security Strategy (FNS) 2011–2020 Plan, which aimed to integrate agricultural practices with improved food security and nutrition to promote health and wellbeing (Ministry of Agriculture 2011). While a comprehensive update on the specific implementation and outcomes of the FNS is not readily available, Guyana has made strides in addressing food security and nutrition.

Subsequent government initiatives and strategies, such as the Agriculture Development Strategy 2021-2025, indicate a continued focus on these areas. The country has made progress in reducing poverty and hunger, as evidenced by declining malnutrition rates, particularly in children. Official data indicate that by 2022, the number of chronically undernourished children, as determined by the condition's most prevalent symptom, stunting, had decreased by 43.6 per cent since 2000 (Guyana Chronicle, 2024). However, challenges persist, including disparities in access to nutritious food and the prevalence of non-communicable diseases linked to diet (Guyana Chronicle, 2023a).

According to the Ministry of Health, diabetes affects one in 10 adults across the country and is considered a major health problem as it is one of the leading causes of premature death and illness (DPI 2022). In 2021, the Ministry estimated that approximately 60,000 Guyanese were living with diabetes (News Room 2021a). The Ministry of Health is collaborating with several international partners to provide comprehensive diabetes care, promote testing for diabetes status, and offer diabetes prevention and treatment through health centres in all regions. Guyana has also committed to achieving World Health Organisation (WHO) targets for diabetes by 2030, including 80 percent targets for diagnosis and control of symptoms, and a 100 percent target for persons with Type 1 diabetes having access to affordable insulin and blood glucose self-monitoring (DPI 2022).

Hypertension is a dominant risk factor for ischemic heart disease and cerebrovascular disease, and the second leading cause of morbidity in Guyana (Sockalingam et al. 2021). In May 2023, PAHO reported that 24.5 percent of Guyana's male population and 21.5 percent of the female population are currently living with hypertension (PAHO, 2023a); hypertension afflicts an estimated 18 percent of adults across the Americas region (Guyana Chronicle 2023a). Current initiatives are aimed at equitable access to care for hypertension and cardiovascular risk management through primary care clinics across the country (The Guyana Chronicle 2023a; Ministry of Health 2023a).

Communicable Disease

Communicable diseases—including Tuberculosis (TB), human immunodeficiency virus (HIV), and malaria—continue to impact productivity, quality of life, and wellbeing in Guyana, particularly in the interior Regions. This is due to several interrelated factors, including poverty, nutritional deficiency, and inadequate access to biomedical health services.

Tuberculosis continues to be a priority health concern in Guyana. It was nearly eradicated in the 1980s but saw a resurgence in the 1990s due to its association with the HIV/acquired immunodeficiency syndrome (AIDS) epidemic (Table 1.4). In 2019, the TB mortality rate (age-adjusted and per 100,000) was 18.8 overall, with a rate of 8.9 in women and 29.3 in men, indicating a large gender imbalance (PAHO 2023a). By 2021, the overall mortality rate had increased to 22 per 100,000. Around the world, both incidence of and mortality from TB were noted to increase between 2020 and 2021 because of the COVID-19 pandemic and associated challenges providing and accessing TB diagnosis and treatment (WHO 2022a).

In 2021, the country had a TB incidence rate of 83 per 100,000, following 20 years of fluctuation from 2000 to 2021 (WHO 2022b). Guyana has one of the highest TB incidence rates in the Americas region (World Bank 2023c). For comparison, the overall incidence rate for the Americas region in 2021 was 30 per 100,000, while the global incidence rate was 134 per 100,000 (WHO 2022b).

TABLE 1.4 ESTIMATED BURDEN OF TUBERCULOSIS IN GUYANA, 2021

Estimates of TB Burden	Number [a]	Rate per 100,000 Population [a]
Total incidence (includes HIV+TB)	670 (500–860)	83 (63–106)
HIV-positive incidence	130 (89-170)	16 (11–22)
HIV-negative TB mortality	130 (110–150)	2.5 (1.2–3.7)
HIV-positive TB mortality	52 (44–60)	6.4 (5.5–7.5)
Total incidence (includes HIV + TB): Americas Region	309,000 (287,000–332 000)	30 (28–32)
Total incidence (includes HIV + TB): Global	10,600,000 (9,850,000–11,300,000)	134 (125–143)

Source: WHO 2022b

[a] Ranges shown in parentheses represent uncertainty intervals.

There are approximately 20,000 cases of malaria annually in Guyana, largely in the interior regions. The disease is most prevalent in Regions 1, 7, and 8 (WHO 2022b; Figure 11.16). There has been a rising malaria incidence linked to gold mining. Between 2008 and 2014, Guyana experienced a marked increase in malaria cases, particularly in regions with high gold mining activity. Study reports a strong correlation between the international gold price and the number of Plasmodium falciparum malaria cases, especially among men and boys aged 15-50, who are more likely to be involved in mining activities. This demographic was identified as having the highest proportion of malaria cases, suggesting that gold mining played a major role in malaria transmission (Salazar et. al, 2021).

Additionally, malaria cases have surged during periods when the gold price was high, indicating increased mining activity and associated population movement. A one percent increase in gold price was associated with a 2.13% increase in malaria infections in mining populations after one month and a 1.63% increase in non-mining populations after two months (Salazar et. al, 2021).

While gold mining was identified as a primary driver, climatic factors such as La Niña events also showed a positive correlation with malaria transmission. These events can influence mosquito reproduction and survival, further exacerbating malaria spread (Salazar et. al, 2021).

Malaria control strategies in Guyana, particularly in mining regions, need to consider the impact of economic activities like gold mining. Monitoring the international gold price could serve as an indicator for predicting malaria trends, helping to allocate resources and interventions more effectively. The mobility of mining populations, along with often poor access to healthcare and the prevalence of substandard antimalarials, complicates malaria control efforts in these regions (Salazar et. al, 2021). Comparatively, there is low to no risk along the coastal belt (including Georgetown) and in Regions 3, 4, and 5 (Public Health Scotland Undated).

Malaria control efforts, such as distribution of insecticide-treated bed nets and indoor residual spraying, have been ongoing in these regions for decades. After an initial reduction in malaria prevalence in the early 2000s, the number of cases increased from 2007 to 2012. Data indicates a correlation with a surge in mining activities within the interior regions, which coincided with a period of high international gold prices (Kaieteur News, 2015). The country's Central Vector Control Service now sends mobile teams to work directly with populations residing in mining camps (USAID 2014; ERM Fieldwork, 2024). The highest number of cases was reported in 2012 (approximately 31,600 cases); in more recent years, annual case reports numbered 18,830 in 2019, 17,200 in 2020, and 20,800 in 2021 (Mendoza 2022). Recent floods in Guyana have posed a risk of increased incidences of malaria in interior Regions (Guyana Times 2021b).

Dengue fever, chikungunya, lymphatic filariasis, and Zika are also locally transmitted in Guyana (i.e., they are present in the community and passed from Guyanese to Guyanese). Unlike malaria, transmission of these diseases tends to be common in populated and urbanised areas.

Lymphatic filariasis and soil-transmitted helminthiasis continue to be problematic in Guyana, leading to deformity, malnutrition, and social stigma in impacted populations. In 2017, lymphatic filariasis was the tenth most common cause of disability from illness in Guyana (IHME 2023). Transmission largely occurs in urban and poor socioeconomic environments, and the highest levels in Guyana are found in the most populated areas (Niles et al. 2021). Most of Guyana's populations are at risk of lymphatic filariasis, representing more than 700,000 people in 2018 (Niles et al. 2021).

Efforts to combat these diseases include mass drug administration campaigns and improvements in sanitation in endemic areas. Several inter-agency public health programs have been established to address prevention and treatment, including the Ministry of Health's Lymphatic Filariasis Elimination Program (Niles et al. 2021) and a partnership between PAHO's Regional Program for Neglected Infectious Diseases and the United States Agency for International Development (USAID) (PAHO 2023b).

In 2020, the estimated HIV infection incidence rate[8] (new diagnoses) was 37.3 per 100,000 population. The age-adjusted mortality rate[9],[10] for HIV was 34.9 per 100,000 population in 2019, representing a decline of 20.8 percent since 2000 (PAHO 2023a). In 2021, the number of people living with HIV in Guyana was estimated at 9,700, and the prevalence rate[11] in the population aged 15 to 49 was 1.4 per 100,000 (UNAIDS 2021; Table 1.5). This prevalence is high compared to other countries in Latin America and the Caribbean; the regional and global prevalence rates are 0.5 and 0.7 per 100,000 population, respectively (World Bank 2023c). Progress has been made in addressing the HIV epidemic in the country, with a significant reduction in HIV incidence (per 1,000 population) since 2003; however, between 2008 and 2017, AIDS mortality (per 1,000 population) slowly increased from 0.11 to 0.15, before levelling at 0.14 in 2018 and 2019 (UNAIDS 2021).

TABLE 1.5 ESTIMATES OF HIV AND AIDS PREVALENCE IN GUYANA, 2021

Population Living with HIV	Number [a]	Rate (per 100,000 population)[a]
Total adults and children	9,700 (8,800–11,000)	n/a
Adults (aged 15 and over)	9,300 (8,400–10,000)	1.4 (1.3–1.6)
Women (aged 15 and over)	4,700 (4,200–5,200)	1.5 (1.4–1.7)
Men (aged 15 and over)	4,600 (4,100–5,200)	1.3 (1.2–1.5)
Children (aged 0 to 14)	<500 (<500-<500)	NA

Source: UNAIDS 2021

[a] Ranges represent uncertainty intervals.

Maternal and Child Health

Between 1995 and 2021, infant mortality in Guyana steadily decreased from 41.66 to 23.22 deaths per 1,000 live births (Figure 1.4). The fertility rate is 2.4 children per woman, with early childbearing (women aged 15-19) at a rate of 62 per 1,000. Contraception used among married women was reported at 53.4% while 81.4% of women received antenatal care from a skilled provider. Delivery care statistics reveal that 92.2$ of births were attended by skilled personnel, and 89.7% of deliveries took place in health facilities. Additionally, 90.7% of newborns were weighted at birth, and the postnatal care coverage within two days of delivery was 89.1% for mothers and 91.3% for newborns. These figures indicate substantial health service coverage for mothers and children in Guyana (UNICEF, 2020).

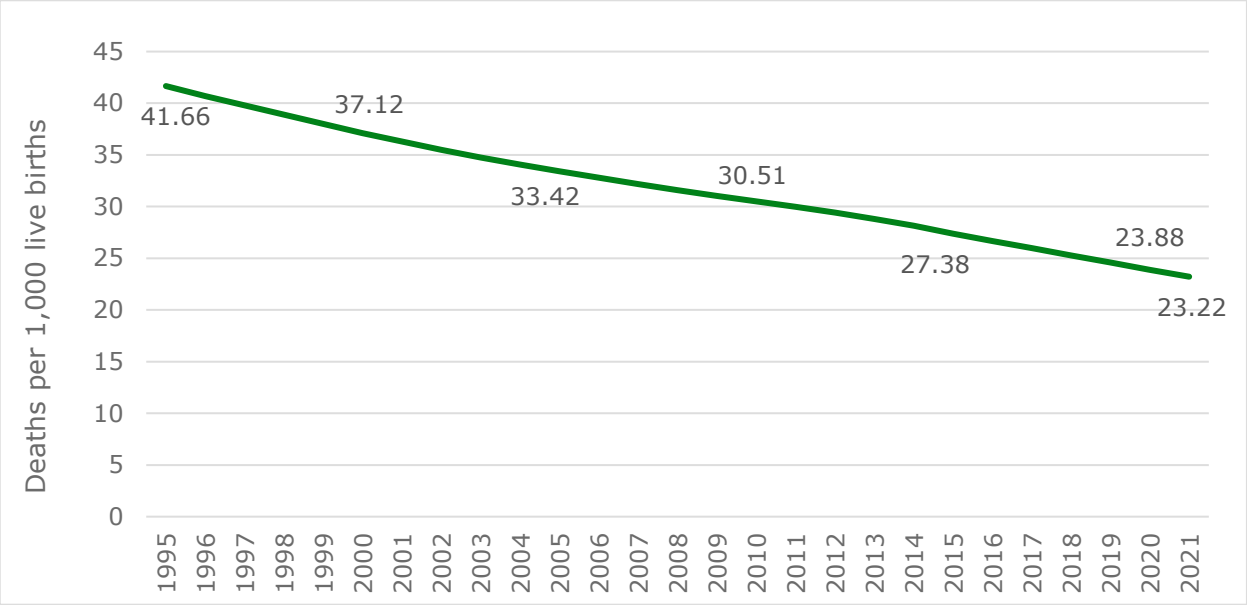
[8] Incidence rate: The number of new cases of a disease diagnosed in a specific time period. Source: https://www.ncbi.nlm.nih.gov/books/NBK430746/

[9] Age-adjusted mortality rate is the estimated total number of deaths in a population, divided by the total number of that population after removing the effect of differences in the age distribution, expressed per 100,000 population, for a given year, in a given country, territory, or geographic area. Source: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/1156

[10] Mortality rate: The number of deaths from a specific cause in a specific time period. Source: https://www.who.int/data/gho/indicator-metadata-registry/imr-details/1157

[11] Prevalence rate: The proportion of a population that has a specific condition at a specific point in time. Source: https://www.cdc.gov/nchs/hus/sources-definitions/prevalence.htm

FIGURE 1.4 ESTIMATED INFANT MORTALITY RATE, GUYANA 1995–2020

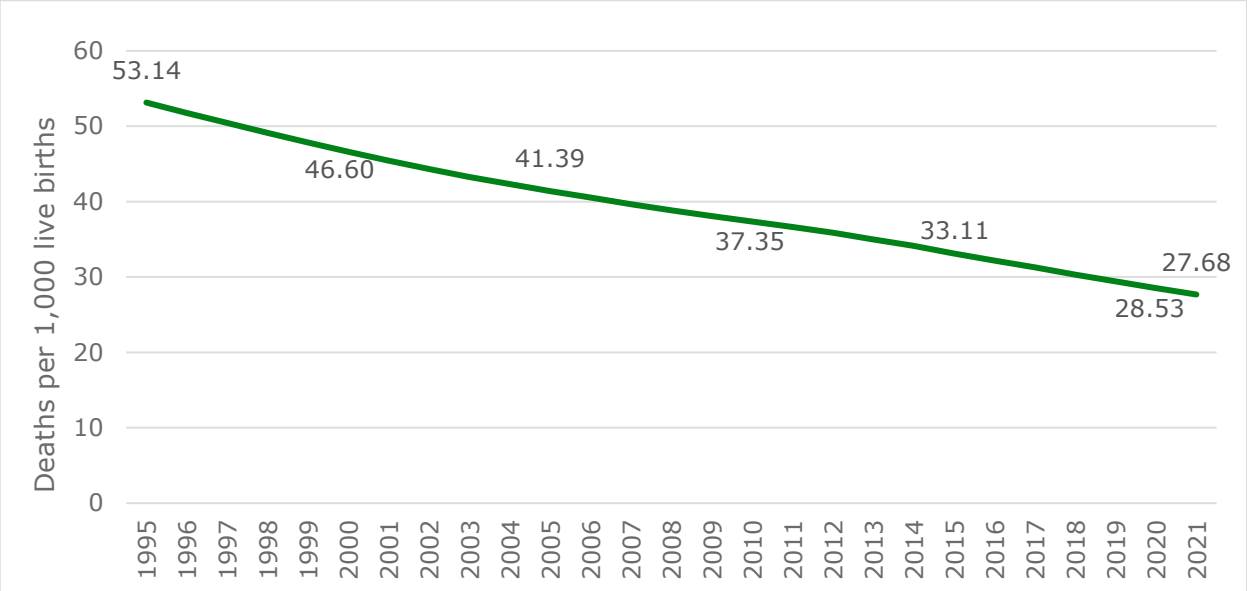


Source: PAHO 2022a

Note: Data derived from PAHO Core Indicators Open Data portal. Estimated infant mortality rates are based on data from the UN Inter-agency Group for Child Mortality Estimation.

