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ALPART JAMAICA

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ENVIRONMENTAL IMPACT ASSESSMENT

Proposed Mining and Quarrying at "Outer Valley" Section of SEPL 541, St. Elizabeth

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Environmental Impact Assessment

Proposed Mining and Quarrying At “Outer Valley” Section of SEPL 541 St. Elizabeth

Prepared for:

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1.1 BACKGROUND

JISCO Alpart Jamaica Limited, (hereafter called JISCO Alpart) plans to carry out bauxite mining in part of the area designated as Special Exclusive Prospecting Licence (SEPL) 541. The mining is initially planned for the south eastern section of SEPL 541 known as the "Outer Valley". Pursuant to the above intent, JISCO Alpart has made an application for an environmental permit to the National Environment & Planning Agency (NEPA) in accordance with the requirements of the Natural Resources Conservation Authority (NRCA) Act of 1991, the Natural Resources Conservation (Permit and Licenses) Regulations of 1996 and the amendments of 2015. The application was submitted to NEPA in May 2020 and subsequently the Agency requested that JISCO Alpart carry out an Environmental Impact Assessment (EIA) Study in the specific area "Outer Valley" section of SEPL 541 which is slated for mining and is located in the parish of St Elizabeth and is shown in Figure 1-1 and Figure 1-2

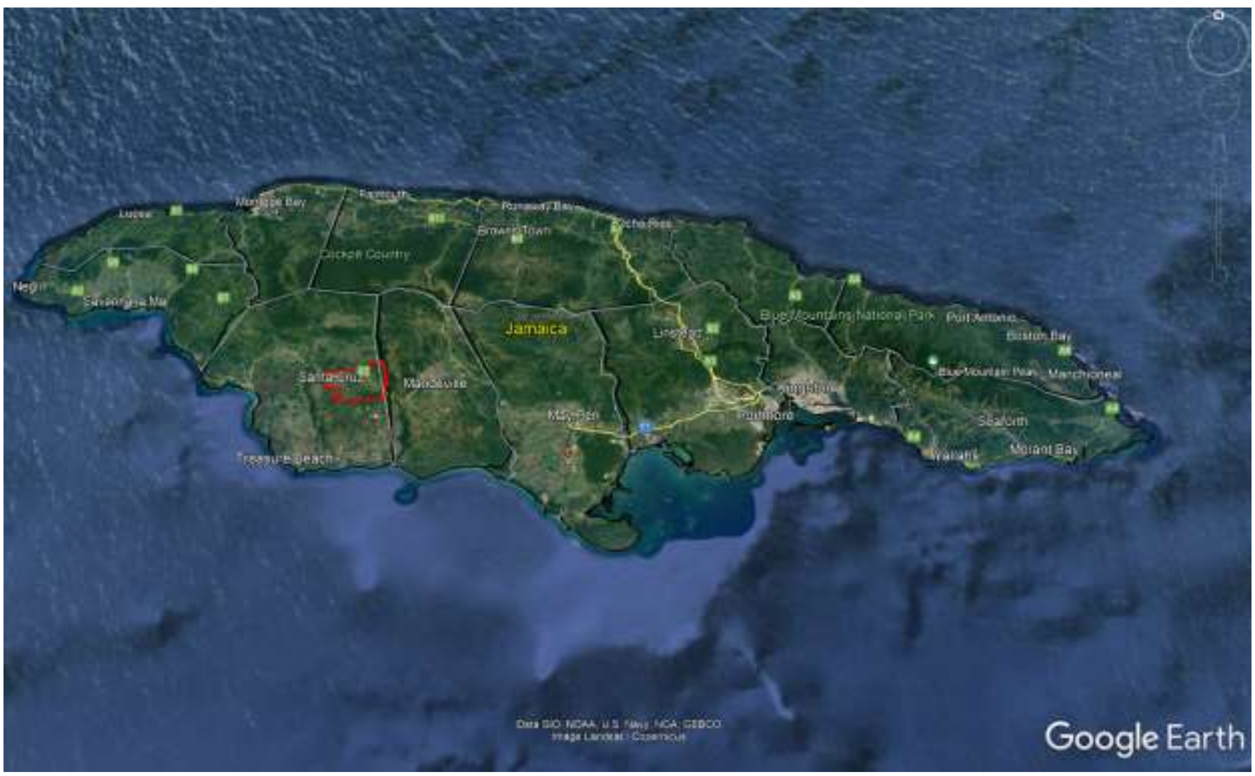


Figure 1-1: Map of Jamaica showing the location of "Outer Valley" Section of SEPL 541 in St. Elizabeth

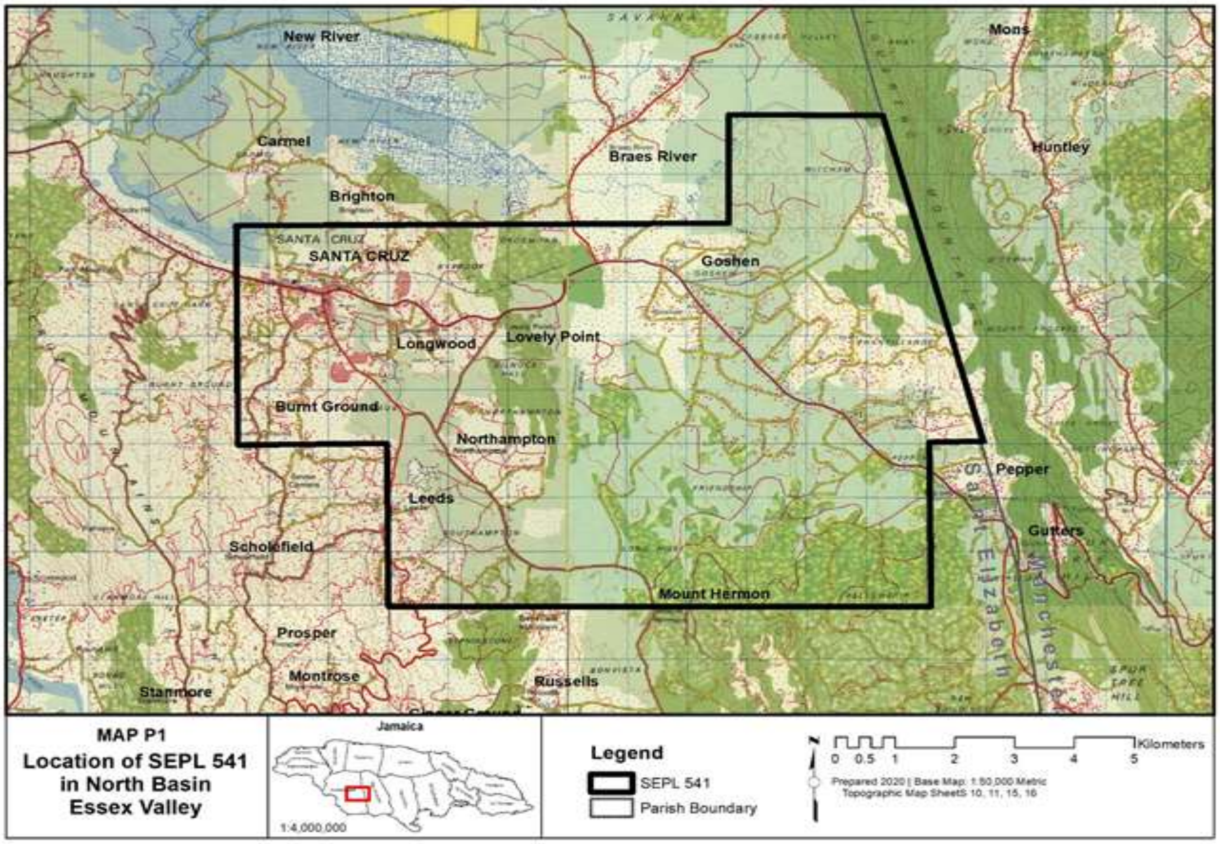


Figure 1-2: Location of Study Area

The Environmental Permit is required to cover the following activities which will take place in the proposed mining area: land clearance within the SEPL for construction of haul roads and mining of bauxite, stockpiling, ore loading and off-loading, limestone screening as well as the transport and conveyance of bauxite. Approval of the Environmental Permit is a prerequisite for JISCO Alpart to make application to the Ministry of Mining to convert the specified area within SEPL 541 into a Special Mining Lease (SML). It is proposed to conduct bauxite mining in the designated Outer Valley area of SEPL 541 for a period of about ten years and extract approximately 17 million metric tonnes of bauxite.

After bauxite mining is complete, the mined-out pits will be rehabilitated and restored to various end uses such as a pasture, housing, agriculture, and greenhouses in compliance with the Regulations of the Mining Act.

JISCO Alpart has engaged the services of the consultancy firm, EnviroPlanners Ltd. to carry out this Environmental Impact Assessment (EIA). This Draft Final EIA Report is presented in fulfillment of the Terms of Reference (TOR) issued to JISCO Alpart dated August 18, 2020, which is summarized in the following section.

1.2 Terms of Reference

The Terms of Reference of this Environmental Impact Assessment Study as required the National Environment and Planning Agency is as follows:

1. Executive Summary
2. Introduction
3. Legislation & Regulatory Consideration
4. Project Description
5. Description of the Environment
6. Public Participation
7. Impact Identification & Assessment and Analysis of Potential Impacts
8. Impact Mitigation
9. Residual Impacts
10. Analysis of Alternatives
11. Environmental Monitoring & Management

1.3 General Approach & Methodology

The general approach and methodology involved a series of consultations with key stakeholders, research, literature reviews, field investigations, monitoring and sampling in the areas of; the physical environment (air quality, water quality and noise), the biological environment, hydrogeology, geomorphology, geology, socio-economic and archeology. In this way, all aspects of the agreed TOR for the EIA were satisfied.

1.4 Main Findings

1.4.1 Project Description

The Outer Valley section of SEPL 541 which is proposed for mining is located in the parish of St. Elizabeth as shown in the Figure 1-1. This area borders with northern boundary of Special Mining Lease 167 (SML 167) where JISCO Alpart is currently conducting bauxite mining (Figure 2-1 and 2-2). This area was strategically selected so that access to the ore bodies in the Outer Valley section of SEPL 541, will be done predominantly by extension of the existing haul road network currently being used to transport bauxite mined in the northern section of SML 167. Bauxite from SEPL 541 Outer Valley section will be extracted and transported via haul road to the No. 2 Raw Ore Material Stockpile and from there to the JISCO Alpart refinery via existing conveyor.

1.4.2 Legislation and Regulatory Considerations

The relevant regulatory framework which applies to this mining project has been identified and reviewed and presented in section 3.0 of this report. It covers the relevant acts, regulations, standards and international treaties, protocols and conventions to which Jamaica is signatory.

There are many different types of legislation and regulations that will impact various aspects of this project, and these were perused and use to guide the design of the project. The legislative landscape changes rapidly at times and therefore measures should be taken to update this register during the operational phase of the mining project.

1.4.3 Description of the Environment

The environment of the proposed mining area has been defined by various studies both related to this EIA as well as previous assessments done during the exploratory activities and project feasibility study. The Outer Valley section of SEPL 541 has been the subject of various land uses in the past and is not in pristine. The anthropogenic disturbance has been documented in the Archeological Impact Assessment and the Biological study. Common uses over the years have included agriculture, housing, small commercial activity, and charcoal burning.

1.4.3.1 Geology, Hydrogeology, and Geomorphology

The Essex Valley, where the proposed mining activity will take place, is a low lying, broad valley extending south-southeast from the swampy lowlands of the Upper Morass to the coast. The Essex valley is bounded on the east by the Spur Tree Hill escarpment (part of the Don Figueroa Mountains) and on the west by the Santa Cruz Mountains. To the south the Essex Valley increases in elevation to form the faulted crests of the series of east-west ridges which overlook the steep and in places precipitous descent (such as Lovers Leap) to the coast. The Essex Valley is divided into two sections or topographic basins defined by the topographic divide between them. The topographic divide does not coincide with the groundwater and drainage divides because of the limestone nature of the terrain. The Outer Valley section of SEPL 541 is located within the north topographic basin abutting on the swamps around Braes River/New River and the Upper Morass

The White Limestone Group is the most important rock unit, by volume, in the island. There are several members of the White Limestone Group and they are generally highly permeable and form the main groundwater aquifer along the south coast of the island. The primary water resources type of the Outer Valley section of SEPL 541 is groundwater that occurs within the karstified limestone aquifer, the Newport Limestone Formation, that outcrops throughout the project area. Groundwater flow (subsurface flow) is to the north-northwest as determined by the groundwater table elevation contours.

Because of the karstic nature of the Newport Limestone that underlies the northern Essex Valley there are no surface water resources that traverse the area. The surface water resources are all located west and north-west of the Essex Valley, draining water from springs and the wetlands of the Upper Morass towards the Grass River and the Black River.

The geology/ hydrogeological study concluded that while no formal study has been done on the impacts of bauxite mining on water resources in Jamaica there has been no recorded detection of quality or quantity issues resulting from the mining of bauxite. The Water Resources Authority (WRA) maintains monitoring networks for ground (over 1800 sites) and surface water (over 130 gauging stations) systems across the island.

1.4.3.2 Air Quality/Water Quality/Noise

Environmental monitoring in the study area covered air quality, water quality and noise. PM10 is the parameter used for air quality assessment. Twenty-four-hour readings were carried out between July 2020 and September 2021 at four sites within the study area; Mitcham, North Hampton, Santa Cruz and Goshen. The air quality sampling results did not show any exceedances of Jamaica's Ambient Air Quality Standard.

The results from water sampling in the area revealed instances where sodium levels (14.2 at the Penny Cooke Well in November 2020) exceeded the standard of 12 ppm. From historical data and the hydrogeological study, this exceedance may be linked to the JISCO Alpart alumina refinery operations.

Noise readings were measured at Lower Northampton, Northampton, Mitcham, and Santa Cruz.

The averages over each measurement period were assessed against the Jamaica National Noise Standard (JNNS) limit of 55 dBA. The following conclusions can be made:

- Average noise readings ranged from 37.1 dBA to 61.4 dBA.
- Instances when readings exceeded the standard of 55 dBA was due to traffic and in one case the exceedance was attributed to the use of a power saw.

It can be concluded that except for localized sources, the existing sound levels within the study are compliant with the applicable standard.

1.4.4 Ecological Services/Biological Environment

The study was conducted between early January to September 2021. In Jamaica, changes in biodiversity are generally related to two types of seasonal changes: rainfall, and the winter/summer in the temperate zones. Significant changes have been documented in some habitats in relation to wet and dry seasons. The period studied here includes the dry season around February as well as what is termed the secondary wet seasons of May-June. Additionally, much of the biodiversity associated with the primary wet season, September to December is generally still around in January. It is well established that the avian fauna changes significantly during the northern temperate winters and summer, resulting in groups of birds termed "winter migrants" and "summer migrants". The time period during which this study was conducted captured both the winter and summer migrants.

The main vegetation type observed throughout the assessment are fields: herbaceous crops, followed by modified (disturbed) dry limestone forest. The area assessed during the survey appears to have been significantly disturbed by anthropogenic factors over the years, with signs that significant clearance of the original vegetation had occurred. The majority of the trees encountered were seedlings or saplings; however, there was also a considerable number of mature trees (larger DBH classes: >35 cm DBH) scattered across the project area.

The reptilian fauna identified consisted of 11 lizards, 4 snakes (3 endemic) and 1 freshwater turtle. There were 9 endemic lizards: 7 tree lizards, 1 gecko and 1 galliwasp. Two species of lizards were introduced; these were *Hemidactylus mabouia* and *Anolis sagrei*. Seven species *of amphibians were detected; three were endemic (Eleutherodactylus gossei, Eleutherodactylus caundalli, Osteopilus ocellatus)* and four species were introduced.

The land use categories of the Forestry Department were adapted for this study. The main land use categories observed were “Fields: Herbaceous Crops”, followed by “Disturbed Broad Leaf Forest” on limestone hills. The vegetation is typically associated with early stages of ecological succession. The area has been significantly disturbed by anthropogenic factors over the years.

A total of 194 plant species from 67 families were recorded; 30 species are endemic. Most of the plants encountered were trees and shrubs; a few climbers, grasses and epiphytes were also observed. The land use category with the highest species diversity was Secondary Forest and Fields with 119 species; while the lowest diversity was observed in the Disturbed Broad Leaf Forest with 64.

A total of 5 invasive plant species were encountered. These were: Logwood (*Haematoxylum campechianum*), Red Bead (*Aenanthera pavonia*), Common Bamboo (*Bambusa vulgaris*), African Tulip (*Spathodea campanulate*) and Lead Tree (*Leucaena leucocephala*); all of which were widespread across most of the land use categories.

Thirteen species of bats were detected; three species are endemic. The trophic guilds were: frugivore (2), piscivore (1), insectivore (8) and nectarivore (2). Three species were recorded only from the Peru caves. No bat species with “special conservation status*”, (i.e., species that are common but have never been evaluated against the IUCN’s Red List ranking as the Red List refers to “species at high risk of global extinction”*, was detected. The other mammals encountered include dogs, goats, cattle donkeys, cats, mongooses, and rats. The Jamaica Coney was not detected, and members of the communities were not aware of or had ever seen it.

Eighty-four of Jamaica’s 184 species of birds were observed: 66 residents, 18 migrants. Eighteen of Jamaica’s 31 endemics were recorded. The birds observed in the study were typical of dry forests and open fields, and most of the species were observed in the Secondary Forest and Fields. There were a number of forest-dependent species such as the Crested Quail Dove, Jamaica Becard, Yellow-shouldered Grassquit, Rufous-tailed Flycatcher and Jamaican Pewee. Seven nocturnal birds were observed. The Crested Quail Dove and the Jamaican Parakeet are listed as Near-threatened by the IUCN.

In terms of seasonality, a total of 79 bird species were recorded in the winter season (January-April); 15 of which were migrants. In the summer season (June - July), a total of 66 species were recorded, 5 were migrants.

Forty-two species of butterflies from 5 families were recorded; there were 7 endemic species and 6 endemic subspecies. Over 250 species of other insects were collected. Twenty-eight species of land snails from 11 families were recorded. Many of the snail species are generally associated with disturbed areas; two such species are *Thelidomus aspera* (endemic) *and Zachrysia provisoria* (introduced). Other Arthropods include whipscorpion, spiders and millipedes.

Eight species are fauna are on the IUCN Red List, these are as follows: three reptiles, the yellow snake, (*Chilabothrus subflavus)* and the Jamaican Slider (*Trachemys terrapen*) are listed as Vulnerable; the Southern Jamaica Banded Geckolet (*Sphaerodactylus parkeri*), is listed as Endangered; one Amphibians, the Jamaican Laughing Treefrog (*Osteopilus ocellatus*) is listed as Near Threatened; three birds, the Crested Quail Dove (*Geotrygon versicolor*), the White-crowned Pigeon (*Patagioenas leucocephala)*, and the Jamaican Parakeet (*Eupsittula nana*), listed as Near-threatened; one butterfly, the Jamaican Kite swallowtail (*Protographium Marcellinus)* is listed as Vulnerable.

One significant cave complex was examined, this is the Peru Cave complex. The ecosystem within the cave is very vibrant, and this cave complex is perhaps the most sensitive habitat encountered during this study.

The main anthropological impacts in the study area include human settlements, agriculture, charcoal burning, selective harvesting of logs and unregulated dumping.

The following mitigation measures are recommended:

1. Efforts should be made to avoid the removal of the larger trees within the project area, especially those that support other plants, such as climbers, bromeliads and orchids.
2. Clear cutting of the limestone hills in these areas should be avoided as much as possible and where practical, a buffer zone of 30 m should be placed around limestone hills.
3. Transportation of invasive species during the clearing and rehabilitation process should be properly managed.
4. Any caves/sinkholes which are encountered should be examined for the presence of bats. If a colony of bats is encountered the matter should be reported to NEPA such that appropriate actions can be decided.
5. The caves should be monitored during mining to see if there is any direct and indirect impact of the mining on the fauna in the cave.
6. The following special conservation measures are recommended:
7. Fresh water turtles: The freshwater turtle (*Trachemys terrapen*) occurs in ponds in the area. Turtles should be removed from any ponds which are to be disturbed, and relocated to appropriate ponds.

8. Orchids and Bromeliads: Orchids and large tank bromeliads (*Hohenbergia*) occur mainly on large trees (DBH >35 cm). The Jamaica Laughing Frog, is listed as Near Threatened by the IUCN. This species is dependent on bromeliads, *Hoenbergia* spp. If it is not possible to preserve a tree then the orchid and *Hohenbergia* should be relocated to an appropriate site.
9. Blue Swallowtail Butterfly (*Protographium marcellinus*): The Disturbed Broadleaf Forest on the slopes of the Don Figueroa Mountain it is a breeding site for the vulnerable species. This area is not slated to be mined, this area is not slated to be mined, but there is the possibility that other breeding sites exists. If such areas are identified, then NEPA should be consulted and care must be taken to ensure minimum disturbance.
10. Peru Cave complex: The caves are outside the area to be mined; however, they should be monitored when the nearest sites are being mined.

1.4.5 Heritage

An Archaeological Impact Assessment (AIA) was carried out on the Proposed Bauxite Mining Area designated Outer Valley Section of SEPL 541 in the parish of Saint Elizabeth. The study was conducted over approximately 4 weeks of field visits in April and May 2021.

The objective of this assessment was to identify resources with archaeological significance within the study area and to describe the risk that the proposed mining activity would have on these resources. The findings presented can then be used by JISCO and the relevant regulatory bodies to make informed decisions on any future mining activities in the area. The assessment also outlines steps that could be taken to mitigate, manage, and monitor the effects of future mining in the area.

The archaeological remains distributed within the Outer Valley section of SEPL 541 represent the important heritage of the area. Habitation of the area during the Taino and pre-Taino periods of Jamaican history has left little, if any, remains. Similarly, evidence of the historic Spanish activity in the area has been mostly lost to time and development. Most of the archaeological sites identified in the area are from the period of English colonization in Jamaica, both before and after emancipation. Such sites include plantation houses, other historic houses, churches, graves, and remnants of the plantations and pens that existed in the area during the 18th and 19th centuries. Also, where more modern archaeological remains exist in the area they have been noted. The area, in general, has seen much development in recent decades and as such many historic sites have been destroyed or removed to make room for development. However, those that do remain should be assessed, and if necessary, protected.

A total of 76 sites and structures of archaeological significance have been identified in the area, as listed in the Archaeological Impact Assessment. Other sites may be present in the area but hidden by dense vegetation. However, to reduce the likelihood of this, local residents with knowledge of the heritage of the area were consulted to help the team identify significant sites that were difficult to locate.

1.4.6 Natural Hazards

A Natural Hazard vulnerability assessment was done. Jamaica is vulnerable to tropical cyclones due to its location within the Atlantic hurricane belt and has been impacted by several hurricanes, Tropical Storms and Tropical Depressions in the past. The most recent being Tropical Storm Ida in August 2021. The general project area will be vulnerable to tropical cyclones especially during the Atlantic Hurricane Season which is established to be June 1 - November 30 of each year. Flooding could also be a primary concern for the project given the depressions which will result from mining activities. Landslides associated with heavy rains are also possible on the steeper slopes. Flooding could affect the project as it could create safety hazards for employees and mining and transportation of bauxite.

The Island also has a history of droughts. Dry periods especially if there are high winds could cause challenges to dust control.

Jamaica, due to its location on the Caribbean Plate margin, is susceptible to seismic activity. Seismicity mapping provided by the Earthquake Unit of the University of the West Indies, has indicated that there is a concentration of seismic activities in the country's eastern parishes of St. Thomas, Portland, Kingston and St. Andrew. Despite the location of the project being outside of this zone, there is still significant vulnerability.

All stages of the mining project can be significantly affected by Natural Disasters to which Jamaica is exposed. JISCO must ensure that an Emergency Response Plan which has been approved by the Office of Disaster Preparedness and Emergency Management is in place before operations commence. The plan should outline procedures which cover various emergency scenarios such as fire, storm, earthquakes and spills, including actions to be taken before and after emergency situations and outline roles and responsibilities.

1.4.7 Heritage

Most of the archaeological sites identified in the area are from the period of English colonization in Jamaica, both before and after emancipation. Such sites include plantation houses, other historic houses, churches, graves, and remnants of the plantations and pens that existed in the area during the 18th and 19th centuries. Also, where more modern archaeological remains exist in the area they have been noted. The area in general has seen much development in recent decades and so many historic sites have been destroyed or removed to make room for development. However, those that do remain will be assessed, and protected according to the recommended mitigation measures.

1.4.8 Socio-economic Environment

The Socio-economic survey to determine the demography as well as attitude and perception towards the proposed quarrying and mining project was conducted in the area. The communities that were included in the survey are Goshen, Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship and Fellowship.

The results from the survey revealed:

Fifty percent (50%) of lands in the area was “Mixed Use” and forty eight percent (48%) residential use. The other 2% were generally open space and ruinate.

Forty-seven percent of respondents achieved secondary education level, while 16% were trained in some vocational areas and tertiary level programmes, respectively.

The majority of roadways in the communities (Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship and Fellowship) are not paved with asphalt. There are either paved with marl (limestone aggregate) are in their soil covered surfaces. These surface conditions, makes it difficult to navigate these roads, as they are subject to rainfall causing them to be in deplorable conditions, and often subject the communities with dust and ponding, where water settles and mosquitoes breeding sites.

Eighty-three (83%) of respondents believed mining operations adversely affected the air quality in the community. Despite the health and environmental concerns associated with bauxite mining, residents obtained benefits from mining operations. Thus, a notable percentage of respondents reported that bauxite mining is beneficial for the community (64%) and country (77%), increased employment opportunities (71%), resulted in better infrastructure in the community (51%) and supported local business enterprises (53%).

The Socio-economic study revealed that there is a core of individuals that have a positive perception of mining in the communities, however, much work will be needed to educate the community as to how JISCO Alpart plans to carry out mining in a sustainable manner.

1.5 Public Participation

Public Participation is measured by public interaction as well the future Public Meetings that will be organized. Public Participation to date has been by way of a socio-economic study as well as interaction with the community during air and water quality monitoring as well as noise level assessment. The biological study also involved informal interaction with the communities within the study area.

In the case of air quality monitoring, community residents were approached to house samplers on their premises. The Socio-demographic Survey and the Attitude and Perception Survey were carried out in eight communities by administering a questionnaire to 220 persons from as many households. The questionnaires were administered by sixth form students from the St. Elizabeth Technical High School (STETHS), supported by two members of staff. This was strategically done as the interviewing team knew the area and engaging them represented another form of community interaction.

Public meetings will be held in accordance with the Guidelines for Conducting Public Presentation at a time and location that will be agreed and signed off with the National Environment and

Planning Agency. The agenda will include, presentation of the findings of the EIA. All documents will be made available to the public.

1.6 Impact Identification, Assessment and Mitigation

Comprehensive analysis was carried out on the potential impacts on the physical, biological, social-economic and heritage aspects of the project. Based on the potential impacts and the proposed mitigation plans, keen attention must be placed on installing proper drainage, dust and noise control, protection of archeologically significant items as well as minimizing irreversible loss of habitats. JISCO Alpart must ensure land rehabilitation which complies with or exceed regulatory requirements in order to minimize the impact on flora and fauna. The removal of houses should be avoided as much as possible, in instances where this is unavoidable adequate compensation must be provided. A robust community relations programme should be maintained.

Environmental impacts were ranked according to significance, duration, type and reversibility.

Physical impacts were identified for both pre-mining and mining operations. Main potential impacts identified are fugitive dust, aesthetics, soil erosion increased turbidity of water sources and noise. Mitigative measures to address these impacts Includes; wetting of exposed areas for dust control, utilize fuel efficient low noise equipment and control speed limit, pit rehabilitation (aesthetics and safety), contouring to direct water away from sensitive receptors (soil erosion and turbidity) and limiting operating hours (noise). Fuel storage must be done in a bunded areas and handled according to spill prevention protocols.

An Air Quality Monitoring Programme must be implemented to monitor the impact of fugitive dust and to ensure that prompt corrective actions are taken if any non-compliance is identified. Solid waste is to be removed and disposed at an approved facility.

The project site is vulnerable to natural disasters because of Jamaica’s location in the Caribbean basin. Natural hazards such as hurricane and earthquake must be handled in accordance with an approved Emergency Response Plans which includes pre and post event procedures such as drills, liaison with municipal departments such as the fire department and police.

Biological Impacts such as loss of fauna, habitat loss and fragmentation were identified. Proposed mitigation includes reserving buffer areas, relocation of sensitive species, limiting site clearance to the minimum necessary to allow for mining and construction of haul roads and proper rehabilitation of mined out areas.

Socio-economic impacts include; possible disturbance of housing, farming and other activities; creation of jobs and employment opportunities and a general boost in economic activities. Mitigation should include; avoidance as much as possible and adequate communication and compensation in instances where avoidance is not practical.

Items of cultural significance have been identified and their locations noted. During site clearance and mining care must be taken to secure and preserve these items

Public health impacts relate to the potential of fugitive dust. Dust control by way of wetting areas with water must be used to mitigate this impact. The JNHT must be alerted of any artifact encountered during mining activities.

A risk assessment showed that where mine trucks cross public roads can be an area of concern. Adequate controls such as the use of signage and traffic warders must be utilized.

1.7 Residual Impacts

Residual impacts are impacts that will remain after mitigation measures have been applied. These are mainly of an ecological and socio-economic nature and focus must be placed on strategies to avoid or minimize these negative impacts.

1.8 Analysis of Alternatives

Three alternatives were analyzed. These were: (1) The No Action Alternative, (2) The Proposed Mining Activity, and (3) Location.

The No Action alternatives denies JISCO Alpart the bauxite needed to secure future operations, but would also allow for the lands to continue with its present use or be available for alternative use. The proposed mining project will provide the tonnage needed to secure future operations and comes with the attendant benefits to the country and communities. The location alternative makes the case for SEPL 541 as it will provide the quality and quantity and reduce the initial infrastructure needed to access the bauxite. Other locations would also likely impact more sensitive ecosystems.

1.9 Environmental Monitoring and Management

The proposed mining activity is to be carried out under the existing JISCO Alpart Environmental Monitoring Programme which covers all significant aspects of its operations. Environmental aspects are continually assessed and adequate mitigative measures and monitoring put in place. Environmental monitoring equipment which are compliant with applicable regulations are used. Calibration of the measuring devices used is done on a regular basis, in accordance with the manufacturer's recommendation, to assure the integrity of the data. Analysis of the samples is done an approved or certified laboratory. The results must be used by JISCO Alpart for continuous improvement and reports submitted to the applicable government departments/agencies as per regulatory requirements.

1.10 Conclusion

The Outer Valley section of SEPL 541 possesses the quantity and quality of bauxite required by JISCO Alpart for a viable plant upgrade and expansion investment. The ore bodies identified in the proposed site are located on lands that are owned by JISCO and are already significantly disturbed.

Bauxite mining is known to have negative impact on people and the environment notwithstanding the important national economic benefits from investment, employment and foreign exchange earnings. Therefore, in order to minimizes the negative effect on people, the environment and the cultural heritage in the area as per the following:

1. Adequate mitigations are implemented to control and minimize the impacts identified
2. JISCO Alpart has been engaged in mining activities for over fifty years must ensure that best practice is always applied and the most environmentally friendly technology/equipment is used on the project.
3. There is adequate legislation and monitoring to ensure proper regulatory control.

2 INTRODUCTION

2.1 HISTORY AND BACKGROUND OF THE PROJECT

Jiuquan Iron and Steel (Group) Co., Ltd. (referred to as JISCO), founded in 1958 is one of the most important aluminium producers in China, having two aluminium production bases of 350kt/annum in Longxi and 1,350kt/annum in Jiayuguan. With a total output capacity up to 1700kt/annum, JISCO is regarded as China's fifth largest primary aluminium producer with very strong competitive power and consuming alumina of about 3,400kt/annum.

The Alpart alumina plant in Nain, St. Elizabeth, Jamaica was originally financed by US Kaiser Aluminium Co., Ltd., US Reynolds and Anaconda in 1968, and was commissioned in 1971. In June 2016, JISCO purchased the Alpart operations from the then owners UC Rusal. The refinery which had closed was restarted in November 2016.

In 2018, JISCO announced plans for additional investment in Jamaica to include modernization and expansion of the existing plant, the construction of a new refinery and upgraded power generation facilities. The feasibility study determined that additional bauxite reserves would be needed to sustain operations over a period of approximately 25 years. It has, therefore, become necessary to convert the Outer Valley section of the existing Special Exclusive Prospecting Licence (SEPL) 541 to a Special Mining Lease (SML) as shown in Figure 2.1 below.

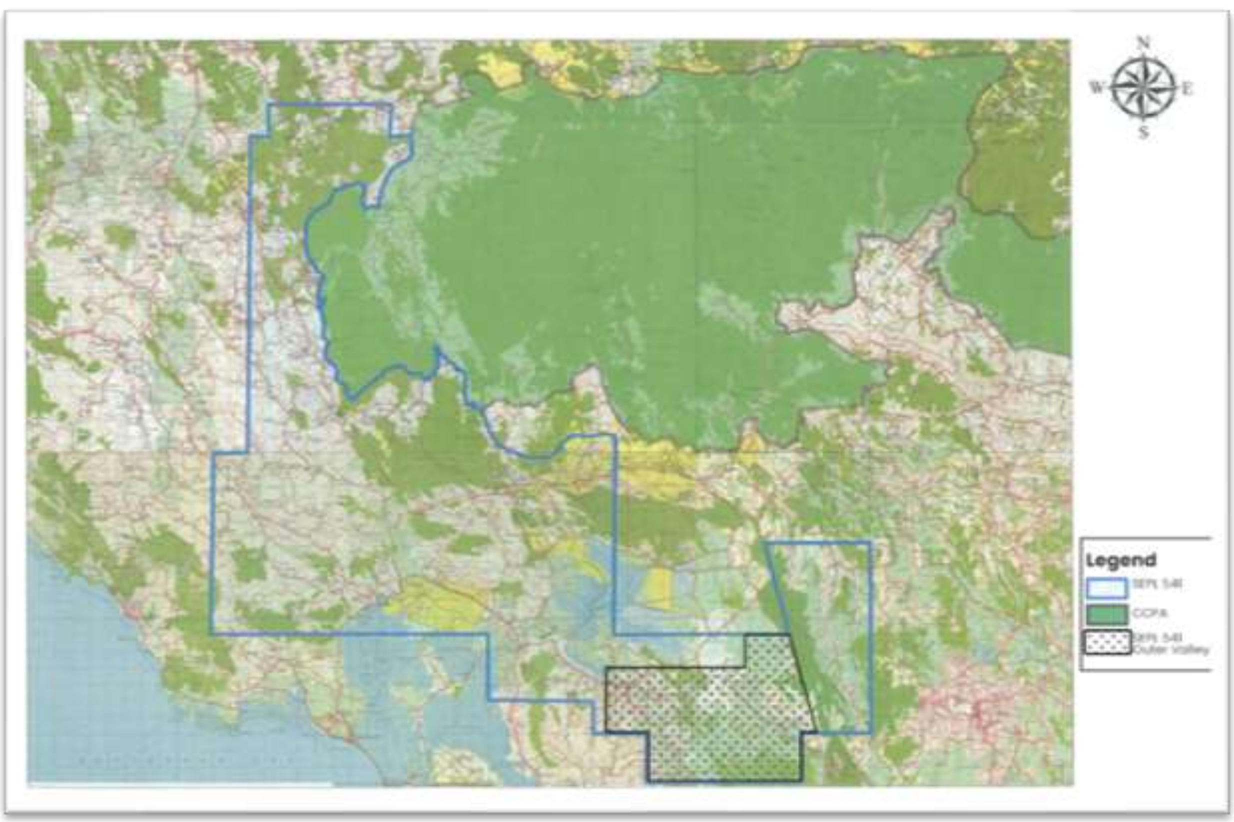


Figure 2-1: Map of SEPL 541 Showing "Outer Valley Project Area

The Outer Valley section of SEPL 541 was selected as it is adjacent to SML 167 for which Alpart currently holds a license to mine SML 167, and active mining is currently in progress. It holds a Special Exclusive Prospecting License (SEPL 541) which allows the company to explore for bauxite within this boundary.