Sustainable Development Goals (SDGs), established by the United Nations as part of the 2030 Agenda for Sustainable Development, outline targets aimed at improving health and wellbeing. Among these, the health-related SDG targets include ending preventable deaths of newborns and children under 5 years of age, reducing neonatal mortality to as low as 12 per 1,000 live births, and reducing under-5 mortality to at least as low as 25 per 1,000 live births. Guyana is making progress toward these goals with an under-5 mortality rate of 27.68 per 1,000 live births in 2021 (Figure 1.5) and a neonatal mortality rate of 15.0 per 1,000 live births in 2019, reduced from a high of 21.8 in 2012 (PAHO 2022a). In 2019, Guyana's maternal mortality ratio was estimated at 109.76 per 100,000 live births, an improvement from 190.08 per 100,000 in 2000 (Figure 1.6).

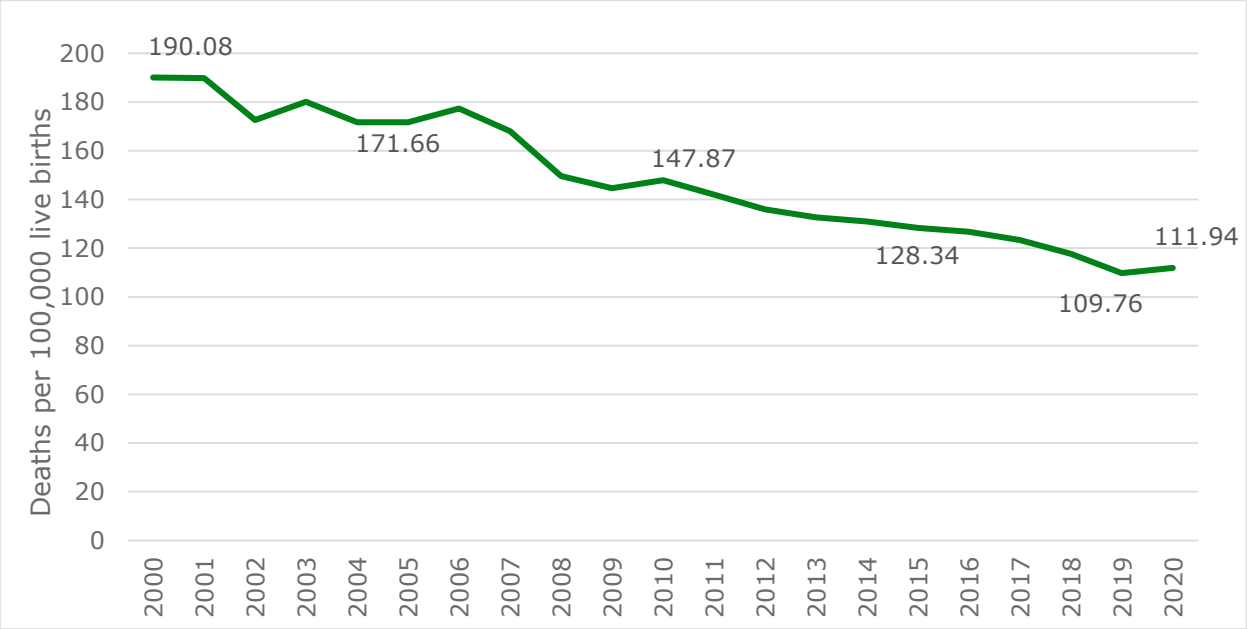
FIGURE 1.5 ESTIMATED UNDER-5 MORTALITY RATE, GUYANA 1995–2021



Source: PAHO 2022a

Note: Data derived from PAHO Core Indicators Open Data portal. Estimated under-5 mortality rates are based on data from the UN Inter-agency Group for Child Mortality Estimation.

FIGURE 1.6 ESTIMATED MATERNAL MORTALITY RATIO, GUYANA 2000–2020



Source: PAHO 2022a

Note: Data derived from PAHO Core Indicators Open Data portal. Estimated maternal mortality ratios are based on data from the WHO, UNICEF, United Nations Population Fund (UNFPA), World Bank Group, and United Nations Department of Economic and Social Affairs (UNDESA) / Population Division.

In relation to adolescent fertility rate, Guyana exhibited a 36.8 percent decrease between 2000 and 2022 (102.3 vs 64.6 live births per 1,000 women aged 15 to 19 years). This is relatively high compared to other areas of the Caribbean, including averages of 50.4 for Latin Caribbean

and 37.9 for non-Latin Caribbean countries. For all maternal ages, a high proportion of pregnant people received antenatal care at a healthcare facility[12] in Guyana (96.0 percent in 2018) and 97.0 percent of births were attended by skilled birth personnel in 2021 (PAHO 2023a).

Mental Health

Guyana has made efforts to strengthen the mental health sector in recent years. In 2022, the PAHO Non-communicable Diseases and Mental Health Unit collaborated with the Ministry of Health to conduct a special meeting with a focus on the status of mental health activities in the country. The Minister of Health signalled the country's intention to develop a comprehensive mental health plan that would (1) provide a framework to address mental, neurological, and substance use disorders and self-harm and (2) accelerate the movement toward the provision of improved mental health services at the community level (PAHO 2022b).

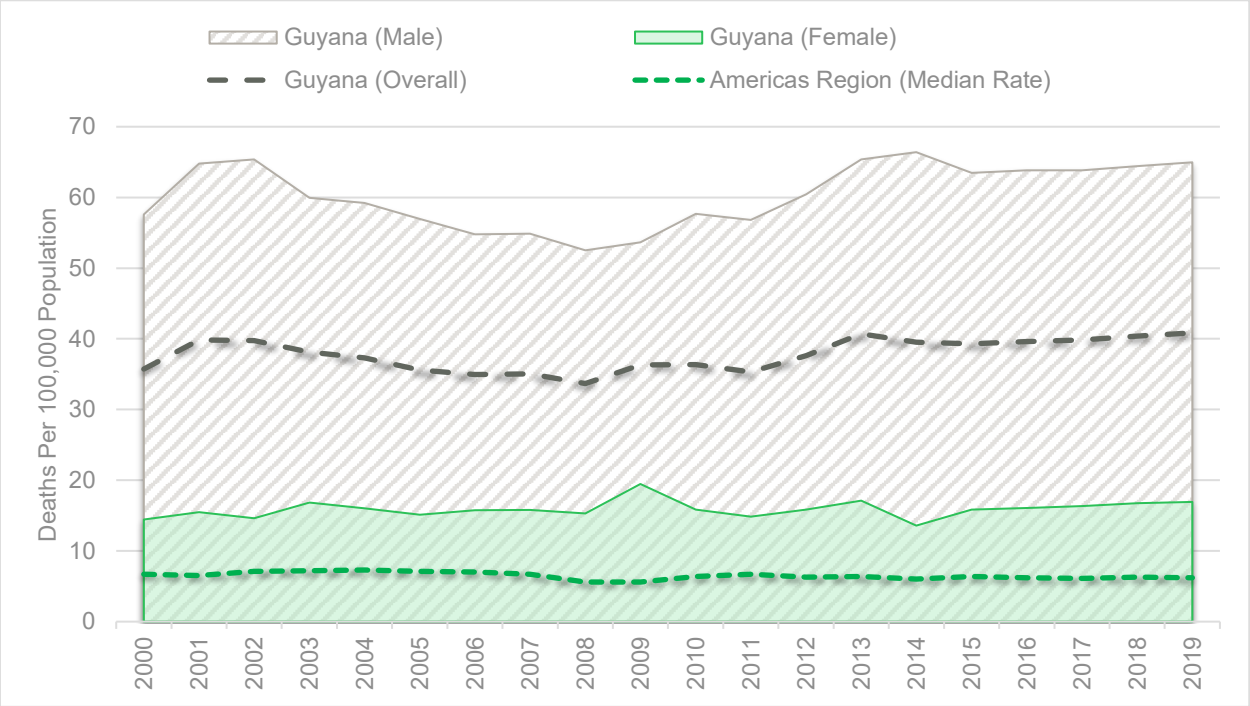
The Mental Health Protection and Promotion Bill was passed in the National Assembly in August 2022, marking an improvement to previous legislation which allowed for discrimination against people with mental health challenges. The bill provides for improved access to mental health services by communities across the country and focuses on integrating mental health services into Guyana’s primary healthcare system. The Ministry also plans to introduce telemedicine, including providing access to psychiatric care (Stabroek News 2022).

Suicide and Suicide Prevention

Guyana reports a relatively high suicide rate at the national level. Since 2008, the age-adjusted suicide rate has shown a generally increasing trend from 33.67 deaths per 100,000 people in 2008, to a high of 40.84 in 2019 (the most recently available annual data; PAHO 2021, 2022a). Rates are substantially higher among males compared to females (64.95 and 16.95 deaths per 100,000 in 2019, respectively) (Figure 1.7).

[12] A healthcare facility is a location that provides biomedical health care. In this context, it includes hospitals, health posts, and health care centres. Source: https://medlineplus.gov/healthfacilities.html

FIGURE 1.7 SUICIDE MORTALITY RATE (AGE-ADJUSTED), GUYANA 2000-2019



Source: PAHO 2022a

Note: Data derived from PAHO Core Indicators Open Data portal. Suicide rates are based on data from the WHO Global Mortality Estimates 2019.

In 2019, Guyana had the highest country-level suicide rate in the Americas region (PAHO 2021), with an overall rate (both sexes) that is 57.5 percent above the next-highest country (Suriname with a rate of 25.9 deaths per 100,000 population), while the median for the region is 6.2 deaths per 100,000. Suicide has been acknowledged as the third major cause of death in the 15 to 44 age group (Green State Development Strategy 2019). In 2016, Guyana's Chief Medical Officer reported that rates were particularly high in Regions 2, 3, and 6, with the most common method being ingestion of poisons such as pesticides. No single reason was pinpointed for this phenomenon, but the shortage of mental health workers and the stigma associated with mental illness—leading to untreated depression—are thought to be contributing factors, as well as the ease of access to pesticides and other toxic agricultural substances (Ministry of Public Health 2016, pers. comm.).

The Mental Health Protection and Promotion Bill provides for the establishment of a National Suicide Prevention Commission and suicide prevention centres, among other measures to help curb the high suicide rate in Guyana. The Commission will develop a suicide prevention strategy to prevent suicide and make provisions to support families and others affected by suicide (News Room 2022). Additionally, the Ministry of Health is now working with international partners—including academic institutions and NGOs—to understand the causes of suicide and how it impacts the family of victims. The Ministry has also begun training primary healthcare practitioners on how to recognise depression in patients who seek therapy to ensure prompt responses.

1.2.3.3 QUALITY OF LIFE

Access to Basic Utilities

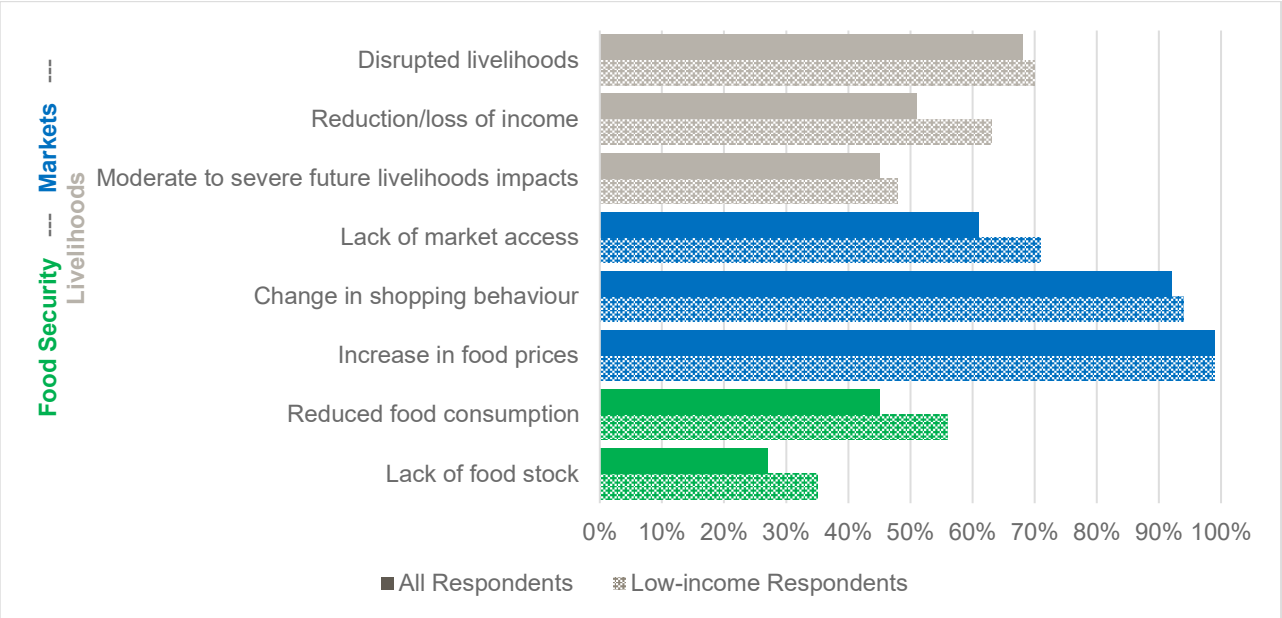
Access to basic utilities including drinking water, sanitation services, and electricity are determinants of health, and are often factors that result in marginalisation of certain groups (including but not limited to remote communities) and negative health outcomes.

Food Security and Cost of Living

Since 2020, supply chain disruptions and other macroeconomic changes have influenced the quality of life for people living in Guyana in a variety of ways, including impacts on livelihoods, food security, and cost of living. The 7th survey of Caribbean nations gathered data on these impacts between March and April 2024, comparing findings with previous survey rounds conducted between April 2020 and May 2023 (CARICOM and WFP 2024). Forty-four percent of the respondents experienced some form of livelihood disruption in 2024, which is a reduction from 60 percent in 2023; 38 percent experienced reduced market access (compared with 52 percent in 2023); 81 percent experienced changes in shopping behaviours (compared with 90 percent in 2023); and increased food prices declined by 1 percent in 2024 compared with 2023 (Figure 1.8).

A survey of Caribbean nations gathered data on these impacts between April 2020 and August 2022 (CARICOM and WFP 2023). Most respondents experienced some form of livelihood disruption (68 percent), as well as reduced market access (61 percent), changes in shopping behaviours (92 percent), and increased food prices (99 percent). These changes have had a disproportionate impact on low-income populations, particularly with regard to food security (including food stock and consumption), access to markets, and loss of income.

FIGURE 1.8 SUMMARY OF FOOD SECURITY AND LIVELIHOODS SURVEY RESULTS, GUYANA (2020-2022)



Source: CARICOM and WFP 2023

Note: Results based on the fifth round of surveys, conducted in August 2022. This survey had a total of 675 respondents (65 percent female), although the online questionnaire resulted in limited inputs from people without internet connectivity.

Global food prices have risen dramatically since 2020 and reached an all-time high in March 2022. In the non-Latin Caribbean countries (including Guyana), the food inflation trend has averaged 10.2 percent across 20 countries (CARICOM and WFP 2023); rising food costs can in turn result in reduced access to food, particularly for low-income populations. Guyana is a unique case in that the growth of Guyana's export-oriented oil sector has benefited positively from escalating oil prices, although the country also currently imports fuel for electricity generation, as well as many food products and other goods. Overall, inflation in Guyana as of July 2022 was reported to be 5.7 percent overall, and 9 percent for food products, making essential food purchases unaffordable for many households in Guyana (CARICOM and WFP 2023).

Impacts on livelihoods have been seen across Guyana, driven by the pandemic and ongoing cost of living crisis. Nearly two-thirds (65 percent) of respondents reported a compromised ability to pursue their livelihoods, compared to a regional average of 55 percent; impacts were more widespread among low-income households. In response to job losses and/or reduced incomes, secondary or alternative income sources are becoming more important. Livelihoods in the construction and agriculture sectors were most reported to be constrained, and the reason for disruption was most often related to the cost (and unaffordability/inaccessibility) of livelihood inputs (e.g., animal feed, fertiliser); these issues are associated with supply chain disruption and price inflation more broadly (CARICOM and WFP 2023).

Households' access to markets has also been adversely affected since 2020, overwhelmingly due to challenges related to declining incomes and reduced finances in the face of a rising cost of living and price inflation (CARICOM and WFP 2023). Impacts among low-income households and those without regular employment were elevated compared to the rest of survey respondents.

With declining financial means and rising costs, the survey indicates that people are choosing to purchase cheaper, less preferred foods, in smaller quantities. This often results in less healthy and less diversified foods, and less ability to maintain a stock of food in the home (CARICOM and WFP 2023). More than a third (37 percent) of respondents indicated that they were skipping meals or eating less to counter food costs (including 49 percent of women), while 8 percent reported going a day or more without eating. Again, rates were higher among low-income respondents and 89 percent of those considered to have below-average incomes reported that they found it difficult to eat enough. Coping strategies included use of financial savings to meet food needs, reduction in essential non-food expenditures (including health and education expenses), and decisions to sell assets to pay for food and other needs (CARICOM and WFP 2023).

Recognising the importance of food security for community health, the Guyana Bureau of Statistics has reportedly added the Food Insecurity Experience Scale to the Guyana Labour Force Survey to measure and report on levels of food affordability and food insecurity (UN Guyana 2023). The survey was most recently published in 2021 and did not yet include these indicators (Bureau of Statistics 2023).

1.2.3.4 SAFETY AND SECURITY

Natural Hazards

Although Guyana is not exposed to a wide range of natural hazards, several risks remain notable. According to the INFORM Risk Index (Inter-Agency Standing Committee and the

European Commission, 2020), the country's major natural threats include flooding, tsunamis, droughts, and epidemics which together represents the most likely natural hazard risks.

Guyana is vulnerable to the impacts of global climate change due to its low-lying coastal areas, as many areas lie below mean sea level and a high percentage of the population and critical infrastructure are located along the coast (World Bank 2021; GPL 2021). Both changes in rainfall patterns and predicted sea-level rise associated with climate change pose significant threats to the Guyanese population and its livelihoods.

Drought and heatwaves also occur, affecting inland ecosystems. During 2025 fieldwork, participants frequently expressed that current dry season was longer and more severe than in previous years, creating issues with access to potable water and limiting water-based travel (ERM Fieldwork, 2025). This historical heat and drought were noted across the Amazonian region (Espinoza et al, 2024). In addition to heat-related health impacts, these events can exacerbate challenges related to water resource availability and allocation, particularly when water resources are in demand for human consumption and household use, agriculture, other industrial uses, and for hydropower generation (GPL 2021). Moreover, the occurrence of Amazonian fires, often exacerbated by dry conditions, poses a significant threat to air quality and biodiversity, further compounding environmental and public health challenges in the region (Brown, 2024). In 2024, the Guyana EPA has recorded over 91,000 fires, burning approximately 5,045 square miles of land with smoke affecting multiple regions, prompting evacuations and health warnings (King, 2024).

Security and Police Presence

The Guyana Police Force (GPF) is responsible for maintaining law and order nationally by enforcing the laws of Guyana (GPF, Undated). Each region in Guyana has a Regional Division, and the regional headquarters for Region 8 is the Mahdia Police Station.

Guyana faces challenges pertaining to safety and security. The Institute for Economics & Peace ranks Guyana 106 out of 163 worldwide, rating the country as being at a "medium" state of peace (IEP, 2023). Nationally, the country has a high crime rate, with murder and armed robbery being major concerns (U.S. Department of State, 2024; Government of Canada, 2024; World Nomads, undated). The most recent information from the GPF for 2023 reports that the number of homicides rose from 122 in 2022 to 159 in 2023 (Guyana Country Security Report, 2024). Murder at the national level is usually related to domestic disputes (more often with female victims) and substance abuse.

While there was a 17 percent decrease in serious crimes from 2022 to 2023 (Guyana Country Security Report, 2024), petty crimes such as theft, car break-ins, pickpocketing, purse snatching, assault, and robbery remain a concern, particularly in urban areas and certain neighbourhoods in Georgetown. This reduction in serious crimes may be attributed to increased police efforts and community initiatives. However, police presence, particularly outside of urban areas, is limited (Gov.uk, 2024).

Road conditions and navigating road networks remain a safety risk in Guyana. Traffic accidents are prevalent in Georgetown, with speeding and driving under the influence of alcohol as contributing factors. Road and driving conditions are poor, and dirt roads in the interior may be impassable during the rainy season (Guyana Country Security Report, 2024).

Sexual and Gender-Based Violence

Guyana has high rates of domestic, sexual, and gender-based violence (SBGV); these are considered significant public health and human rights issues in the country. Domestic and SBGV encompass physical, emotional, and sexual abuse within intimate relationships, families, and the broader community. The prevalence of these issues reflects broader societal challenges, including gender inequality, cultural norms, and socio-economic factors (UN Women, 2019).

According to a report conducted by UNICEF representing women aged 15 to 49, 17.1 percent of women in this age group believe that a husband is justified in beating his wife for reasons such as neglecting their children, arguing with him, refusing sexual intercourse, or going out without informing him (Government and Guyana and UNICEF 2021). The prevalence of such attitudes varies by location, with high percentages observed in rural areas (19.3 percent) compared to urban areas (10.2 percent). Additionally, there are general safety concerns among women, noting their perceptions of safety in their neighbourhoods and their experiences with crime, including robbery and assault (Government of Guyana and UNICEF 2021; ERM Fieldwork 2025).

According to one national survey, over half of all women in Guyana have experienced some form of SBGV with an intimate partner (UN Women, 2019). The country has one of the highest rates of femicide[13] in the Caribbean at 8.8 per 100,000 (World Bank, 2019). Sexual violence, including rape and sexual assault, is also prevalent in Guyana. The Guyana Police Force recorded 176 cases of rape in 2020, reflecting a slight increase from previous years (Guyana Police Force, 2020). However, these figures likely underrepresent the prevalence of rape due to underreporting and social stigma.

Alcohol and drug use often intersect with SGBV, creating a complex and dangerous environment. The use of substances often exacerbates aggressive behaviour and impairs judgement, leading to increased instances of violence (United Nations Office of Drugs and Crime, 2019). Studies show a correlation between substance abuse and the perpetuation of violence, as well as victimisation (World Health Organisation, 2022). Such substances can exacerbate existing social and economic inequalities, contributing to power imbalances and normalised violence.

Cultural norms, traditional gender roles, economic stress and poverty are also linked to increased rates of domestic violence. In Guyana, economic challenges exacerbate tensions within households, leading to high risks of domestic abuse (Heise, 1998). Financial dependency on abusive partners further complicates the situation, making it difficult for victims to leave abusive relationships.

Guyana has attempted to address such domestic and SGBV through legislative and policy measures. The Domestic Violence Act of 1996 and the Sexual Offences Act of 2010 are key pieces of legislation aimed at protecting victims and prosecuting offenders. Additionally, the establishment of specialised units within the police force and partnerships with NGOs have strengthened the support system for victims (UN Women, 2018).

[13] Intentional killing with a gender-related motivation. Source: https://www.unwomen.org/en/news-stories/feature-story/2022/11/five-essential-facts-to-know-about-femicide

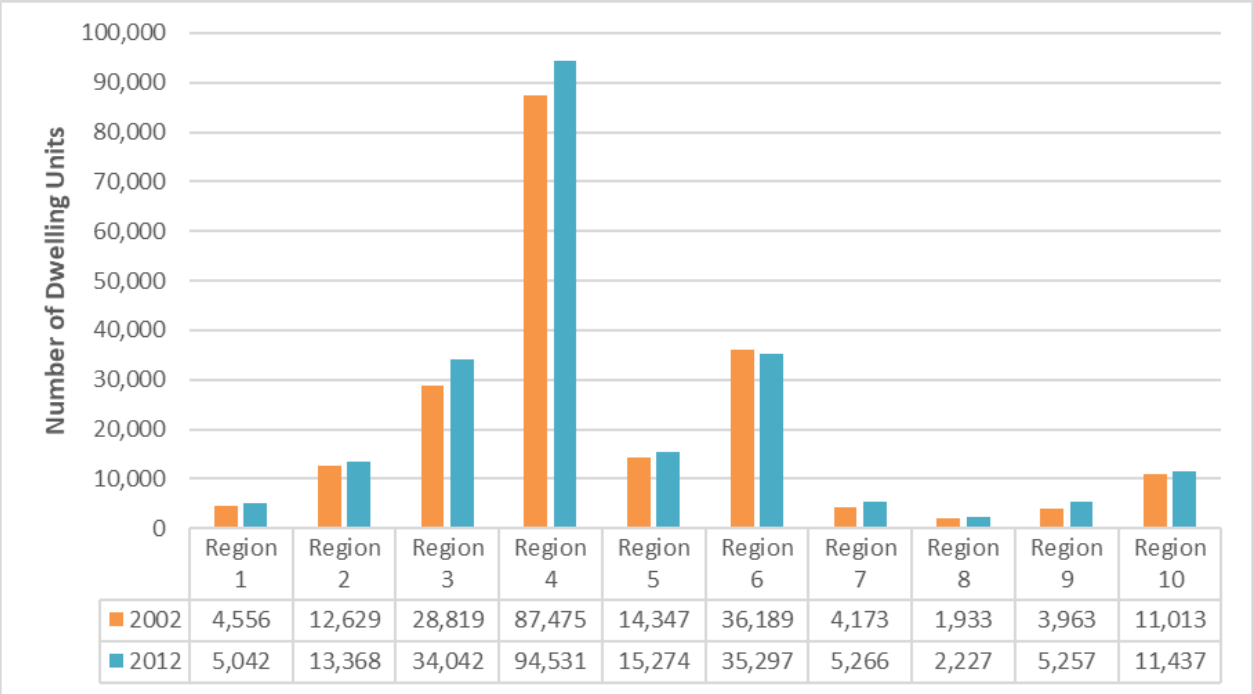
1.2.4 SOCIAL INFRASTRUCTURE AND SERVICES IN GUYANA

1.2.4.1 SOCIAL INFRASTRUCTURE IN GUYANA

Housing

According to the Guyana 2012 census data (BSG, 2012), a total of 221,741 dwelling units were recorded in the country, which represents an increase of 8.1 percent in comparison to the 2002 census results. Regions 3, 4, and 6 contain the largest proportion of the population. Figure 1.9 shows the number of dwelling units by region. According to the 2012 data, 214,999 of the total 221,741 dwelling units were occupied, suggesting that 3 percent were either vacant or closed dwelling units, compared to 8.8 percent in the 2002 census. Occupancy rates were high for all ten administrative regions according to the 2012 census (Figure 1.10).

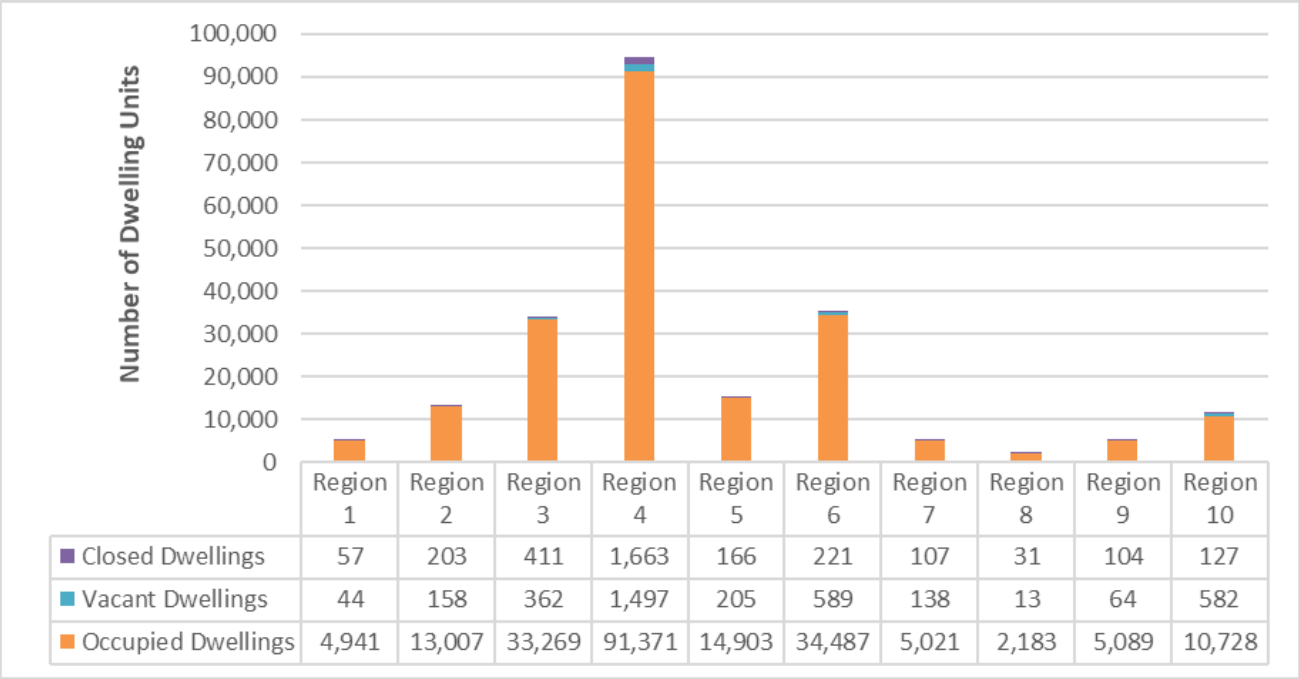
FIGURE 1.9 DISTRIBUTION OF DWELLING UNITS: 2002 AND 2012.



	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8	Region 9	Region 10
2002	4,556	12,629	28,819	87,475	14,347	36,189	4,173	1,933	3,963	11,013
2012	5,042	13,368	34,042	94,531	15,274	35,297	5,266	2,227	5,257	11,437

Source: BSG 2012

FIGURE 1.10 NUMBER OF OCCUPIED, VACANT AND CLOSED DWELLING UNITS: 2012



Source: BSG 2012

Detached houses are the most common type of housing in all regions and most homes are owned by their occupants (BSG 2012). The census data indicates that Regions 3 and 4 have a higher proportion of rented and squatted homes. An Inter-American Development Bank (IDB) study on the Caribbean housing sector reported that Guyana had a housing deficit of 34 percent (meaning, a deficiency in the number of housing needed to accommodate the population of an area), with the need for an additional 20,000 units, and improvements for about 52,000 low-income category households (IDB 2016a).

Housing Market

Guyana's housing market data is lacking, and the Guyana Bureau of Statistics is looking to improve housing market data (IMF 2022). Key real estate indicators, such as residential/ commercial price indices, consumer/business sentiments (as a measure of real estate outlook), volume of houses and dwellings, and/or volume of real estate loans, are not available (Chow 2020).

The housing price index (a subset of the national Urban Consumer Price Index) has been relatively stable since 2019, showing little inflation for housing costs. In comparison, sub-group indices for food and transportation/communication showed significantly higher inflation over the past decade (BSG 2025). However, other sources report that housing prices have increased substantially since 2019, as the development of high-end properties may contribute to upward pressure on average prices, and increased construction costs (labour and materials) may also push prices higher across a broader range of properties. The rise in housing costs has led to affordability challenges for local Guyanese as prices and rental rates soar, especially near central business areas (Nadir 2024).