JISCO-Alpart plans to conduct bauxite mining in Outer Valley section of SEPL 541 over a period of approximately twenty-five (25) years. Figure 2-2 shows the layout of the project in relations to SML 167 and the Outer Valley section of SPEL 541.

In May 2020, JISCO Alpart made an application to the National Environment & Planning Agency (NEPA) for an Environmental Permit to mine a selected area within SEPL541. This is in keeping with the requirements of the Natural Resources Conservation Authority (NRCA) Act of 1991, Section 9 and the Natural Resources Conservation (Permit and License) Regulations of 1996 and the subsequent amendments of 2015. NEPA instructed that JISCO Alpart carry out an Environmental Impact Assessment (EIA) on the selected area of Special Exclusive Prospecting Licence 541 (SEPL 541) located in the parish of St Elizabeth as shown in Figure 2-1.

The environmental permit is required to cover the following activities which will take place in the proposed mining area: land clearance, within the SEPL for construction of haul roads and the mining of bauxite, stockpiling, ore loading and off-loading, limestone screening as well as transport and conveyance of bauxite.

Specifically, JISCO Alpart Jamaica is seeking approval from the National Environment & Planning Agency (NEPA) to convert the southern section of Special Exclusive Prospecting License (SEPL) 541 designated as “Outer Valley” to a Special Mining Lease. Mining in this area is projected to commence within 5- 10 years.

This Environmental Permit is being sought following reasons:

1. JISCO has completed exploration activities and must now make plans to mine the area as part of the reserves.
2. Mining in the Outer Valley section of SEPL 541 is projected to start in 5 - 10 years. The time is required to apply for and acquire the Special Mining Lease (SML) and put in place the structures and procure equipment etc.
3. The main areas where orebodies have been identified are already owned by Alpart and are in close proximity to an existing network of haul roads to the refinery.

Transportation will involve moving bauxite mined from the ore-bodies via existing and new haul roads to a cable belt and ultimately stockpiling the ore.

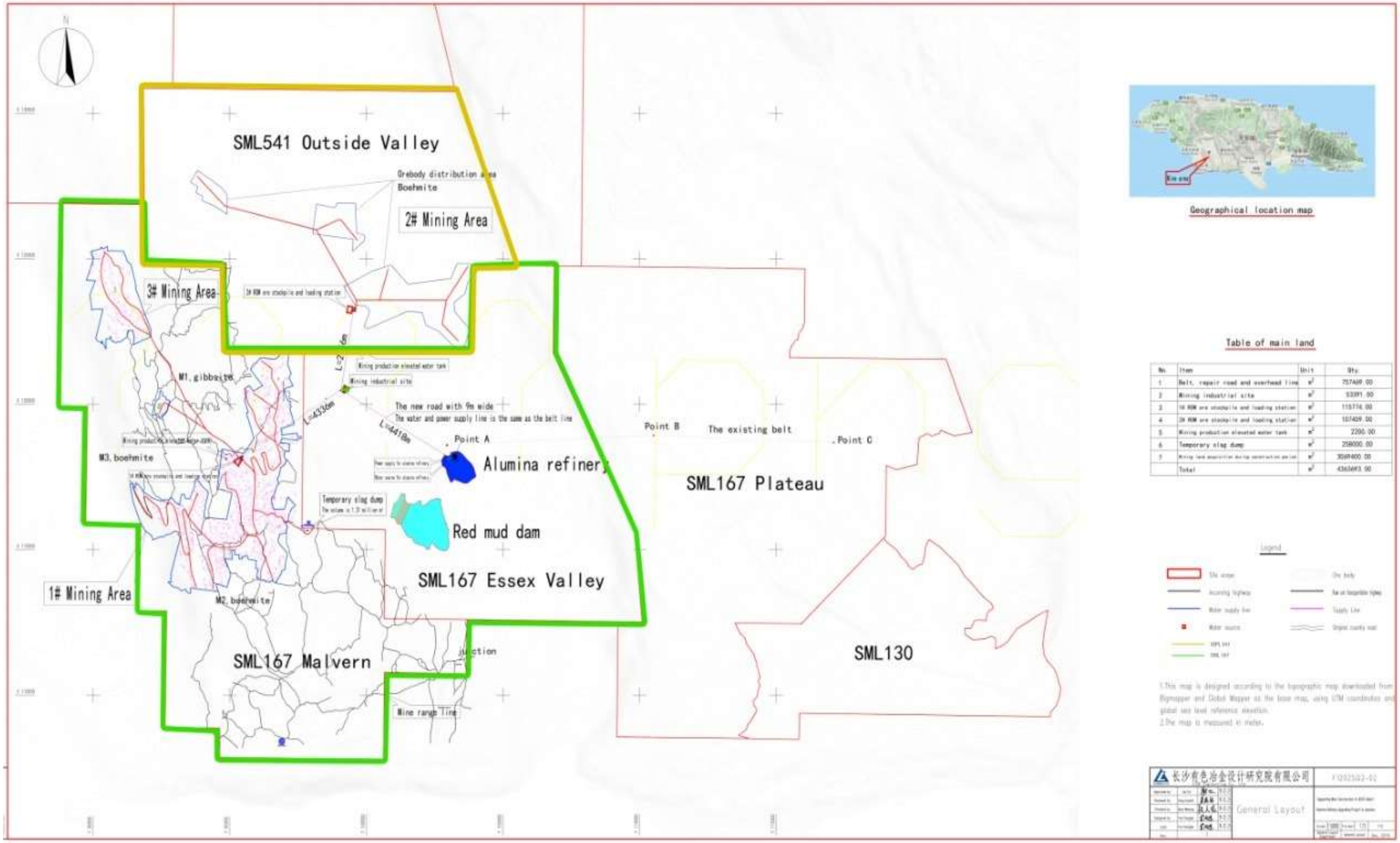


Figure 2-2: Location of Outer Valley Section of SEPL 541 in relation to SML 167

2.2 Delineation and Justification of the Boundary of the Study

The study area referred to as the Outer Valley section of SEPL 541 is located in the parish of St. Elizabeth and covers the area as delineated in Figure 2-3. The area includes the communities of; Fellowship, Friendship, Northampton, Goshen, Gilnock and Burnt Ground, etc. The exploratory work done in the Outer Valley section of SEPL 541 confirm the availability of bauxite in the appropriate quality and quantity in this area. The orebodies identified are shown in Figure 4.3 and is shaded in blue.

Over 90 percent of the orebodies are located in field or grassland type vegetation and most of these lands are already owned by JISCO.

Ore bodies can be accessed via extension of existing haul roads. As shown in Figure 2.2 the Outer Valley section of SEPL 541 is contiguous with the area where active mining is currently being done in the north western section of SML 167.

The Outer Valley area of SEPL 541 was chosen because of these reasons:

1. The bauxite lands in that area are either already owned by JISCO Alpart or are on Government lands that are assigned by a special lease agreement to JISCO Alpart.
2. Drilling for quality & tonnage in these deposits have been completed.
3. The close proximity of this area to the Refinery and the present network of haul roads
4. The orebodies are located in areas that are already significantly disturbed and away from sensitive features and population centres.

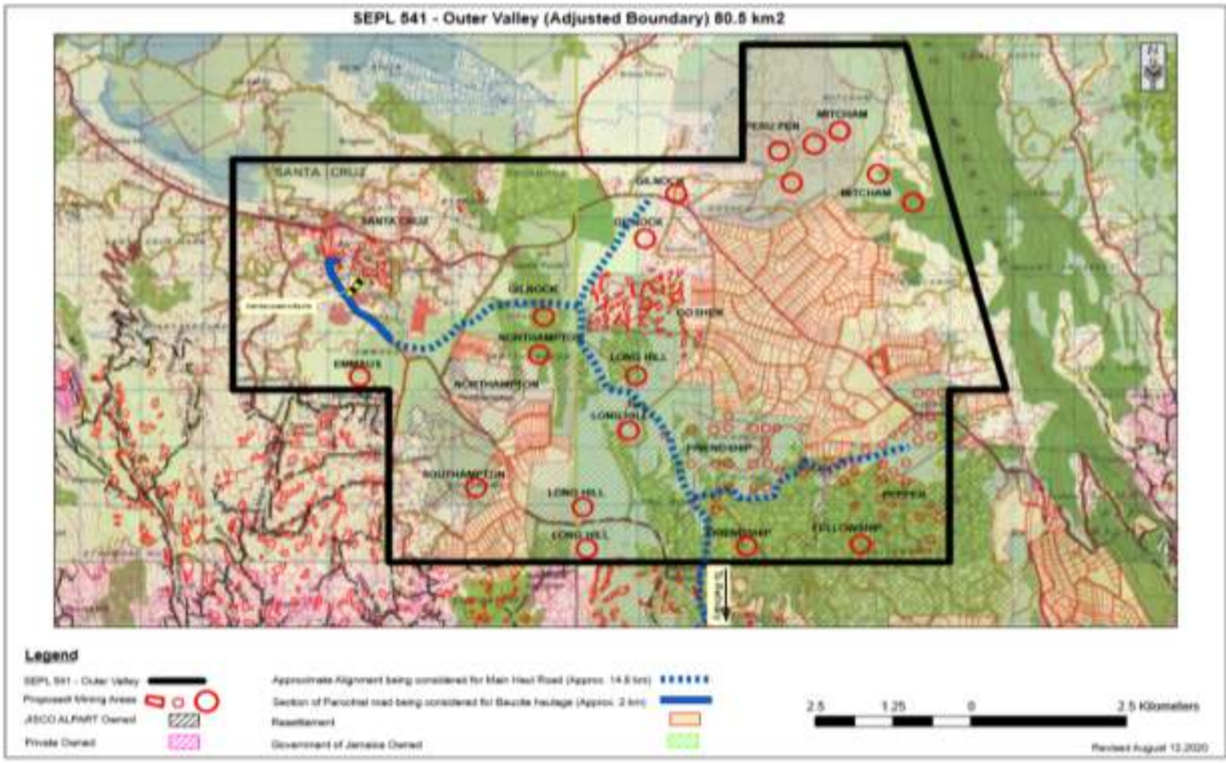


Figure 2-3: Boundary of the Proposed Project Area

2.3 General Methodology

The general approach to this study involved utilizing subject matter experts as per the requirements of the Terms of Reference (TOR) issued by NEPA for An Environmental Impact Assessment for the Proposed Mining and Quarrying at Nain, St. Elizabeth (SEPL) by JISCO ALPART Jamaica Limited dated 18 August 2020. The requirements can be summarized as follows:

1. Description of physical, biological, hydrogeological, heritage and socio-economic features of the proposed mining site.
2. Impact identification.
3. Summary of natural hazards risks that could impact the site.
4. Public Health Concerns.
5. Impact Mitigation.
6. Analysis of alternatives
7. Environmental monitoring and management

Research and other preparatory work for this EIA such as interviews with key stakeholders commenced August 2020. This was followed by field work such as sample collection, monitoring and measurements. For all subject areas, information was obtained from primary and secondary sources, field work and monitoring data. Established protocols for sample collection and analyses were followed.

The following assumptions and constraints were identified:

- The EIA was undertaken, and the resulting conclusions made, using the material made available to the EIA team by the client and members of their project team, together with other available and publicly accessible material including existing literature and studies, as well as communication with local experts. Quality control was therefore important as errors could affect the conclusions made. All efforts have been made to ensure that the information used as a basis for the assessment is accurate and up to date.
- Results from air quality, noise and water quality monitoring could be influenced by the accuracy and precision of the equipment which is used. In addition to this, there could be human errors involved in the measurements. In order to minimize this, qualified and experienced persons were utilized as well as reliable equipment. All sampling protocols are in compliance with the Natural Resources Conservation Authority (Air Quality) Regulations, 2006.
- Standards were used to calibrate equipment to ensure accuracy and precision.
- The sample size taken for the socio-economic study complied with established standards, and based on the techniques employed can be assumed to be the views of the remaining population. However, there is a percentage error associated with surveys of this scale.
- Maps and other information sources are the latest available versions.
- Data entry was subjected to established techniques to ensure accuracy.

3 Policy, Legislation, and Regulatory Considerations

3.1 Environmental Legislation

There are several national environmental and planning laws and regulations that are relevant to the mining project. These also include planning regulations and other regulations that are applicable to supporting activities such as land acquisition and haul road construction.

Table 3-1: Legislation, regulations, and policies which govern the mining of bauxite in Jamaica

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
Acts		
Natural Resources Conservation Authority (NRCA) Act	1991	The Act establishes the Natural Resources Conservation Authority and sets out its functions, which includes the management, conservation and protection of the island's natural resources by way of the effective management of the physical environment and the promotion of public awareness of the ecological systems of Jamaica. Section 10 outlines the power of the Authority to request Environmental Impact Assessments such as the one that is being carried out regarding SEPL 541.
Natural Resources Conservation (Permits and Licenses) Regulations The Natural Resources Conservation (Permits and Licenses) (Amendment) Regulations.	1996 2015	These regulations set out rules and procedures regarding licenses and permits pursuant to the Natural Resources Conservation Act of Jamaica. Section 3 requires an application for the grant of a permit to undertake any enterprise, construction or development of a prescribed description or category in a prescribed area shall be in the form set out as Form I in the Schedule. This justifies why a permit is required for this mining project. Section 8 requires licenses in accordance with section 12 (1) of the Natural Resources Conservation Authority (NRCA) Act for any discharge of sewage or trade effluent emanating from the mining or any other activity associated therewith.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
Natural Resources Conservation Authority (Air Quality) Regulations.	2006	The NRCA (Air Quality Regulations, 2006) provides the framework for regulating emissions from major and significant point sources and are developed pursuant to Section 38 of the NRCA Act, 1991. The regulations outline the ambient air-quality limits for specific parameters. Parameters of interest are referred to as critical air pollutants, namely: total suspended particulates, particulate matter having diameters of 10 micrometres or less (PM10), lead, sulphur dioxide, photochemical oxides (ozone), carbon monoxide and nitrogen oxide. The regulations will dictate standards that are to be complied with for air monitoring around the project area. The mining of bauxite generates total suspended particles (dust) from extraction of the ore and from movement of the mining vehicles in the transportation of the ore along haul roads. The motorised equipment involved in the mining operations can also potentially cause emissions of gases, micro-sized particulates and other chemicals and will be monitored as prescribed by the Regulations.
Natural Resources Conservation (Prescribed Areas) (Prohibition Category of Enterprise, Construction and Development) Order and Amendment	1996 (2000) 2015	The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996 and the Permits & Licensing Regulations was passed pursuant to section 9 of the Natural Resources Conservation Authority Act, 1991. The Order provides that the entire island of Jamaica is a prescribed area and lists specified categories of enterprise, construction or development that require a permit. The Order lists mining and mineral processing of bauxite which makes it relevant to the project.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
Natural Resources Conservation (Wastewater and Sludge) Regulations.	2013	Outlines the responsibilities of owners and operators of wastewater treatment plants in ensuring that the prescribed standards are met. Operators of facilities that generate sludge and discharge treated (sewage) effluent and trade effluent to the environment will require new licences under three possible categories: construction of a new wastewater treatment plant or reconstruction (rehabilitation and or upgrade) of an existing treatment plant; the operation of a wastewater treatment plant; and the discharge of treated sewage and trade effluent into the environment. The initial phase of this mining project is relatively small and will not require a waste water treatment license. However, this regulation is being included for consideration in the event of expansion.
Mining Act	1947 (1995)	The Mining Act regulates the procedure for mining and prospecting for minerals in Jamaica. Under the Act, it is not lawful to mine unless there is an approved mining lease. The Act requires a Special Mining Lease for land prior to mining. This EIA is in partial fulfillment of the requirements of an Environmental Permit which must be in place prior to the issuance of a mining lease.
The Mining Regulations	1947	An Act to control and regulate all matters related to mines and mining under section 99 of the Mining Act.
Mining (Safety and Health) Regulations	1977	Outlines a safe system of work for the mining industry. JISCO Alpart has a comprehensive Safety Programme, which complies with the Mining (Safety and Health) Regulations and which is applied to all sections of their operations. Close monitoring of the programme is administered daily and periodic reports are submitted to the Commissioner of Mines.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
The Parish Council Act	1901 (2007)	The Act informs the functions, mandate and purview of the Parish Councils now known as Municipal Corporations as per The Municipalities Act. The roles and functions of Municipal Corporations are outlined which will impact on mining operations and its employees in the areas of Public Health, Fire Services, and Water Supplies, building regulations and street lighting
Town and Country Planning Act	1958 (1999)	The objective of this Act is to ensure the orderly development of land. This is achieved through Development Orders which are legal documents used by the planning authorities to inter-alia provide for protection of amenities and conservation and development of the resources of the prescribed area. The development Order will inform the allowed developments for the lands earmarked for mining.
The Town and Country Planning (Manchester Parish) Provisional Order	2013	This order is made in keeping with section 5 (1) of the Town and Country Planning Act. The Town & Country Planning Act, empowers the Town & Country Planning Authority to prepare, in conjunction with the Local Planning Authority, legal documents called Development Orders for specific areas across Jamaica or for the entire island. The aim of these documents is to regulate and control the use of land; ensuring that land is not mis-used but is complementary rather than conflicting.
Town and Country Planning (St. Elizabeth Parish) Provisional Development Order	2018	This Development Order sets out the framework, guidelines and policies for planning and development in St. Elizabeth. It enables the Local Planning Authority and/or the Town and Country Planning Authority to regulate land developments within the area defined as the Development Order Area.
Building Act	2018	The Building Act has a modern legislative framework that will serve to reduce the vulnerability of Jamaica's built environment and ensure public safety, is now in effect.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
		The Building Act 2018 came into force on January 15 and repeals the Kingston and St. Andrew Building Act and the Parish Councils Building Act. “The Act is critical to the effort to prevent new squatter settlements from being built, promote sustainable development, establish and enforce internationally-accepted building standards and rules for individuals and entities providing construction material and services.
The Factories Act	1943 (2009)	An act to make provision for the registration and supervision of factories, and for the safety of workers employed therein. Under Section 4 of the Factories Act, the Minister may make regulations for the purposes of ensuring the safety, health and welfare of persons who are employed in any factory or in connection with machinery. This addresses the use of personal protective equipment (PPE), standard operating practices for safe operations (SOP) and other specific guidelines for safe and healthy operations in the mining industry.
The Public Health Act	1985 (1996)	An act to make provision for promoting the public health and for preventing the spread of communicable and epidemic diseases. This act will be important to JISCO Alpart as it will guide the interface with the Ministry of Health.
The Disaster Preparedness and Emergency Management Act	1993	An Act to ensure the development and implementation of policies and programmes to achieve and maintain an appropriate state of national and sectoral preparedness for coping with all emergency situations which may affect Jamaica. JISCO Alpart will need to ensure that their emergency plans are aligned with the directions given by the Office of Disaster Preparedness and Emergency Management.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
The Water Resources Act	1995	An act to provide for the management, protection and controlled allocation and use of the water resources of Jamaica; to provide for water quality control and for the establishment and functions of a Water Resources Authority.
The National Solid Waste Management Act	2001	The National Solid Waste Management Authority Act (2001) is "an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority. The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste.
Disaster Risk Management Act	2015	This Disaster risk Management Act repeals the previous Disaster Preparedness and Emergency Management Act and makes new provisions for the management and mitigation of disaster, the reduction of risks associated with disaster, and other connected matters.
Fire Brigade Act	1988	The Act primarily addresses the administration of the agency with the mandate to respond to fires. The JFB remains the authority of the government on issues related to fires. This Act will be relevant in the drafting and updating of Emergency Plans relating to fire.
The Wild Life Protection Act	1945 (1991)	An act to make provision for the protection of certain wild animals, birds and fish and for other matters relating thereto and connected therewith. The Wild Life Protection Act is the only statute in Jamaica that specifically protects designated species of animals and regulates hunting in Jamaica.
The Endangered Species (Protection, Conservation	2000 (2015)	The Endangered Species (Protection, Conservation and Regulation of Trade) Act was created in 2000 in order to ensure the codification of Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
and Regulation of Trade) Act		This Act governs international and domestic trade in endangered species in and from Jamaica. Under this act, the functions of NEPA include the grant of permits and certificates for the purpose of international trade, the determination of national quotas and the monitoring of the trade in endangered species. This Act will be used in the Flora/Fauna section of this EIA and will guide outcomes regarding identification of any endangered species.
The Forest Act	1996	This Act sets out the role and function of the Forestry Department and the Conservator of Forests. The Act vests responsibility in the Conservator of Forests for developing and maintaining an inventory of forests and lands suitable for the development of forests. Mining will not impact any protected forestry areas.
The Forest Regulations	2001	Makes provision for a Conservator and Forest Management Plans. Authority to close or restricts roads that could impact forests.
The Jamaica National Heritage Trust Act	1985	This Act makes provision for the protection of national monuments and protected national heritage and the establishment of the Jamaica National Heritage Trusts for this purpose. The JNHT must be consulted in the event that any historical artifacts are identified during the mining operations.
The Watershed Protection Act	1963	Governs the activities operating within the watersheds, as well as, protects these areas. Watersheds do not exist within the project area. The Act is being included in this section in the case it becomes relevant to any future expansion.
The Flood Water Control Act	1958 (1995)	An act to make provision for the construction, improvement, repair and maintenance of works for the control of flood water, and for other matters connected therewith
Main Roads Act	1932 (1985)	An act to consolidate the laws relating to main roads.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
		Knowledge of this act is essential, as there is the possibility of haul roads crossing the main roads.
Parochial Roads Act	1932 (1985)	An act to consolidate the laws relating to parochial roads.
The Road Traffic Act	1938 (2016)	The Road Traffic Act replaced the 1938 Act. It established new offences, as well as provide increased penalties for breaches. Among the features are: a restriction on handheld devices; and a requirement for drivers to have a licence in their possession while operating a vehicle. The Act must be complied with as haul trucks are expected to cross public roads.
The Draft Occupational Safety & Health Act	2017	Oversees the prevention of injury and illness resulting from conditions at the workplace, the protection of the safety and health of workers and the promotion of safe and healthy workplaces. The JISCO Alpart Safety Programme will have to comply with this Act when it is gazetted.
Minerals (vesting) Act	1947 (1994)	This Act declares all minerals (as defined in this Act) being in, on, or under any land or water, whether territorial waters, river, or inland sea, to be vested in and subject to the control of the Crown. The Act also requires any person to mine any minerals only in accordance with the legislation governing mines and mining and provides that royalties shall be paid to Government. The Act sets out rules relative to the payment of royalties and grants regulation-making powers to the Minister.
Bauxite and Alumina Industries (Encouragement) Ac	1950 (1997)	An act to make provision for the grant of special concession to producers in Jamaica of bauxite and alumina

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
Bauxite and Alumina Industries (Special Provisions) Act	1977 (1982)	An Act to Make special provisions for bauxite, alumina and other related enterprises in which the Government participates, and to provide that income tax paid by any bauxite producer shall be allowed as a credit against production levy payable by that bauxite producer.
Bauxite (Production Levy) Act	1974 (1998)	An Act to provide for the imposition of a production levy on bauxite and laterite won in Jamaica, and for matters incidental thereto or connected therewith.
Standards		
Ambient Air Quality Standards Regulations for Jamaica	1996	The regulations outline the ambient air-quality limits for specific parameters. Parameters of interest are referred to as critical air pollutants, namely: total suspended particulates, particulate matter having diameters not less than 10 micrometres (PM110), lead, sulphur dioxide, photochemical oxides (ozone), carbon monoxide and nitrogen oxide. The regulations also cover the parameter photochemical oxides which are measured as ozone, an end-product of photochemical reactions. The Ambient Air Quality Standards Regulations include Primary standards which state the minimum level of air quality aimed at protecting public health. The secondary standards are aimed at the promotion of public welfare and the prevention of damage to animals, plants, and property. These regulations will be used as standards to determine compliance of ambient air measurements at all stages of the project.
Draft NRCA Ambient Water Quality Standards (Fresh Water/Marine Water)	2009	Lists standards for critical parameters in fresh and marine waters for the island of Jamaica.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
		At this time, the standard has not been gazetted. However, they may be used to assess ground water in the area.
Jamaica National Noise Standards (Extracted from the Recommendations for National Noise Standards for Jamaica, 1999)	1999	Outlines noise standards for industrial, commercial, residential and silent zones. These standards will be used to determine compliance of noise measurements taken in communities.
Guidelines		
NRCA Guidelines for the preparation of a Closure Plan for Industrial Type Projects	2006	This guideline describes a Closure Plan as the procedures for decommissioning of a facility and the removal of all the possible contaminants to air soil and water and closure to the satisfaction of the relevant standards and regulations. It is likely that a closure plan will be required. The requirements are outlined in this document.
NRCA Guidelines for a Site Contamination Assessment Report/ Remedial Action Plan	2006	The guidelines serve to assist Permitted Facilities or Volunteer Facilities in developing their Site Remediation Plans which is required at the completion of a detailed site investigation. These guidelines will govern any clean up necessary in the event of any spills of hazardous substances.
National Restoration Committee Guidelines for the Rehabilitation of Lands Disturbed for Mining Bauxite	2012	Chaired by the Mines & Geology Division of the Ministry of Mining and Transport, the objective of the Committee is to develop the requisite guidelines and knowledge that will facilitate more effective management of the restoration process. JISCO Alpart is accountable to this committee to ensure that rehabilitation practices are compliant with regulations and established procedures.

Act, Standard Guideline or Policy	Operational Date (Last Amendment)	Relevance to the Project
Policies		
Environmentally Sound Management of Hazardous Waste (Green Paper)	2017	A comprehensive policy for the management of hazardous waste on the island. This includes waste electrical and electronic equipment which will be generated by the project
Forest Policy	2017	The vision of Jamaica's Forest Policy is that by 2062, forests and biodiversity are sufficiently restored and sustainably managed. This policy will need to be included in long term mining plans.
National Strategy and Action Plan on Biological Diversity in Jamaica	2016 - 2021	This initiative will assist the Jamaican government to meet its obligation under the Convention on Biological Diversity. The bauxite companies will be major stakeholders in some of the strategic goals outlined in the document.

3.2 International Agreements

Environmental management in Jamaica is guided not only by national policies and legislation but also by several international and regional agreements. The island's commitment to relevant international agreements is highlighted below.

1. The Stockholm Convention on Persistent Organic Pollutants (POPs). The Stockholm Convention covers the management of various chemicals considered as POPs including Pesticides, Polychlorinated Biphenyls and Brominated Flame Retardants (BFRs) which is widely used in electronic equipment casings and cathode ray tubes which is a component of televisions and cathode ray tubes. The convention bears relevance to the project as Stockholm restrictions on certain BFRs will take place beginning 2030. Purchases of electronic equipment such as computers and other process control equipment should be therefore be BFR free to avoid having to replace them when restrictions come on stream.

2. The Kyoto Protocol mandated that industrialized nations cut their greenhouse gas emissions at a time when global warming was growing. It was adopted in Japan in 1997. Initially focusing only on industrialized countries, it was eventually amended to include developing countries. The project will involve the use of heavy equipment which can emit greenhouse gasses. Hence vehicles and heavy equipment to be used during the project should be fuel efficient and properly maintained and managed to minimized the release of greenhouses gases such as carbon dioxide.

3. The Paris Climate Agreement was adopted in 2015 to address climate change and its negative effects. The Agreement requires countries to cut greenhouse emissions. Again, the potential for greenhouse gas emissions demands that this international agreement be taken into consideration during planning and implementation of the project.

4. Montreal Protocol on Ozone Depleting Substances. Jamaica phased out chlorofluorocarbons (CFCs) in refrigeration in 2006. This is not expected to be an issue with this mining project but should still be considered.

5. Agenda 21, a non-binding plan of the United Nations with regards to Sustainable development. The plans outline 27 principles which should be taken into consideration during the design and operation of this project.

4 PROJECT DESCRIPTION

4.1 PROJECT LOCATION

The project area is located within the central region of the parish of St. Elizabeth with the eastern boundary running alongside the parish border between Manchester and St. Elizabeth. See Figure 4-1 below.

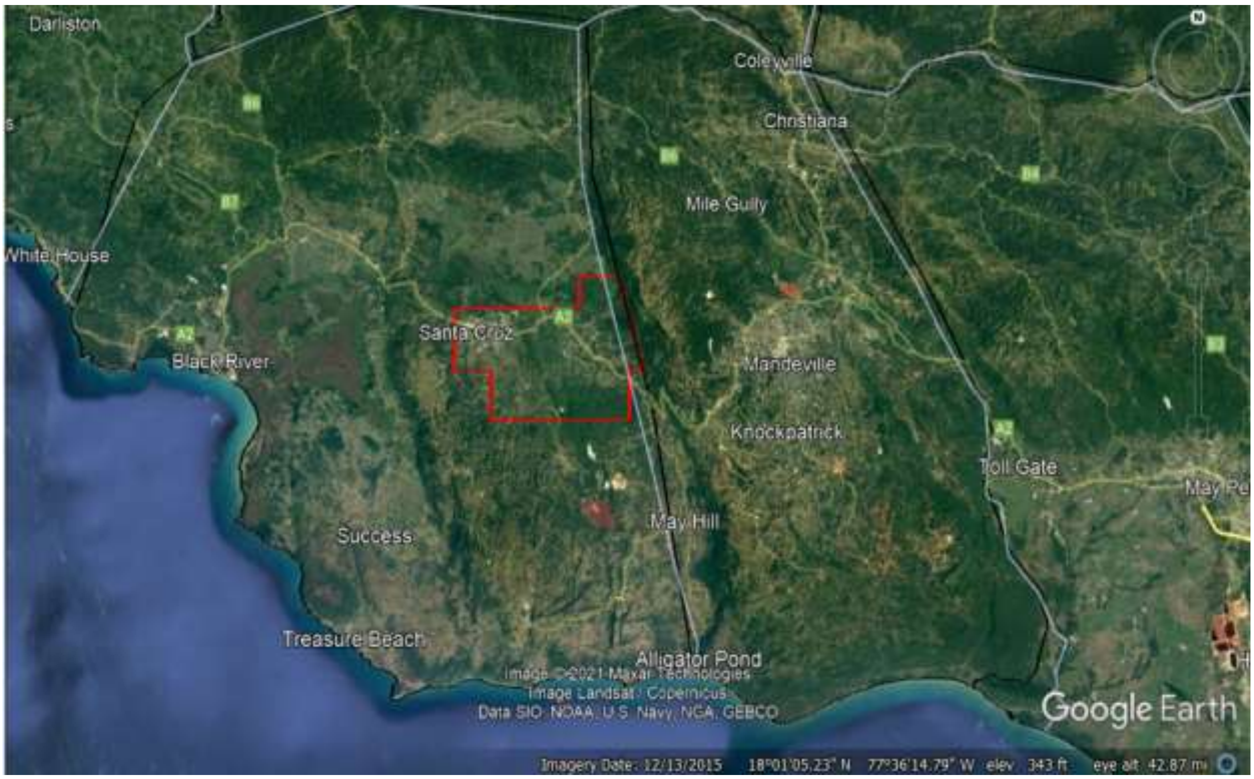


Figure 4-1: Google Earth image of the Project Location

The Google Earth map below (Figure 4.2) reveals that the area is dominated by lands previously disturbed for various types of agricultural use. The only major built up area is the town of Santa Cruz. Details on the distribution of the vegetation type is presented in section 5.4.2.1 of this report and is shown in Figure 5-29.

Figure 4-2: Google Earth map showing features within the project area

4.2 PROJECT RATIONALE

In 2016, JISCO acquired the Alpart alumina operations in Jamaica from UC Rusal. The refinery commenced operations shortly after and made the first shipment of Alumina by December 2017, however the plant experienced frequent downtime associated with the aging equipment.

In 2019 JISCO shutdown production at the Nain refinery and made a strategic decision to implement a modernization and expansion programme at the plant. The modernization and expansion project will involve a total investment of USD $1.1 billion over a five-year period. This planned upgrade will result in a more efficient refinery with advanced technology and facilities. The production capacity will be increased from 1,65 million tonnes to 2 .0 million tonnes per year.

During the refinery upgrading project it is estimated that approximately 1000 jobs will be provided for local personnel and contractors. Once the refinery restart operations it is expected there will be up to 500 direct job opportunities created with another 500 indirect jobs for the local communities.

One of the pre-conditions for the investment in the refinery modernization and expansion is adequate supplies of bauxite. The feasibility study for the project indicated that for the project to be viable it will be necessary to secure bauxite supplies for at least 25 years of operation.

The exploratory work done in the Outer Valley section of SEPL 541 confirm the availability of bauxite in the appropriate quality and quantity. The orebodies identified are shown in Figure 4.3 and is shaded in blue. In order to be able to mine the bauxite, it is necessary to convert the Outer Valley section of SEPL 541 to a Special Mining Lease (SML).

As was mentioned in Section 2.1 and shown in Figure 2.2 the Outer Valley section of SEPL 541 is contiguous with the area where active mining is currently being done in the north western section of SML 167, and as such the additional infrastructure required to facilitate access and mining activity in the project area is minimized.