Rental costs are reported to have risen by as much as 300 percent in Georgetown, attributed to increased demand generated by the current economic boom (Chairman of the Private Sector

Commission, cited in Guyana Chronicle 2022) (Meusa 2022). In particular, the chairman noted that foreigners coming to do business in Guyana are willing to pay higher rental rates, which drives an upward trend for the housing rental market. Chow (2020) suggests that demand from both foreigners and Guyanese living abroad could be influencing housing prices, noting that further data is needed to understand the impact of these variables.

Prior to the global COVID-19 pandemic, a high-demand/low-supply imbalance in the housing market reportedly resulted in unprecedented rental costs, with some properties seeing drastic price increases by 2019, as buyers sought land or investment properties in and near Georgetown (including the East Bank of the Demerara River). This trend has continued, with rental prices increasing, creating challenges for the local community (Ba, 2024). The availability of higher-end, high-security properties desirable to foreign workers remains low, and industry and diplomatic employers have enacted limitations on workers' housing expenses to limit upward pressure on rental rates (Morollo, 2021).

The cost of purchasing a residential property in Georgetown in 2022 could be $75 million GYD ($360,000 USD) and upwards depending on design, location, and other amenities (ERM Fieldwork, 2024). In more affluent areas such as Bel Air and Subryanville, the cost for properties may exceed $100 million GYD ($481,000 USD). Properties in East Coast Demerara sell for over $35 million GYD ($168,000 USD); in West Coast Demerara prices start from $17 million GYD ($82,000 USD). Properties in neighbourhoods on the East Bank of the Demerara River, in proximity to the capital city, are sold at an average of $30 million GYD ($144,000 USD), although prices are noted to vary significantly depending on the neighbourhood (Guyana Real Estate Services 2022).

Informal Housing Settlements

Informal housing settlements increased in the 1980s and 1990s due to housing supply constraints, causing many people to occupy vacant parcels (IDB 2016b). The Ministry of Local Government and Regional Development (MLGRD) has worked in recent years to regularise[14] some informal settlements, particularly in the Georgetown area, by providing services such as paved streets, drainage, septic tanks, and water supply. If informal settlement sites are not suitable for regularisation to permanent neighbourhoods, or intended for future expansion and development, they are moved to other locations (IDB 2016b, 2016a).

In 2021, the Central Housing and Planning Authority (CPHA), in collaboration with the United Nations Human Settlements Programme, launched the Guyana Strategy for Informal Settlements Upgrading and Prevention—Participatory Slum Upgrading Programme, to address informal housing settlements across Guyana. The program aims to ensure accessible housing, regularise lands, and upgrade dwelling areas. The scope includes a database on the informal settlements in Guyana, a strategy to upgrade informal settlements, building awareness, offering incentives, and advancing partnerships for financing and capacity building. The CPHA's work so far has seen regularisation efforts in 164 of 174 settlements, benefitting 21,027 households (MOHW, 2023), and there are ongoing efforts to regularise and relocate informal settlers in various areas through the National Squatter Regularisation and Relocation Programme (MOHW, 2023). Efforts to improve living conditions have included programs like Core Homes under the Adequate Housing and Urban Accessibility Program, establishing new

[14] Regularisation is a process that attempts to restructure informal and unauthorised settlements in terms of physical, legal, official and administrative set ups of land management as well as improving the living condition of its dwellers.

house lots, and supporting infrastructure and policy measures to support home ownership, including access to financial resources.

Electricity

In 2023, 98 percent of Guyanese residents had access to electricity, including 91.6 percent of rural residents and 98.9 percent of urban residents (World Bank, 2025). Compared to the rest of the region (Latin America and the Caribbean), Guyana ranks among the lowest in terms of electricity coverage, as most other nations exceed 98 percent coverage (even in rural areas). More than 90 percent of its installed generation capacity is thermal, relying on expensive imported heavy oil and diesel fuels (U.S. Department of Energy 2020).

Most of the electricity in Guyana is generated, transmitted, and distributed by the state-owned utility Guyana Power and Light Incorporated (GPL Inc.). GPL operations include power generation, transmission, and distribution across the country. As of 2021, GPL provided service to approximately 188,000 customers through the coastal electrical grid (the Demerara-Berbice Interconnected System [DBIS]), in addition to small, isolated grids on the Essequibo coast, the town of Bartica, and the island of Leguan (Williams and Sologuren Blanco 2021). The DBIS is noted to have low reliability due to the age of its generators.

GPL has integrated 17 new generators into the system powered by heavy fuel oil and diesel, with the aim of increasing the electricity delivery capacity (Guyana Times 2024). In addition, a marine power supply vessel powered by heavy fuel oil was connected to the DBIS in May 2024; this vessel is intended to generate additional electricity and alleviate pressure on the existing system, particularly during peak-use periods, for a contracted period of 2 years (Guyana Chronicle 2024). Despite the integration, challenges to supply adequate power to fulfil the demand of the population persist.

Additionally, a power supply vessel was connected to GPL's DBIS at Berbice to support the generation capacity of the company with the expectation of supplying an additional 36 megawatts of power to Guyana in. To supplement electricity generation, two power ships were also brought into the country, and GPL intends to implement a variety of power generation projects in the coming years, including wind and solar (intermittent sources supplemented by battery storage), biomass, hydropower, natural gas, and hybrid systems (GPL 2021). As part of the Low Carbon Development Strategy (LCDS), the Government of Guyana is working to develop low-carbon energy resources (including solar, hydropower, wind, biomass, and natural gas) to meet rapidly rising demand (LCDS 2022). As part of the LCDS, the government has also predicted that renewable energy will dominate Guyana's electricity supply by 2041.

Telecommunications

A total of 700,000 cellular mobile connections were active in Guyana in early 2025, equivalent to 84.0 percent of the total population (Kemp 2025). Access to 4G network has been available since 2016, and the country's first 5G voice over LTE (long-term evolution) service was installed in 2022 (E-Networks 2022). The government has signalled its intention to prioritise the economic liberalisation of Guyana's telecommunications market to encourage greater investment and competition in the sector (Guyana Chronicle 2020).

Internet service in Guyana consists of two major communications companies and several smaller companies providing broadband and satellite services. Services are more readily available on the coast, with limited availability in the interior regions. In January 2025, the

internet user rate was 85.9 percent of the total population, indicating a 0.6 percent increase from January 2024 (Kemp 2025).

The Government of Guyana has embarked on series of programs to address internet inequity in the country; including the national eGovernment Programme, which developed a Digital Governance Roadmap for Guyana (e-Governance Academy 2018), and the campaign to provide free internet access in public spaces and underserved communities (such as hinterland communities) (DPI, 2022b).

Further efforts to bridge the digital divide between the coast and interior include government investment in a satellite ground station to provide connectivity services to over 160 locations in hinterland areas. This initiative benefits approximately 60,000 residents living in remote communities nationwide (DPI 2022b) and has the potential to increase the internet provision rate to levels comparable to North America. In addition to domestic telecommunications programs and projects, the government is also involved in bilateral cooperation and global efforts to develop and promote universally accessible digital platforms (Office of Prime Minister 2022).

Social Welfare

The Ministry of Human Services and Social Security is responsible for the development and implementation of social protection policies and programs to improve the wellbeing of the people of Guyana. Its focus is to provide effective social services to vulnerable groups, promote gender equality, and protect the rights of children, the elderly, and disabled persons. Programs address a range of social welfare topics including sexual offenses and domestic violence, human trafficking, gender affairs, and women's leadership (MHSSS Undated).

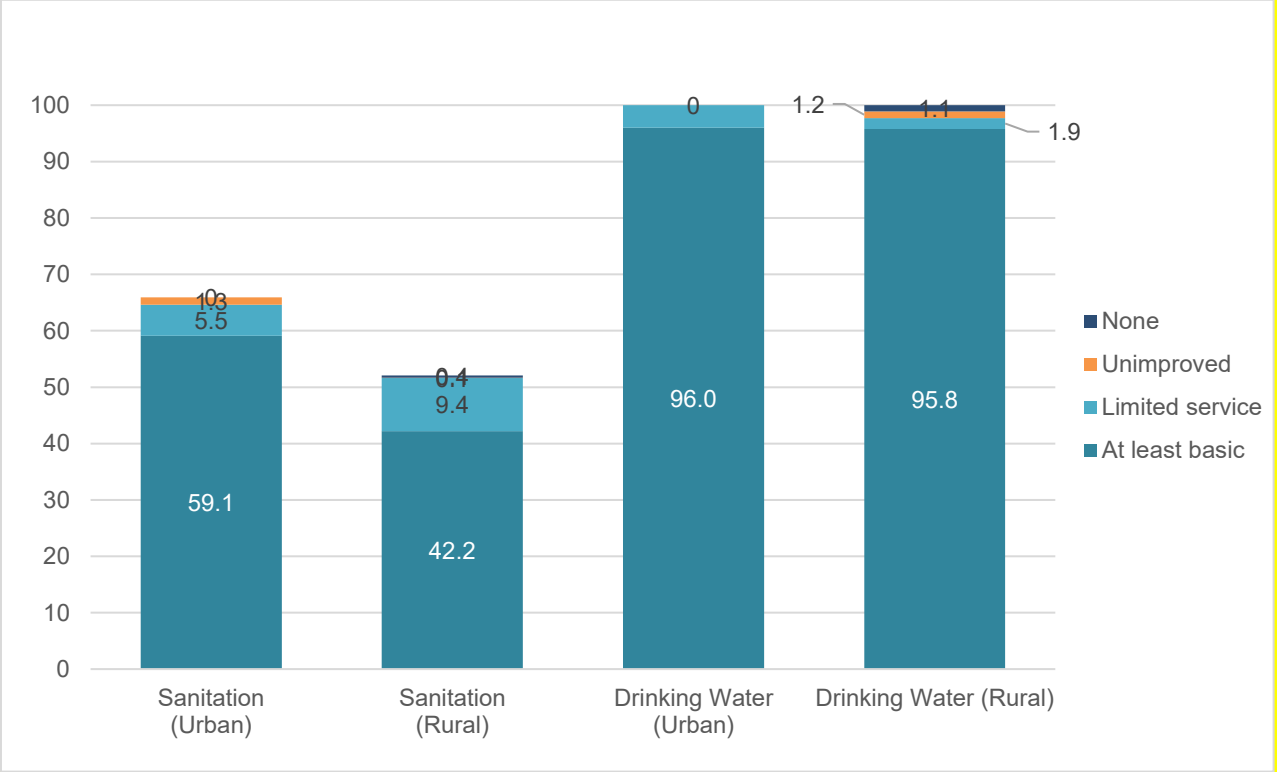
The Ministry of Amerindian Affairs (MoAA) in Guyana is responsible for the development and implementation of policies and programs to improve the wellbeing of the Indigenous Peoples of Guyana. These projects support women's small businesses, language revival, cultural enhancement initiatives, hinterland schools, ecotourism, and community and infrastructure development. Over the years, initiatives such as the Hinterland Employment and Youth Service program and Community Support Officers have provided support and opportunities for youth across the country, skills-training and substantive financial assistance to facilitate business investments and growth (MoAA 2023).

The MoAA also has a Social and Welfare Department that addresses both social welfare and health for Amerindian communities, supported by social workers and nursing staff. The department seeks to address labor and welfare issues, including assisting people to apply for benefits they are entitled to from the National Insurance Scheme and the old-aged pension scheme (MoAA Undated).

Water and Sanitation

Most of Guyana's population has access to basic drinking water supplies, including 96.0 percent of urban populations and 95.9 percent of rural populations (WHO/UNICEF 2023). A lower proportion has access to basic sanitation services, including 59.1 and 42.2 percent of people living in urban and rural areas, respectively (Figure 1.11).

FIGURE 1.11 WATER AND SANITATIOH SERVICE LEVELS IN URBAN AND RURAL AREAS OF GUYANA, 2022



Source: WHO/UNICEF 2023

Note: "None" is designated as open defecation (for sanitation) and untreated surface water sources (for drinking water). Specific definitions of unimproved, limited, and basic service are available through the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) global database.

The Government of Guyana has a goal of 100 percent treated water coverage by 2025 (Guyana Chronicle 2024a) and has committed to increase treated water coverage on the coastline by 90 percent by the end of 2025 (Guyana Chronicle, 2025). There have been ongoing investments such as the construction of 13 new treatment plants across the country as well as upgrades to existing water treatment plants (Guyana Chronicle 2024b). In 2023, Guyana Water Inc. (GWI) announced the construction of 40 new wells and extensions to 30 existing well systems in the Hinterland Regions, resulting in new access to potable water for 12,000 residents, including more than 7,000 who will receive potable water for the first time (Kaieteur News 2023).

GWI maintains a public wastewater management system of approximately 24 sewage pumping stations within most urban communities in Region 4 (central Georgetown) as well as a septic receiving station at Tucville (South Georgetown). These two systems collect effluent from a fixed population of 60,000 residents along with a transient population of another 200,000 persons (GWI Undated (a)).

1.2.4.2 WASTE MANAGEMENT IN GUYANA

Waste Management Authorities

Several public sector agencies are involved in waste management in Guyana including the Environmental Protection Agency (EPA), Ministry of Local Government and Regional Development (MLGRD), Ministry of Public Health, Ministry of Natural Resources, RDCs, NDCs, and TCs, and there is some overlap in roles and responsibilities. The two key organisations involved in waste management are the EPA and the MLGRD; their roles in waste management are further elaborated below.

Environmental Protection Agency

The EPA is responsible for permitting waste disposal sites. In addition, Manufacturing/Industry is one of the EPA's program areas, under which is the Waste Management sub-program (EPA Undated). Within this sub-program area, the EPA manages the policies, guidelines, and standard operating procedures regarding waste management and resource recovery. The aim is to realise maximum value from natural resources and ensure a "green environment." The core function of the Waste Management sub-program is to manage waste entering the environment in an environmentally sound manner. Through this function, the EPA provides technical assistance in the development, management, and operation of waste management facilities; conducts research and analysis on the recovery of useful energy from solid waste; and develops guidelines and standards for the disposal of hazardous waste and other types of waste. Through the same sub-program, the EPA also coordinates and implements the obligations of the Basel Convention and controls the import and export of hazardous waste through granting authorisations. The waste management sub-program focuses on three topics: solid waste management, hazardous waste management, and waste reduction and recovery (EPA Undated).

The Ministry of Local Government and Regional Development

The MLGRD is the primary government agency that links the various local authorities with the central Government of Guyana. It facilitates, coordinates, and monitors the execution and implementation of projects, programs, and activities in the various local government arms and ensures that these activities conform with the legal framework and government policies. This Ministry is also leading the development of the National Solid Waste Management Strategy. The MLGRD has direct oversight over the Haags Bosch Landfill (HBL) site, as well as the waste management activities of RDCs, NDCs, and TCs.

Municipal/Non-Hazardous Waste Management Facilities

Aside from the HBL in Region 4, most regions in Guyana rely on dumpsites for the disposal of municipal waste, with each region having at least one dumpsite. In addition to receiving municipal waste from household collections, these dumpsites are also used for the disposal of commercial and industrial waste. Although dumpsites are intended for the disposal of nonhazardous waste, restrictions on incoming waste are not always enforced.

The Government of Guyana is seeking to develop a more coordinated approach to waste infrastructure planning that is compatible with land use planning and promotes coordination and optimisation of waste management facilities across all regions. The Ministry of Communities (predecessor to MLGRD) is working to progressively rehabilitate illegal dumpsites, disused dumpsites, and poorly operated dumpsites. In 2019, the Sanitation

Management Unit collaborated with the EPA to embark on assessments of existing dumpsites and proposed landfill sites in each administrative region across Guyana. The project was working toward a countrywide sustainable waste management system. The MLGRD has controlled dumpsites at Lusignan (Region 4); Byderabo in Bartica (Region 7); Rose Hall and Esplanade in New Amsterdam (Region 6); and Bon Success in Lethem (Region 9).