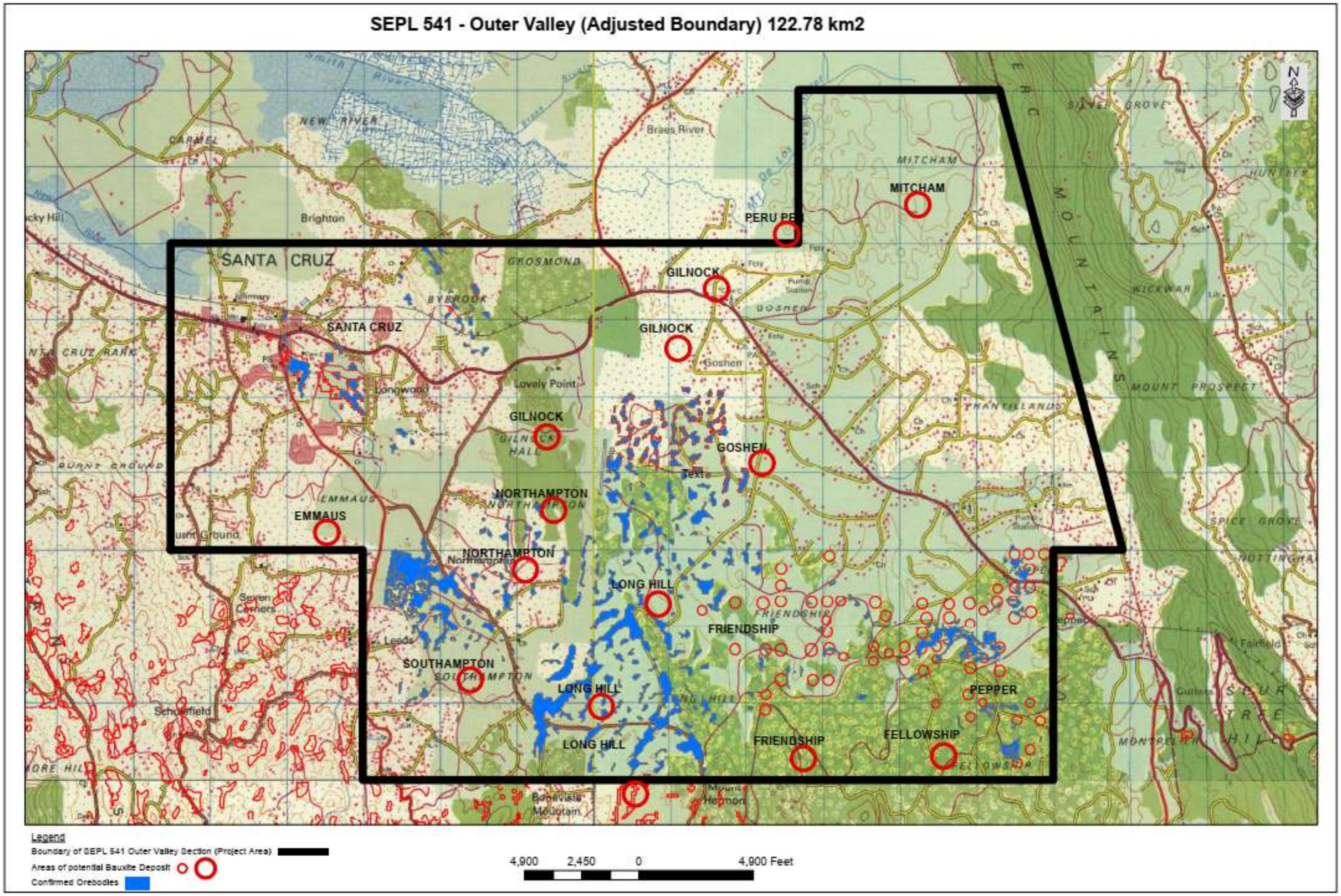


Figure 4-3: Confirmed Orebodies (shaded in blue) in the Outer Valley Section of SEPL 541

4.3 Components and Layout of Project

The proposed layout of the project is shown in Figure 4-4. ***(The map was compressed in order to fit on the page and so details may not be clear, however full-size map is included as an addendum)*** This includes part of the cable belt to be used to transport bauxite to the plant, haul roads, ore bodies and a stockpile.

The main elements of the project are:

1. haul road construction
2. clearing of land for mining
3. mining of bauxite ore
4. transportation by haul road
5. transportation by cable belt
6. stockpiling
7. rehabilitation
8. ore loading and off-loading stations
9. limestone screening

The development of the bauxite mining project planned in three phases:

- Pre-Operation Phase
- Operation Phase
- Rehabilitation Phase

Information on these phases is presented in the sections and figures below.

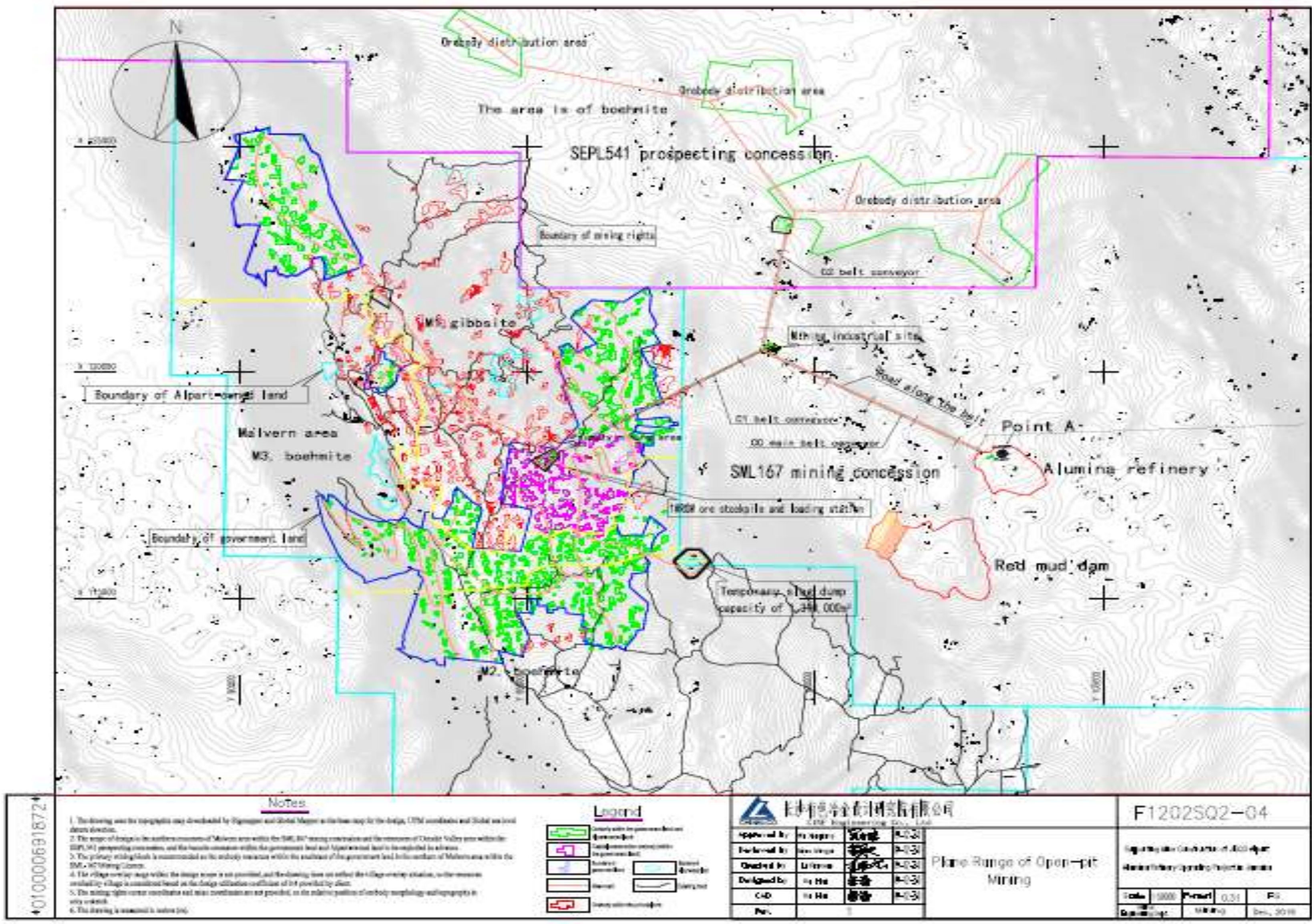


Figure 4-4: Plan View of Project

4.4 Pre-operation

This section will be presented as laid out in the Terms of Reference.

4.4.1 Exploration and Drilling

This phase of the project was already complete 2011 - 2018 and will not be included in the activities under this permit application.

4.4.2 Location of Stockpiles

The No. 2 Raw Ore Material (ROM) stockpile will be located in the proposed mining area as shown in Figure 4-4.

4.4.3 General Access to Site and Access to Ore Bodies

Figure 4-4 shows the proposed locations of haul roads. The mining area trunk road will run east to northwest with roads branching off leading to each ore body. Eight (8) km of haul roads will be constructed and 7,111,08 m3 of infrastructure stripping will be completed.

4.4.4 Clearing of Land for Mining

Typically, bauxite in Jamaica occurs in karst depressions. These are classified as pocket deposits and their size and shape are extremely variable. Thickness varies from several centimeters to over 30 meters.

Mining of pits will utilize the open pit method. The land is cleared using tractors and scrapers. Approximately 61 cm (0.61m) of topsoil will be removed and stockpiled on the perimeter of the pit for post mining restoration of the land, as required by law. Standard procedure is to mine the pit in benches of 3 - 5m thickness using an excavator. The bauxite will be loaded into trucks and transported to the refinery via private haul roads for stockpiling.

4.4.5 Plant/Administrative Office

The main Plant/Mining and Administrative offices will be located outside the project area. However, the plan is to place a container office within SML541 to be used as a shift change area. There will also be a power distribution room to provide power to the site.

4.4.6 Duration, Timing, and Working Hours of the Initial Phase

The pre-operation phase will include construction of haul roads and installation of the cable belt to the plant and will take 3 - 4 years with the work hours being from 8:00 a.m. to 4:00 p.m.

4.4.7 Comprehensive Drainage Assessment and Design:

Construction of intercepting ditches and drainage ditches will be done, and haul road and pits cambered such that all runoff is away from lands no owned by JISCO Alpart.

4.4.8 Method of Sewage Treatment and Disposal

Portable toilet facilities will be utilized for the project. The toilets will be provided and maintained by a contractor. Disposal will be carried out by standard methods.

4.4.9 Traffic Impact Assessment

Figure 4-5 shows the National Works Agency's, road network map of the area. The NWA classification carries the following definitions:

Class A roads – These are roads of National Importance that link one or more major areas or towns of the island with other major areas or towns. These are also known as arterial roads.

Class B roads – These roads, also known as secondary roads, are those roads of regional importance that connect with arterial roads.

Class C roads – These roads, also known as tertiary roads, normally, only of local importance and have the function of allowing communication and contact within districts.

Analysis of the proposed mining area indicates one Class A road, one class C and other unclassified roads and tracts. There are two crossings of mine haul road and public/private roads: in Goshen the main haul road will cross over the main Gutters to Santa Cruz Class A road and in the Sorn Hill area, the haul road will cross over the Nain to Myersville Class B Road.

Crossings will be manned by traffic wardens or flag persons.

Figure 4-5: Jamaica Roads Inventory

4.4.10 Road Construction Plan and Method

The haul roads have a total length of 67.963km. Haul roads will be constructed in phases ahead of the expansion of the mine. The equipment involved in the road construction/rehabilitation include:

- A D9 Bulldozer
- Haul trucks to transport material for road rehabilitation.
- A Front-end Loader to stockpile and load material
- A scrapper to spread material along the roadway
- A roller or compactor to compact the material on the road.
- Water truck

Where the haul road crosses a parochial road traffic wardens will be employed to ensure that there is proper crossing. Signage will be in place upon the approach to the haul road crossing. Motorists on the parochial roads will have the right of way.

Trucks will only operate during daylight hours, and in the event of low lighting warders will be equipped with coloured light wands.

4.4.11 Procedure for Haul Road Construction

The standard procedure for haul road construction is:

1. Stripping of site for construction
2. Cutting road alignment
3. Setting out and establishment of required vertical profile
4. Transporting, spreading and grading of marl/fill material from borrow pits to form road base
5. Construction of embankments and drainage outlets along road alignment
6. Blasting of rock where applicable and approved by Owner's representative - (Rock is defined as 'Material that is visible above ground or underlies the soil, overburden or unconsolidated material, that cannot be ripped or dislodged by a D10 Bulldozer using a single ripper blade')
7. Preparation of mass haul diagram for the hauling of required construction material along road alignment and disposal of excess material where necessary
8. Backfilling of mined out pits located along road alignment
9. Cutting and loading of marl from borrow pits.

4.4.12 Sources of Potable Water

Potable water will be supplied from a tank.

4.4.13 Electricity Supply

Electricity will be supplied to the site via overhead cables.

4.4.14 Solid Waste Disposal – Pre-Operation

All solid waste will be sent to the refinery for disposal according to the existing waste management procedures - Appendix No. 9 - (Section 13.9)

4.4.15 Auxiliary Facilities

There will be no auxiliary facilities as defined by the Terms of Reference – fuel storage, generators, water storage tanks etc.

4.4.16 Duration and Phasing

Three (3) phases will be involved:

Pre-mining Phase - 1 - 2 years

Construction Phase - 2 years

Operational Phase - 10 years.

4.4.17 Storage Access

Storage areas will include the No. 2 ROM stockpile previously mentioned and the storage areas for topsoil/overburden.

4.4.18 Blasting

There will be no blasting

4.4.19 Operational Power Supply

Any power that is required during operations will be supplied using portable generators.

4.4.20 Operational Waste Disposal

All waste generated must be transported from the site and disposed of as described in the waste management procedure Appendix No.9.

4.4.21 Fencing and Security

Fencing of areas around mined-out pits in locations where the risk of the public or animal gaining access is high. Alpart should provide adequate security to cover the proposed mining areas when the project commences.

4.4.22 Buffer Areas

There will be buffer areas to mitigate impacts to springs and wells, which are located in proximity to the orebodies, utilising the following guidelines:

1. The company will mine no closer than 6 m from any water feature such as wells, sinkholes, streams, rivers, and ponds.
2. There will be no mining within 6 m of any structure of archaeological importance.
3. There will be no mining within 50 m of the centerline of a public road.
4. Mining in relation to proximity to private property will be compliant with the requirements of the Mining Act.

4.5 Operations

4.5.1 Actual Quarry (Mine) Site

The quarry layout is shown in Figure 4-4. The site will accommodate: 130 m of cable belt, a main haul road with roads branching to the ore bodies and a stockpile. According to the nature of the ore, the raw ore does not need to be broken up, but the mined ore comes mixed with limestone, which will be screened. The raw ore storage yard and loading station are equipped with feeding equipment of belt conveyor, screening equipment and limestone outlying facilities. There will be a cable belt maintenance road and mining road which is 6 m wide. The main path of the belt maintenance road extends along the belt direction.

4.5.2 Mining and Haulage of Bauxite – Quarrying Method, Machinery

The mining of bauxite will take place from ore-body areas shown in Figure 4-3 and the mining schedule is presented in Table 4-2. Access to these ore-bodies will be done using haul-roads and pit-roads. The trucks will be loaded by an excavator or by a front-end loader to their licensed laden load limit. The plan is to truck the bauxite directly to the stockpile No. 2 via haul roads and from there by conveyor to the plant.

The following equipment will be involved in the mining and haulage of bauxite:

Table 4-1: List of Main Mining Equipment

Serial number	Equipment name	number (each)	weight of equipment (tonne) Unit weight	Total weight
1	Hydraulic Excavator (backhoe), ($4m^3$)	3	70.0	210.0
2	Hydraulic Excavator (backhoe), ($2m^3$)	2	45.0	90.0
3	Articulated Dump Truck (39t)	23	30.8	708.4
4	Wheeled loader ($5m^3$)	2	33.0	66.0
5	Wheeled loader ($3m^3$)	2	16.8	33.6u
6	Caterpillar D10T Dozer	2	65.4	130.8
7	TY320B Crawler Dozer	3	37.2	111.6
8	VOLVO G990 Scraper	1	16.0	16.0
9	Road Roller	1	18.0	18.0

10	20m^3 Engineering Sprinkler	1	15.1	15.1
11	10t tanker	2	12.0	24.0
12	Maintenance Vehicle	3	15.0	45.0
13	Material Car	2	5.0	10.0
14	Tool Car	3	2.0	6.0
Total		50		1484.5

The average distance from mining pit to the mine site stockpile is about 5-6 kilometers, and the ore-carrying truck travels every 35-45 minutes on average.

4.6 Mining Plan – Quarrying Rate/Nature and Quantity of Material to be Extracted

The intended use for the final mined material (bauxite) is for it to be processed at the Alpart refinery into smelter grade alumina for shipment to overseas customers. The available ore amount (dry ore amount) is 4095kt with a retention period of 1.05 years. Reserve mining amount (dry ore amount) 2496kt, retention period 0.64A. The construction period is considered as 2 years. SEPL 541 outside valley mining will start at the third year after completion of the project.

Principles to be followed in compiling the mining schedule are:

1. Meet the scale requirements.
2. Carry out multi-pit mining to meet the requirements of ore blending.
3. Appropriate near and far mining, balanced transport equipment.
4. First mining the ore bodies located in areas where the company already has access.

The production schedule of SEPL 541 Outside Valley, is shown in Table 4-2 below.

Table 4-2: SEPL 541 Outside Valley Production Schedule

Project	unit	Year 1	Year2	Year3	Year4	Year5	Year6	Year7	Year8
Qualified dry ore quantity	t	1450000	1450000	1450000	1450000	1450000	1450000	1450000	1450000
Crude wet ore quantity	t	2102500	210250 0	210250 0	210250 0	210250 0	2102500	210250 0	2102500
Al_2O_3	%	44.76	44.76	44.76	44.76	44.55	40.38	40.38	40.38
SiO_2	%	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
A/S		20.29	20.29	20.29	20.29	20.29	20.29	20.29	20.29
Stripping volume	m^3	252000	252000	252000	252000	252000	252000	252000	
	t	420500	420500	420500	420500	420500	420500	420500	
Stripping ratio	t/t	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Average truck distance	km	5.20							
Cable Belt distance	km	7.25							
Haul road construction	km	3.2	3.2	3.0	3.0	2.5	2.5	2.5	1.2
Haul road land	hm^2	7.6	7.6	6.6	6.6	6.6	6.4	6.4	5.0
Clearing quantity	hm^2	30	30	30	30	30	30	20	

4.7 Air Quality/Noise Generation and Control

4.7.1 Stockpiling of Bauxite at the Alpart Refinery

Road trucks will be used to transport the bauxite from the orebodies to the stockpile.

The following equipment will be involved in the building of the stockpile:

- A D10 or D6 Bulldozer – to manage the benching of the stockpile.
- A water truck for dust suppression

4.7.2 Environmental Aspects, Impacts, and Mitigation – Stockpiling Activities

The environmental aspects associated with the bauxite stockpiling activities are as follows:

Table 4-3: Physical Environmental aspects, Impacts and Mitigation of Stockpiling Activities

	Aspects	Potential Impact	Control Measures
1.	Transportation of bauxite	a) Bauxite spills causing fugitive dust, runoff to storm water system, noise	Truck to carry bauxite within the weight limit, trucks to be covered, wet haul roads. A Speed limit of 40km/hr to be mandated on the haul roads and adequate signs erected. Security patrols monitor and enforce same. Safety and Mining officers monitor the dusting situation. Water is used as a dust suppressant and trucking is halted if the dusting is considered excessive
2.	Bauxite offloading	Bauxite spills, fugitive dust, noise	Off-loading in designated areas, conduct wetting of material. Noise will be controlled by ensuring that equipment is well maintained and that operations are done only within permitted working hours.
3.	Stocking of bauxite	Bauxite spills, fugitive dust, noise	Stocking in designated areas, conduct wetting of material and covering with dust control mesh if necessary.
4.	Bauxite storage	Fugitive dusting, runoff to storm water system	Install screens or traps on storm water drain, periodical wetting of stockpile.

4.7.3 Environmental Aspects, Impacts and Mitigation – Mining

The environmental aspects associated with the mining of bauxite are as follows:

Table 4-4: Physical Environmental Aspects, Impacts and Mitigation - Mining

	Aspects	Potential Impact	Control Measures
1.	Clearing & stripping of land, removal of topsoil.	Fugitive dusting, noise	Only work in conditions that will not generate nuisance dust - Apply water as dust suppressant. Ensure that equipment are well maintained and that operations are done only within permitted working hours.
2.	Mining the Ore bodies	Fugitive dusting, noise	Visual observation, curtail mining during high winds. Apply water as dust suppressant
3.	Loading bauxite on to trucks	Fugitive dusting, noise	Apply water as dust suppressant
4.	Transporting bauxite within the Mining area	Fugitive dusting, noise	Apply water as dust suppressant

4.7.4 Environmental Aspects, Impacts and Mitigation – Haul Road Construction

The environmental aspects associated with the construction and rehabilitation of the haul roads are as follows:

Table 4-5: Physical Environmental Aspects, Impacts and Mitigation – Haul Road Construction

	Aspects	Potential Impact	Control Measures
1.	Cutting, clearing, earth movement	Fugitive dusting, noise	Apply water as dust suppressant Ensure that equipment are properly maintained and that operations are done only within permitted working hours.
2.	Harvesting of material for road construction	Fugitive dusting, noise	Apply water as dust suppressant
3.	Transport of material for road construction	Fugitive dusting, noise	Apply water as dust suppressant
4.	Spread and compact material	Fugitive dusting, noise	Apply water as dust suppressant

4.7.5 General Noise and Dust Control Strategy

DUST CONTROL

- All mining equipment must be serviced and maintained to obtain optimal operating conditions which will improve efficiency and help to reduce noise.

- Excess backup alarms will be limited while considering safety as a priority.
- Mining operations will be done only between the hours of 7 am and 7 pm.
- Community Meetings will be held with residents to get feedback on noise levels.
- Noise levels Must be measured in surrounding communities and appropriate actions taken.

NOISE CONTROL

- Mining time will be limited to day time hours and six days per week.
- Public Meetings will be held with the communities
- Where noise from mining operation could impact places of worship, mining activities are to be suspended during times of worship.
- Excess back up alarms will be limited, while considering safety as a priority.

A Fugitive Dust Control Procedures should be developed and submitted to NEPA as part of the Special Condition for Environmental Permit. The Procedure should include the following:

- All unsealed surfaces will be regularly wetted (water truck) with the frequency determined in response to visual observations and daily climatic conditions.
- The number of exposed surfaces at any point during the life of the operations will be minimized. The timing of land clearing and stripping will be undertaken in accordance with the framework of the mine plan.
- Haul roads will be maintained by graders and water trucks.
- Dust generating activities will be minimized or avoided during dry and windy conditions.
- Stockpiles will be maintained in tight zones and watered down where necessary.

4.8 Land Use and Habitat Loss

The nature of bauxite is such that it involves the extensive land clearing and removal of topsoil in order to access the mineral which may be found between 1 – 30 metres below surface. The project will therefore result in significant loss of land use and natural habitat for both flora and fauna.

The orebodies where mining will occur within the project area are all currently disturbed site, which are mainly grasslands and field. The habitat loss is therefore not as significant.

The mandatory regulatory required rehabilitation once mining is completed will also ensure that in the long term the habitat is restored.

4.9 Safety Programme

Worker Safety will be managed using the JISCO Alpart Safety Program. All employees or the relevant contractor/sub-contractor will be equipped with proper personal protective equipment (PPE) as required for working on Alpart premises including; safety glasses, mono-goggles, face shield, hard hats, steel-toed rubber safety boots, ear protection, leather gloves and the like. Dust masks shall be worn when working in dusty conditions. The relevant safety program will be in place for all employees to observe Alpart's Safety Rules and perform their work in a safe manner throughout the execution of the job. Alpart's Safety Rules will be communicated during scheduled safety orientation sessions and daily Job Safety Analysis or Job Safety Plans will be done prior to any field activity.

4.10 Mine Closure

4.10.1 Decommissioning

The mine closure plan will have two components - Progressive or concurrent mine closure and final mine closure or decommissioning. Progressive mine closure will include the restoration done continually during the period of the mining operations, whereas final mine closure or decommissioning includes activities towards end of life of the mines. Decommissioning will be managed according to the various closure elements which are detailed below:

4.10.1.1 Mined-Out Land

Mined out land will be restored for future use. Details of reclamation and rehabilitation are outlined below. Mined out land will be restored as per the requirements of the Mining Act. The Mines and Geology Division of the Ministry of Transportation and Mining is the chief regulatory agent responsible for the acceptance and certification of mined out lands.

4.10.1.2 Water Quality Management

Alpart will continue to monitor water quality in the area from wells, streams and other water features within the mining area.

4.10.1.3 Air Quality Management

During the decommissioning stage and for one year after Alpart will continue to carry out air quality monitoring using Hi-volume and PM10 stations.

4.10.1.4 Infrastructure

The haul roads will be assessed as to future utilization. If a decision is made to decommission, it will be rehabilitated by covering with topsoil and planting appropriate vegetation. The conveyor belt will be decommissioned by dismantling and relocation of the structures. Support facilities and other infrastructure like electrical transmission line, water line, water works, sewer line, telephone cables will be relocated.

4.10.1.5 Disposal of Mining Equipment

The decommissioning of mining equipment will involve removal and relocation of equipment such as excavators and graders.

4.10.1.6 Safety and Security

The area will remain under the surveillance of Alpart's security organization.

4.10.1.7 Disaster Management and Risk Assessment

Possible natural hazards that may affect the area are described in section 5.3. Any such incident affecting the area during or after the decommissioning area will be addressed using the Alpart emergency response procedures.

4.10.1.8 Care and Maintenance

The area will be reviewed and assessed every three years. Repair and rehabilitation will be carried out as required.

4.10.2 Rehabilitation

Jamaica has taken a legislative approach to restoration of land after bauxite is extracted. JISCO Alpart is bound legally by the Mining Regulations to ensure that land is restored after mining. After a pit is certified mined out by the Commissioner of Mines and permission is given to rehabilitate, it is shaped, the topsoil replaced and grass planted depending on the end use. This restored land in many instances is used for farming and many farmers have established successful crops on this land. Restored land has to be certified by a team led by the Commissioner of Mines and includes the Jamaica Bauxite Institute.

The Reclamation Goal is to:

- Restore mined out lands to comparable levels of pre-mined productivity.
- Assist in developing economic programmes on rehabilitated lands to benefit local farmers and communities.
- Develop mined-out lands into modern resettlement communities.
- Incorporate restored land into the overall development plans of the parish.

Management of Process:

I. Alpart Mines Management personnel will visit all mined-out Bauxite pits.
II. If satisfied that there is no additional bauxite that can be harvested from the pit, a request is made of the Commissioner of Mines, Mines and Geology Department, to have their Mining Inspector visit the pit and declare it Mined Out.
III. The Commissioner of Mines will issue a Mined-Out Certificate for that pit. Alpart then has three years to have the pit reshaped, topsoiled, revegetated, and brought to a condition where it can be Certified Restored.
IV. Alpart will issue a contract to a private Reclamation Contractor (for Reshaping and Topsoiling of the pit) and a Rehabilitation Contractor (for the revegetation, fencing, fertilizing and management of the pit until it is ready to be assessed for Restoration Certification.
V. The Commissioner of Mines is then invited to inspect the pit and issue a Restoration Certificate.

VI. This is then forwarded to the GIS and Accounts Department and the Restoration Liability is removed from the books.

Reclamation Process:

I. Alpart reclaims its mined-out pits using private contractors and equipment to do reclamation (backfilling, reshaping and relaying of topsoil) on a per acre or cubic meter of earth moved payment basis.
II. Alpart endeavors at all times to reshape its mined-out pits to a bowl shape with gentle slopes. Alpart does not leave shear faces.
III. Prior to mining, the orebody surveyed and drilled at 15m (50 ft.) intervals to determine the boundaries of the bauxite and its depth and quality.
IV. The 61cm (2 ft.) of topsoil that was removed from the surface of the orebody and stockpiled outside of the pit mining area is reused in the rehabilitation of the pit after mining
V. Where adequate material cannot be generated from the perimeter of the orebody to achieve the necessary slopes and configuration, then material is generated elsewhere and trucked to the orebody.
VI. A mix of rock rejects and bauxite (which can contain up to 20 % bauxite) is sometimes trucked from the screening and cable belt load stations for fill material. Reclamation reports a swell factor of up to 2.5 to 1 after reshaping. The reshaped pits do not retain water for any period of time and natural sinkholes are not blocked in the reclamation process, but the pit is shaped whenever possible to channel run-off water to these natural drainage points.
VII. Topsoiling is usually, but not always, done immediately after reshaping. The Rehabilitation contractor takes over at this point.

Rehabilitation

I. Prior to the start of the rainy periods, the land is ploughed, using a contracted farm tractor, and the area is de-stoned manually. Poultry manure is spread manually and grass is also cut and planted manually. These manual tasks are done on contract.
II. Cut grass is transported to the planting sites by the Contractor.
III. Alpart perimeter fences all of its rehabilitation lands. Fencing is by Contract, and the materials (fence posts, barbed wire, etc.) are transported to the various sites by tractor.
IV. During the maintenance period (12 – 18 months depending on rainfall), a top dressing of inorganic N.P.K. fertilizer is used to promote vegetation growth and more organic fertilizer is added where necessary.
V. The restored pits are inspected by the Inspectorate Branch of the Mines and Geology Department (Commissioner of Mines) and the Jamaica Bauxite Institute and approved if it meets or exceeds Government standards.
VI. A Restoration Certificate is then issued by the Commissioner of Mines.

4.11 Potential for Growth or Expansion

The present application for an environmental permit covers the orebodies identified in "Outer Valley" section of SEPL 541 (see Figure 4-6), and specifically the orebodies as shown in Figure 4.3. Within the same Outer Valley section, other potential orebodies were identified and pending further investigation and exploration mining could be extended within the Outer Valley section of SEPL 541.

If and when this option is pursued the required regulatory approval must be obtained. (This could be an application for an amendment to the permit.

Figure 4-6: Map of SEPL 541 Showing Outer Valley Section

5 DESCRIPTION OF ENVIRONMENT

5.1 PHYSICAL ENVIRONMENT

5.1.1 Geology, Geomorphology/Hydrology

5.1.1.1 Physiography

The Essex Valley, where the Alpart (JISCO) bauxite/alumina plant is located, is a low lying, broad valley extending south-southeast from the swampy lowlands of the Upper Morass to the coast. The Essex valley is bounded on the east by the Spur Tree Hill escarpment (part of the Don Figueroa Mountains) and on the west by the Santa Cruz Mountains. To the south the Essex Valley increases in elevation to form the faulted crests of the series of east-west ridges which overlook the steep and in places precipitous descent (such as Lovers Leap) to the coast.

The Essex Valley is divided into two sections or topographic basins defined by the topographic divide between them. The topographic divide does not coincide with the groundwater and drainage divides because of the limestone nature of the terrain. The Outer Valley section of SEPL 541 is located within the north topographic basin abutting on the swamps around Braes River/New River and the Upper Morass (See Figure 5-1 below).