Wastewater

GWI, a company established in 2002, currently provides water for over 145,000 homes, schools, and offices in Guyana (GWI Undated). Amerindian communities in the interior also receive water from GWI, and the company has a goal to provide 80 percent of those communities with water by 2025.

There are currently 24 sewerage pumping stations operated by GWI that form a sewerage system in central Georgetown along with a septic receiving station located at Tucville. The liquid waste or sewage from approximately 60,000 residents (plus approximately 200,000 transient individuals) is collected by these two networks' stations (GWI Undated). GWI also operates water treatment facilities in 27 locations around Guyana (GWI Undated).

GWI plans to construct two effluent treatment plants as part of its developmental program. These plants will be located at the end of the Georgetown Sewerage System and the Tucville Sewerage System (Global Infrastructure Magazine 2023).

1.2.4.3 INDUSTRIAL/HAZARDOUS WASTE MANAGEMENT FACILITIES

There are a limited number of facilities for the treatment of hazardous and industrial waste in Guyana, although the construction and proposal of additional facilities are growing commensurate with the planned expansion of oil and gas activities. Environmental Technical Solutions (ETS) (formerly Tiger Rentals Guyana Inc.) and Sustainable Environmental Solutions Guyana, Inc. (SES), located at the Guyana Shore Base Inc. Facility in Georgetown, are currently the primary providers of hazardous and non-hazardous waste treatment services in Guyana. Both facilities employ a variety of waste treatment technologies (sorting/segregation of recyclables, physical/chemical/thermal treatment of hazardous and non-hazardous wastes), discharge of its treated fluids as permitted to the Demerara River, and disposal of treated non-hazardous solid waste, as well as other wastes received (including general trash, paper/cardboard, and scrap wood) to the HBL.

In addition to ETS and SES, several private waste management facilities and tank cleaning services have come online to manage hazardous and non-hazardous waste treatment, however, these services are not available in interior locations but are centred in Region 4. Some of these facilities include:

- Eternity Investment Inc. (EII) is a scrap metal consolidation and exporting facility that also accepts and manages lead acid batteries and electronic waste. EII is authorised by the EPA to manage electronic waste. The main scrap yard for the facility is located in a sparsely developed area of Madewini near the Cheddi Jagan International Airport (CJIA), Region 4. Avinash Contracting and Scrap Metal is a facility authorised by the EPA to manage scrap metal, which includes both consolidation and exporting. The facility's scrapyard is located at Lot 9 in Coverden East Bank Demerara, Region 4.
- Marine vessel tank cleaning operations are being developed in Guyana. The cleaning process that is employed in Trinidad is manual and generates large volumes of wash water

and solids. The tank cleaning system to be used in Guyana includes a solids removal system and wash water reuse technology.

1.2.4.4 TRANSPORTATION IN GUYANA

This section describes the existing land, air, and water transportation infrastructure in Guyana.

Road Network

Guyana has an approximately 7,080-kilometre road network serving a country of 214,920 km^2, with an average of 19 percent comprising primary roads and 21 percent comprising feeder roads that link primary routes connecting major towns across the coast and selected communities in the interior. The entire road network is heavily reliant on bridges and culverts to serve areas with a dense system of drains and canals along the coastal lowlands where most of the population resides. The primarily unpaved Hinterland Regions road network accounts for the remaining 60 percent of the total road network (World Bank 2024).

Georgetown has a compact, grid-based street network. The port area is linked to central Georgetown via the East Bank of Demerara Public Road. Most intersections are not signal controlled; where signals do exist, they can be frequently out of service. Pedestrian overpasses were recently installed at several areas along the East Bank of Demerara Public Road to improve pedestrian safety and assist in reducing traffic congestion.

Traffic congestion is a chronic problem in and around Georgetown. Many different types of vehicles including cars, large commercial vehicles, mini-buses, horse-drawn carts, bicycles, mopeds, scooters, and motorcycles share the same travel lanes. Traffic congestion occurs frequently, particularly just before and after school. Numerous factors contribute to traffic risks, particularly at night (OSAC 2020), including driver behaviour, poor road conditions, lack of streetlights, lack of enforcement of traffic laws, narrow roads and streets, and shared use of roads by vehicles, bicycles, scooters, pedestrians, and free-range livestock. Reckless driving, speeding, and driving under the influence of alcohol contribute to traffic incident rates.

Vehicular travel between Vreed-en-Hoop and Georgetown requires crossing the Demerara Harbour Bridge, which has one travel lane in each direction and a weight limit of 18 tonnes for general traffic (22 tonnes for special crossings). Vehicular traffic is subjected to daily bridge closures to allow larger vessel traffic to pass through the bridge's central section into and out of the Demerara Harbour. Daily closures typically last for 90 minutes and can create significant congestion on either side of the bridge.

The Ministry of Public Works plans to replace the Demerara Harbour Bridge with a new bridge from Nandy Park to La Grange, upstream of the existing bridge. The replacement structure will be a fixed four-lane bridge with a vertical clearance over the channel of approximately 50 meters above the maximum tide level. The Ministry of Public Works issued a request for proposals for the construction of the new bridge in February 2022 (Guyana Ministry of Public Works 2022). Construction had commenced in May 2023 (Guyana Times 2023). The project is ongoing, and construction is currently at approximately 76.91 percent (Guyana Chronicle 2025).

Marine Transportation and Navigable Waters

Guyana's marine transportation integrates an extensive network of rivers (such as the Demerara, Essequibo and Berbice), and a comprehensive range of marine transportation services (such as ports and ferry services) that connect coastal areas to inland communities,

facilitating trade, industrial activity, commuting, and tourism (particularly river tours). The Maritime Administration Department (MARAD) is responsible for inspecting and surveying vessels, including their hulls, machinery, and equipment. They also handle matters related to cargo handling and stowage. The port also has a security section ensuring compliance with international ship and port security (MARAD Undated).

The main port is the port in Guyana is referred to as the Port of Georgetown, and is located at the mouth of the Demerara River, equipped to handle cargo for exports and imports, facilitating international trade. It accommodates various types of cargo including containerised goods, bulk cargo, and general cargo. The port has a river frontage of 2 nautical miles and six commercial wharves with water depths ranging from 5 to 7 meters and handling approximately 50,000 tons annually (Bhattacharjee 2022). Other ports in Guyana include the Port of Essequibo connecting Parika (Region 3), Linden (Region 10) and Demerara (Region 4); The port of New Amsterdam and subsidiary facility Port Everton located on the eastern shores of the Berbice River; The port of Linden located 93 south of Georgetown and is famous for its bauxite mining industry; and the port of Kaituma located 96 kilometres upstream on the Kaituma River, near the western end of the seaboard (Bhattacharjee 2022).

1.2.4.5 AIR TRANSPORTATION

Guyana's air transportation infrastructure includes two international airports: CJIA and Eugene F. Correira International Airport (ECIA; also commonly referred to as Ogle Airport). Nearly 100 aerodromes serve smaller towns and villages, principally in the Hinterland regions. The CJIA and ECIA provide direct international flights to the Caribbean, South America, Central America, and North American countries. CJIA is located at Timehri, 40 kilometres south of Georgetown; ECIA is located approximately 6 kilometres from Georgetown, and has developed into the principal domestic air hub, providing commercial and cargo transport services primarily between Georgetown and the hinterland regions.

Air transportation in Guyana supports a variety of sectors including agriculture, tourism, and the extractive sectors. In 2019, Guyana ranked 104 out of 211 countries on the Air Connectivity Index (IATA 2020), and 49 out of 141 economies for the quality of its air transportation infrastructure (World Economic Forum 2015).

According to government officials, the passenger volume at four of Guyana's major ports of entry (CJIA in Timehri, Ogle's Eugene F. Correia Airport, Lethem Border, and Moleson Creek in Corentyne) saw an increase with a total of 931,450 international passenger movements across its four key ports of entry by the close of 2023. The figure represented 93 percent of the goal set by the Government of Guyana (Kaieteur News 2024).

1.3 EXISTING LAND USE

1.3.1 EXISTING LAND USE IN GUYANA

1.3.1.1 GUYANA'S ECOREGIONS

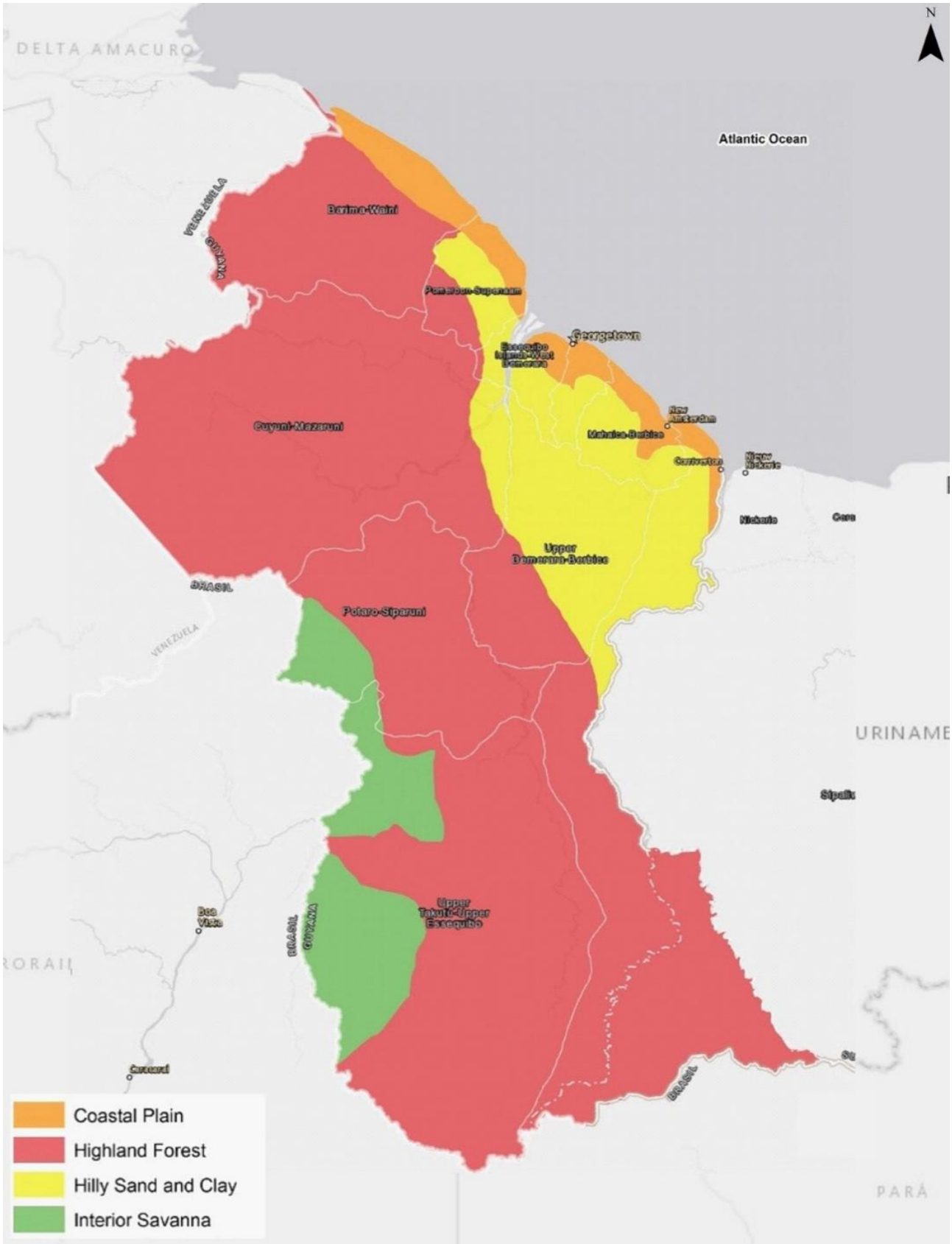
Guyana covers 214,920 square kilometres (km^2) and is bordered by the Atlantic Ocean to the north, Brazil to the south, Suriname to the east, and Venezuela to the west. It can broadly be divided into four ecoregions:

- The low **coastal plain** stretches approximately 9,202 km^2, from the Corentyne River in the east to Waini Point in the west, and ranges from approximately 5 to 65 kilometres wide

along the coast. It accounts for less than 8 percent of the country's land area and is approximately 1.4 meters below mean high tide level. The coastal plain is known for its silty clay, peat and sandy soils which are conducive to agriculture.

- The **hilly sand region** is a largely vegetated zone dominated by white, sandy soils and undulating terrain lying inland from the coastal zone. This zone is approximately 28,920 km^2, is largely forested, and contains most of the country's bauxite and stone mineral deposits.
- The **forested highlands** extend from the hilly sand region to the country's southern borders and are part of the pre-Cambrian Guiana Shield. This zone comprises about 73 percent of the country's land mass – approximately 156,450 km^2 – and is often divided into the western highlands and southern uplands. The highland region is known for its mountain ranges, dense forest, and gold and diamond mineral resources.
- The **interior savannas** consist of two main savanna complexes: the Rupununi Savannas and the Intermediate Savannas. The Rupununi Savannas cover 15,540 km^2 and lie in the southwestern part of the country. The Intermediate Savannas cover 5,180 km^2 and are 97 kilometres from the mouth of the Berbice River.

FIGURE 1.36 THE ECOREGIONS OF GUYANA



EPA/MNR 2014

1.3.1.2 LAND DISTRIBUTION AND OWNERSHIP

There are three types of land tenure in Guyana (GLSC 2013):

- **Public lands** include state-owned land and government land. State lands are held by the people of Guyana and may be licensed, permitted, or leased for various purposes including agriculture, forestry, and mining. Government lands have been granted to the Government of Guyana by the state, to be developed for public purposes such as healthcare, schools, land development schemes, etc. Combined, public land is estimated to account for between 76 percent (GLSC 2013) and 85 percent of all land in Guyana (GLSC 2018).
- **Private (freehold) lands** are bought and sold in the freehold market and are held under either a "certificate of title" or "transport of property." Transactions are recorded by the Land Registry or Deeds Registry, respectively. Private lands are estimated to account for between 2 percent (Khemraj 2019) and 10 percent (GLSC 2013) of all land in Guyana.
- **Amerindian lands** are held under communal title and are collectively owned by the respective Indigenous groups and are not subject to transfer or sale. Combined, Amerindian lands account for approximately 17 percent of land in Guyana (GLSC 2024).

1.3.1.3 LAND USE ADMINISTRATION

There are three government entities responsible for the administration of land for mining, forestry, and agriculture:

- **Guyana Land and Surveys Commission** (GLSC), in accordance with the State Lands Act and Regulations, manages the distribution of public lands for agriculture, commercial, industrial, ecotourism and shelter and settlement use.
- **Guyana Geology and Mines Commission** (GGMC), in accordance with the 1979 Act, distributes limited-term concessions for mineral resources. The Act of 1979 mandates the GGMC to promote mineral production, provide guidance on resource exploitation, and conduct mineral exploration and research, and therefore governs the issuance of prospecting and mining licenses categorised by scale: Small-scale operations require a prospecting license, with subsequent steps including notice submission payment of fees to the GGMC. Medium and large-scale operations involve prospecting licenses and additional requirements such as environmental assessments and management plans (Mining Act, 1989).
- **Guyana Forestry Commission** (GFC), in accordance with the Forest Act of 2009 (Forest Act, 2009) and the National Forest Plan that has been developed to address forest policies (GFC Undated), is responsible for administration and management of all state forest land. The National Forest Plan outlines the strategic framework and guidelines for principles of sustainable forest management, including maintaining healthy ecosystems, biodiversity conservation, and ensuring long term productivity of resources, consistent with the Green State Development Strategy[15]. The Plan outlines four specific objectives that drive all activities: delivering economic benefits form the forest; conservation, protection and sustaining the forest; governing the forest to ensure current and future benefits; and building human and institutional capacity for management of activities in the forest (NFP, 2018).