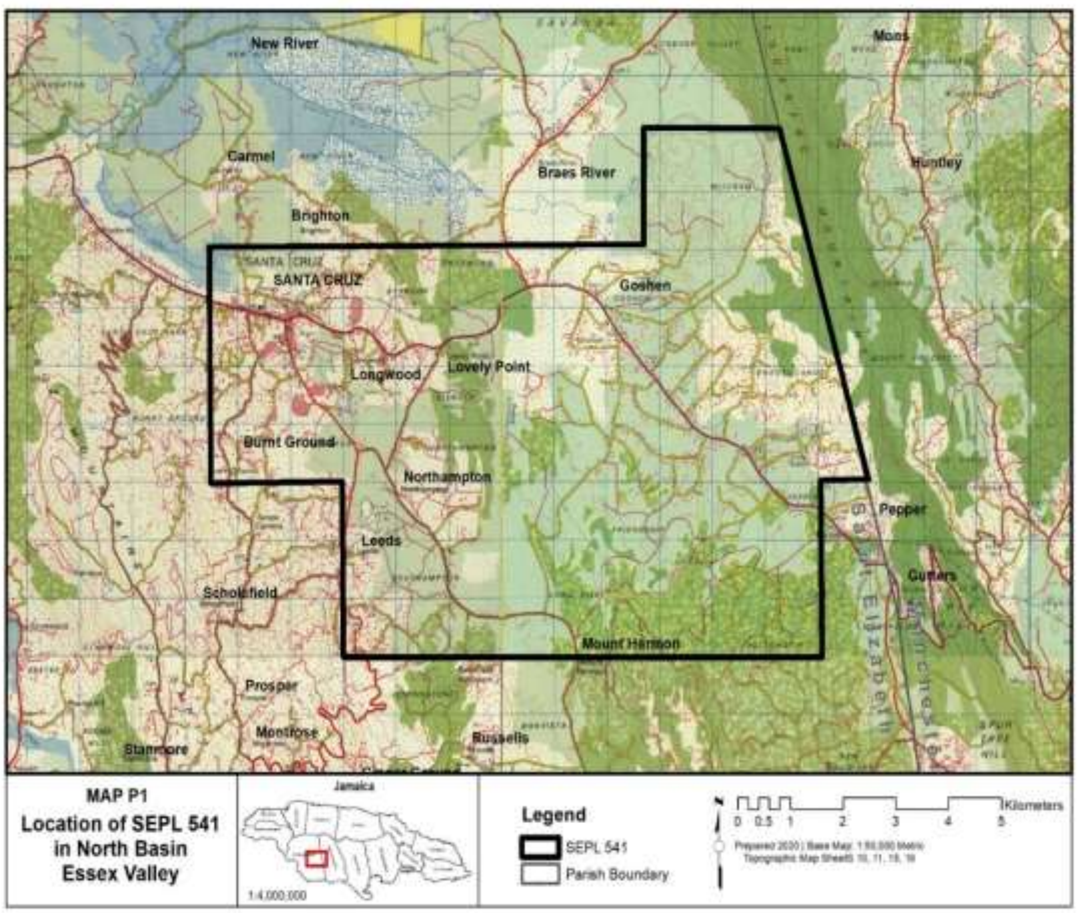


Figure 5-1: Location of SEPL 541 Outer Valley Section in the North Essex Valley

5.1.1.2 Geology

5.1.1.2.1 General

The White Limestone Group is the most important rock unit, by volume, in the island. There are several members of the White Limestone Group and they are generally highly permeable and form the main groundwater aquifer along the south coast of the island. (See Figure 5-2)

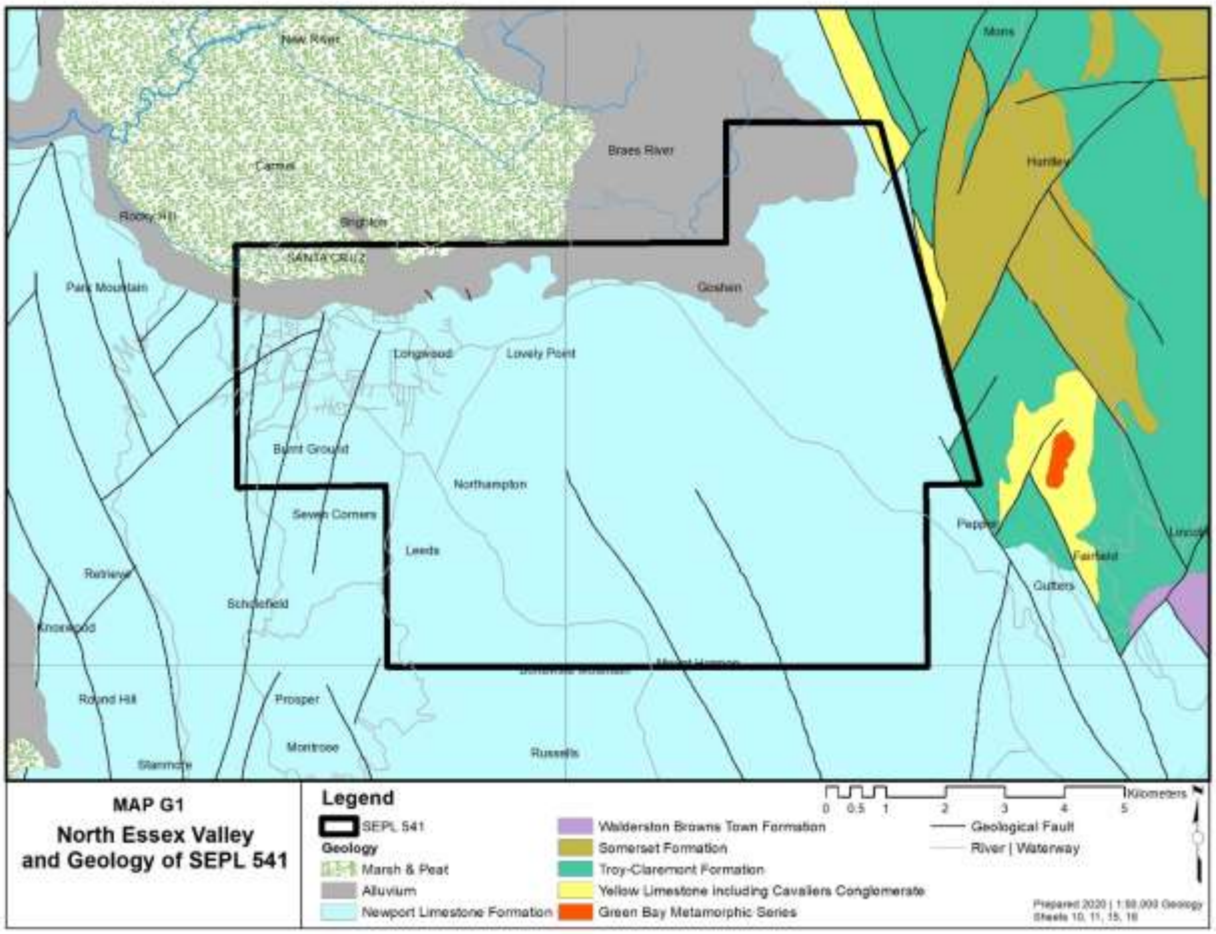
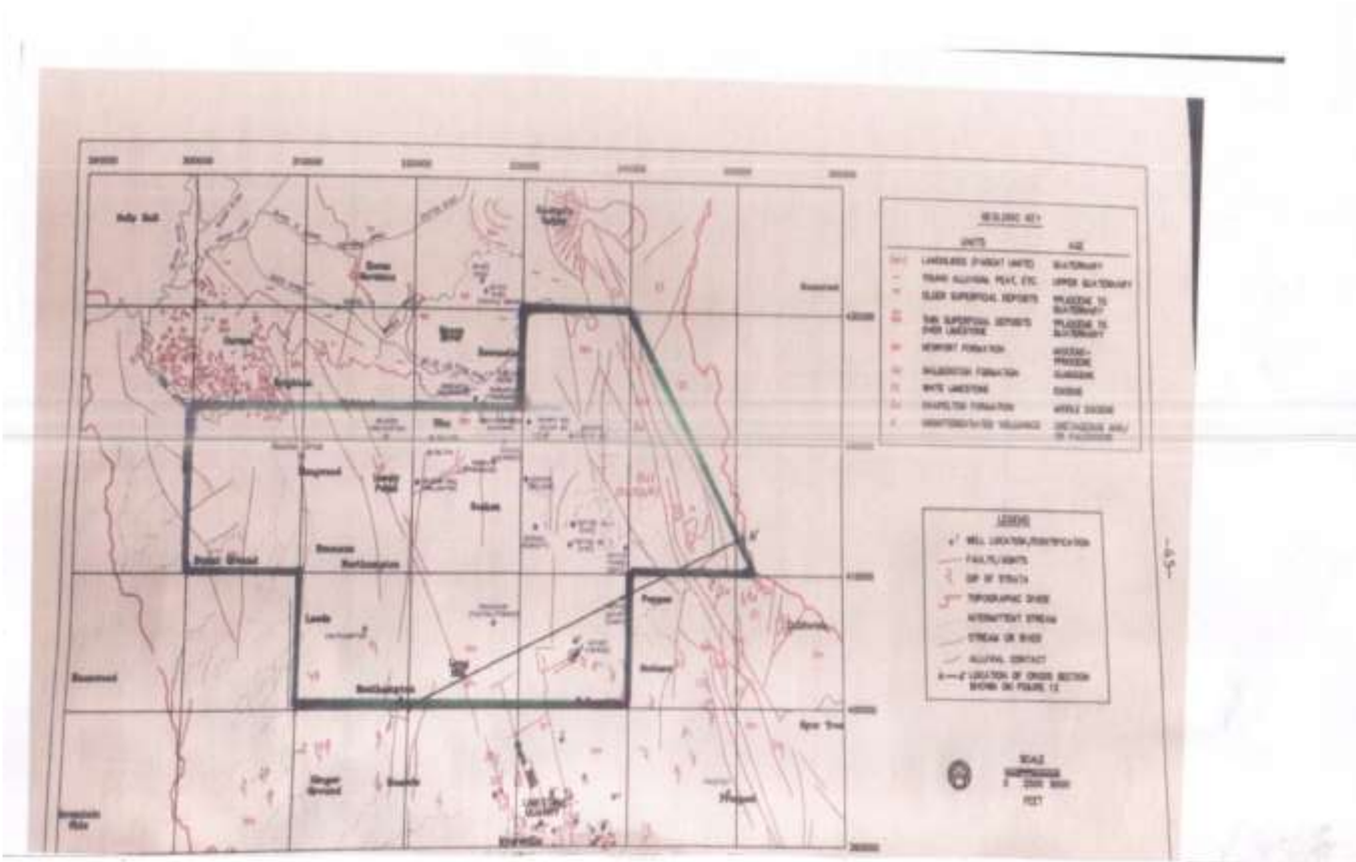


Figure 5-2:North Essex Valley and Geology of SEPL 541 Outer Valley Section

The Newport Limestone Formation, a member of the White Limestone Group, outcrops over most of the surface area of the Essex Valley. The Newport limestone also outcrops over nearly 100% of the Outer Valley Section of SEPL 541. Alluvium, consisting of stiff gray clay, outcrop along the northern boundary of the Outer Valley Section. To the east of and outside the boundary of the Outer Valley Section other members of the White Limestone Group such as the Troy-Claremont, Somerset and Walderston Limestone Formations outcrop. The Spice Grove Inlier consisting of the Yellow Limestone and the Green Bay Metamorphic Series surrounded by the Troy-Claremont Limestone is located east of and outside the boundary of the Outer Valley section. An inlier is an outcrop of older rocks surrounded by younger rocks. (See Figure 5-2).

The geologic features of the northern Essex Valley including Outer Valley section of SEPL 541 is shown in Figure 5-3.



MAP G2-GEOLOGIC FEATURES-NORTH SECTION ESSEX VALLEY SHOWING SEPL 541
(AFTER E. OROBINSON 1990 AND FROM GURR AND ASSOCIATES INC, NORTH MUD LAKE RISK ASSESSMENT VOLS 1-3, NAIN, ST. ELIZABETH, APRIL 1991 FOR ALPART AND JBI.)

Figure 5-3: Geologic Features - Northern Section Essex Valley and Outer Valley Section of SEPL 541

5.1.1.2.2 Stratigraphy

The stratigraphy illustrates succession of the various rock formations for an area such as the Outer Valley Section. The stratigraphy of the Essex Valley within which the Outer Valley Section is located was set out by Robinson 1990. See Figure 5-2 for the stratigraphic units in within and outside the Outer Valley.

The stratigraphy of the Outer Valley is listed below:

- Alluvium, swamp and peat
- Bauxite deposits
- Newport Limestone (White Limestone Group)

5.1.1.2.3 Alluvium

The alluvium, which outcrops in the Outer Valley section of SEPL 541, was deposited by the rivers draining the area. The alluvium varies in thickness from <1metre (m) to 30m and directly overlie the Newport Limestone where it occurs. The alluvium does not function as an aquifer and does not readily yield water to wells and springs (See Figure 5-2).

5.1.1.2.4 Bauxite Deposits

The bauxite deposits in the Outer Valley Section occur as pocket like to blanket like deposits on the karstified surface of the White Limestone Group in this case the Newport Limestone Formation. The bauxite deposits vary in thickness with the greater thickness in the depression of the wavy, erosional (karstified) surface of the limestone. While most of the bauxite deposits close to the Alpart (JISCO) plant have been mined out several deposits have been identified within the Outer Valley Section of SEPL 541. See Figure 5-4 for sites of proposed bauxite mining areas of deposits within SEPL 541.

5.1.1.2.5 Newport Limestone

The Newport Limestone Formation outcrops over 99% of the area of SEPL 541. It is the only member of the White Limestone Group within the Outer Valley section of SEPL 541 and the entire Essex Valley.

At the surface the Newport Limestone is usually in the form of hard, recrystallized micrites (micro crystalline calcite with grain size less than 0.01mm) very poorly bedded. In quarries, such as near the Alpart (JISCO) plant the hard surface is underlain by softer even chalky to granular micrites. Fossils are abundant, mainly molluscs, corals and foraminifera. The fossils indicate the depositional environment of the Newport Limestone as a shallow water inshore area. Molluscs are today found in shallow water inshore areas. North of the Alpart (JISCO) plant within Outer Valley section of SEPL 541 close to the Alpart (JISCO) Pepper wellfield the limestone becomes softer at the surface with no case hardening (Robinson 1990).

The thickness of the Newport Limestone was proven by the Santa Cruz oil well drilled by Stanolind Jamaica in 1957 to a depth of 2,661.5m. A thickness of 1400m of Newport Limestone was encountered atop 340m of Walderston Limestone (WRA Database and Robinson 1990). Geologic cross sections across the Essex Valley are illustrated as Figure 5-2 with the A-A" cross section in the southern area of SEPL 541 shown on map 5-2. The thickness and stratigraphy of the geology is seen in the top cross section of Figure 5-2. The cross sections indicate similar thickness of the White Limestone member the Newport Limestone beneath the Essex Valley and the Outer Valley section of SEPL 541.

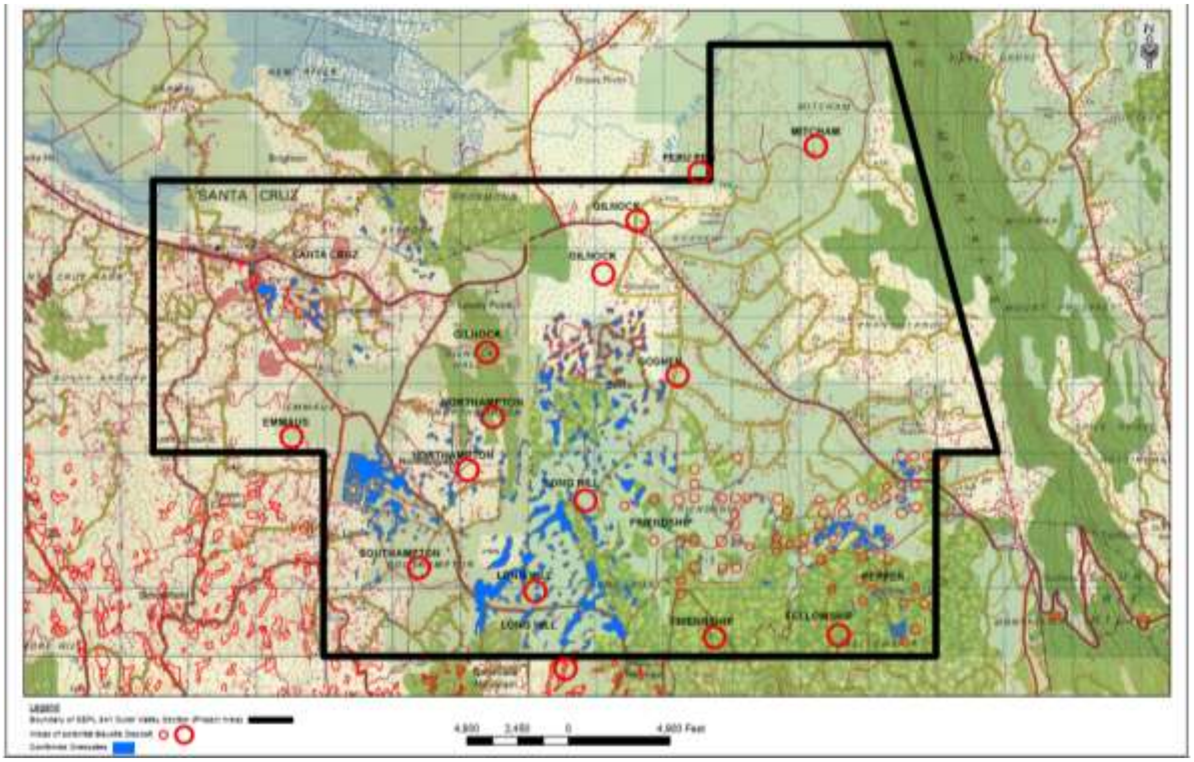


Figure 5-4: Location of Proposed Bauxite Mining Areas (shaded blue) within the Outer Valley Section of SEPL 541

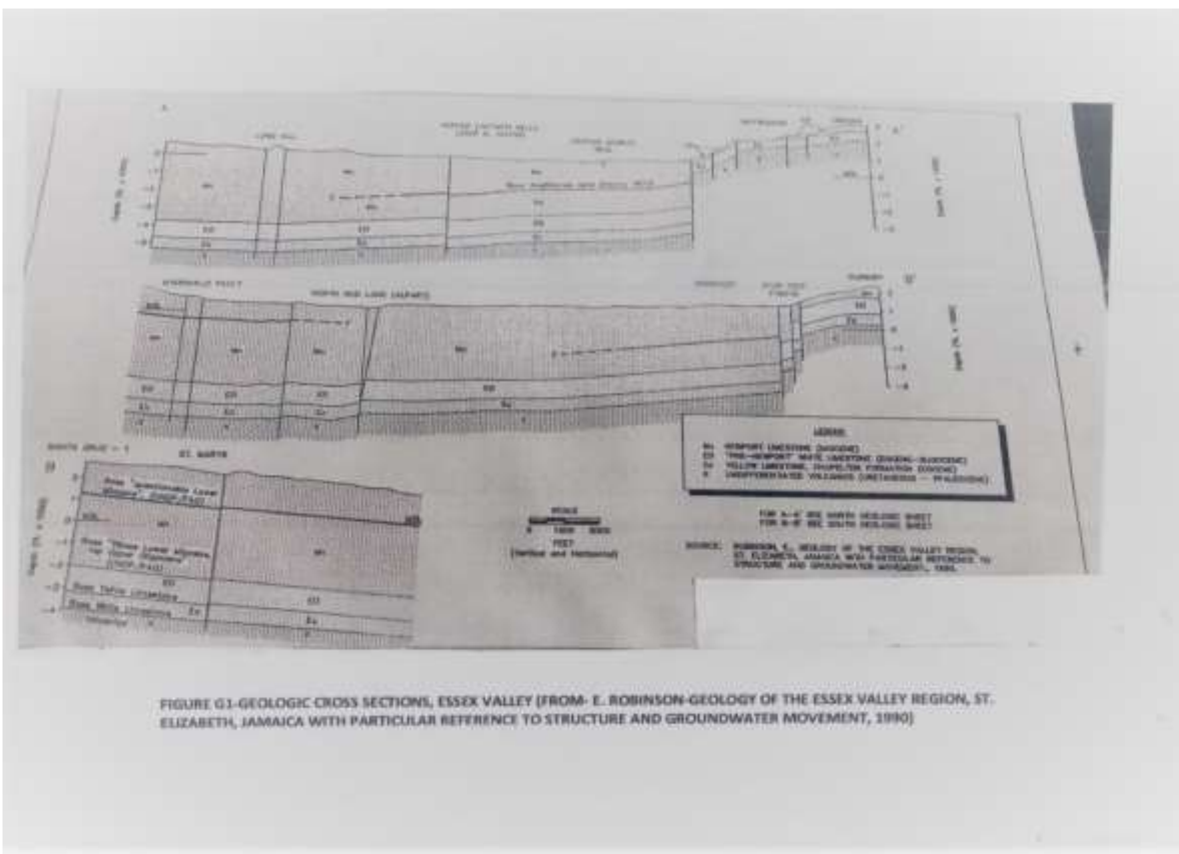


Figure 5-5: Geologic Cross Sections

5.1.1.2.6 Structure

The Essex Valley is dissected by several south-north trending fault systems that extend into the southern and western area of Outer Valley Section. (See Figure 5-2). These south-north faults are crossed by east-west faults leading to limestone blocks being created. One such east-west fault enters Outer Valley Section of SEPL 541 at the western boundary. The major fault system trending SE-NW is the Spur Tree fault System. It literally forms the eastern boundary of the Outer Valley Section. This fault system has a down throw of 760-920m on the western side (Robinson 1990) and is responsible for the formation of the Essex Valley and the thickness of the Newport Limestone.

The Essex Valley Fault System trends N-S, SE-NW and SW-NE. This fault system trends around the JISCO plant and the red mud lakes and for the most part do not enter the Outer Valley Section except in the western section as they trend west of the Outer Valley Section of SEPL 541. This fault system extends northwards as far as the Upper Morass. Fault systems are permeable pathways that enhance groundwater flow.

5.1.1.2.7 Hydrostratigraphy

A hydrostratigraphic unit is a geologic formation or series of formations which demonstrate a distinct hydrologic character. In Jamaica geologic formations are characterized either as aquifers or aquicludes. Rock formations with sufficient permeability to support perennial well and spring yields are classified as aquifers while those that don't have the permeability to support perennial yields are classified as aquicludes. Groundwater is the primary resource potential of aquifers while surface water is the main potential of aquicludes due to their low permeability.

The Newport Limestone Formation that outcrops within the Outer Valley Section of SEPL 541 is the main hydrostratigraphic unit and is one of the most productive aquifers in the island. The alluvium, consisting mainly of clays, along the northern boundary of the Outer Valley and south of the Upper Morass functions as an aquiclude. See Figure 5-6.

The limestone aquifer, formed by the Newport Limestone Formation, functions as a single hydraulic unit with high transmissivity of $278m^2/d$ or greater (WRA 1990). Transmissivity is the rate of movement of water at the prevailing kinematic viscosity through an aquifer of unit width under a unit hydraulic gradient. The groundwater exists in the aquifer under water table conditions. The limestone aquifer exhibits mature karstic features with extensive fracturing and faulting (major and minor faults and joints) leading to high secondary permeability. **High infiltration capacity, pre-dominant sub-surface drainage and highly compartmentalized conduit flow make the aquifer very productive and very susceptible to contamination.**

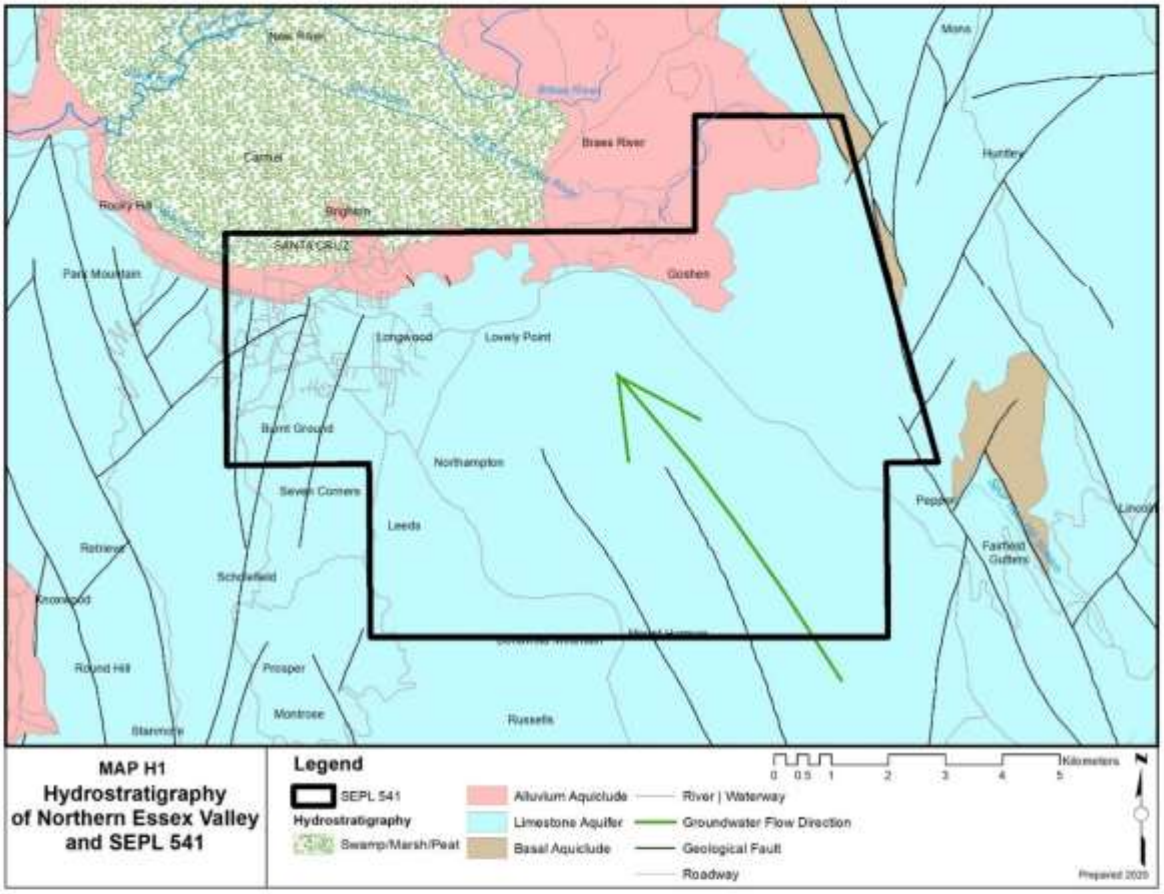


Figure 5-6: Hydrostratigraphy of Northern Essex Valley

5.1.1.2.8 Drainage

The Outer Valley Section of SEPL 541 has 100% of its area a highly karstified limestone with high permeability and infiltration rates. The rainfall across the area rapidly goes underground and sub-surface drainage characterizes the Outer Valley and the Essex Valley as a whole.

There are a few gullies that originate from the higher elevations but are seasonal in flow depending on rainfall. Perennial surface water systems occur in the extreme north of the Essex Valley and outside the boundaries of the Outer Valley Section. The surface water systems generally all flow west to northwest towards the Grass River and onto the Black River the main drainage system of the Black River Hydrologic Basin. This surface flow direction takes the surface water away from the Outer Valley. The surface water systems drain the swampy areas north of the Outer Valley, which form part of the Upper Morass. The rivers include the Braes River, the Mt de las Uvas River and the New River. The areas drained include Braes River, Brighton, Santa Cruz and New River. The Braes River has its source at Braes River, the Mt. de las Uvas River has its source in the Cabbage Valley area and the New River has its source in the swampy area just west of Santa Cruz.

The Water Resources Authority (WRA) has the responsibility under the Water Resources Act 1995 for the monitoring of ground and surface waters across the island. In the northern Essex Valley, outside the boundary of the Outer Valley, the following rivers are monitored by the WRA through the establishment of recording stream gauging stations

- Mt de las Uvas River near Wilton
- Braes River at Braes River; and
- New River near Lacovia

The Mt de las Uvas gauging station is currently operational while Braes River station was damaged in 2018 and is still to be repaired. The New River gauging station was discontinued in 1991 as it was temporarily established to monitor flood flows in New River during a flood event. See Figure 5-7 for the locations of these stations in relation to the Outer Valley.

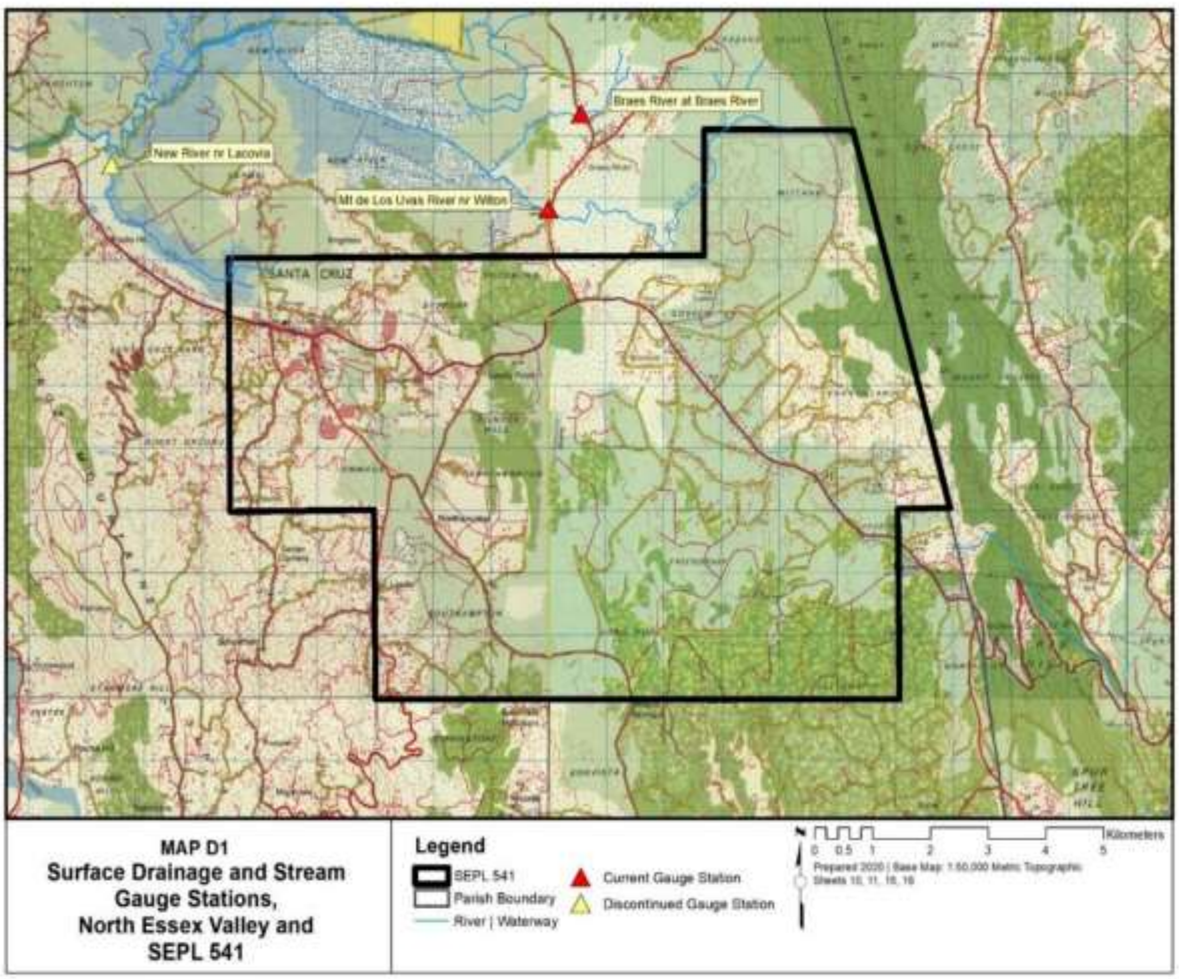


Figure 5-7: Surface Drainage and Stream Gauge Station North Essex Valley

Groundwater flow (subsurface flow) is to the north-northwest as determined by the groundwater table elevation contours. See Figure 5-8 (From Robinson 1990).

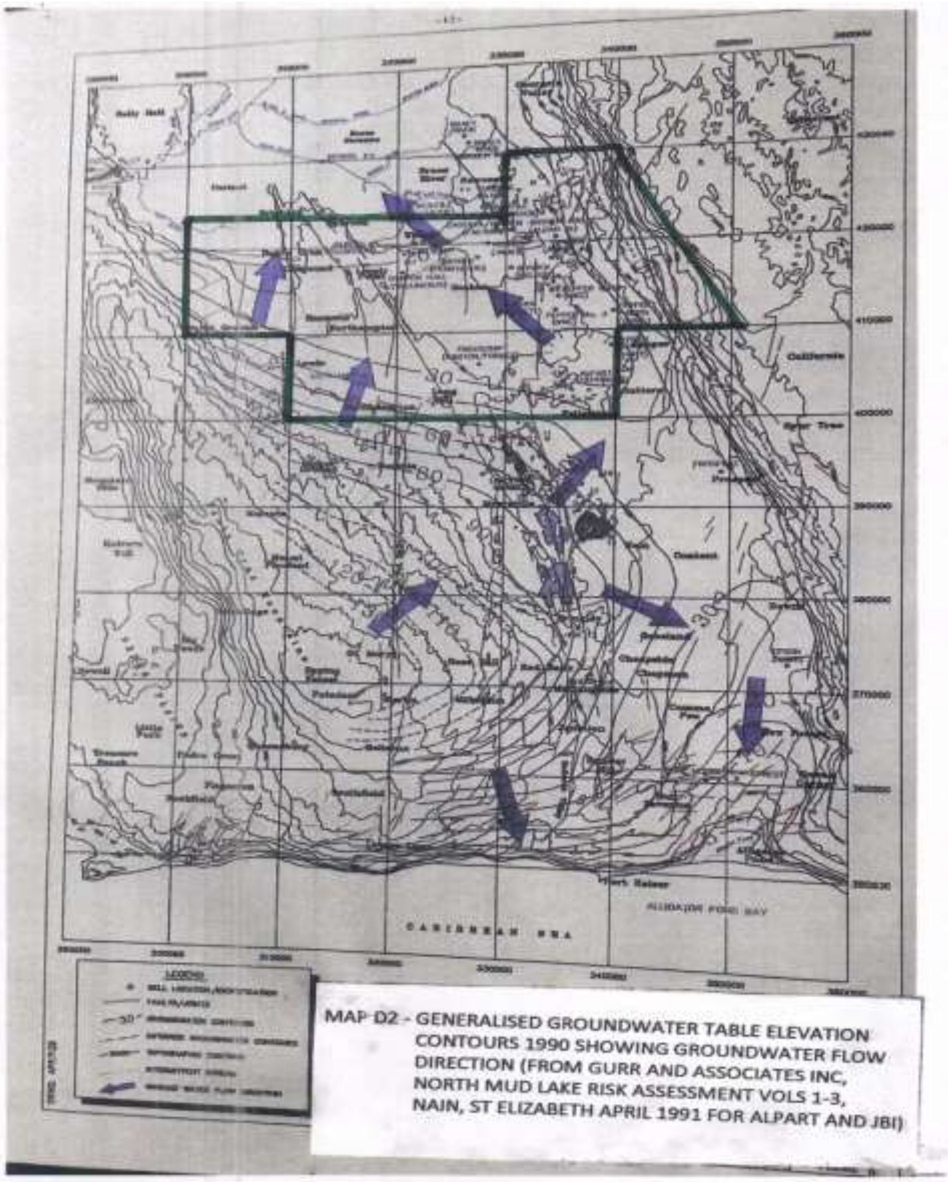


Figure 5-8: Generalized Ground water Table Elevation Contours

5.1.1.2.9 Water Resources

<u>Groundwater</u>

The primary water resources type of the Essex Valley and Outer Valley Section of SEPL 541 is groundwater that occurs within the karstified limestone aquifer, the Newport Limestone

Formation, that outcrops throughout the Outer Valley. Groundwater is tapped by the construction of boreholes into the limestone aquifer which may or may not be developed into production wells. The boreholes developed into production wells are pumped to provide water to meet the demand for municipal, agricultural and industrial uses.

There are 39 boreholes located within the Outer Valley Section of SEPL 541 and 19 boreholes within a 1-kilometre radius of the boundaries of the Outer Valley Section. Figure 5-9 shows the locations of these boreholes.

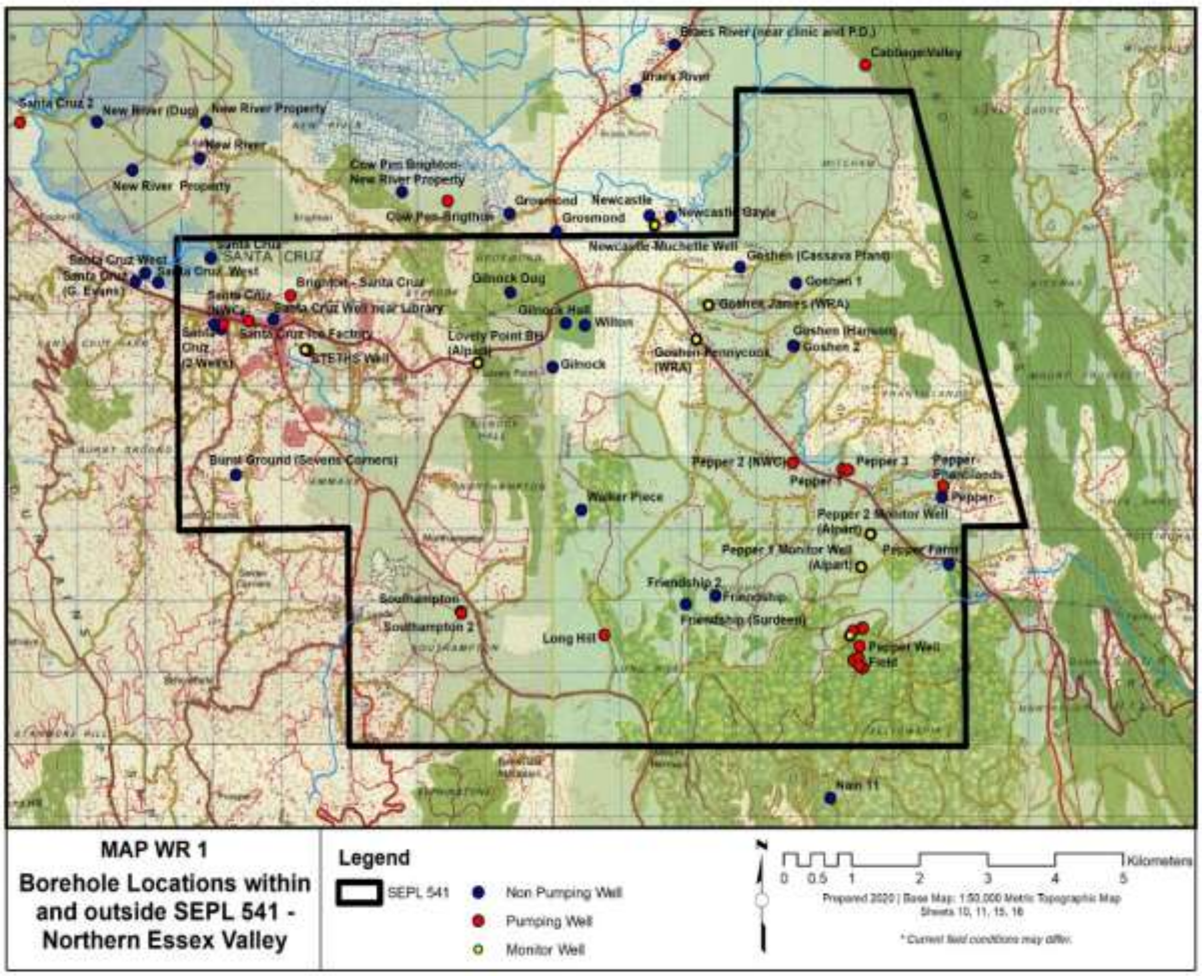


Figure 5-9: Borehole Locations within and outside the Outer Valley Section

5.1.1.2.10 Types of Boreholes/Wells

There are three types of boreholes/wells located within and outside the Outer Valley Section of SEPL 541. These are:

a) Drilled large diameter

b) Drilled small diameter; and

c) Hand Dug

The drilled large diameter boreholes are usually developed into production wells that are pumped to meet various water demands. Tables 5-1, 5-2 and 5-3 lists the construction data for the large diameter production wells. Table 5-1 lists the wells pumping for municipal uses, Table 5-2 lists the production wells which are now out of service and Table 5-3 lists the wells owned and operated by JISCO for industrial and domestic water to the plant at Nain. Tables 5-4 and 5-5 lists the hand dug wells along with one (1) monitor well drilled by the UNDP/FAO GOJ water resources assessment of the Black River Basin project of the mid to late 1960s and is now owned by the WRA.

5.1.1.2.11 Status of Wells

Table 5-1 show that the National Water Commission (NWC) owns and operates 7 of these wells listed, the St. Elizabeth Municipal Corporation (SEMC) owns and operates 1 well and the St. Elizabeth Technical High School (STETS) owns and operates one well that supplies the school with water. The NWC has 3 wells (Pepper 1, 2 and 3) that are the source of water for the Greater Mandeville Area, 3 wells (Santa Cruz 1 and 2 and Southampton 2) that are the source of water for Santa Cruz and 1 well (Long Hill) which is the source of water for Essex Valley and Junction. The Santa Cruz #1 well is reportedly not active at this time (WRA February 2021). The well at Phantilands owned and operated by the SEMC serves the Pepper area while the well located on the STETHS compound is pumped a few hours every day. It should be noted that the first large diameter production well to be drilled in the northern Essex Valley and located within the Outer Valley Section of SEPL 541 was the Pepper well now known as Phantilands and the source of domestic water for the Pepper area. This well was drilled in October 1951 by Kaiser Bauxite Company Ltd one of the partners of Alumina Partners who constructed and originally operated the bauxite/alumina plant at Nain now owned/operated by JISCO.

Table 5-2 lists the production wells that are now out of service. These were used primarily for agricultural purposes with the exception of the Santa Cruz Ice Factory well. The decommissioning of these wells is as a result of the closure of dairy farms and agro-industrial plants such as those at Pepper and Goshen by Alpart, the Agricultural Development Corporation (ADC) and Ministry of Agriculture (cassava factory) respectively. It is very possible that some of these wells may be returned to service if and when conditions for doing so become a reality.

Table 5-3 lists the wells drilled by Alpart at Pepper north of the plant to provide domestic and industrial water to the plant after the original wells drilled at Nain near the plant were contaminated by bauxite/alumina waste. Included in this list are four small diameter wells drilled to obtain information on geology, water levels and water quality. Alpart had in the past monitored, and JISCO should now be monitoring these wells, on a monthly basis. The data is to be submitted quarterly to the members of the GoJ bauxite/alumina monitoring committee the membership of which includes the Jamaica Bauxite Institute (JBI), the National Environment and Planning Agency (NEPA), the Mines and Geology Division (MGD) and the WRA.

Drilled small diameter boreholes are primarily monitor wells constructed and monitored by Alpart/JISCO and/or WRA. These small diameter boreholes were drilled to obtain geology, water level and water quality data. They are usually completed with PVC, steel or galvanized pipe as the casing with diameters less than or equal to 15.24cm. The 5 monitor wells shown on Map 5-6 are Nain 11, Pepper MW 1 and MW 2, and Lovely Point are all owned by Alpart/JISCO as a component of its monitoring program. The fifth small diameter well is the Burnt Ground monitoring well drilled to obtain hydrologic data for the water resources assessment of the Black River basin in the 1960s.

Tables 5-4 and 5-5 lists the hand dug wells that are located within the SEPL 541 and the 1 km radius of the boundaries of the Outer Valley Section of SEPL 541.

The hand dug wells were constructed before the introduction in Jamaica of mechanical well drilling in the 1940s. Hand dug wells are usually located where the ground water table is high, approximately less than 3 metres below ground level. The hand dug wells are located in the northern region of the Valley Section of SEPL 541 close to the swampy area of the Upper Morass. As seen in tables 5-4 and 5-5 the hand dug wells are large in diameter (>1.5m) and are completed using cut stone (limestone blocks) or concrete as casing to stabilize the walls of the well. The hand dug wells are literally wide and shallow sumps storing groundwater which may be abstracted using a pump or a bucket. The WRA utilizes some hand dug wells as index (monitor) wells to obtain hydrologic data – water levels and water quality.

The common factor of all three types of wells is that they tap the karstified limestone aquifer of the Essex Valley that, with its high infiltration rate and permeability, is highly productive and most susceptible to contamination.

Table 5-1: Summary of Production Well Construction Data – for Municipal Wells - SEPL 541

Name of Well	**Drill Hole**		**Casing Assembly**					**Water Level**		**Yield Test**			**Lithology**				**Elev. (m. amsl)**
	Dia. (cm)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Draw down (m)	Type	From (m)	To (m)	Thickness (m)	
Pepper 1* (NWC)	60.96 40.64	51.8 106.7	Plain Perf Open hole	60.96 60.96 40.64	0 30.48 51.8	30.48 51.8 106.7	30.48 21.32 54.9	30.48	8.18	10,902	36.47	4.54	Clay Newport limestone	0 29	29.0 106.7	29.0 77.7	38.66
Pepper 2 * (NWC)	60.96 40.64	45.72 106.7	Plain Perf Open Hole	60.96 60.96 40.64	0 27.4 45.7	27.4 45.7 106.7	27.4 18.3 61.0	23.8	7.42	5,587	36.2	12.2	Clay Newport limestone	0 14	14 106.7	14 92.7	31.22
Pepper 3 * (NWC)	60.96 40.64	53.4 106.7	Plain Perf Open Hole	60.96 60.96 40.64	0 35.4 53.6	35.4 53.6 106.7	35.4 18.2 53.1	32.5	6.16	8,945	35.4	2.57	Clay Newport Limestone	0 29	29 106.7	29 77.7	38.66
Santa Cruz 1 + (NWC)	50.8 40.64	18.3 61.0	Plain Perf	40.64 40.64	0 21.3	21.3 61.0	21.3 39.7	16.8	-	2,180	32.0	15.2	Bauxite Newport Limestone	0 6.1	6.1 61	6.1 54.9	--
Santa Cruz 2 +(NWC)	40.64	65.53	Plain Perf	40.64 40.64	+2 13.71	13.71 65.53	14.33 51.82	3.66	11.58	8722	7.19	3.53	Red Clay Newport Limestone	0 6.1	6.1 65.53	6.1 59.43	15.24

Southampton 2+ (NWC)	43.2	114.3	Plain Perf	35.6 35.6	0 89.9	89.9 114.3	89.9 24.4	91.15	-	5,249	94.06	2.91	Clay Newport Limestone	0 7.0	7.0 114.3	7.0 107.3	-
Long Hill# (NWC)	45.72	137.2	Plain Perf	40.64 40.64	+0.6 77.11	77.11 137.2	77.72 60.1	77.72	5.84	9,087	81.63	36.79	Bauxite Newport Limestone	0 6.4	6.4 137.2	6.4 130.8	87.56
Phantilands ^ (SEMC)	50.8 40.64 36.58	106.7 140.2 153.9	Plain and Perf Open Hole	40.64 40.64 36.58	0 112.8 140.2	112.8 140.2 153.9	112.8 27.42 13.7	67.06	11.03	4,143	68.0	0.91	Bauxite Newport Limestone	0 9.1	9.1 153.9	9.1 144.8	78.09
Santa Cruz (STETS)	30.48	42.67	Plain Perf	30.48 30.48	+0.6 17.07	17.07 42.67	17.67 25.60	8.59	-	2,725.5	8.60	0.009	Limestone	0	42.67	42.67	-

- ***Greater Mandeville Water Supply**
- **+Santa Cruz Water Supply**
- **#Essex Valley/Junction Water Supply**
- **^Pepper Water Supply**

Table 5-2: Summary of Well Construction Data – Wells not in Operation up to February 2021 - SEPL 541

Name of Well	**Drill Hole**		**Casing Assembly**					**Water Level**		**Yield Test**			**Lithology**				**Elev. (m. amsl)**
	Dia. (cm)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Draw down (m)	Type	From (m)	To (m)	Thickness (m)	
Santa Cruz (Ice Factory)	20.32	24.4	Plain Perf	20.32 20.32	0 8.84	8.84 24.1	8.84 15.26	13.4	-	1,177	13.41	0	Clay Newport Limestone	0 6.2	6.2 24.4	6.2 18.2	-
Goshen 1 ADC	50.8 40.64	18.3 44.2	Plain Open Hole	32.38 40.64	0 37.2	37.2 44.2	37.2 7.0	12.5	-	5,451	13.87	1.37	Clay Newport Limestone	0 4.57	4.57 44.2	4.57 39.63	-
Goshen 2 ADC	-	45.72	-	-	-	-	-	8.99	-	7,086	20.42	11.43	Clay Newport limestone	0 7.01	7.01 45.72	7.01 38.71	-
Goshen MAF	45.72	106.98	Plain Perf Open Hole	48.72 48.72 45.72	0 21.95 46.94	21.95 46.94 106.98	21.95 22.25 60.04	12.04	-	10,902	12.64	0.6	Clay Newport Limestone	0 6.5	6.5 106.98	6.5 100.48	-
Goshen Cassava Factory	50.8 45.72	45.11 106.7	Plain Perf Open Hole	45.72 45.72 45.72	+0.6 22.02 46.86	22.02 46.86 106.7	22.62 24.84 59.84	11.94	-	14,173	13.16	1.22	Red Clay Newport Limestone	0 20.12	20.12 106.7	20.12 86.58	-
Friendship (Surdeen)	35.56	82.3	Plain Perf	30.5 30.5	+1 46.3	46.3 82.3	47.3 36.0	39.10	-	6,624	40.17	1.07	Clay Newport Limestone	0 1.5	1.5 82.3	1.5 80.8	-

Friendship 2	15.24	36.58	Plain Perf	15.24 15.24	0 28.10	28.10 34.20	28.10 6.10	25.91	9.13	76	-	-	Bauxite Newport Limestone	0 5.79	5.79 36.58	5.79 30.79	35.04
Friendship	30.48	33.53	Plain Perf	30.48 30.48	0 21.34	21.34 33.53	21.34 12.19	22.91	-	2,180	25.96	3.05	Clay Newport Limestone	0 4.57	4.57 33.53	4.57 28.96	-
Southampton 1	30.4 25.4	15.24 107.6	Plain Plain Perf	30.48 20.32 20.32	0 15.24 60.0	15.24 60.0 81.4	15.24 44.8 21.3	88.23	7.22	3,870	88.85	0.61	Clay Newport Limestone	0 7	7 107.6	7 100.6	95.45
Brighton-Santa Cruz	30.48 20.32	12.19 24.38	Plain Perf	30.48 20.32	0 +0.92	9.14 24.38	9.14 25.30	1.52	-	1635	1.52	0	Clay Newport Limestone	0 8	8 24.38	8 16.38	-
Pepper Dairy	36.58	109.73	Plain Perf	36.58 36.58	0 82.3	82.3 109.73	82.3 27.43	79.85	-	600	85.34	5.49	Red Clay Newport Limestone	0 0.3	0.3 109.73	0.3 109.70	-

Table 5-3: Summary of Construction Data of Alpart Production and Monitor Wells-SEPL 541

Name of Well	**Drill Hole**		**Casing Assembly**					**Water Level**		**Yield Test**			**Lithology**				**Elev.**
	Dia. (cm)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Draw down (m)	Type	From (m)	To (m)	Thickness (m)	**(m. amsl)**
Pepper 1 Alpart 7	30.48	121.92	No	Data	On	Casing	Seen	70.71	10.67	8177	74.37	3.66	Newport Limestone	0	121.92	121.92	81.38
Pepper 3 Alpart 8	30.48	121.92	No	Data	On	Casing	Seen	58.52	8.63	8177	66.14	7.62	Newport Limestone	0	121.92	121.92	67.15
Pepper 4	30.48	121.92	No	Data	On	Casing	Seen	57.17	8.33	1090	57.17	7.31	Newport Limestone	0	121.92	121.92	65.5
Pepper 5 Alpart 9	55.88 30.48	82.30 121.92	Plain	45.72	0	82.30	82.30	47.93	38.54	8018	65.78	17.86	Newport Limestone	0	121.92	121.92	86.47
Pepper 5R Alpart 9R	609.6 508.0	57.9 152.4	Plain Perf	457.2 457.2	0 61	61 152.4	61 91.4	49.1	-	10,900	60.1	11.0	Newport Limestone	0	152.4	152.4	-
Pepper 6 Alpart 10	55.9 30.48	97.54 121.92	Plain Perf Open Hole	45.72 45.72 30.48	0 71.63 97.54	71.63 97.54 121.92	71.63 25.91 24.38	64.18	8.18	9,555	67.0	2.89	Newport Limestone	0	121.92	121.92	72.36
Pepper 11 Alpart	60.96 35.56	134.11 149.35	Plain Screen Perf Open Hole	50.8 50.8 50.8 35.56	0 67.06 121.92 134.11	67.06 121.92 134.11 149.35	67.06 54.86 12.19 15.24	72.96	6.75	5342	102.49	29.53	Newport Limestone	0	149.35	149.35	79.71

Pepper MW 1 (Alpart)	15.24	121.92	Plain Perf	10.16 10.16	+0.91 62.56	62.56 121.92	63.47 59.97	36.58	-	No	Yield	Test	Brown Clay Newport Limestone	0 10.67	10.67 121.92	10.67 111.25	-
Pepper MW 2 (Alpart)	15.24	121.92	Plain Perf	15.24 15.24	+0.91 60.96	60.96 121.92	61.87 60.96	39.93	-	No	Yield	Test	Newport Limestone	0	121.92	121.92	-
Lovely Point MW (Alpart)	20.32	92.96	Plain Screen Plain Open Hole	15.24 15.24 15.24 15.24	+0.3 56.7 65.83 87.17	56.7 65.83 87.17 92.96	57.0 9.14 21.33 5.79	51.81	6.1	No	Yield	Test	Newport Limestone	0	92.96	92.96	57.91
Nain 11 MW (Alpart)	3.96	183.79	Plain Screen	15.24 15.24	0 146.30	146.30 183.79	146.3 15.24	139.29	7.84	294	155.14	15.85	Red Clay Newport Limestone	0 2.44	2.44 183.79	2.44 181.35	147.13

Table 5-4: Summary of Construction Data of Hand Dug Wells – SEPL 541

Name of Well	**Drill Hole**		**Casing Assembly**					**Water Level**		**Yield Test**			**Lithology**				**Elev. (m. amsl)**
	Dia. (m)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Draw down (m)	Type	From (m)	To (m)	Thickness (m)	
Walker Piece	2.44	32.46	Concrete	2.44	0	32.44	32.44	31.48	7.81	No	Yield	Test	Newport Limestone	0	32.46	32.46	39.29
Goshen LS (James)	2.44	5.71	Cut Stone	2.44	0	5.71	5.71	4.11	6.56	No	Yield	Test	Newport Limestone	0	5.76	5.76	10.67
Goshen LS (Pennycook)		5.97	Concrete					5.00	6.68	No	Yield	Test	Newport Limestone	0	5.97	5.97	11.68
Newcastle (Heath)		2.62						1.04	7.03	No	Yield	Test	Newport Limestone	0	2.62	2.62	8.07
Newcastle (Muschette)	1.83	5.42	Concrete	1.83	0	5.42	5.42	2.75	7.24	No	Yield	Test	Newport Limestone	0	5.42	5.42	9.89
Wilton (Densham)	1.67	4.02	Cut Stone	1.67	0	4.02	4.02	3.60	6.58	No	Yield	Test	Newport Limestone	0	4.02	4.02	10.18
Gilnock Hall (Reynolds)	2.13	27.43	Cut Stone	2.13	0	27.43	27.43	26.52	6.16	No	Yield	Test	Brown Clay. Newport Limestone	0 4.88	4.88 27.43	4.88 22.55	32.68
New River		3.66						2.82	2.74	No	Yield	Test	Newport Limestone	0	3.66	3.66	5.56

(Dunkley)																	
New River (ADC)	1.52	3.14	Cut Stone	1.52	0	3.14	3.14	2.29	3.22	No	Yield	Test	Newport Limestone	0	3.14	3.14	5.51
New River (ADC)	1.37	5.62	Cut Stone	1.37	0	5.62	5.62	5.04	2.69	No	Yield	Test	Newport Limestone	0	5.62	5.62	7.73

Table 5-5: Summary of Construction Data of Hand Dug Wells and WRA Monitor Well – SEPL 541

Name of Well	**Drill Hole**		**Casing Assembly**					**Water Level**		**Yield Test**			**Lithology**				**Elev. (m. amsl)**
	Dia. (m)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Draw down (m)	Type	From (m)	To (m)	Thickness (m)	
Santa Cruz (Ralston)	0.91	3.69	Concrete	0.91	0	3.69	3.69	1.55	2.53	No	Yield	Test	Newport Limestone	0	3.69	3.69	4.08
Santa Cruz West		7.25	Concrete		0	7.25	7.25	6.70	2.13	No	Yield	Test	Bauxite Newport Limestone	0 1.2	1.2 7.25	1.2 6.05	8.83
Santa Cruz (near Library)		8.93	Concrete		0	8.93	8.93	7.77	3.01	No	Yield	Test	Newport Limestone	0	8.93	8.93	10.78
Santa Cruz (Rowe)	1.83	13.53	Cut Stone	1.83	0	13.53	13.53	13.04	3.36	No	Yield	Test	Newport Limestone	0	13.53	13.53	16.40
Pepper (Kaiser)	1.83	40.54	Cut Stone	1.83	0	40.54	40.54	Dry	-	No	Yield	Test	Red Pebbles. Newport Limestone	0 4.88	4.88 40.54	4.88 35.66	-
Braes River (nr Clinic)		19.81	Concrete		0	5.50	5.50	5.50	9.70	No	Yield	Test	Newport Limestone	0	19.81	19.81	15.20
Grosmond (Barrett)		6.16						5.36	6.66	No	Yield	Test	Newport Limestone	0	6.16	6.16	12.02
Gilnock (Reynolds)		11.58						10.35	7.01	No	Yield	Test	Newport Limestone	0	11.58	11.58	17.36

Cow Pen (Brighton New River)		3.20						2.74	2.62	No	Yield	Test	Newport Limestone	0	3.20	3.20	5.36-
Burnt Ground (WRA)	6.35	111.25	Plain Perf Plain Perf	3.81 3.81 3.81 3.81	0 94.79 100.89 103.94	94.79 100.89 103.94 110.33	94.79 6.10 3.05 6.4	97.26	3.85	No	Yield	Test	Newport Limestone	0	111.25	111.25	101.11

5.1.1.2.12 Surface Water

Because of the karstic nature of the Newport Limestone that underlies the northern Essex Valley and the Outer Valley Section of SEPL 541 there is no surface water resources that traverse the area. The surface water resources are all located west and north-west of the Outer Valley Section, draining water from springs and the wetlands of the Upper Morass towards the Grass River and the Black River. The main surface water systems are the Braes River that flows from the west of Braes River township to the southwest to join the Smith River; the Mt de las Uvas River that flows southwest from the Cabbage Valley area to join the Smith River near Grosmond and the New River which flows northwest from just west of Santa Cruz to join the Black River at Lacovia. The Smith River flows northwest through the swamps of the Upper Morass to join the Grass River and eventually the Black River north of Lacovia.

The WRA has been monitoring streamflow at two sites along the Braes and Mt. de las Uvas Rivers. The data for the Braes River extends from 01 March 1966 to 31 December 2020 and for the Mt. de las Uvas River from 01 January 1967 to 9 July 2016. Both data sets have large gaps in the data up to 1 year or more in time making analysis of safe yield impossible. The plot of the stream flow data from the WRA Web Map (on line hydrologic database) for Braes River is shown as Figure 5-10 and for the Mt. de las Uvas River as Figure 5-11.

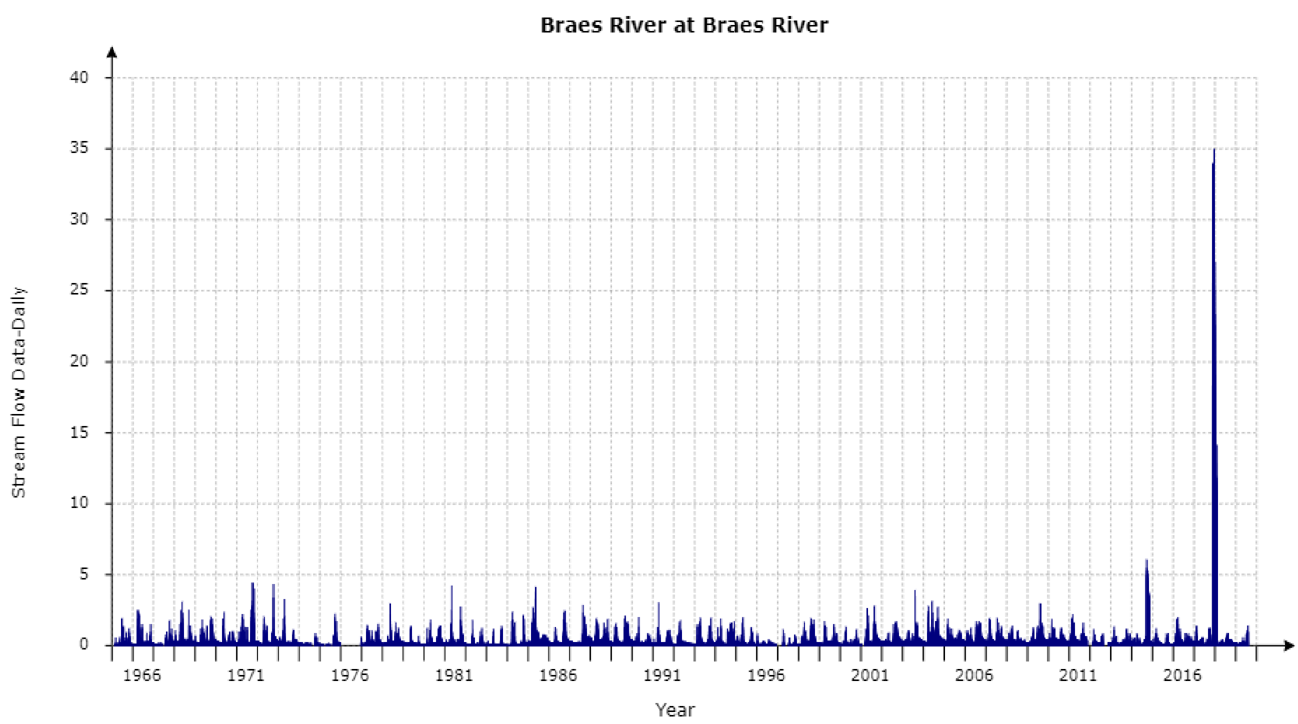


Figure 5-10: Plot of Stream Flow Data for Braes River in Cubic Metres per Second (1966 - 2020)

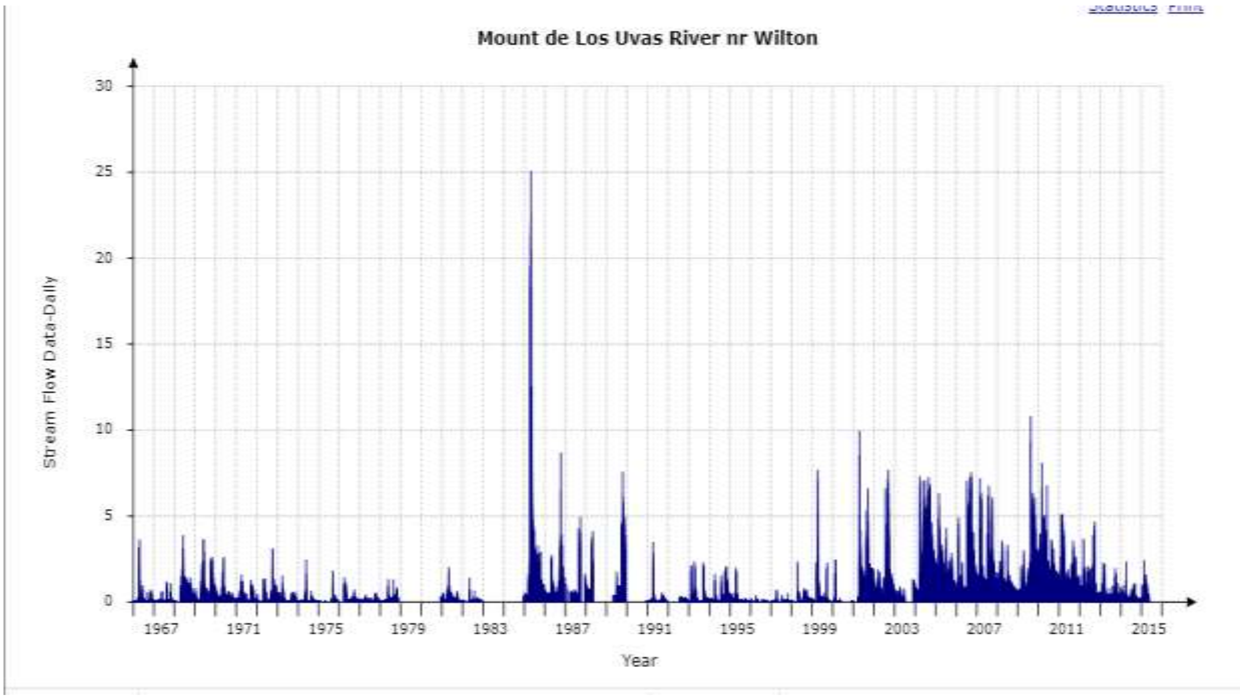


Figure 5-11:Plot of Stream Flow Data for Mt. de las Uvas River near Wilton in Cubic Metres per Second

The daily flow at Braes River is less than 5cumecs except in late 2014 when the flow exceeded 5cumecs and in January and February 2019 when the flow was between 34 and 35cumecs.

The Mt. de las Uvas River flow indicate daily flows being less than 5cumecs up to 1986 when the flow exceeded 5cumecs with a high of 25cumecs in May 1986. The flow has consistently exceeded 5cumecs after 2000 declining to less than 5cumecs after 2011. This increase in the stream flow could most probably be due to the tropical storms Lili and Isidore in September and October 2002 that impacted the south coast of Jamaica with heavy rainfall causing flooding of many areas including New River. These were followed by hurricanes Charley and Ivan in 2004, hurricanes Dennis and Emily in 2005, hurricane Wilma in October 2005, hurricane Dean in 2007 and hurricane Gustav in 2008. The seven-year period between 2002 and 2009 was a most severe weather period. It is possible that the flows were not as high in the Braes River as in the Mt. de las Uvas River as the rainfall was stored in the Upper Morass with discharge by several other rivers to the north into the Black River.

The Braes and Mt. de las Uvas Rivers drain areas outside and north of and away from the Outer Valley Section of SEPL 541 and the mining of bauxite from deposits within the Outer Valley Section is not expected to have an impact on the river flows and quality.

5.1.1.2.13 Springs

The karst topography of the Essex Valley and the Outer Valley Section of SEPL 541 limits the amount of surface water flow to only a few small springs and rivers. The northwards subsurface flow exits the Essex Valley and Outer Valley as spring flow north of the Outer Valley. Small springs occur north of the Outer Valley Section of SEPL 541 and close to the edge of the alluvium aquiclude near the Upper Morass.

There are some springs flowing from the west face of the Don Figuerero Mountains east of the Outer Valley, at Spice Grove and Nottingham. These flows are captured by the Newport Limestone before the flow enters the valley floor. These springs (4No.) include Spice Grove, Big Spring, Little Spring and an unnamed spring.

In the Outer Valley Section of SEPL 541 dry gullies are located which contain surface flow only during and after heavy rainfall events for short periods.

There is no spring within the Outer Valley Section of SEPL 541 and none that is being used for any domestic or agricultural use. No spring flow has been allocated by the WRA through its licensing system to abstract and use water.

Allocation of Water

The discussion in the sections above and the well data listed in Tables 5-1, 5-2 and 5-3 indicates the high dependence of the entire northern Essex Valley and the areas within the Outer Valley Section of SEPL 541 on groundwater for municipal, industrial and agricultural uses.

The WRA has the responsibility under the Water Resources Act 1995 for the allocation of water across the island through the granting of licences to abstract and use water. All ground and surface water systems must first obtain the licence from the WRA where a daily volume is allocated with conditions. The licence is renewable upon expiration providing the licence conditions are met. Table 5-6 below lists the wells that have been licenced by the WRA with the volumes allocated as well as those wells pumping without a licence from the WRA.

Table 5-6: List of Production Wells with Licenced Volumes and Status-Outer Valley section of SEPL 541

Name of Well	Application /Licence Number	Date of Issue	Volume Allocated m^3/d	Comment
Pepper 1 (NWC)	A2019/68	05/03/2020	5,669.03	Licence being renewed. Greater Mandeville Water Supply
Pepper 2 (NWC)	A2017/56	22/08/2017	4,432	Greater Mandeville Water Supply
Pepper 3 (NWC)	A2017/54	22/08/2017	9,085	Greater Mandeville Water Supply
Santa Cruz #1 (NWC)	No	Licence	Issued	Santa Cruz Water Supply. Well reportedly not in service
Santa Cruz #2 (NWC)	A2017/28	18/7/2018	9,100	Licence will expire June 17, 2021. Santa Cruz Water Supply
Southampton 2 (NWC)	A2018/13	18/07/2018	3,050	Licence expired. Santa Cruz Water Supply
Long Hill (NWC)	A2017/19	Pending	8,176	To be approved. Essex Valley Water Supply
Phantilands (SEMC)	NO RECORDS LOCATED			Pepper Water Supply
Goshen ADC	R04/2015	21/04/2020	1,962	Well decommissioned
Goshen MinAgF	79/016	24/08/1985	8,536	Not regularized – Well out of Use
Pepper Dairy (Hansen)	NO RECORDS LOCATED			Well not in use
Goshen Cassava Plant (Hansen)	NO RECORDS LOCATED			Well not in use
Goshen James	NO RECORDS LOCATED			Dug well reportedly pumping
Santa Cruz Ice Factory	NO RECORDS LOCATED			No licence - Pumping illegally
Brighton	86/026	06/08/1987	114	Expired licence
Santa Cruz (STETS)	A2015/38	23/06/2015	820	Expired licence
Alpart 8/Pepper 3	A2017/89	28/07/2017	10,900.80	JISCO plant supply
Alpart 7/Pepper 1	A2017/94	28/07/2017	7,085.50	JISCO plant supply
Alpart 10/Pepper 6	A2017/96	28/07/2017	10,900.80	JISCO plant supply
Alpart 11	A2017/97	28/07/2017	3,270	JISCO plant supply
Alpart 9/Pepper 5	A2017/98	28/07/2017	6,159	Replacement well drilled – not licenced to abstract and use water
Alpart 9R/Pepper 5R	C2018/07			Permit to drill but no licence to abstract granted to JISCO

As can be seen from Table 5-6 no surface water or spring flow has been allocated for any use within the Outer Valley in the northern Essex Valley.

5.1.1.2.14 Water Quality

Naturally occurring groundwater quality, except where contaminated by industrial and municipal effluents or seawater, is adequate for all standard uses. Physical, chemical and bacteriological quality are generally as follows:

- pH 7.0 to 7.2
- EC 450 to 700 micromhos/cm
- TDS 250 to 450 mg/l
- Coliform 5 MPN/100ml

TDS (Total Dissolved Solids) tend to be above what is ideal for industrial boilers without softening but the bacterial quality requires minimum treatment such as chlorination for use as a public (municipal) supply source.

- pH 7.0 to 7.2
- EC 300 micromhos/cm
- TDS 200 mg/l
- Coliform 2,400 MPN/100ml

Instances of industrial and municipal effluents have affected both surface and ground water quality and have limited water use in some areas of the Essex Valley. Sugar factory/rum distillery effluents (wash water and dunder) have contaminated flow in the Black River that drains the Black River Hydrologic Basin within which the Essex Valley and Outer Valley Section of SEPL 541 are located making it unsuitable for use as a source of domestic water although the high nutrient load may enhance suitability for irrigation. Industrial effluents from the bauxite/alumina industry have also impacted groundwater quality in the Black River Hydrologic basin and the Essex Valley sub-basin.

5.1.1.3 Ground Water Contamination in the Essex Valley

Any contamination of water resources in the Essex Valley is most likely to have resulted from the improper disposal of industrial effluent from the Alpart bauxite/alumina plant at Nain. No other source of contamination has been identified in the Essex Valley.

5.1.1.3.1 Historical

Alumina production by Alpart began at the Nain plant in May 1969. Five wells were drilled in the immediate vicinity of the plant to supply water for operations and domestic demands. In early March 1970 high sodium concentrations were noted in the operating wells. This was followed by a decline in production of the wells and the drilling of a replacement well (Nain #6 in 1970) to meet the water demands. The sodium concentrations continued to increase until all the wells were contaminated and unable to be used for domestic purposes at the plant. See Table 5-7 below.

Table 5-7: Water Quality Data for Nain Wells 1972 - 1974

Well Name	pH (Units)	Sodium (Na) (mg/l)	Chloride (Cl) (mg/l)	Date of Analysis	Comments
Nain #1	11.3	590	54	24/9/74	In Operation
Nain #2	10.9	470	120	5/6/72	Abandoned
Nain #3	10.9	355	74	12/6/72	Abandoned
Nain #4	9.3	203	43	24/9/74	In Operation
Nain #5	9.8	210	80	10/9/73	Out of service
Nain #6	8.4	75	24	10/9/74	In Operation

Table WQ 1-Water Quality Data for Nain Wells 1972-1974. (Source-Karl H. Weibe, Mandeville Water Supply Hydrogeologic Study, Upper Morass Basin, 1974).

The contamination of the Nain wells and the loss of production/yield led to the drilling of the wells at Pepper several miles north of the plant in the Northern Essex Valley and within the southern area of the Outer Valley Section of SEPL 541. Six wells were drilled at Pepper but only five were commissioned.