[15] The Green State Development Strategy: Vision 2040 is Guyana's twenty-year, national development policy that reflects the guiding vision and principles of the 'green agenda'.

These three entities may also distribute land in common space for different purposes. Leases of government-owned lands are issued by the GLSC or other designated authorities. Freehold titles are recorded by two separate agencies: the Deeds and Commercial Registries Authority (DCRA), and the Land Registry. The DCRA is responsible for administering the laws enacted by Parliament affecting land (DCRA Undated). The Land Registry was established to simplify land registration and provide security of tenure to owners of titled public lands (Land Registry Undated).

According to a study of the land registration system in Guyana conducted by the Inter-American Development Bank (IDB), the country's dual property registration systems (title registration and deed registration) have regulations that overlap, conflict and are considered complex and bureaucratic ((IDB 2010). They are also considered ineffective in managing and enforcing rights. As a result, many landowners do not register their properties or keep their ownership rights up to date (IDB 2010). However, in recent years, the capacities of the DCRA and Land Registry have improved to enable better execution of their legal mandates. In addition, the GLSC is working to regulate land to provide security of tenure on public lands.

Guyana has a National Land Use Plan (GLSC 2013) that guides the GLSC in land management and administration. Separately, the GLSC has implemented the Mainstreaming Sustainable Land Development and Management (SLDM) project (SLDM 2021), which focuses on strengthening institutional and human capacities for participatory and integrated land use planning. The SLDM project began in 2018 and involves several activities, including land monitoring, surveying, valuation, and mapping, as well as updating equipment, technology, tools and systems, and capacity building through training for GLSC staff and other partner agencies (Seelall 2021). This includes updating national base maps, which are currently outdated (Chabrol 2022).

1.3.2 MAJOR LAND USE ACTIVITIES IN GUYANA

1.3.2.1 MINING

Mining is an established industry with an extensive history in Guyana. There are six mining districts in the country, all of which are in the interior (GGMC 2025). All scales of mining—from artisanal and small mining (ASM) to large-scale operations—are overseen by the GGMC. Although Guyana has a formalised system of ASM, there is also a high degree of informality associated with the sector, particularly given the large area in the interior regions that a restricted number of GGMC officers are managing and overseeing, as well as dynamic influxes of people from Brazil, Colombia, and Venezuela. A wide range of spatial and quantitative data also confirms intensive mining activity in Guyana, with higher-resolution data indicating substantial ASM activity near waters and streams (Maus et al. 2022).

Over the years, the mining sector, driven primarily by gold production, was the largest contributor to Guyana's GDP; however, with the emergence of the oil and gas industry, petroleum now stands as the country's dominant economic contributor. Mining still accounts for a substantial portion of the country's GDP. In 2024, the gold mining sector contributed $116,509 million GYD (approximately $557 thousand USD) to the national GDP (Bank of Guyana 2025). Gold production increased by 0.5 percent specifically, due to the increase in production by the sole large scale operating foreign company (Guyana Gold Fields Inc. [Zijin]) by 30.9 percent. Artisanal and small-scale mining operations which accounted for 67.0 percent of total declarations recorded a 9.9 percent decline attributed to unprecedented weather

patterns (dry weather and heavy rainfalls) throughout the year (Bank of Guyana 2025). To uphold Guyana's commitment to the continued development of the mining sector in the interior, the Government of Guyana had awarded 150 medium-scale mining blocks within for mining districts in Guyana's interior (including Potaro, Region 8) (News Room, 2024).

Mining, and particularly ASM, has been identified as a driver of environmental issues and land use and ownership conflicts, including with Indigenous communities, but also an important activity in Guyana's path to meeting Sustainable Development Goals (SDGs) (Laing et al. 2021). ASM is also a main driver of deforestation, accounting for up to 74 percent and 91 percent of annual deforestation between 2009 and 2018 (GFC 2019), and a key source of contamination of water through pervasive use of mercury in smaller-scale dredge operations, with knock-on effects for human health and wellbeing (see Community Health and Wellbeing Section 10.2).

1.3.2.2 FORESTRY

Forests cover over 19.3 million hectares of Guyana's landmass, and about 12.6 million hectares have been designated as State Forests and placed under the management of the GFC. Indigenous peoples manage approximately 17 percent of the remaining forest area, and the rest have been designated as protected and research areas (EITI 2023). Guyana's forestry industry currently employs over 25,000 people (GFC 2025), and production output by volume is focused on logs, lumber, roundwood, and split wood (Parkinson 2023; GFC 2020).

Driven through commitments to reducing deforestation and carbon emissions, Guyana has in recent decades tied forest conservation in interior regions to sustainable development funding. The Reducing Emissions from Deforestation and Forest Degradation (REDD+) Investment Fund finances activities identified under the Government of Guyana's Low Carbon Development Strategy (LCDS) (World Bank 2024), with the LCDS acting as an importance source of development funding for interior communities, particularly Amerindian communities (Government of Guyana 2024). Partly as a result of the REDD+ structure and the LCDS, Guyana reportedly has one of the lowest rates of deforestation, with more than 99 percent of Guyana's forest cover maintained (Parkinson 2023).

Guyana manages approximately 5.3 million hectares of forest for timber extraction, approximately 29 percent of total forest area (Liui et al. 2024). In 2024, the forestry sector expanded by 4.6 percent mainly due to an increase in roundwood production of 19.3 percent. Sawn wood and logs production increased by 5.9 percent and 4.8 percent respectively (Bank of Guyana 2025).

The log tagging system in Guyana reports the origin, movement, and sale of timber products to support a sustainable forestry sector (GFC 2013), although as the above section ('Mining') demonstrates, drivers of deforestation and forest degradation are complex, and overlapping use and ownership rights sometimes create uncertainty and limit investment in sustainable forest management (Liu et al. 2024).

1.3.2.3 AGRICULTURE

Most of the cultivated land is concentrated in the coastal plain, where most of the population also resides (World Bank 2023). Large-scale and commercial-scale agriculture is dominant in the coastal areas of Regions 2, 3, 4, 5, and 6 and occurs to a lesser extent in Region 1 and other Regions of Guyana. As of 2021, agricultural lands represented 5.3 percent of the total land area in Guyana (World Bank 2023). The main agricultural crops in the coastal areas are

sugar, rice, and coconut plantations, interspersed with smaller-scale establishments of cash crops, non-traditional crops (e.g., grains, oil seeds, roots and tubers, vegetables, spices, and fruits), and livestock (Seoraj 2021; Ministry of Agriculture 2021). Sugar cane plantations, playing a foundational role in colonial practice in the region, are found in Regions 3 through 6, as well as rice cultivation in Regions 2 through 6, and coconut cultivation in Regions 1 through 6 (Seoraj 2021). Agriculture in the interior regions includes livestock rearing on the Rupununi plains but is largely characterised by smaller-scale and subsistence farming, livestock rearing, and poultry production (Ministry of Agriculture 2017; ERM Fieldwork 2025).

1.3.2.4 INDIGENOUS LAND USE

The population of the interior regions of Guyana are primarily Indigenous peoples (74.5 percent), and of the 96 formally titled Indigenous lands in the country, most are in interior regions (BSG 2012; MoAA 2025) (for land ownership and governance, see also Indigenous Peoples Section 10.8). On titled and untitled lands, Indigenous communities often engage in traditional practices like hunting, fishing, and subsistence agriculture. Titled communities possess the legal documentation and official recognition of Indigenous rights that, in principle, safeguard the lands from potential disputes or external threats. Based on conflicts over land use, including mining in and near Amerindian land titles, there are some calls for revisions to the 2006 Amerindian Act to, broadly, increase decision-making power over land title demarcation and land use rights by Amerindian groups (Amerindian Peoples Association; Forest Peoples Programme; Rainforest Foundation US, 2019; Sharples 2021). Titled land rights do not include subsurface rights.

1.4 INDIGENOUS PEOPLES IN GUYANA

Indigenous peoples in Guyana, referred to as Amerindians (a term defined in the 2006 Amerindian Act to represent Guyana's First Peoples[16]), are known historically as the first inhabitants of Guyana. The Amerindian population in Guyana was approximately 78,492 total in 2012 (BSG, 2012), or 10.5 percent of the total population—nearly double that of 1980 (Table 1.6).

TABLE 1.6 DISTRIBUTION OF POPULATION BY ETHNIC/NATIONALITY GROUP IN GUYANA (1980–2012)

Ethnic Background	Population				Percentage			
	1980	1991	2002	2012	1980	1991	2002	2012
African/Black	234,094	233,465	227,062	218,483	30.8	32.3	30.2	29.3
Amerindian	40,343	46,722	68,675	78,492	5.3	6.5	9.1	10.5
Chinese	1,864	1,290	1,396	1,377	0.3	0.2	0.2	0.2
East Indian	394,417	351,939	326,277	297,493	51.9	48.6	43.4	39.8
Mixed	84,764	87,881	125,727	148,532	11.2	12.1	16.7	19.9
Portuguese	3,011	1,959	1,498	1,910	0.4	0.3	0.2	0.2
White	779	308	476	415	0.1	0.04	0.06	0.06

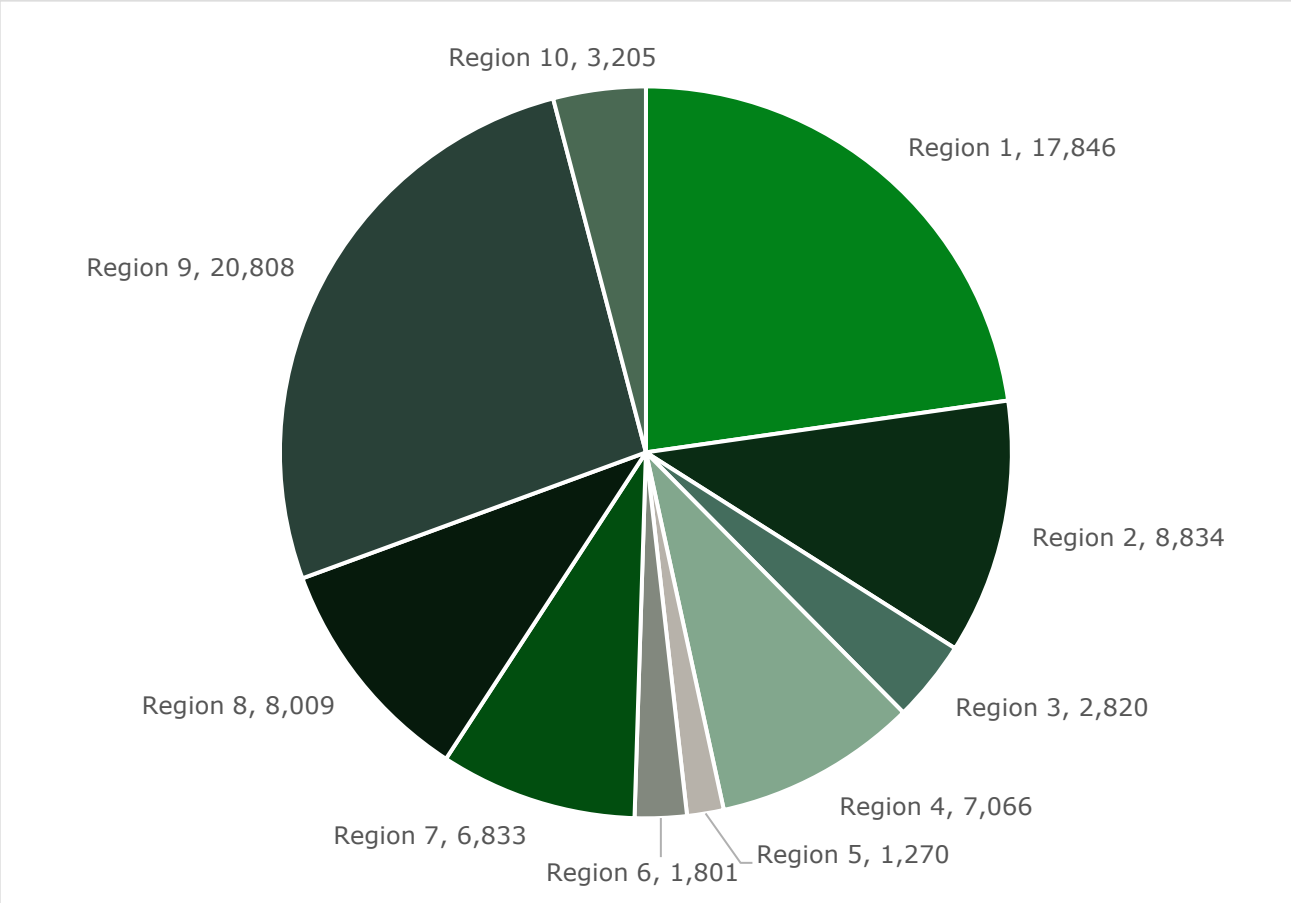
[16] Source : https://observatoriop10.cepal.org/en/instrument/amerindian-act-no-6-2006#:~:text=The%20Act%20provides%20for%20the,the%20promotion%20of%20good%20governance.

Ethnic Background	Population				Percentage			
	1980	1991	2002	2012	1980	1991	2002	2012
Other	294	107	112	253	0.04	0.01	0.01	0.03
Total	**759,566**	**723,671**	**751,223**	**746,955**	**100**	**100**	**100**	**100**

Source: BSG, 2012

Most Amerindian peoples live in interior regions, making up 85.8 percent of the population in Region 9, 72.3 percent in Region 8, 64.5 percent in Region 1, and 37.1 percent in Region 7 (BSG, 2012) (Figure 1.12). In addition to formally titled Amerindian settlements in interior regions, Amerindian peoples also reside in other communities throughout Guyana.

FIGURE 1.12 AMERINDIAN POPULATION BY REGION (2012)



Source: Derived from BSG, 2012

Over the years, the Government of Guyana has pursued several initiatives to increase support for Indigenous peoples. Guyana endorsed the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) in 2007[17]; however, it is one of the few countries in South America that has not ratified ILO Convention 169, the Indigenous and Tribal Peoples'

[17] Source : https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf

Convention[18], which sets legally binding standards for national governments with respect to Indigenous rights and lands (IWGIA, Undated).

In addition to the Government of Guyana, the Amerindian People's Association (APA) is a non-governmental organisation founded in 1991 by Indigenous leaders (APA, Undated). The APA is an advocacy group that promotes the rights and interests of Amerindian peoples throughout the country. One of the APA's goals is to map, re-map, and confirm land title boundaries for Amerindian communities in Guyana.

1.4.1 AMERINDIAN GROUPS AND LANGUAGE

There are nine groups of Amerindians in Guyana, with groupings based on language. These groups include the Warraus, the Arawaks, and the Caribs (Karinya), who have historically lived on the coast (mainly in Regions 1 and 2); and the Wapishana, the Arecunas, the Macushis, the Wai Wais, the Patamonas (sometimes Patamunas), and the Akawaios, who have historically lived in the interior (mainly Regions 7, 8, and 9) (Indigenous World 2023; MoAA Undated). Each of these groups have their own distinct customs, languages and culture, and maintain a close connection to their traditional lands and practices.

There are an estimated 14,000 speakers of Amerindian languages with varying degrees of fluency in Guyana (Village Voice, 2023). Language experts have grouped the nine Indigenous languages into three Indigenous language families based on similarities: Carib, Arawak, and Warrau (Village Voice 2023). Often, speakers of an Indigenous language may be able to understand a speaker of another language within the same group. Indigenous languages are primarily oral and passed down through generations of oral tradition. Some Indigenous groups have lost ability to converse in their languages at the village level, with younger generations raising concerns about Indigenous language preservation. This was found to be the case during ERM fieldwork carried out in Amerindian communities in Region 8, where participants stated that generally only some elders speak Indigenous languages (ERM Fieldwork, 2025).

The preservation of Amerindian languages is important for maintaining cultural continuity, traditions, environmental understanding, and the unique perspectives of Indigenous communities in Guyana. The Ministry of Amerindian Affairs has created an Amerindian Language Revival Programme to revitalise the use and understanding of Indigenous languages. This initiative will be offered to students from interior regions residing at dormitories in Georgetown (St. Vincent Times 2022, INews Guyana 2021). The University of Guyana, through the Department of Language and Cultural Studies, has also carried out research, documentation, and educational programs, aiming to revitalise Indigenous languages. One such initiative is the Amerindian Language Project (ALP) which focuses on studying and preserving languages and their cultural significance (Guyana Chronicle 2020).

1.4.2 LAND OWNERSHIP

Some Amerindian communities hold collective title to the land on which they reside. The difference between 'titled' and 'untitled' Amerindian lands lies in the legal recognition and protection of ownership, where titled land means an Amerindian community legally owns the land (Ministry of Amerindian Affairs, 2024). There are 96 titled Amerindian Villages across the

[18] Source : https://normlex.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C169

country, and several Amerindian communities untitled land (GLSC, 2024). Notably, titled land does not include sub-surface rights.

Titled Amerindian lands have undergone a formal titling process involving communities demarcating ancestral lands, and consultations between government authorities and Indigenous communities to determine the boundaries and rights associated with the demarcated land. There are legal documentation and official recognition of Indigenous communities' ownership rights, with aims to safeguard the lands from potential disputes or external threats. Based on provisions in the Amerindian Act of 2006, Amerindian communities requesting titled lands are required to show their use and occupation of the land for at least 25 years, and to have a population of at least 150 people for a continuous five years preceding the application (Ministry of Amerindian Affairs, 2024). Titled lands are governed by Village Councils, led by a Toshao (discussed in the following section). Titled land is privately held by the village, and Village Councils are responsible for allocating lands to residents, in accordance with the Amerindian Act of 2006.[19]

Untitled Amerindian lands, however, are territories that have not undergone the formal titling process and lack legal documentation specifying ownership rights. While there is no formal land ownership, leadership structures such as Community Councils, led by a Chairperson or Councillor, oversee decision making and community affairs. Community leaders work with government agencies to access resources and address community issues. However, land rights remain a challenge, with ongoing efforts to secure titles and protect Indigenous territories in untitled Amerindian communities.

Mining concessions granted prior to the issuance of Amerindian land titles in 2007 (based on a "save and except" clause[20]) drives some ongoing debate at the national level about protection of Indigenous peoples' customary land tenure systems, inadequate land titling boundaries, and whether there is a need to formally embed the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) in any future revisions to the Amerindian Act of 2006 (Sharples, 2021).

1.4.3 AMERINDIAN GOVERNANCE

In 2005, the Ministry of Amerindian Affairs (MoAA) was established to safeguard, protect, and promote the social, cultural, and economic interests of Indigenous Peoples in Guyana. The MoAA's activities address topics including social welfare, health, scholarships, community development, governance, and land titling (MoAA, 2023). Under the MoAA, the Amerindian Development Fund supports the implementation of capital projects in Indigenous communities, including support for infrastructure and economic development. Past projects have supported women-led small businesses, multipurpose buildings, village offices, lodging (including guest houses and eco lodges), community centres, food processing centres (such as cassava mills), and contributed to the upgrading of trails and construction of bridges (MoAA, 2023).

In 2021, a draft plan of action for the protection and promotion of traditional Indigenous knowledge in Guyana was advanced by the MoAA and The National Toshaos Council, which represents the different Indigenous leaders and peoples of Guyana (Jafferally, 2021). If and when the plan is formally adopted, Guyana will effectively recognise the importance of

[19] Source : https://parliament.gov.gy/documents/acts/4680-act_no_6_of_2006.pdf
[20] This clause has been used by miners to deny the village rights over the area if the miner obtained their concession before the village got its title.

Indigenous Knowledge for the development and implementation of public policies (UNESCO 2021).

At the local level, Amerindian communities in Guyana are led by elected Toshaos (Amerindian leaders) and Village Councils. The role of Village Councils and Toshaos are described in the Amerindian Act of 2006. The Village Council is responsible for the good governance and wellbeing of the community and the promotion of the sustainable use, protection, and conservation of village lands and the resources on those lands under the provisions made in the Amerindian Act of 2006.

Although Toshaos are directly involved in Village Council affairs, they also play a broader leadership role in their communities, including engaging of village residents (Ministry of Health 2021). According to the Amerindian Act of 2006, a Toshao is "*responsible for ensuring good governance including accountability and transparency… and keeping peace and order in the Village*" (Amerindian Act, 2006). Toshaos and Village Councillors are elected every three years. Both men and women can be elected as Toshaos, and often multiple generations of families are involved in Village Councils and community leadership.

In addition to leading Village Councils, Toshaos represent their villages on the National Toshaos Council (NTC). Established under the Amerindian Act (2006), the National Toshaos Council is the highest formal authority representing all Amerindian villages in Guyana and functions as the key interlocutor on behalf of all Indigenous communities. The National Toshaos Council comprises of Toshaos from each Amerindian village and is administratively governed by an executive, meets biennially, and elects its 20-member executive function every two years.

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CULTURAL

ERM CRM Baseline Report - (Stronghold Guyana Inc, a subsidiary of Mako Mining Co.)

Prepared By: Louisa B. Daggers, University of Guyana

This report serves as an initial Desk-Based Assessment (DBA) for the Mining company Strong hold Guyana Inc. The report is supported and informed by CRM fieldwork conducted within the project area. The DBA provides a baseline understanding of the archaeological and cultural heritage potential of the concession, integrating available documentary sources with data derived from pedestrian survey and ground-truthing exercises. The utility of this report lies in its role as a preliminary assessment tool, offering insights into the probability of encountering archaeological sites and features, identifying potential areas of cultural significance, and highlighting the need for further systematic investigation where warranted.

Executive Summary

This report presents the results of an initial Desk-Based Assessment (DBA) supported by archaeological fieldwork undertaken within the Stronghold Mining concession between April 5th and 12th, 2025. The purpose of the study was to assess the cultural heritage potential of the project area and to identify site types, features, and areas of archaeological and cultural significance that may require further consideration during future development.

The concession is situated in a rocky highland landscape characterized by extensive outcrops, steep slopes, ravines, and swampy depressions. Vegetation cover varied from dense forest to cleared and disturbed zones, with Ground Surface Visibility (GSV) ranging from 0% to 100%. Survey methods combined intuitive pedestrian coverage, transect sampling, and ground-truthing exercises, with intermittent vegetation clearance where necessary. The survey documented Large portions of heavily disturbed by past and ongoing mining activities, including pits, machinery remains, and cleared surfaces. Two historic English bottles were recorded along transect line E14 and Two rock shelters were identified within the Area of Influence shovel test probes (STPs) with in the site yielded no archaeological materials. The area has the potential for medium to high probability for caves, rock shelters, and petroglyphs/pictographs in areas of greater topographic relief, and a high probability for historic mining sites throughout the concession.

Encountering habitation sites, Terra Preta soils, or large lithic workshops is assessed as low to medium due to the absence of favorable fluvial terraces and geomorphic settings.

Administrative Framework – Cultural Heritage

	Objective	**Relevance to the Project**
Legislation		
National Trust Act (1972) Cap. 20:03.	Stewardship of historic resources and places of cultural significance.	Governs the management of any building, structure, object, or other manmade or natural feature that is of historic or national cultural significance that could be impacted by the Project. Would also apply to the Project in the event of a chance find, in which case the act would require strong hold mining to work cooperatively with the National Trust of Guyana to manage any resources discovered.
Amerindian Act (2006)	Recognizes the rights of indigenous peoples and communities and provides for participatory governance. The Act supports and encourages their right to preserve a traditional culture, cultural landscapes and traditional knowledge and languages as a minority group.	Supports the conservation of indigenous cultural heritage and patrimony. Under the Act, the management, conservation and protection of cultural lands, artefacts and natural resources are within the remit of the Village Council and provides for collective decision making with regard to research and development.

	Objective	Relevance to the Project
The Environmental Protection Act (1996)	Provides for the management, conservation, protection and improvement of the environment and has provisions for the prevention or control of pollution. The Act also establishes the Environmental Protection Agency (EPA).	One of the responsibilities of the EPA is to work with the National Trust of Guyana to identify and evaluate the direct and indirect impact of material assets, cultural heritage and landscape.
The Draft National Cultural Policy of Guyana (2013)	Intends to adapt and implement locally acceptable standards to identify and inventories archaeological and historical sites and artefacts, and to actively promote and support all efforts aimed at the preservation and restoration of national patrimony.	Established the framework through which the Government can support the conservation and management of cultural resources.
United Nations Educational, Scientific and Cultural Organization Convention on the Protection of the Underwater Cultural Heritage (2001)	Protects "all traces of human existence having a cultural, historical, or archaeological character" that have been underwater for over 100 years.	Would apply to any submerged cultural heritage in the Project AOI. Guyana ratified in 2014.
United Nations Educational, Scientific and Cultural Organization Convention on the Protection of World Cultural and Natural Heritage (1972)	Provided the basis for identification of UNESCO World Heritage Sites.	Presents definitions for cultural heritage and natural heritage which may apply to the project locations. The Convention would apply to the project only if the Government identifies site within the development areas for consideration as a World Heritage Site.

Archaeology of Potaro-Siparuni Guyana.

Region sub region two remains relatively understudied, with limited archaeological investigations conducted within the project area and its surrounding landscape. Among the few exceptions are the pioneering surveys of Meggers & Evans (1960) in the Pakaraimas, William's (2004:371–372; n.d.) research along the Mazaruni, Potaro, and Essequibo Rivers, and subsequent investigations at Iwokrama by Plew (2002, 2005).

One of the most significant categories of archaeological sites identified in this region comprises ground stone features, frequently located along major river courses. These include recessed stone vessels in rock shelter floors and burial urns interred within shaft burials situated on hilltops. Sites associated with the Horticultural Period have been documented on the Essequibo (n=7) and Siparuni (n=1) Rivers.

Past excavations have enhanced our understanding of the archaeology the region. On the Essequibo River, test excavations were carried out at Errol's Landing, Alexis Marcel's Island, and Makari Falls (Williams, 1996a), while Plew (2002) excavated at the Reserve Base Camp (Field Station). Notably, Errol's Landing yielded a particularly dense concentration of ceramic sherds (Plew & Pereira, 2008). Radiocarbon dates obtained produced dates ranging between 2,080 ±70 B.P. (Beta-76246) at 45–60 cm and 2,910 ±80 B.P. (Beta-76247) from deeper deposits firmly placing the lower levels of the site within the early Horticultural Period.

Petroglyphs at Kurukupari on the Essequibo River exhibit stylistic elements consistent with the so-called *Enumerative*and *Fish-Trap* traditions. Williams (1985a) has argued that these styles correspond to distinct chronological phases, cultural traditions, and subsistence strategies. Their presence underscores the diversity of symbolic expression and the potential linkage between rock art, social identity, and resource exploitation within the landscape.

Archaeological evidence from the broader region, including sites within the Iwokrama Reserve, dates to the Archaic Period. The material record suggests a pattern of broad-spectrum foraging, with communities exploiting a wide range of ecological niches. This adaptive strategy is reflected in the varied site types documented in the reserve, which collectively illustrate the dynamic interaction between cultural practices and the riverine environment.

Recorded sites of Administrative region eight (Potaro Siparuni)

To date there are approximately 66 identified and or reported archaeological sites raging from Site Number: VIII-1:1 -VIII-1:4 to VIII-2:1 to VIII-1:62. With in both subregion one and two, below are the known sites in subregion one.

Artifacts, Features and sites expected within Stronghold Project Area (Sub-Region 2)

The concept of *archaeological significance* is generally defined worldwide as the potential of an artifact, feature, or site—prehistoric or historic—to contribute knowledge about the prehistory or history of a region. By this definition, all cultural materials, regardless of period, should be regarded as significant.

Nevertheless, certain categories of remains are often considered of heightened importance due to their direct association with specific tasks, technologies, and cultural practices. These include lithic tools, ceramic vessels, historic glass and ceramic wares, metal implements, as well as associated features and site contexts. Such materials, when recovered in situ, provide critical insights into technological choices, social organization, and resource use.

It is important to recognize that prehistoric and historic artifacts are fundamentally *refuse*—the by-products of human activity, whether intentionally discarded or inadvertently lost. In historic contexts, particularly those of the 18th through early 20th centuries, materials tend to occur in larger quantities, with site areas frequently more extensive. For example, the remains of early mining activities often comprise a combination of structural features, activity areas, and dense distributions of refuse. These patterns not only mark industrial activity but also frame the broader cultural and economic histories of the region.

	Table of known sited in region No. 8 subregion No.2				
Ceramic sites	Petroglyphs/Pictographs	Chipping station	Grinding surface	Terra Preta	Historic
20	21	1	17	1	2

Areas Likely to Produce Evidence of Prehistoric or Historic Artifacts/Sites/Features with Probability Noted

For the purposes of this study, *levels of probability* reflect the degree to which a particular site or feature type is commonly or specifically associated with a given topographic or geomorphological setting, as documented within the project area and its broader locale.

High-probability areas are those landscapes that consistently demonstrate a strong association with particular site or feature types. These typically include caves and rock shelters, which are recurrently linked to habitation, burial, or ritual activities. The distribution of such contexts, however, will vary in accordance with local terrain and geological conditions.

Medium-probability areas denote locations where sites and features are known to occur with some regularity, often in relation to specific geomorphological or hydrological characteristics. Such settings include areas of natural drainage (e.g., prominences, ridgelines) as well as locations where water naturally accumulates (e.g., ponds, seeps, and springs). These areas frequently supported both habitation and specialized activities, making them favorable for site discovery.

Low-probability areas are those where archaeological materials are less frequently encountered or are unlikely to be preserved due to environmental or geomorphological conditions. Nevertheless, given the variability of human land use strategies, even these settings cannot be entirely excluded from consideration.
Accordingly, the following site types and features may be anticipated within the project area, arranged here from higher to lower probability of occurrence.

Sherd and Lithic Scatters
These site types are most often located along primary and secondary river or stream benches and terraces. They may also occur in association with falls and riffles, where fishing activities were frequently undertaken in tandem with tool use and discard.
Within the project area, however, no significant fluvial benches, terraces, falls, or riffles are present between the Stronghold PLA. As such, the probability of encountering ceramic and lithic materials in this zone is assessed as *low to medium*.

Caves and Rock Shelters

These features are generally associated with areas of greater topographic relief, particularly where large boulders are exposed along steep slopes. Within the project area, the geomorphology suggests a *medium to high probability* of encountering caves and rock shelters suitable for habitation, burial, or other cultural activities. Such locations are often productive archaeological contexts given their role in both daily use and ritual practices.

Habitation Sites

Habitation sites are typically situated along major river or stream benches and terraces, where Amerindian groups established residential areas and carried out a range of daily activities within defined spaces. Such locations are often marked by dense concentrations of ceramic and lithic materials.

In the present project area, however, there are no significant fluvial benches, terraces, falls, or riffles that would ordinarily support the occurrence of these site types. Consequently, the probability of encountering habitation sites is assessed as *low to medium*. Forest clearance areas may nonetheless represent potential locations where such sites could be identified.

Grinding Surfaces / Features

Grinding surfaces are typically located near or slightly above water levels along major rivers and streams. These features are most often found on exposed, water-worn granite outcrops. Their visibility and accessibility can vary seasonally, with the highest likelihood of exposure occurring during dry periods when water levels are reduced.