5.1.1.3.2 Impact on Pepper Mandeville and Alpart Wells

As stated earlier and shown on Figure 5.8 groundwater flow is to the northwest from the plant and red mud lakes (south and north lakes) towards Pepper-Goshen. In the flow path were the Pepper 1, 2 and 3 wells developed by the then National Water Authority (NWA) now the National Water Commission (NWC) for the Greater Mandeville Water Supply in the mid-1970s. The NWA expressed a concern that the Pepper wells could be contaminated by the "red mud" waste that had impacted the Nain-Alpart wells. The Engineering Contractors for the Greater Mandeville Water Supply Project, Montgomery Engineers, had an assessment done of the likely effects of the pollution at Nain on the Pepper groundwater reservoir. Several proactive measures were recommended including the use of the Nain wells as scavenger wells to reduce and prevent movement of the contaminant plume northwards.

In 1990 Alpart utilized the services of Gurr and Associates out of Florida, USA to conduct a risk assessment of the north lake being used for the disposal of red mud. In a model of the aquifer a northern moving contaminant plume was identified and the Gurr report showed a higher risk to the Mandeville Pepper wells if the north lake was used for mud disposal. The joint monitoring team of GoJ and Alpart personnel agreed to install 2 monitoring wells between the projected plume and the Mandeville Pepper wells. The Alpart Pepper Monitor Wells 1 and 2 were constructed in early 1998 at Pepper as an early warning system and are shown on Figure 5.9.

Water quality data at JISCO (Alpart) Pepper well field showed the pH increasing from 7.2 to 7.9 between 1975 and 2010 while sodium concentration rose from <7mg/l to a high of 70mg/l in the southernmost well (#7) in 2006. See Figure 5-12. The last well to be drilled in the JISCO Pepper well field was the Pepper #9R (drilled in July 2019) to replace the Pepper #9 well that had shown declining yields. The water quality assessed during the well performance (step test) of this well indicated the following water quality for sodium as summarized in Table 5-8. No pH or chloride analytical results were reported. The sodium concentrations reported were elevated above ambient but were all less than 30mg/l.

No sodium or pH concentrations were reported for the constant rate test.

Table 5-8: Sodium concentration of discharge from Pepper #9R Well

Sodium Concentration for Pepper #9 Well-Well Performance Test				
Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**
24.0 mg/l	26.8 mg/l	19.0 mg/l	25.9 mg/l	18.5 mg/l

The NWC's Mandeville Pepper wells continue to report pH of 7.2 to 7.8 and sodium concentration of <7mg/l-(WRA database 2020).

Analytical data from one Braes River tributary, fed by groundwater from the Essex Valley, show pH of 7.0 to 7.2 and sodium concentration of <7mg/l (WRA database 2020).

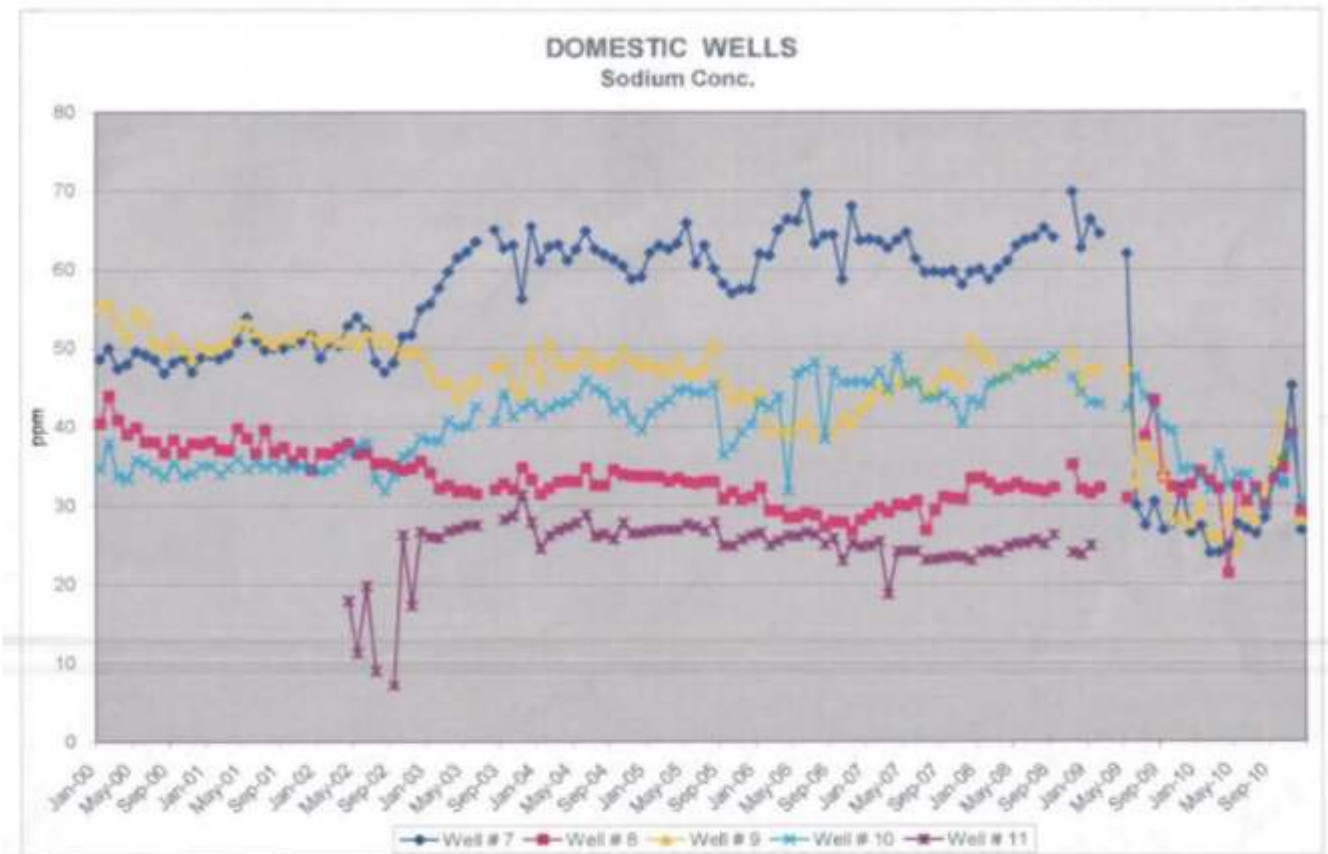


Figure 5-12:Sodium concentration for JISCO Pepper Wells 2000 - 2010

The elevated levels of sodium recorded at the JISCO (Alpart) Pepper well field is likely to have results from seepage from the red mud detention pond into the underground water and not as a result of bauxite mining. No impact on the Pepper Mandeville water supply wells and the Phantilands (SEMC) well from the caustic contamination at Nain have been reported.

5.1.1.4 Impact of Bauxite Mining on Water Resources

5.1.1.4.1 Limestone Bauxite Relationship

Jamaica's bauxite occurs as a blanket deposit atop the limestones of the White Limestone Group. The limestone has a wavy erosional surface with highs and lows (peaks and depressions). The bauxite deposit is thickest in the depressions of the limestone and is the primary ore deposit mined. There is no widespread clearance of forest cover to mine bauxite as in strip mining for copper or other ores.

The members of the White Limestone Group are all aquifers with the exception of the Montpelier Limestone Formation which is classified as an aquiclude. In the Essex Valley the bauxite deposits overlie the Newport Limestone Formation that functions as one hydraulic unit. As stated in the section on geology the Newport Limestone exhibit mature karstic features typified by a very high infiltration capacity, predominant subsurface drainage and highly compartmentalized conduit flow. Transmissivity is very high. The Newport Limestone is the most productive aquifer in the island. Karst terrains are characterized by sinkholes, caves, springs, disappearing/reappearing streams and other land surface depressions formed by erosional activities.

5.1.1.4.2 Impacts Globally

There are several reports of studies on the impacts of bauxite mining on water resources globally. The reports indicate that the impacts are primarily on surface water sources especially as the operational mode of mining is different from Jamaica. In many cases the bauxite ore is washed in ponds before being transported to the plant. Overflows, dike breaches and spills all occur into rivers that supply water to the industry and villages/towns nearby. This is the case in India, Vietnam and Malaysia.

In Australia after 36 years of monitoring bauxite mining in the Jarrah Forest with 3 monitoring zones- one control zone with no forest clearing and mining, the second a zone with just clearing of forest cover and no mining and the third zone with forest cover clearing and mining of bauxite; the impact on groundwater was found to be minimal and only on shallow groundwater (<10m). Deep groundwater was not affected and after 11 years of cessation of mining the shallow groundwater returned to normal. In fact, the impacts observed from the forest clearing only zone was similar to the one with forest clearing and mining indicating that mining was not the cause of the impact.

The hydrological response to mining could not be distinguished from responses to other catchment disturbances which do not disrupt the regolith including forest thinning and clearing.

5.1.1.4.3 Impacts Locally

While no formal study has been done on the impacts of bauxite mining on water resources in Jamaica there has been no recorded detection of quality or quantity issues resulting from the mining of bauxite. The Water Resources Authority (WRA) maintains monitoring networks for ground (over 1800 sites) and surface water (over 130 gauging stations) systems across the island. Surface water systems draining bauxite mining areas on both the north and south coast as well as groundwater systems tapping the White Limestone Formation with which the bauxite deposits across the island are associated (see above) are regularly monitored.

The Newport Limestone Formation outcrops along the entire south coast of the island and is the major aquifer for the parishes of St Catherine, Clarendon, Manchester and St Elizabeth the chief bauxite mining areas.

Several mining areas have been flooded with no noted effect on water quality of wells and rivers such as turbidity/discoloration from the runoff/drainage of these areas and no decline in ground and surface waters over the years. The Jamalco Harmons bauxite mines in South Manchester were flooded during the passage of tropical storms Lili and Isidore in September and October 2002 respectively. The bauxite mines were under water and were closed for several months.

The flood waters drained south towards the Alligator Hole River at Canoe Valley and to the Milk River via Scotts Pass and no discoloration and/or turbidity of the flows was recorded by WRA staff (including this hydrogeologist) monitoring the Alligator Hole and the Milk Rivers. In fact, at Scotts Pass, Manchester, many persons had picnics by and swam in the Milk River and even suggested that hotels be established to take advantage of the high and clear groundwater flows sustaining the river. In western Clarendon around the Milk River-St Toolies area the National Irrigation Commission (NIC) closed its 6 wells (Milk River 1, 2, and 3 and St Toolies 1, 2 and 3) and supplied agricultural and domestic water from the St Jago/St Toolies springs originating from rainfall and subsurface flow from the Mile Gully mining area. **All this groundwater originated from active bauxite mining areas**.

The Moneague/Clapham area in St. Ann has been flooded several times since 1734 with a major flood in 2005 that took 4 years to be drained. The Moneague/Clapham area was in 2005 being mined of the bauxite deposits by Windalco. The flood waters from the Moneague/Clapham area drained via subsurface pathway to the northeast appearing as springs on the western bank of the White River at Up Park Pen above the NWC's intake for the Labyrinth water treatment plant. There was no report of any discoloration and/or turbidity of the White River flow. A February 2021 assessment (flow analysis) of the White River flows gave a reliable yield of 3.0cubic metres per second (cumecs) or 259,000cubic metres per day (m^3/d) or 57million imperial gallons per day (migd). This assessment (flow analysis) utilized data from the WRA's recording gauge stations at Exchange and Labyrinth on the White River for the period 05 May 1989 to 30 September 2020-over 32years of data. No decline in flow on the White River has been recorded. **The use of the White River for tourism, recreational and public water supply has not reported as having been impacted in its quality and quantity by mining of bauxite in the recharge (Moneague/Clapham) area of the river.**

The updated Water Quality Atlas 2019, published by the WRA, showed that, to the date of publication, bauxite mining along the south coast of the island did not cause or result in any contamination of either groundwater or surface water resources in the Rio Minho or Black River Hydrologic Basins, which Basins are spread across the South Coast of Jamaica and include the areas subjected to bauxite mining. Groundwater was analyzed with the results from several limestone wells and the surface water analyses undertaken by utilizing water sources draining the two basins. **The water quality in the Rio Minho and Black River Hydrologic Basins was assessed as excellent for each of the six Water Quality Indicators used in the assessment except where there was an impact from bauxite refining.**

5.1.1.5 Impact on Wells Within Outer Valley Section of SEPL 541

In Figure 5-13 the areas shaded in blue are the identified (ore bodies) deposits of bauxite within the SEPL 541 that will be mined by JISCO over the next several years. The larger deposits are located to the southeast within the Outer Valley section of SEPL 541 between Long Hill, Northampton, Southampton Goshen. Smaller deposits are located in the Pepper area and just south of Santa Cruz

The NWC well at Southampton, one of the sources of water for Santa Cruz, has one large deposit nearby as well as the Long Hill well, the source of water for the Essex Valley and Junction. There is a small deposit in the vicinity of the Pepper monitoring wells and the JISCO Pepper well field. There are no proposed mining sites in close proximity to the NWC's Mandeville wells - Pepper 1, 2 and 3. The deposits around the JISCO Pepper wells are all upgradient of the NWC's Mandeville water supply wells at Pepper and mining these deposits may be impactful on these wells

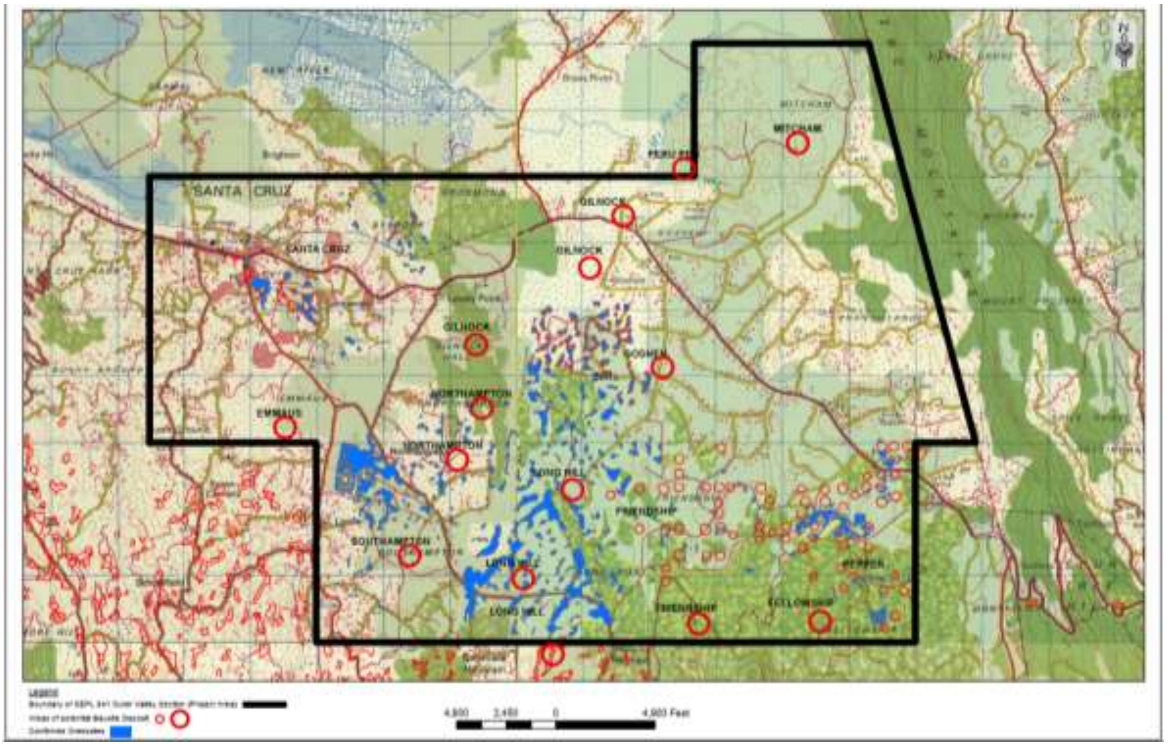


Figure 5-13: Ore Bodies Locations within the Outer Valley Section of SEPL 541

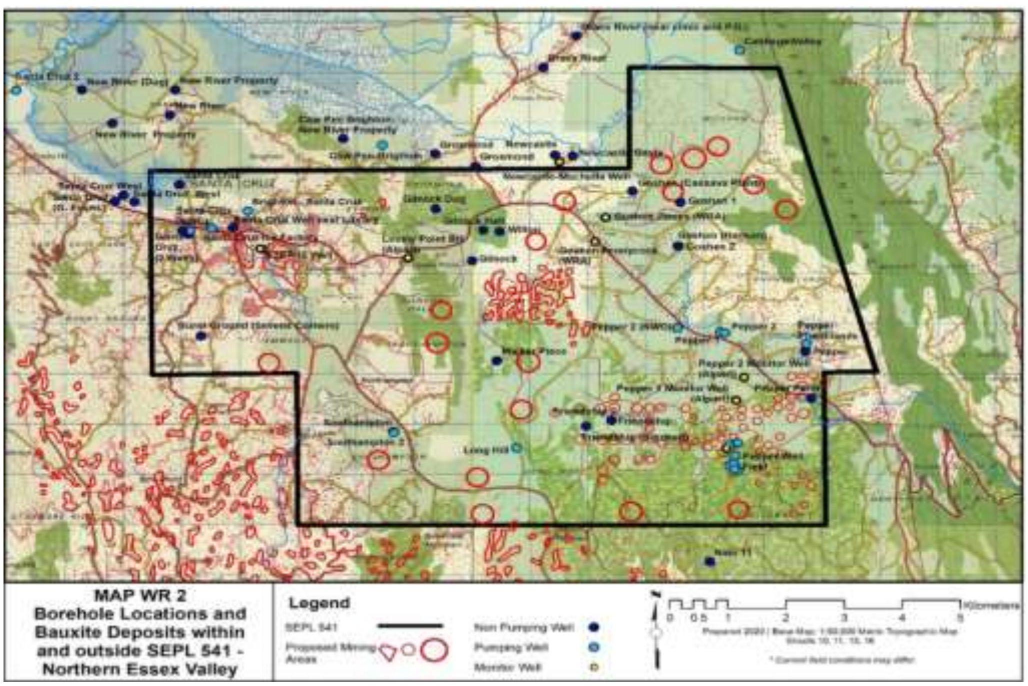


Figure 5-14: Location of Pumping and Non-Pumping Wells within the Outer Valley Section of SEPL 541

Figure 5-14 shows the locations both the production wells and the abandoned and monitoring wells within and just outside the Outer Valley section of SEPL 541.

The wells penetrate an overburden consisting of clay and sometimes bauxite. This overburden varies in thickness and forms the unsaturated zone of the aquifer. Mining of bauxite close to the wells may remove or loosen the overburden leaving the upper part of the steel casing of the well exposed and susceptible to damage. In order to address this risk a buffer zone of at least 30 metres around wells or other such infrastructure is recommended.

The construction of haul roads to move the bauxite mined to the plant will require the compaction of the road surface using heavy duty equipment the vibrations of which may impact the casing of the wells even to the point of the casing being shaken out of verticality. If a pump is installed in the well this may affect the pump operations and the sustainable production of water. In addition, the road surface may be blacktopped using heavy oil and runoff from the road surface may compromise water quality especially via sinkholes and fractures in the highly permeable Newport Limestone Formation. **It is important that caves, sinkholes and other solution features be identified close to each deposit to be mined, and prior to mining being started so that buffer zones can be established to prevent possible incursions into the groundwater.**

Consideration must also be given to the fact that an occurrence upgradient of a well or group of wells may have an impact on that/those well/wells. This is especially important in relation to the NWC's Pepper wells (Pepper 1, 2, 3 wells) that provide water to the Greater Mandeville Area, Santa Cruz and Essex Valley-Junction water supply (Southampton, Santa Cruz 1 and 2 and Long Hill wells) and Pepper water supply (Phantilands well). It is recommended that a minimum distance or buffer between wells and the mining areas be established to prevent any impact on wells and water supply. This should include all wells whether in production or not. The protection of monitoring wells must also be given priority as the data record needs to be extended to measure impacts of the mining operations and the longer the record the greater the confidence in the analysis of the data.

There are pipelines laid across the area of SEPL 541 that transmits and distributes water to towns and communities such as Santa Cruz, Pepper, Junction and Mandeville and to industries such as the JISCO Nain bauxite plant. These pipelines were laid before the advent of digital systems that recorded the locations, type, diameter and other criteria and in many instances the exact locations are not known. Where pipelines are located through or within bauxite deposits, the mining of bauxite may result in damage to the pipelines. This would disrupt water supply to citizens and pose a risk to health and sanitation through contaminants entering ruptured pipelines. **It is recommended that where available the pipeline routes be obtained from the NWC and SEMC and if not available then the mining areas be scanned to detect possible pipelines before mining takes place.**

The mining of bauxite deposits identified within the SEPL 541 is made more difficult by the high level of groundwater development that has taken place over the past 70 years since Kaiser drilled the Pepper well and the number of wells constructed. Planning and preparation of detailed mining plans with emergency actions to be taken if there is an emergency can minimize the risks to water resources and the water infrastructure within the Outer Valley section of SEPL 541.

5.1.2 Air Quality

5.1.2.1 Meteorology

The meteorology of the area is derived from weather data collected at the Alpart Refinery at Nain where a Met. Station is located. The data parameters collected at this station include: Wind speed & direction, Rainfall, Temperature, Relative Humidity and Barometric Pressure. The data used in this analysis was captured between 2009 and 2018.

Meteorological Data

Table 5.9 below summarizes the annual daily averages of weather data collected over the period.

Table 5-9: Annual Daily Averages of Weather Data Collected

Year	Average	Average	Average Daily	Avg (Deg. C)	Avg. Barometric
	W/S (m/s)	WD (Deg.)	Rainfall (mm)	Temperature	Pressure (mBars)
2009	1.91	139.2	2.8	25.5	998
2010	1.75	150.1	6.2	25.3	997
2011	1.65	145.1	2.9	25.4	998
2012	1.81	146.9	3	25.2	997
2013	1.89	143.17	3.2	24.3	994
2014	1.86	143.5	2.8	25.7	986
2015	1.94	144.8	2.4	25.9	988
2016	1.74	142.1	2.3	25	988
2017	2.04	135.8	2.6	25.5	991
2018	2.24	131.25	2.7	23.4	995

The data collected show that the area experiences hot humid weather conditions, with an annual average rainfall of 1900mm for the period shown. The area generally experiences two wet seasons; May to June and September to October, coinciding with the hurricane season. Average daily temperature ranges from a high of 31°C, to a low of 20°C, with an annual average of 22°C. The average daily wind speed is 2 m/s, which predominantly originate from the South East. The climate of the area would mean that the dry season would present an additional challenge to dust control efforts. The wet season may mean a curtailment of mining if conditions prove unsafe for trucking. These safety measures are well established in the current mining procedures and will be utilised if necessary.

5.1.3 Air Quality Monitoring

Air Quality monitoring was carried out from August 2020 to September 2021 in compliance with the Natural Resources Conservation Authority Air Quality Regulations. Figure 5.15 shows the location of these maps in relation to the study area. The sampling period covered both wet and dry seasons.

Air Quality Sampling was done at the following locations:

1. Mitcham
2. Northampton (2)
3. Santa Cruz (1)
4. Goshen

Monitoring at the Northampton (2) and Santa Cruz sites began from August 2020 and for the other two sites, September 2020.

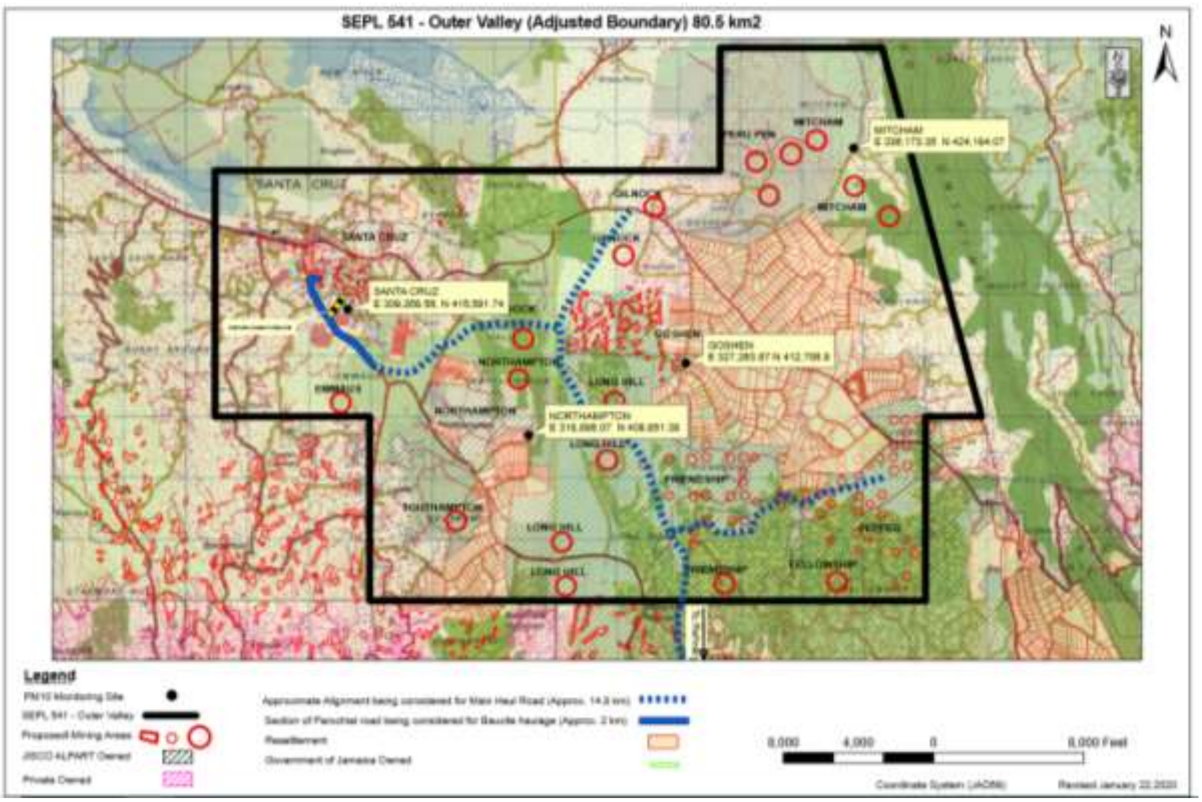


Figure 5-15: Map of Monitoring stations in relation to the EIA area

The annual average PM10 24-readings for each site are shown in Figure 5.16 below. All readings were below the 1996 Ambient Air Quality Standards Regulations for Jamaica annual PM10 of 50 ug/m standard as seen from the graph below. This may be considered as the baseline air quality data for the area.

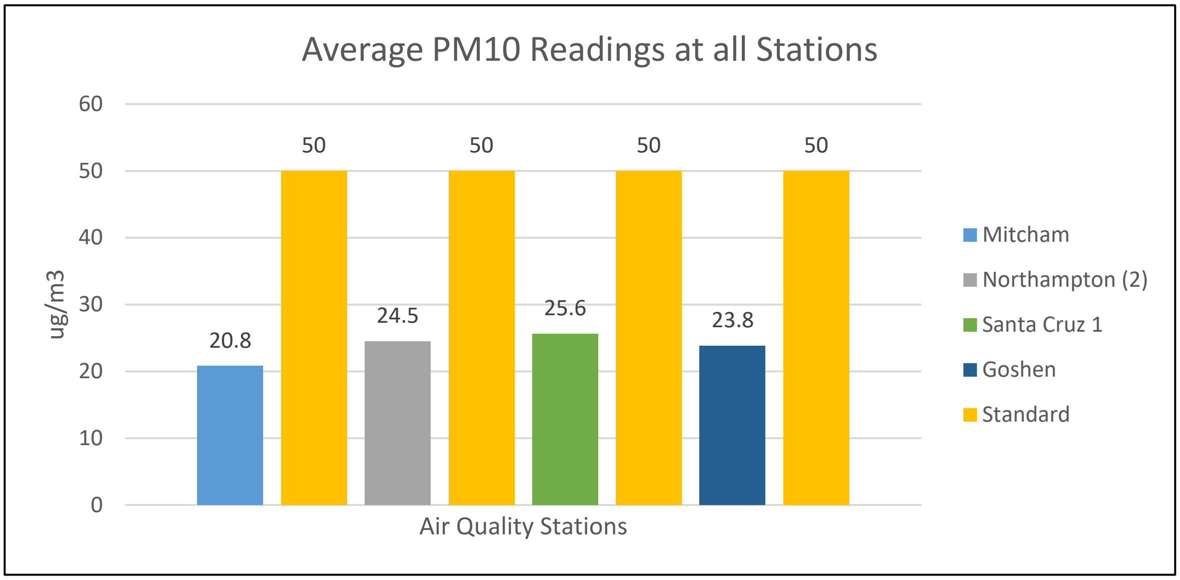


Figure 5-16: Average PM10 readings at all four Sampling Stations compared to Standard

When the 24-hour PM10 readings were averaged for each month at each station, all readings were below the 1996 Ambient Air Quality Standards Regulations 24-hour average for Jamaica of 150 ug/m^3. This is illustrated in the graphs below.

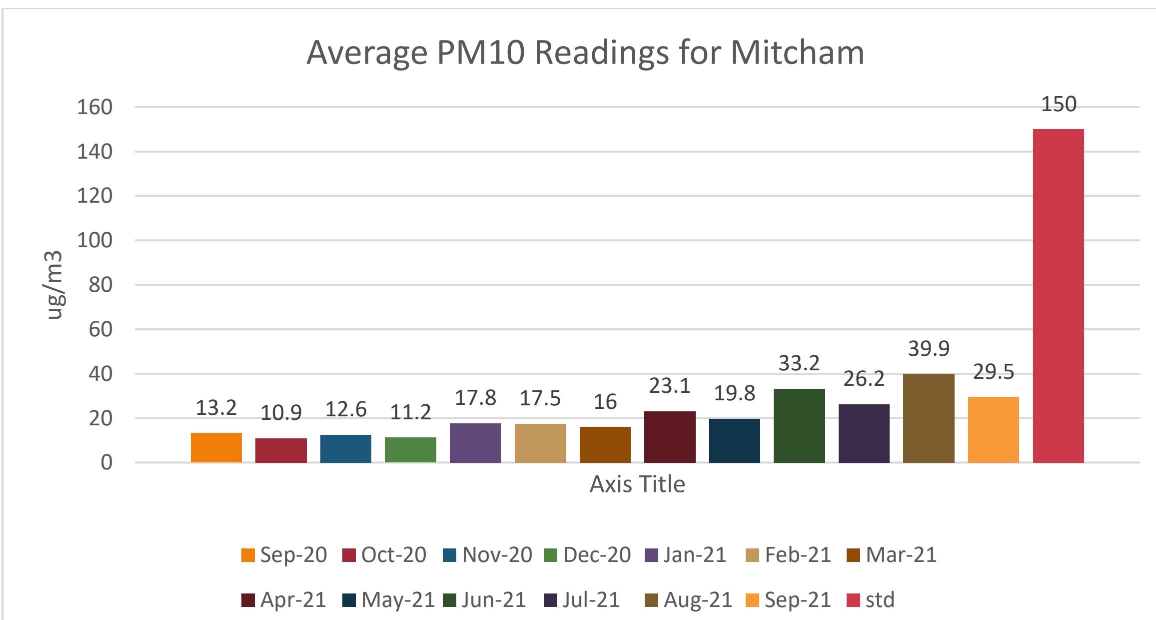


Figure 5-17: Averaged Monthly 24-hour readings for the Mitcham Station

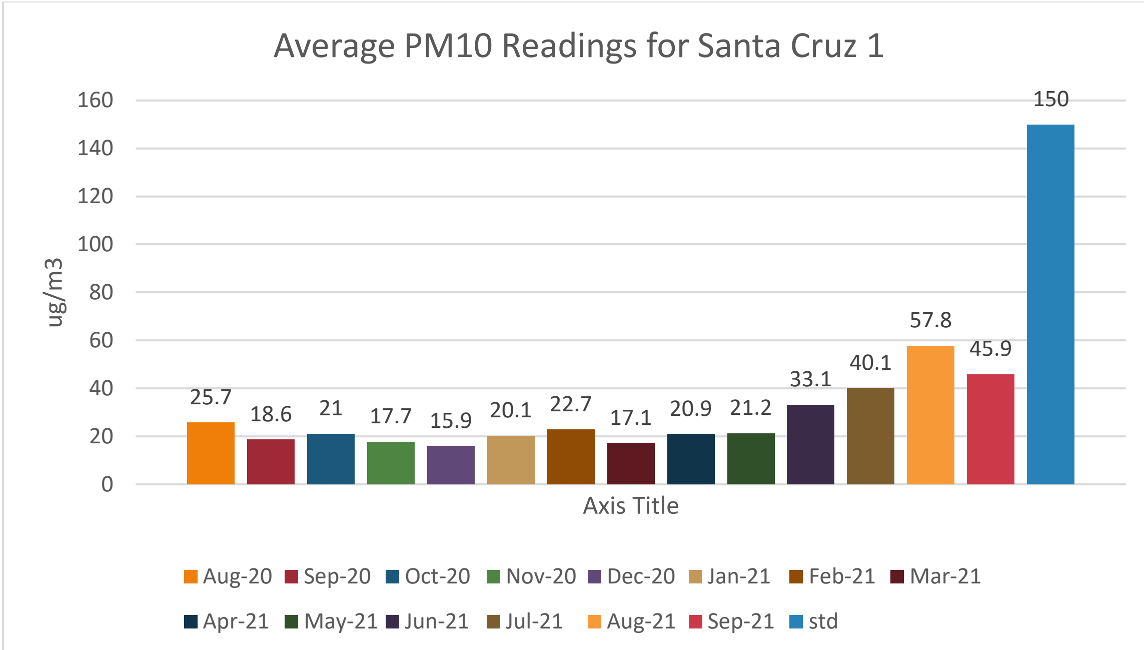


Figure 5-18: Averaged Monthly 24-hour readings for the Santa Cruz 1 Station

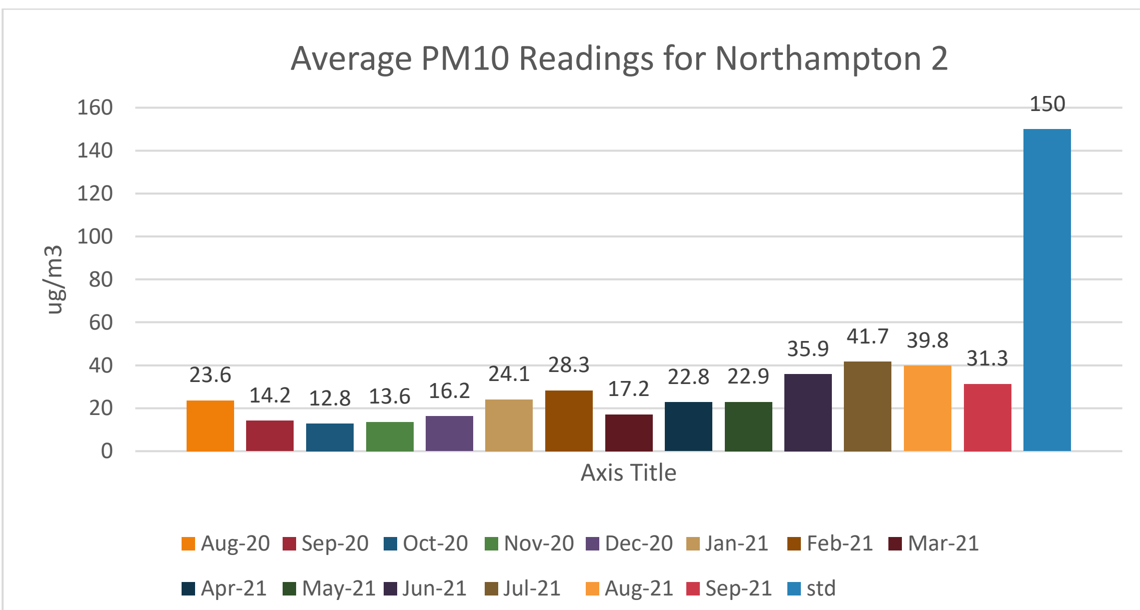


Figure 5-19; Averaged Monthly 24-hour readings for the Northampton Station

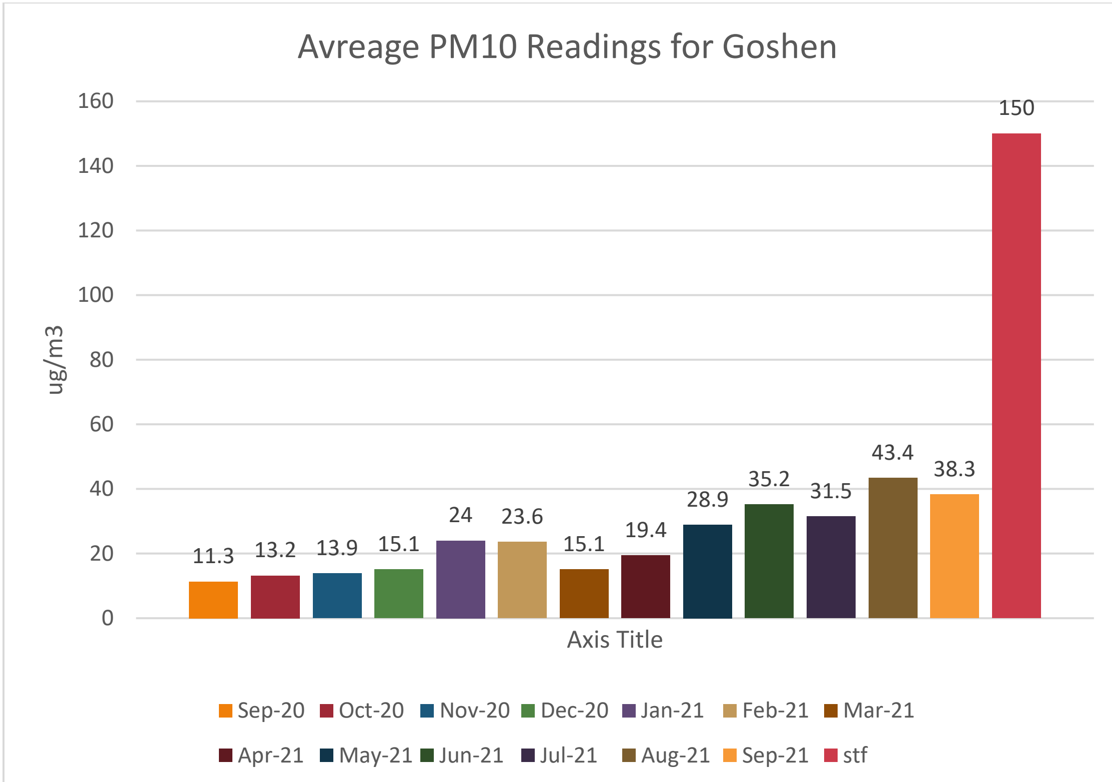


Figure 5-20: Averaged Monthly 24-hour readings for the Goshen Station

The photographs below show the sampling Sites

Figure 5-21: Photographs of Monitoring Sites

Photo 1. Sampler in North Hampton. Photo taken on the 5 Jan 2021

Photo 2. Road to the sampler in North Hampton. Photo taken on the 5 Jan 2021

Photo 3. Sampler in Santa Cruz. Photo was taken on 5 Jan 2021

Photo 4. Road to the sampler in Santa Cruz. Photo taken on the 5 Jan 2021

Photo 5. Sampler in Mitcham. Photo was taken on 5 Jan 2021

Photo 6. Road to Sampler in Mitcham. Photo was taken on 5 Jan 2021

Photo 7. Sampler in Goshen. Photo taken on the 5 Jan 2021

Basis for the selection of each site

- The community size must be greater than 10 or more houses.
- Proximity of community to the proposed ore bodies.
- Location of community to wind direction - upwind or downwind.
- Open Spaces or Locations that are not close to barriers like trees or other tall obstruction/structures.
- Proximity to public roads
- Avoidance of public spaces that have easy access - the tendency is to use private spaces to maintain integrity of sample (avoid tampering)

5.1.4 Water Quality

Wells in the study area were sampled monthly from August 2020 to September 2021. Given the possible anthropogenic sources in the area mainly from the presence of the Alpart bauxite plant, sodium was selected as the main indicator of water quality for this review. Other parameters are shown in Appendix 13.4

The wells that are relevant to the study area are:

1. Pepper NWC
2. Southampton
3. Braes River
4. Penny Cooke Well
5. Mt. De Las Uvas
6. Pepper Government nos. 1, 2 & 3

Well locations are shown in Figure 5.22 and sodium concentrations full year 2020 are shown in the graphs presented as Figures 5-23 to 5-26. Sodium concentrations were compared to the Draft Jamaica National Ambient Water Quality Standard –Freshwater, 2009. The draft standard gives a range of 4.5 – 12 mg/l. This will vary depending on natural factors, such as topographic position and the mineral composition of underlying geology. These act to produce basic physical and geochemical conditions in groundwater that are reflected in physical properties and chemical properties.

The graphs show that the water quality is generally within the Draft Jamaica National Ambient Water Standard. The following exceptions were noted from the data in Appendix 13.4:

1. The water sample taken in November 2020 was there an exceedance recorded in the Penny Cooke well of 14.2 mg/l.
2. Exceedances for sulphate at Pepper NWC during 2020 as well as 2021.

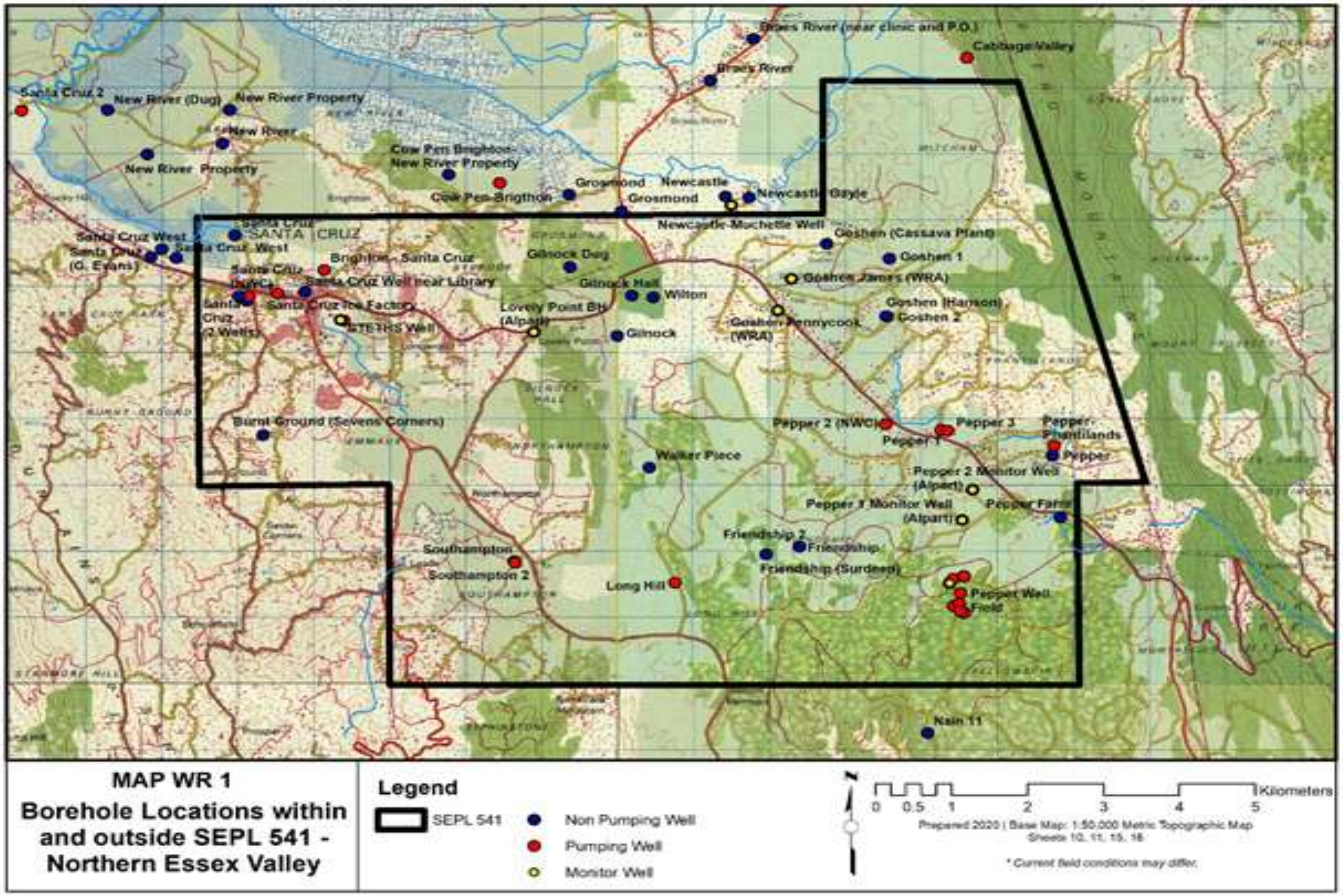


Figure 5-22: Location of wells within the Essex Valley

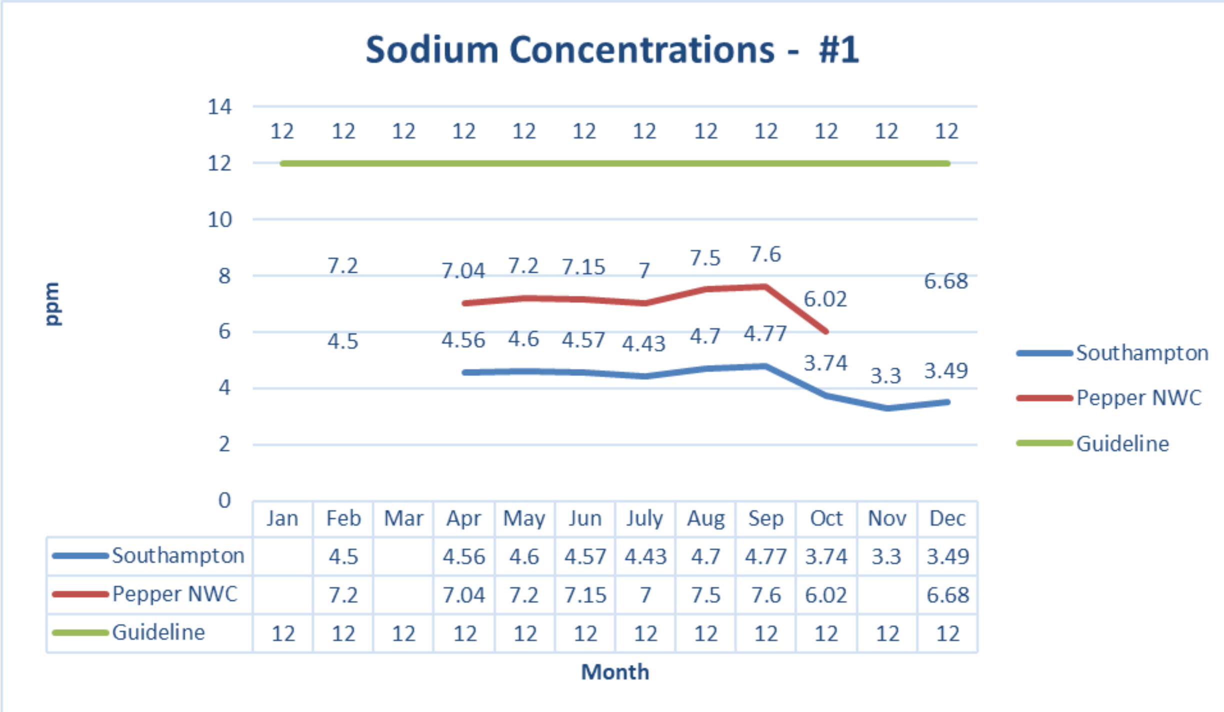


Figure 5-23: Sodium Concentrations for wells: South Hampton and Pepper NWC

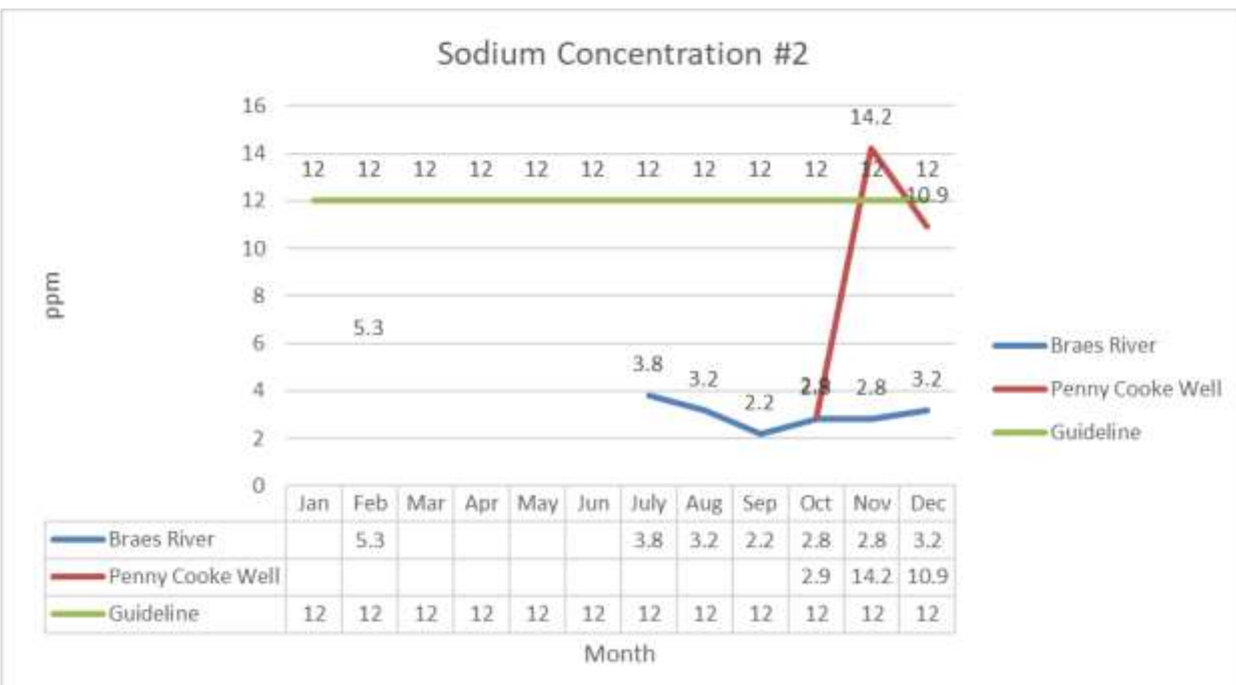
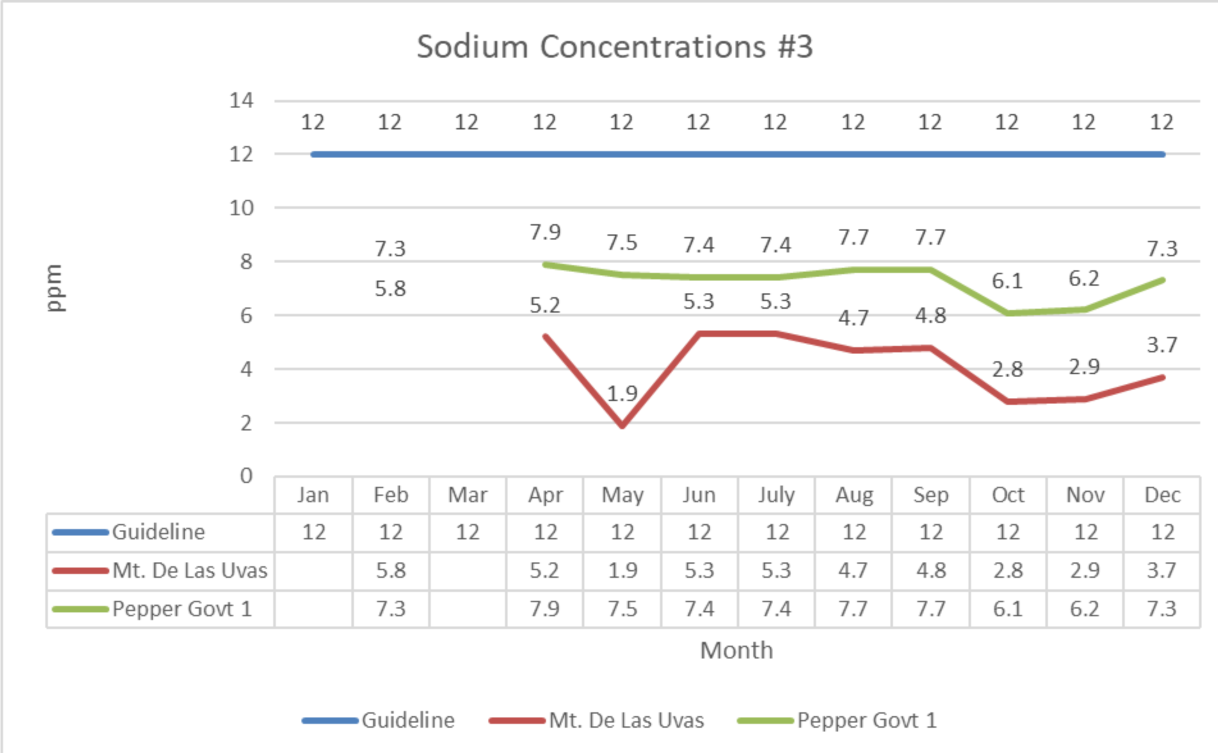
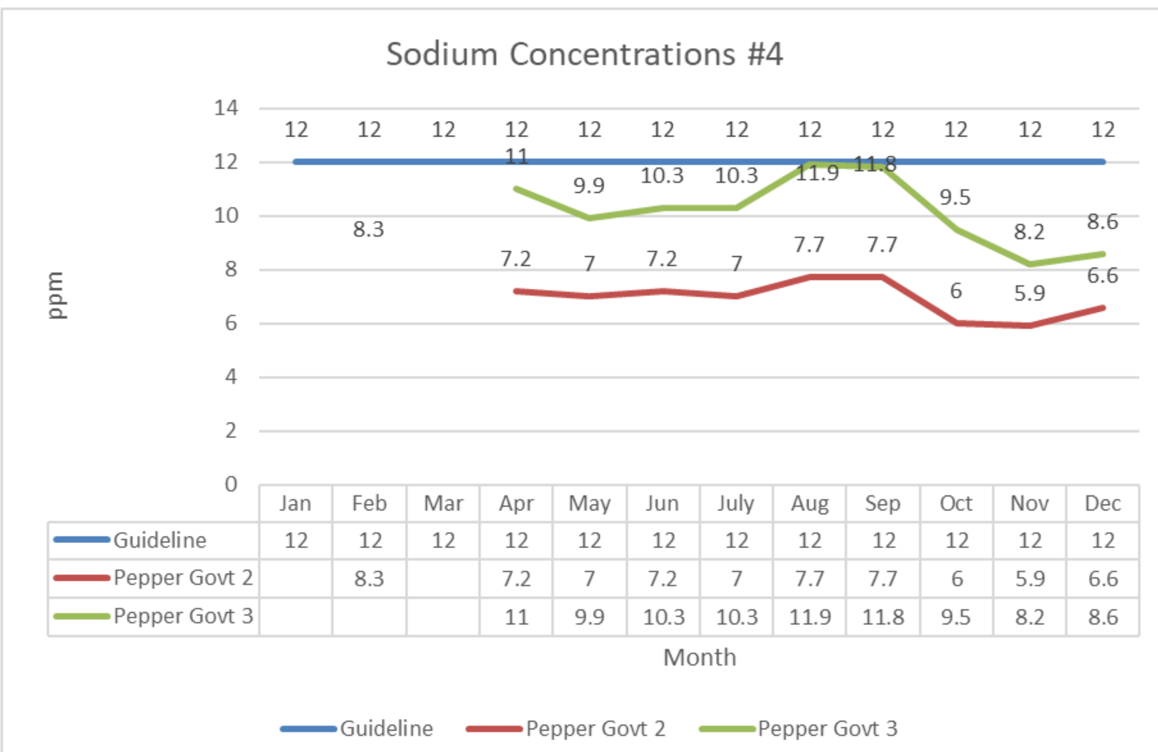


Figure 5-24: Sodium Concentrations for wells: Braes River & Penny Cooke Well



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Guideline	12	12	12	12	12	12	12	12	12	12	12	12
Mt. De Las Uvas		5.8		5.2	1.9	5.3	5.3	4.7	4.8	2.8	2.9	3.7
Pepper Govt 1		7.3		7.9	7.5	7.4	7.4	7.7	7.7	6.1	6.2	7.3

Figure 5-25: Sodium Concentrations for wells: Mt. De Las Uvas and Pepper Government 1



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Guideline	12	12	12	12	12	12	12	12	12	12	12	12
Pepper Govt 2		8.3		7.2	7	7.2	7	7.7	7.7	6	5.9	6.6
Pepper Govt 3				11	9.9	10.3	10.3	11.9	11.8	9.5	8.2	8.6

Figure 5-26: Sodium Concentrations for Stations: Pepper Government 2 and 3

From the graphs it can be seen that the water quality results to date reflect a maximum of 24 ppm. This shows that for some wells the sodium concentration is above the Draft Jamaica National Ambient Water Quality Standard (Freshwater), 2009 recommendation upper limit for sodium of 12 mg/L.

5.1.5 Noise Baseline Measurements

Methodology

Spot measurements for noise levels were conducted to ascertain low-level and high-level readings. A calibrated noise meter was used to measure the sound levels at five (5) areas within the boundary of SEPL 541 as shown below:

1. Goshen
2. Lower Northampton
3. Northampton
4. Mitcham
5. Santa Cruz

The averages over each measurement period were assessed against the Jamaica National Noise Standard (JNNS) limit of 55 dBA. These are shown in the table below. The following conclusions can be made

- Average noise readings ranged from 37.1 dBA to 61.4 dBA.
- There was one set of readings at Northampton which exceeded the standard of 55 dBA due to traffic.
- None of the areas showed exceedances of the standard limit of 55 dBA.

Table 5-10: Baseline Noise Levels

Location	Average Background (dBA)	Average Low-Level dBA)	Average High-Level (dBA)	Coordinates
Goshen	41.7	41.4	50.8	18 02' 15N 077 38'24W
Lower Northampton	40.6	40.8	46.8	18 02'08N 077 40'40W
Northampton	46.5	45.1	61.4	18 02 03N 077 40'27W
Mitcham	38.4	37.3	47.3	18 04'08N 077 36'50W
Santa Cruz	43.2	41.8	48.8	18 02'46N 077 41'30W

5.2 Ecological Services

Climate change, coupled with other stressors, is affecting the ability of many

Ecosystem services are commonly defined as the benefits people obtain from nature. The *Millennium Ecosystem Assessment,* a United Nations report describing the condition and trends of the world's ecosystems, categorizes ecosystem services as:

Provisioning Services such as food, clean water, fuel, timber, and other goods;

Regulating Services such as climate, water, and disease regulation as well as pollination;

Supporting Services such as soil formation and nutrient cycling; and

Cultural Services such as educational, aesthetic, and cultural heritage values, recreation, and tourism.

1. **Food:** Most of the agriculture occurs on the flat lands between the limestone hills. These are the areas likely to be mined leading to displacement of farmers. The displacement of farmers will lead to less food being available in the short term. Some farmers will move to less favourable areas and this will reduce the impact; however, this might result in some level of deforestation. Presently as much of the farming is carried out in areas which had previously been mined, once properly restored agriculture can resume.
2. **Fuel and Fiber**: A significant amount of charcoal is produced. A favourite tree for charcoal burning is logwood. Logwood is a relatively aggressive plant and is the dominant tree in disturbed areas. It is expected therefore, that much of the areas left unattended after restoration will eventually be occupied by logwood, providing a resource for charcoal burning.
3. **Clean Air**: If vegetation is restored this ecological service will continue. It should be noted that forests contribute significantly more than pastures to clean air, consequently until the forests return the contribution to this service will be reduced. Many times, restored lands are used for other aspects of human development, hence the balance of subsequent land usage is crucial.
4. **Filter Water Supplies:** Forests provide much more filtering than pastures. Restoration of the mined areas might not necessarily lead to development of forests, and therefore, there will be reduction of this ecological service.

   There are areas of temporary wetlands. These however, are heavily impacted by the residents and often used for agriculture. If these are mined it is likely that they will not be returned to wetlands.

5. **Control Floods**: This area is part of the St Elizabeth plains and might be susceptible to flooding. Forests are more important in flood control. The percentage of the restored lands returned to forests is crucial here.
6. **Erosion**: There is evidence that areas cleared of vegetation are susceptible to erosion. Proper restoration is crucial to reduce erosion.
7. **Soil formation**: Mining remove will remove the agents of soil formation. This is a very slow process and will take decades for these to be fully restored.
8. **Sustain Biodiversity and Genetic Resources**. Much of the landscape is highly disturbed and occupied by pioneering species. Such vegetation is likely return after restoration. Much of the fauna is highly mobile and will also return. However, groups such as land snails disperse very slowly and their diversity is likely to be highly impacted.
   Restoration of an Ecosystem goes through several stages terminating in climax community. While very few communities which might be categorised as climax was encountered, the Disturbed Broad Leaf Forests were the most mature and these were limited to the limestone hills Don Figuerero Mountain. These which will not be mined. Any removal of such forest will result in loss of diverse communities for the foreseeable future as it takes decades, perhaps centuries, to redevelop. However, no bauxite deposits occur on this limestone hill.
9. **Recreation**: The area is used for bird shooting: bird shooters prefer a mixture of forested and open lands. Restored lands provide this type of habitat. There is also a limited amount of pond fishing, however, most of the ponds are man-made, even resulting from previous mining activities.
10. **Carbon control**: Sequestering and or releasing carbon is a form of climate regulation. While both forests and pastures sequester carbon, the former plays a much more important role. Most of the forests here are the result of natural succession on abandoned lands. If lands are restored this function will resume.
11. **Pollination and Dispersal**: These services are crucial to the agriculture sector and general maintenance of biodiversity. Most pollination is carried out by generalist such as bees and flies. However, there are some specific plant/pollinator relationships which will be disrupted.
12. **Pest control**: The natural habitats provide a reservoir of biological control agents. mining removes these agents. and their return will depend on the nature of the restoration program.

5.3 NATURAL HAZARDS

5.3.1 Hurricane

Jamaica experiences regular hurricanes during the annual hurricane season between June 1 and November 30, as the island has 1,022 Km (635 miles) of coastline and is located within the hurricane belt. Due to the geography and geology, the island also suffers from frequent landslides, flooding, earthquakes and occasional droughts. For Jamaica, debris and sediment flows represent a more destructive and common flooding, causing more deaths and injury than water floods. Recurrent floods affect communities across the island, with the most recent destructive floods occurring in August 2021 from Tropical Storm Grace, the impact of which has not been quantified. Table 5.11 shows some of the most destructive Tropical Cyclones which have affected Jamaica in the past.

Table 5-11: Most Destructive Tropical Cyclones Affecting Jamaica (Cost & Fatalities - Caribbean Statistics)

Event	Year	Category	Cost USD	Fatalities
Hurricane Allen	1980	5	2.57 bill	296
Hurricane Gilbert	1988	5	2.98 bill	318
Hurricane Michelle	2001	4	2.43 bill	17
Hurricane Charley	2004	4	16.9 mill	15
Hurricane Ivan	2004	5	26 bill	92
Hurricane Dennis	2005	4	290 mill	5
Hurricane Emily	2005	5	1.01 bill	17
Hurricane Wilma	2005	5	27.4 bill	52
Hurricane Dean	2007	5	1.66 bill	40
Tropical Storm Gustav	2008	n/a	8.3 bill	112
Hurricane Sandy	2012	3	68.7 bill	233
Hurricane Matthew	2016	5	16.4 bill	564

Fortunately, the national and regional weather services have linked together and afforded improved forecasts and extensive preparedness that help to protect lives and property. Named agencies include: National Oceanic and Atmospheric Administration (NOAA), National Hurricane Center (NHC), Caribbean Disaster Emergency Management Agency (CDEMA) and Jamaica's own Meteorological Service and Office of Disaster Preparedness and Management (ODPEM).

The third National Climate Assessment Reports indicates that 'the intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of the strongest hurricanes, have all increased since the early 1980s' this is attributed to climate change. Hurricane intensity and rainfall are projected to increase as the climate continues to warm. The data supports these conclusions.

Hurricanes are a reality and their destruction is evidenced so planning for disaster risk reduction is absolutely essential to the mining project. Alpart plans for disasters and hurricanes and has established response procedures in mining, and particularly in the plains of St Elizabeth, it is predicted that extreme weather incidents could result in: severe human impact; inland flooding of pits and haul roads; extremely muddy conditions for operation; downed power and communication lines; dangerous road conditions; disruption of operations for trucking and for cable belt transfer; severe disruption of communities among others.

The reduction in the risk of disaster from a direct hurricane encounter or side-effects from a regional storm will be incorporated into the planning and construction phase of the project to mine in Outer Valley section of SEPL 541. The Hurricane Preparedness Plan will incorporate specifics for mitigation of disaster and post-disaster actions in the SEPL zone.

- Haul roads and mining pits will be designed to incorporate proper drainage
- Haul road drainage system will be directed away from communities
- Mining will be suspended during extremely muddy conditions and surface mud removed for drying
- Safety in transportation and for citizens will be of high priority.

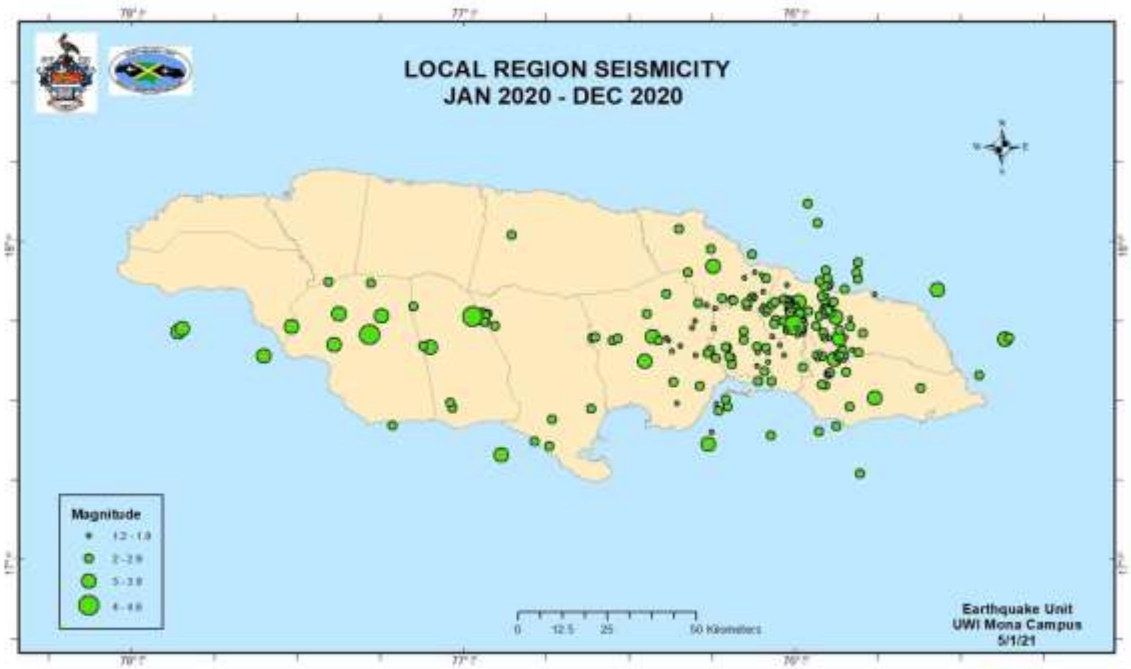
5.3.2 Earthquake

Jamaica is located in a geologically active area, and is therefore subject to earthquakes (as well hurricanes). Jamaica is located along the "northern margin of the Caribbean Plate" and the presence of very active faults on the island makes Jamaica very vulnerable to earthquakes. The erratic nature of earthquakes means that they strike without warning, ranging in intensity from "slight tremors to great shocks, and may last from a few seconds to as long as five minutes". Shocks could even come in series over a period of several day

While an earthquake has not occurred in nearly a century, the island is still highly prone to seismic activity, especially since the last occurrence in 1907 was the most devastating natural disaster in the island's history.

The map shows the earthquake activity for the year 2020. From the legend the size of the circles increases with increasing magnitude. The denser the cluster of earthquakes (circles) the higher the seismicity. As expected, the east shows a lot of activity particularly the Blue Mountain region.

Figure 5-27: Local Seismicity



Source, The Earthquake Unit, The University of The West Indies, Mona

Jamaica's vulnerability to earthquakes will mean that by extension the proposed mining activity has a significant risk of being affected by earthquakes or at least earth tremors. The protection of personnel and equipment is vital and will be covered by the JISCO Alpart Earthquake Policy which is approved by the Office of Disaster Preparedness.

5.3.3 Drought

Drought can be defined as a moisture deficiency that has serious adverse effects on a community usually by reducing food production or surface water supplies.

The long-term mean annual rainfall of Jamaica shows a pattern of two distinct wet months, October and May. The drier months are January, February, March and July. Of notable significance, is that this pattern can vary annually. It is recognized that human activity could influence the global climate system through global warming and this could alter the rainfall patterns of tropical countries like Jamaica.

Jamaica is particularly vulnerable to the drought hazard because of the following reasons:

- As a developing country, Jamaica is particularly vulnerable to drought as we rely heavily on agriculture.
- Jamaica lies within the tropics and so we are dependent on more than one rainy season. A deficiency in any one season can produce a damaging drought.
- The increase in Jamaica's population due to urbanization, has led to a great increased demand for an already limited supply of water.
- Limited/poor national water storage systems.