Within the project area, there is a *medium probability* of encountering grinding surfaces in association with rocky, annually flowing waterways. These features may occur in isolation or in conjunction with other site types, reflecting their role in food processing and tool production activities.

Quarry Sites / Lithic Workshops / Chipping Stations

These sites are most often associated with rock outcrops or eroded areas where raw materials,

particularly quartz, are naturally exposed. They are characterized by concentrations of flakes, cores, and other by-products of stone tool production.
Within the project area, the geological context suggests a *low probability* of encountering quarry or lithic workshop sites. Nevertheless, localized exposures of suitable stone may still yield evidence of small-scale chipping stations or opportunistic tool production.

Petroglyphs / Pictographs

Rock art is typically associated with areas where caves and rock shelters occur, though it may also be found on open-air granite boulders. Motifs are often pecked or painted onto rock facies, and may include geometric, zoomorphic, or anthropomorphic designs.
Within the project area, there is a *medium probability* of encountering petroglyphs or pictographs, particularly in settings with exposed granite or sheltered rock surfaces conducive to preservation.

Historic Sites

Historic remains are most often encountered in association with abandoned mining camps, old mine pits, and waterways that facilitated transport and settlement. Typical materials include bottles, historic ceramics, metal tools, and structural remnants such as housing foundations or equipment scatters.
Within the project area, there is a *high probability* of encountering historic sites and artifacts. This reflects the widespread legacy of 18th–20th century mining and related activities, which often left dense and spatially extensive material traces.

Terra Preta Sites

Terra Preta sites are anthropogenically enriched soils typically located in close proximity to permanent rivers and creeks. They are often associated with flooded landscapes, raised fields, and habitation zones, reflecting long-term human occupation and landscape modification.
Within the project area (PLA), the geomorphological conditions suggest a *low probability* of encountering Terra Preta deposits. This is due to the limited presence of the fluvial and floodplain settings in which such soils are most commonly found.

Overview of Indigenous Traditional Lands within the Area

Although the nearest Indigenous community lies several kilometers from the project area, Indigenous land use patterns and connections to ancestral spaces remain largely undocumented. These relationships can only be clarified through direct community engagement and participatory land-use mapping.

International charters and conventions—most notably the *United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)* and Guyana's *Indigenous Peoples Act (2006)*—affirm the significance of Indigenous traditional lands and resources, including those traditionally owned, occupied, exploited, or acquired over time. Ancestral lands encompass areas of long-term and seasonal use, functioning as corridors of passage, spiritual landscapes, or zones of resource exploitation. Such areas include fishing grounds, hunting territories, and plant-gathering spaces. The *Kaieteur National Park*, located approximately 42 km from the project area, represents both a protected area and an Indigenous sacred site. Given its recognized prehistoric and historic importance, and the broader topographic setting, there is a reasonable probability that other seasonally or spiritually significant Indigenous sites may exist in the wider vicinity of the project area.

However, surface traces of such land use may be obscured or distorted by historic mining activities and environmental processes, including sedimentation and erosion. This underscores the importance of integrating archaeological survey with Indigenous knowledge systems to fully document and respect cultural landscapes.

Survey Report

An intuitive and pedestrian archaeological survey was undertaken within the vicinity of the Stronghold Mining concession between April 5th and 12th, 2025. Survey coverage included the following designated areas: Plant Site, Proposed Quarry and Waste Dump, Waste Dump 1, TSF 1, TSF 2, and the Mine Pit.

The concession area is characterized by rocky highlands, marked by extensive outcrops, steep hills, ravines, and swamps. Vegetation across the project area consists of dense shrub-lands, marsh vegetation, and both primary and secondary forest stands. Ground Surface Visibility

(GSV) during the survey varied widely, ranging from 0% in heavily vegetated areas to 100% in exposed or disturbed contexts. The condition of surveyed areas reflected a continuum of disturbance. In some locations, the landscape has been substantially altered by earlier mining activities, while in others, disturbance results from ongoing infrastructural development, such as road construction and land clearing. Undisturbed areas were also present, particularly within less accessible portions of the terrain, providing potential contexts for intact archaeological deposits. In consideration of the challenging terrain, transects were employed where conditions permitted. In other areas, a ground-truthing approach was adopted, incorporating the use of several random transects in combination with targeted inspection of exposed surfaces. Intermittent removal of vegetation and leaf litter was undertaken to improve visibility where necessary. These adaptive strategies were implemented in response to a range of limitations, including dense vegetation cover, uneven topography, and prior disturbances to the landscape.

Table 1. Survey location within the PLA		
Site / Location	Color on Map	Current state
Plant Site	Blue	Disturbed Historic mine site
Mine Pits	Purple	Partly disturbed due to land clearing, Road development and historic mining
Waste Dump 1	Orange	disturbed largely in accessible
TSF Option1	Green	Partly disturbed previous mining activities
TSF Option 2	Peach	Disturbed in some ares. Limited access

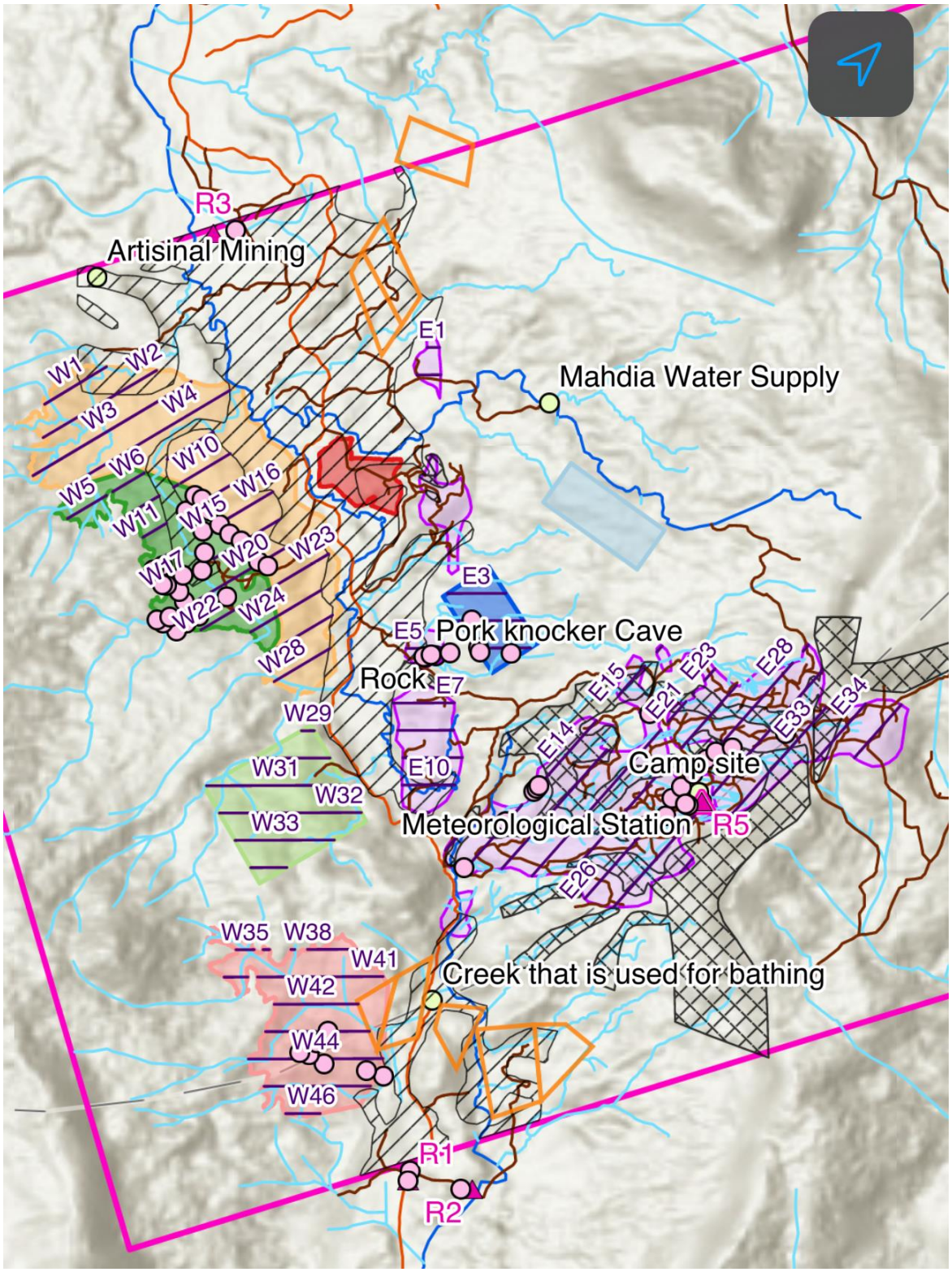

Figure 1. Map of project area highlighting proposed survey transects within the PLA. Pink dots represent survey areas.

Results / Findings

Considerable disturbance was observed throughout the Project License Area (PLA). These impacts stem primarily from historic medium- and small-scale artisanal mining, which generated extensive waste rock piles and tailing ponds. In addition, large portions of the concession consist of swampy terrain, further constraining the effectiveness of site survey and ground visibility. Although the survey design intended to establish and record multiple transects within the project area, the terrain did not permit placement of transects in close proximity. Owing to the difficulty of establishing systematic transects in suitable terrain, an intuitive survey approach was adopted instead.

Plant site: The identified Plant Site has been subject to extensive historical mining and retains visible remnants of past mining infrastructure, including pits, machinery, and associated waste deposits. The area is now completely cleared of vegetation and exhibits a high degree of surface disturbance. As a result, the potential for intact archaeological deposits is considered minimal; however, the site remains of interest for documenting the industrial heritage and material legacy of earlier mining activities.

Figure 2. Abandoned mining infrastructure

The Mine Pits:

Within the vicinity of the Mine Pit, specifically along transect line E14, two historic English bottles were identified. The bottles were exposed on the surface, situated above dense leaf litter. Disturbance within the area was evident and is likely associated with past “pork-knocking” activities or formal mining, consistent with the century-long history of mineral exploitation in the region.

Both bottles were photographed and geo-referenced, with two GPS points recorded (5.205272N 59.124378W and 5.205409N 59.124272W). The artifacts were left *in situ* in accordance with survey protocols.

Figure 3. Images of Historic bottles with the Vicinity of the Mining Pits.

Rock Shelters (Area of Influence – Mine Pits)

Two rock shelters were identified within the Area of Influence (A.O.I.) outlined as the Pit. Both shelters exhibited evidence of past mining activity as well as more recent occupation by pork-knockers.

One shelter at the time of the survey Referred to as Rock shelter (2) was occupied by a Pork knocking a family, as a result access to the area and surveys were limited.

However, the shelter referred to as (Pork knocker cave) is situated on a gentle slope of a small hill, approximately 60 meters south of a rocky tributary. The site base is composed of roughly 85% exposed bedrock and outcrops, with less than 15% consisting of loose sediments (saprolite) derived from the decomposition of shelter rock. At this location, four shovel test pits (STPs) were excavated within the vicinity of Shelter 1, reaching depths of 16 cm, 25 cm, 20 cm, and 27 cm, respectively. All STPs were spaced approximately one meter apart at the base and entrance of the shelter. Despite systematic testing, no archaeological materials were recovered from these contexts.

The absence of cultural material, coupled with the high proportion of exposed bedrock and environmental disturbance, suggests limited potential for intact archaeological deposits at this location. However, Environmental and biodiversity disturbances were also noted, these disturbances ranges from, impacts of rainwater runoffs, including sedimentation, small borrows and materials left behind by small mammals, further affecting site integrity.

Figure 4. Rock Shelter, historically occupied by Port knocke

Table 2. STP. Pork Knocker cave (Rock Shelter 1)	
1- 25 cm	21N 0265403 0575680
2- 27cm	21N 0263952 0576498
3- 20cm	21N 0263939 0576480
4- 16 cm. (Entrance)	21N 0263955 0576482

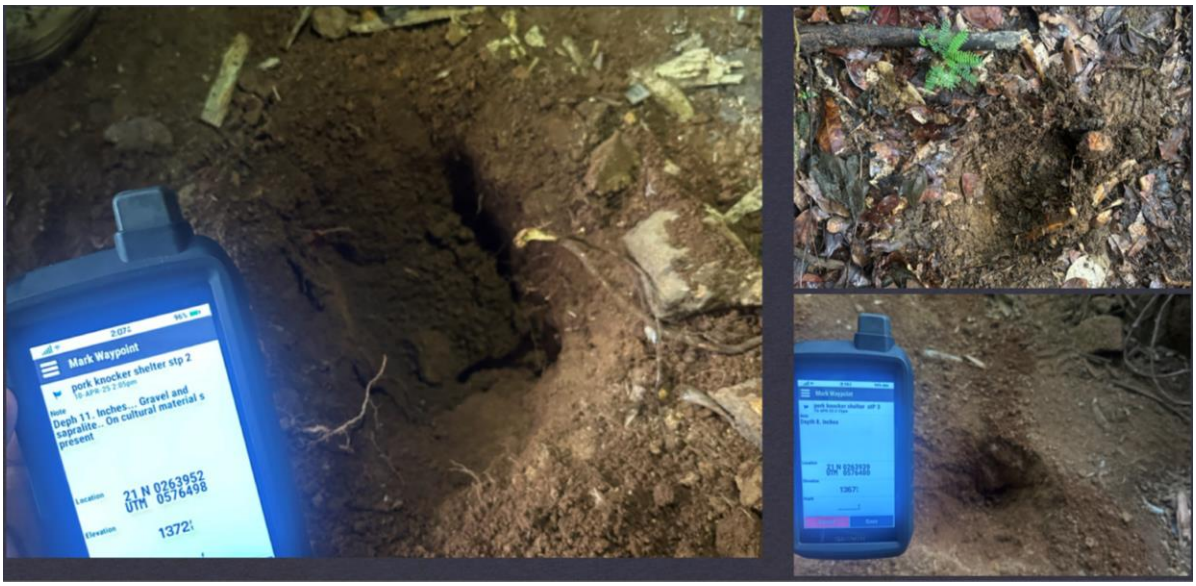

Figure 5. STPs within Rock Shelter one

Figure 4. Rock shelter 2: Site occupied by a pork knocking family.

Waste Dump 1 Site:

Disturbances within this area are particularly notable, largely the result of medium- and small-scale mining activities. Due to the poor condition of the terrain, a systematic transect survey was not feasible. As a result, survey coverage was restricted to the ridge lines of the hill, which remained comparatively intact. The survey did not identify any evidence of archaeological significance within the site.

Figure 4. Image of the tailing pond within the vicinity of Wast Dump 1.

TSF 1

This area presented challenging terrain characterized by extensive outcrops, steep rocky hills, and seasonally flowing streams. Vegetation consists of dense shrubs interspersed with secondary forest. Ground Surface Visibility (GSV) ranged from 0–20%. Survey efforts were necessarily restricted to locations not interrupted by flowing water or dominated by large outcrop hills. Although no archaeological materials were identified during the survey, the geomorphology suggests a high probability of encountering additional rock shelters within this terrain. The survey did not identify any evidence of archaeological significance within the site.

Figure 4. Image of TSF 1, Terrain within this project area

TSF 2

This site is positioned within the vicinity of a valley and presented challenging terrain characterized by extensive swamps and dense marsh vegetation. Survey efforts were therefore limited to accessible roadways and the margins of the existing swamp. No evidence of archaeological significance was identified within the site during the survey.

Potential areas of interest

Areas with the highest potential for archaeological site discovery and documentation within the PLA include (**TSF 1)** and the (Mahdia main water tributary). These areas warrant additional survey and continued monitoring throughout the course of project development activities.

Conclusion

The survey results indicate that while much of the concession has been heavily disturbed, select areas retain potential for archaeological and heritage features, particularly historic mining sites and natural shelters. This report establishes a baseline record for the area and emphasizes the importance of continued monitoring, community engagement, and targeted investigation in less-disturbed zones.

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