Periods of drought will affect the project by increasing challenges to dust control due to dry and windy conditions. Dust control is usually done by wetting the area, erection of wind walls and covering areas such as stockpiles.

5.3.4 Landslides and Flooding

Landslides in Jamaica occur for a variety of reasons. They often occur as a result of natural phenomena, but human activity can also be a factor. The project area is generally flat and as such is not considered to be susceptible to landslide activities due to naturally occurring phenomenon. However, during mining operations pits will be created and these will give rise to potential landslides from human activities.

During mining, the necessary precaution and mitigation must be employed to negate the risk of landslides in the pits.

5.4 BIOLOGICAL ENVIRONMENT

5.4.1 Introduction

This biological assessment was conducted as a part of the Environmental Impact Assessment (EIA), for the proposed mining of the southern and western area of Special Exclusive Prospecting License (SEPL) 541 designated as "Outer Valley".

The study concentrated on the following taxonomic groups: plant (trees, shrubs, grasses, orchids, bromeliads, etc.), avifauna, mammalian fauna, herpetofauna, arthropods (> 3 mm in size) and molluscs. We are cognisant that some taxonomic groups were not sampled or were under sampled. This is a result of the reality that the resources and timeframe necessary to conduct such studies are not available.

Species lists were generated for each taxonomic group and relative abundance is presented using the DAFOR ranking. Emphasis was placed on any species that have any special conservation status, i.e., listed on the IUCN Red List. Attention was paid to the presence of taxonomic groups that are indicators of environmental conditions. The presence of invasive alien species (IAS) was also documented. Ecological relationships were recorded in some cases, but this was limited by time constraints.

The area includes several habitat types. The habitat classification adopted here was that of the Forestry Department of Jamaica classification of land use (2010). The diversity of the faunal and floral groups was studied in each habitat type. Work was also conducted on special areas such as caves and rock faces. The assessment was conducted in different phases to capture the diversity associated with major seasons in Jamaica: dry and wet seasons; and "winter and summer".

Different types of anthropogenic and natural threats to the environment were assessed. These threats included deforestation (resulting from harvesting of timber, charcoal production; the expansion of agricultural lands), invasive alien species, soil erosion due to unsustainable farming practices.

5.4.2 Methodology

The study was conducted between early January to September 2021. In Jamaica, changes in biodiversity are generally related to two types of seasonal changes; rainfall, and the winter/summer in the temperate zones. Significant changes have been documented in some habitats in relation to wet and dry season. The period studied here includes the dry season around February as well as what is termed the secondary wet seasons of May-June. Additionally, much of the biodiversity associated with the primary wet season, September to December is generally still around in January. It is well established that the avian fauna changes significantly during the northern temperate winters and summer, resulting in groups of birds termed "winter migrants" and "summer migrants". The time period during which this study was conducted captured both the winter and summer migrants.

There are limitations in classifying some specimens to the level of species and sometimes even to genus and family. Some groups of Jamaican fauna, and flora to a lesser extent, remains vastly unknown and cannot be classified beyond the level of family at this time. Secondly, most of the Jamaican materials are held in museums in Europe and North America and are not readily accessible for use in classification. The terrestrial invertebrates in particular are poorly studied. Classification was carried out using available literature (see Bibliography), the collections at the Department of Life Sciences, University of the West Indies, and the Natural History Museum of Jamaica. Species that were not fully classified are listed as “Unknown” (Uk).

5.4.2.1 Selection of Sample Sites

The project area was zoned according to the Forestry Department of Jamaica classification of land use (2010). A desktop assessment was carried out with the use of ArcGIS. The land use habitat types identified were as follows:

- **Built area**: buildings and other constructed features such as airstrips, roads, bridges etc.
- **Fields: Herbaceous crops etc.**: herbaceous crops, fallow, cultivated grass/legumes
- **Secondary forest and fields**: broadleaf forest equal or greater than 75% with disturbance levels between 10 - 25%. This level of disturbance distinguishes it from disturbed broad leaf forest.
- **Fields and secondary forest:** >50% Fields, >25% Secondary Forest
- **Disturbed Broadleaf Forest**: forest with broadleaf trees at least 5 m tall and species-indicators of disturbance such as *Cecropia peltata* (trumpet tree). This category has less than 15% disturbance.

Study sites were selected, based on stratified sampling, to include all the existing land use habitat types. The desktop survey was followed by ground truthing verification, which allowed for fine-tuning of the final methods of assessment to be utilized for the different groups of fauna and flora. Eleven sample sites were established (Figure 5-28).

Additionally, the project areas between the selected sites were traversed using the existing road network. Sites of special interest were selected and sampled. Emphasis was placed on the areas along the path of the proposed haulage road. Data were also collected in selected areas such as caves, rock faces or other areas deemed of special importance.

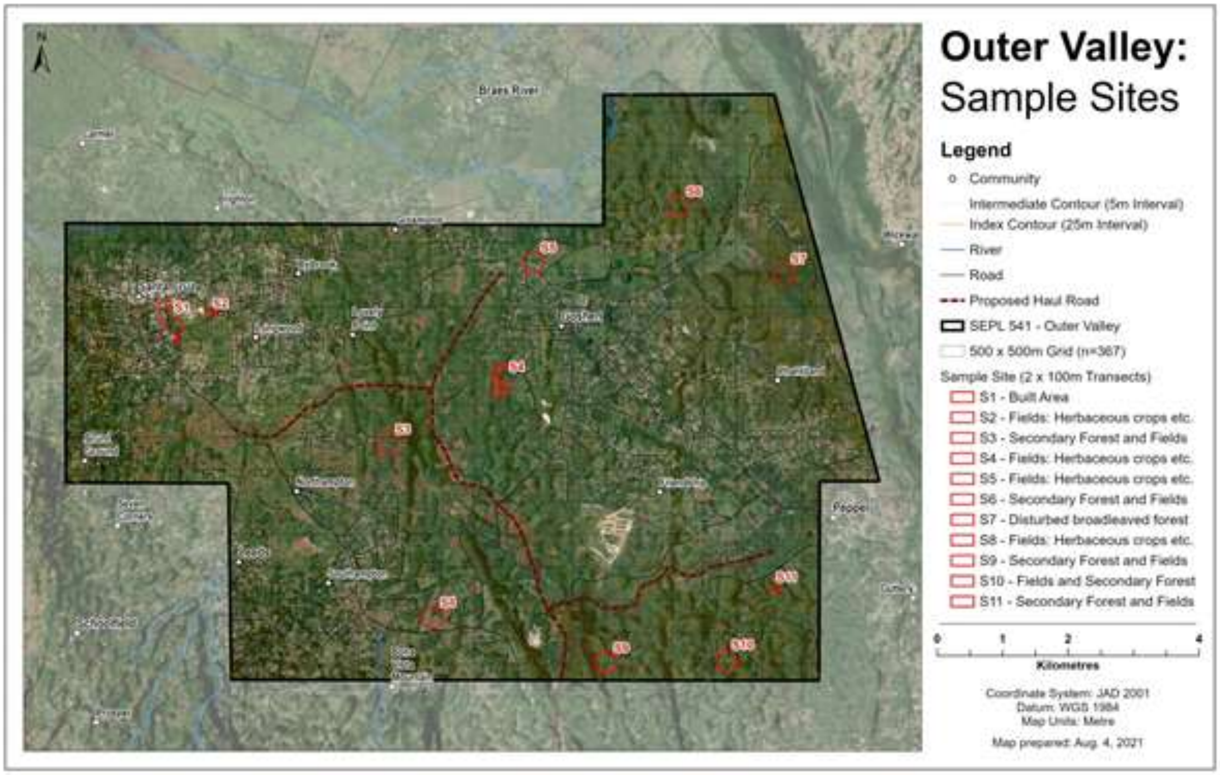


Figure 5-28: Main sample sites for the biodiversity assessment of SELP 541

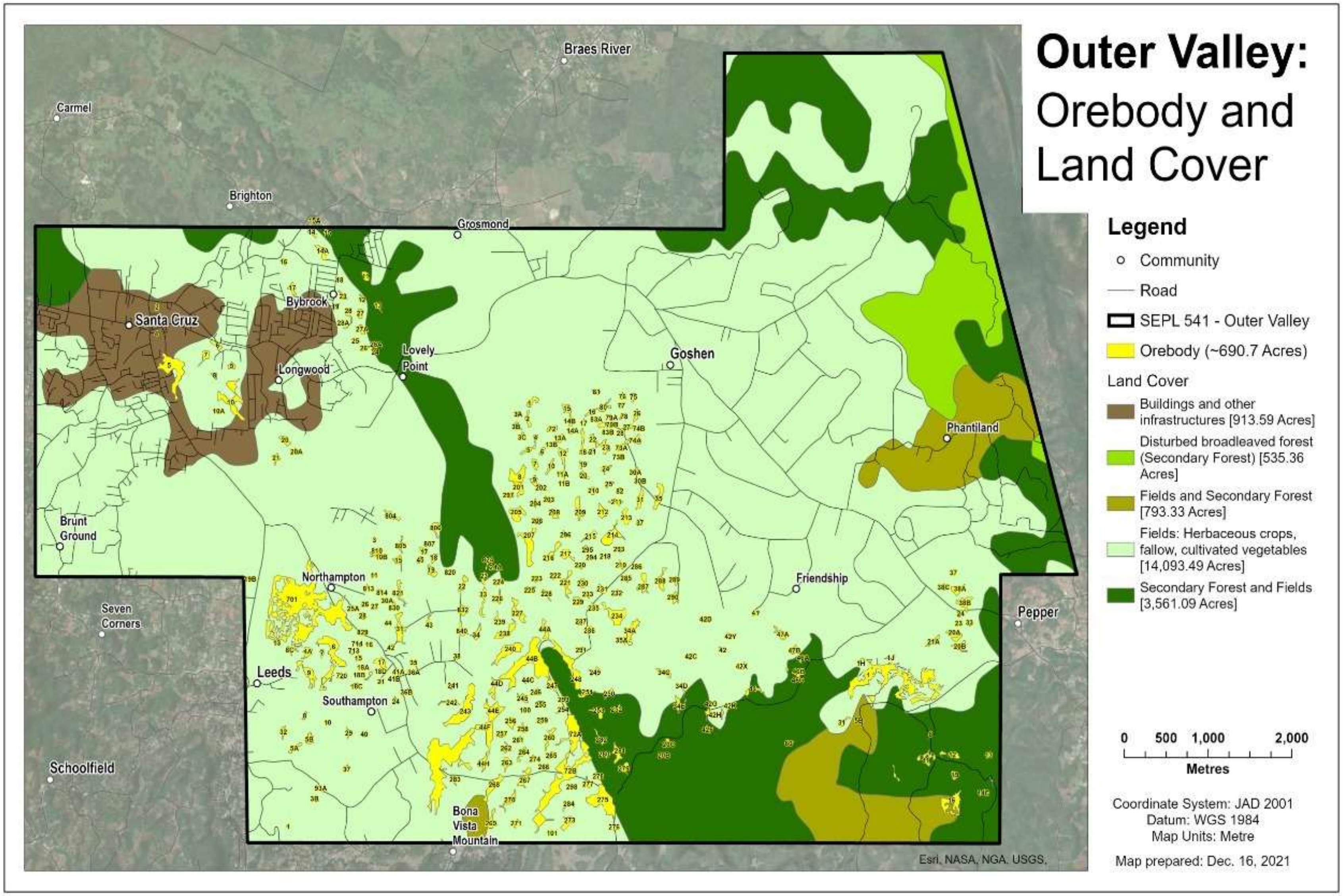


Figure 5-29:Distribution of Orebodies and Land Cover (Vegetation Type)

5.4.2.2 Assessment of the Flora

The floral assessment consisted of, but not limited to, the following activities:

- Based on the desktop and ground-truthing exercises, 22 sample points within the 11 sample sites (2 sample points within each sample site) were randomly selected. A belt transects 500 m2 (100 X 5 m) was established from each point as follows: GPS coordinates were generated for each sample point to be used as the starting point for each transect. A random azimuth (compass) bearing was generated, which dictated the direction of the transect. These points were then uploaded to a GPS handheld device, that was used in the field to navigate to these points for the setting up of the transects (Figure 5-30).
- Transects were at least 200 m apart.
- Vegetation data collected include:
  - ❖ identification of all plant species (trees, shrubs, grasses, orchids, bromeliads, etc.);
  - ❖ a detailed species list;
  - ❖ the diameter at breast height (DBH) of selected trees to assess the dominant DBH classes within each land use type
- In addition, a series of walk-throughs were carried out within the boundaries of the development site; any vegetation encountered that was not observed within the transects was also recorded.
- Plants were identified in the field where possible. In other cases, vouchered specimens were collected and identification carried out using available literature, such as Adams (1972), and the herbarium at the Department of Life Sciences, UWI Mona Campus.
- The DAFOR (D = Dominant; A = Abundant, F = Frequent, O = Occasional, R = Rare) scale of the abundance of plant species was employed to rank the relative abundance of the species.

Figure 5-30: The flora assessment team establishing a transect within a study site classified as Secondary Forest and Fields.

5.4.2.3 Assessment of the Fauna

Taxonomic groups studied are avifauna, mammalian fauna, herpetofauna, arthropods and molluscs. The methods utilized for the different animal groups are described below. Additionally, general walkthrough of the area was carried out and any species encountered were recorded. Discussions were also held with local people about species they had encountered.

5.4.2.4 Herpetofauna Survey

<u>Day survey</u>

The amphibian and reptile assessments included searching trees (including under bark), stone piles, bromeliads, small water bodies, and miscellaneous debris.

Specimens were generally identified in the field and pictures were taken for further study if necessary. It was necessary to capture some specimens for closer examination (Figure 5-31); these were placed in glass bottles or catchment containers but were subsequently returned to the habitat. Herpetofauna which could not be identified in the field, were identified using available literature including Caribherp (2015) and Schwartz & Henderson (1991).

Figure 5-31: Examination of a lizard collected in the field

<u>Night survey</u>

Night surveys were also carried out in selected areas, primarily to identify the frogs as these were very vocal at night. AudioMoth1.0.0 acoustic devices were also used to document the vocalization of these species.

Figure 5-32: AudioMoth were deployed in areas such as "cow throughs" and a rock hole

5.4.2.5 Bat Survey

5.4.2.5.1 Examination of Possible Roosting Sites in the Day

Possible bat roosts, caves, rock holes, man-made structures or trees were examined, both day and night. Caves and rock holes, referred to as "bat holes", were identified using available literature as well as from discussions with the local people.

5.4.2.6 Acoustic survey

The AudioMoth 1.0.0 acoustic recorder was used to survey the bats. It records calls of vocal vertebrates in their immediate surrounding area ≈10 m of the device.

Each AudioMoth device was programmed as follows: start and end time 18:00:00 - 24:00:00; sample rate 384 kHz; medium gain; recording intervals of 10 seconds with 30 seconds sleep duration. These were deployed for at least seven nights at selected sites.

Because the effective range of the AudioMoth was limited to 10 m, it was important that locations at which the devices were deployed were strategically selected. Water sources in this dry landscape are limited and they provide not just drinking sites, but possible feeding sites for bats which feed on fishes or aquatic insects. Devices were deployed in the vicinity of ponds (natural and artificial) and livestock watering troughs. Other sites targeted include likely foraging sites such as open fields, as well as entrances to possible roosting sites (Figure 5-32).

An Anabat Walkabout™ acoustic detector was used to record bat activity while walking along line transects. The Anabat Walkabout detector was configured to record audio files automatically, once the device is triggered by a frequency as low as 8 kHz. The study was carried out from 7:00 pm to 9:30 pm.

Figure 5-33: AudioMoth device deployed in the field. Right: AnaBat Walkabout devise in use

5.4.2.7 Survey of other Mammals

Sites generally associated with coney were examined for traces of coney activity. The coney sometimes leaves traces such as nibbling on small shrubs, droppings and white slime on the substrate (Figure 5-34).

Figure 5-34: Traces which might be used to detect the presence of the Jamaican coney. Left: faecal dropping. Right: white slime on the substrate.

Browning Trail Pro Trail Cameras (Figure 5-35) were deployed at selected sample sites where it was likely to detect a Jamaica Cony; these included possible dens (rock holes, cave mouth). Five cameras were deployed for a minimum 7 of days and they were programmed to record a 5-second video when triggered.

Figure 5-35: Browning Trail Camera in a security box

5.4.2.8 Avifauna Survey

The avifauna survey entailed point counts. At each sample site, four survey points at least 150 m apart were used for the point counts; each count was over an eight-minute period.

Nocturnal birds were documented by sighting as well by the use of by the Anabat Walkabout™ during walk through between 7:00 and 9:30 pm.

5.4.2.9 Analysis of data from AudioMoth™ and Anabat Walkabout™

5.4.2.9.1 Bats

The Kaleidoscope Pro software was used in the sorting and identification of the bat species. This software is embedded with baseline acoustic sound signatures for most species of bats found in Jamaica. The results were then manually validated by viewing spectrograms and listening to the audio.

5.4.2.9.2 Herps and Birds

The Kaleidoscope Pro analysis software was used to analyse audio files. Cluster analysis was used to scan and cluster similar calls. The results are then manually validated by viewing spectrograms and listening to the audio. Reference material for manual identification includes Herps (Caribherp 2021); and Merlin Bird App (Cornell University 2021).

5.4.2.10 Invertebrate Survey

Invertebrate assessments focused on insects, myriapods, spiders, and land snails. Below are details of specific methodologies that were used.

Day survey

At each site, three researchers conducted studies for at least 6 hours, in both the dry and wet seasons. The time spent using each of the different methods was adjusted depending on the habitats. Similarly, the methods utilized during the walk-throughs and drive-throughs were chosen base on the habitats encountered.

Terrestrial Arthropods

- **Direct counts** were made while walking through the study sites and along transects. All invertebrates seen on vegetation, flying or on the ground were recorded. Where immediate identification was not possible, the specimens were collected or photographed for further study. This method is effective for groups such as butterflies, lager insects and spiders which are distinct enough to be identified, by an expert, in the field.
- **Flight nets** were used to collect insects in flight. Some insects were identified in the field, while others were taken back to the laboratory for further study.
- **Direct search** of vegetation was conducted to uncover inactive and cryptic species. (Figure 5-37)
- **Sweep nets** were used to collect specimens from vegetation where possible (5-36**Error! Reference source not found.**). This method is particularly useful in the general collection of cryptic and less active species.
- **Soil dwelling** arthropods in leaf litter, soil, rotting logs and under stones were collected using large forceps. Soil samples were also taken back to the laboratory for detailed study by sorting or by using Berlese funnels.
- **Van Someren- Rydon (VSR) traps** were also used to collect certain flying insects. The baits utilized, rotting meat and rotting fruits, are particularly attractive to flies (Dipterans) but other insects were also trapped (Figure 5-38)

Figure 5-36: Sweep nets were used to collect specimens from vegetation

<u>Land snails</u>

Shells of snails remain long after the death of the snail and so represent a good record of the snail diversity in an area. Live snails hide away during the day and are notoriously difficult to find, consequently emphasis was placed on the collection of the shells.

- Sample plots, 10 X 10 m, were searched for one to two person-hours, depending on the terrain. Hand search of the soil surface as well as hiding places including rotting and fallen logs, rock crevices, beneath or at the base of large loose rocks, leaf litter and tree trunks and leaves was conducted (Figure 5-39).
- Samples were collected during walk-though of the vegetation or while walking along existing paths. Hiding places (see above) were targeted and soil samples from the base of hillsides and trees where shells accumulate were taken back to the laboratory for analysis.

Figure 5-37 Direct search – many arthropods hide in various parts of the vegetation such as leaves and, crevices such under bark

Figure 5-38 Van Someren- Rydon (VSR) trap deployed in the forest. Traps were baited with rotting meat and rotting fruits

Figure 5-39 Collecting land snails samples; shells generally accumulate at the base of rocks. Soil samples were collected and sorted in the laboratory

__Night survey__

Light trapping:

Nocturnal insects were collected using light traps. The light traps used were modified Robinson's light traps, fitted with 175-watt Mercury Vapour Collecting (Figure 5-40). Light bulbs, powered by portable generators. Mercury vapour collecting lights have a wide colour band including the ultra violet spectrum, and collect a higher abundance and greater variety of insects than other standard methods (Muirhead-Thomson 1991). The traps were fitted on 22 litre buckets for portability and crushed newspaper was placed in the buckets to provide hiding/resting places for the insects and so reduce the chance of insects escaping. Collecting began at dusk, approximately 6.00 pm and continued until 5.00 am. Specimens were removed from the traps every three hours. The vegetation and substratum around the traps were searched for insects that are attracted but avoid intense light at the bulb and so did not get trapped.

Land snails

Live snails are generally active at nights. Hence some species which might have been missed by the day-search were recorded at night.

Figure 5-40; Modified Robinson's light trap, fitted with a 175-watt Mercury Vapour collecting light bulb and a funnel with baffles

Aquatic fauna

Aquatic fauna was collected mainly with the use of dip nets. In one case local individuals caught fishes using spear guns.

5.4.2.11 Other Activities

Any anthropogenic or natural threats observed were recorded. These threats included but were not limited to: invasive alien species (IAS), deforestation for timber and charcoal production, expansion of agricultural lands, soil erosion due to unsustainable farming practices as well housing and related human activities.

Special emphasis was placed on the identification of fauna and/or flora suitable for use as bioindicators of environmental health. If such potential bioindicators were identified, protocols which may be used in monitoring the environmental health in, and around the mining sites, were developed.

5.4.3 Results/Discussion

5.4.3.1 Flora Assessment

The main vegetation type observed throughout the assessment are fields: herbaceous crops, followed by modified (disturbed) dry limestone forest. The area assessed during the survey appears to have been significantly disturbed by anthropogenic factors over the years, with signs that significant clearance of the original vegetation had occurred. The vegetation found within the proposed mining areas are typically associated with early stages of ecological succession. A few species for example Spanish elm (*Cordia gerascanthus*) and breadnut (*Brosimum alicastrum*) associated with seral (intermediate) succession were found.

The project site displayed relatively high species diversity, with a total of 194 plant species from 67 families. Most of the plants encountered were trees and shrubs; a few climbers, grasses and epiphytes were also observed.

The majority of the trees encountered were seedlings or saplings; however, there was also a considerable number of mature trees (larger DBH classes: >35 cm DBH) scattered across the project area. The mature trees include breadnut (*Brosimum alicastrum*), red birch (*Bursera simaruba*), mango (*Mangifera indica*) and Spanish elm (*Cordia gerascanthus*).

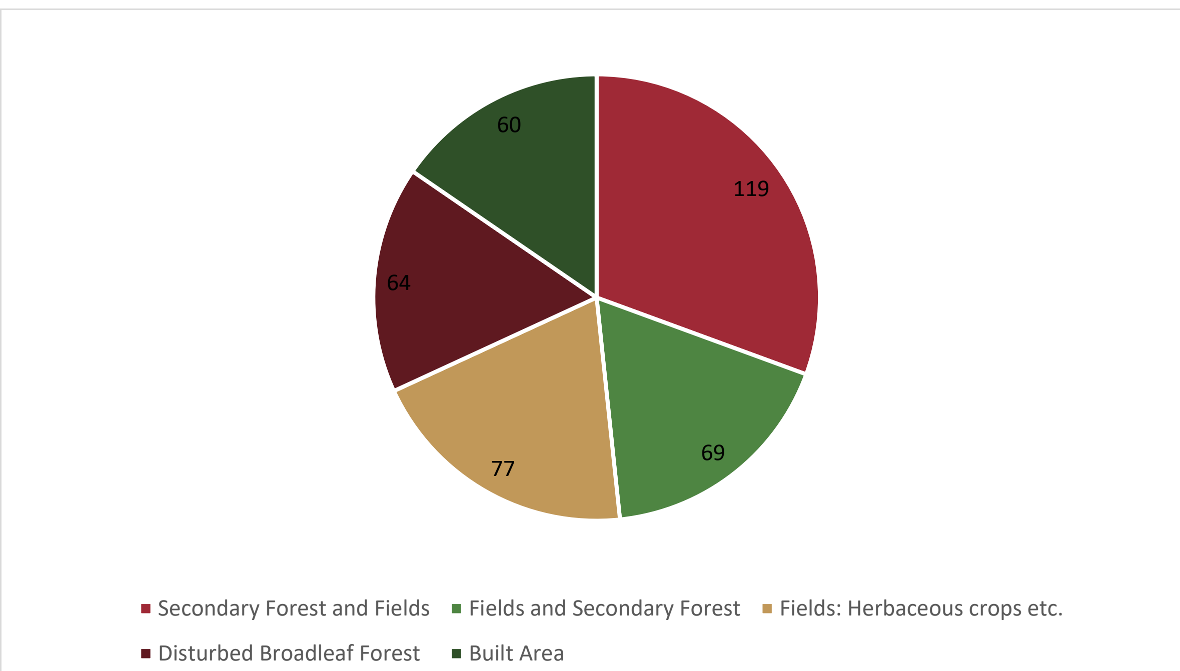


Figure 5-41 Number of plant species observed within each land use category

The land use category with the highest species diversity was Secondary Forest and Fields with 119 species, while the least number of was observed in the Disturbed Broadleaf Forest with 64 species and Built areas with 60 species recorded (Figure 5-41). This observation is not unexpected as the areas classified as Secondary Forest and Fields are highly disturbed and would have an abundance of non-native plants, as well as representatives from the natural vegetation of the area

Several of the species encountered are classified as being most commonly found in thickets and wastelands. Species such as red bead (*Adenanthera pavonina*) are more commonly found in secondary woodlands. Of the 194 plant species 30 endemics were noted (Figure 5-42). God okra (*Hylocereus triangularis*), *Coccoloba longifolia*, mountain grape (*Coccoloba plumieri*) and silver thatch (*Coccothrinax jamaicensis*) are a few examples of the endemic plants observed. The highest endemism was observed in Secondary Forest and Fields (20 species) followed by Disturbed Broadleaf Forest (11). The lowest endemism was in the Fields and Herbaceous Crops and Built Area, both recording 3 endemic species.

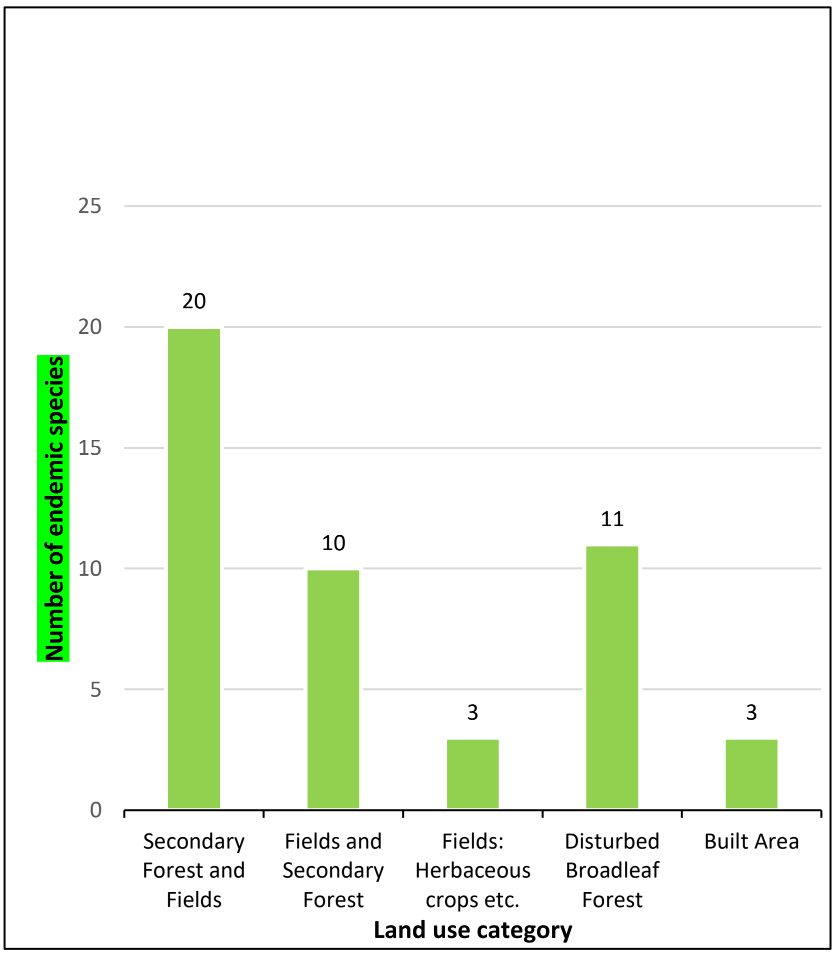


Figure 5-42 Number of endemic plant species observed within each land use category

Figure 5-43 Top: Areas classified as Fields: Herbaceous Crops Etc., that has been abandoned and under fallow. Below: Disturbed Broadleaf Forest.

The presence of certain species such as trumpet tree (*Cecropia peltata*), breadfruit (*Artocarpus altilis*) and pimento (*Pimenta dioica*) is also an indicator of the heavy influence of anthropogenic disturbances on the vegetation, as these are species associated with human disturbance and the proximity of human settlement. Most of the species encountered are classified as locally common according to Adams (1972).

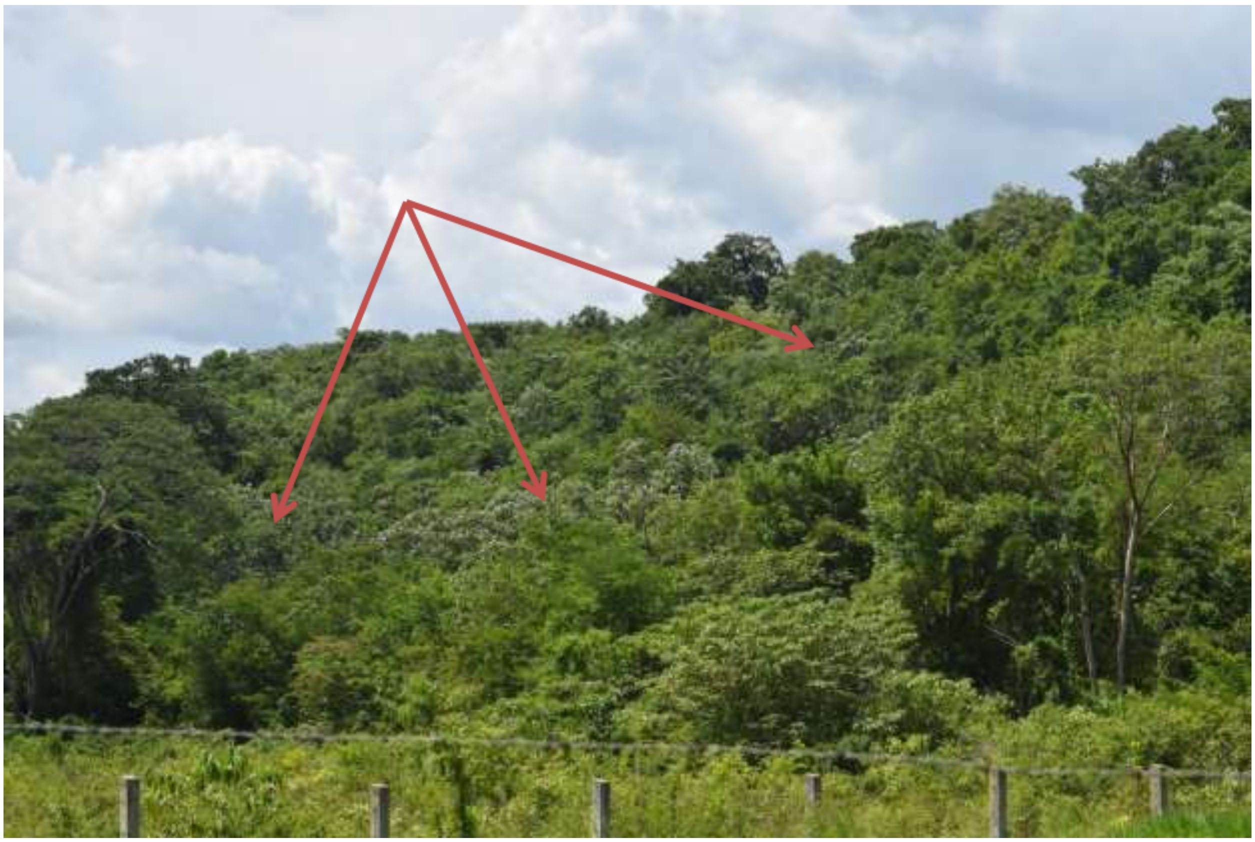


Figure 5-44:Cecropia peltata (white leaves, arrows) an indicator species of previous extensive human disturbances

A total of 5 invasive plant species were encountered, these were: Logwood (*Haematoxylum campechianum*) which was commonly found across all land use categories; Red Bead (*Aenanthera pavonia*), Common Bamboo (*Bambusa vulgaris*), African Tulip (*Spathodea campanulate*) and Lead Tree (*Leucaena leucocephala*); all of which were widespread across most of the land use categories.

A few rare plant species were observed such as the endemic *Casasia longipes*. None of the species encountered is deemed to have any special conservation status.

5.4.3.2 Herpetological Survey

5.4.3.2.1 General Trend

The reptilian fauna identified consisted of 11 lizards, 4 snakes and 1 freshwater turtle (Appendix 13.2). There were 9 endemic lizards: 7 tree lizards, 1 gecko and 1 galliwasp. Two species of lizards were introduced; these were *Hemidactylus mabouia* and *Anolis sagrei*.

The Southern Jamaica Banded Geckolet (*Sphaerodactylus parkeri*) which is listed as Endangered on the IUCN Red List was observed in Herbaceous Field. The species has been reported along the South Coast of Jamaica (Caribherp 2021).

Two species of snakes were observed, these were the Jamaican Blind snake and Jamaican Red Ground snake (Figure 5-45). Two other species of snakes were not observed but reported by the people in the area; these were the Yellow snake, *Chilabothrus subflavus* which is listed as Vulnerable by the IUCN and the Thunder snake *Tropidophis jamaicensis* which were only reported from the Disturbed Broadleaf Forest.

Seven species of amphibians were detected; three were endemic (Appendix 13.7). All the other species were introduced to Jamaica. The low number of native amphibians observed could be due to the limitation in the availability of microhabitats such as tank bromeliads and areas with high moisture. The introduced *Eleutherodactylus johnstonei* (Figure 5-46) and *Eleutherodactylus planirostris* were present throughout the different habitat types. *Eleutherodactylus johnstonei* was the most abundant amphibian in the study area.

Figure 5-45: Jamaica Red Ground Snake

Figure 5-46: Eleutherodactylus johnstonei

The introduced American Bullfrog occurred in most ponds of the within the Herbaceous Fields. They were also reported in the river in the project area by the local fishermen. The residents stated that the mongoose prey on these frogs in the ponds.

5.4.3.2.2 Special Conservation Status

A species of interest, the Southern Jamaica Banded *Geckolet* which is listed as Endangered by the IUCN, was observed in the habitat type Herbaceous Field

The Yellow Snake which is listed as Vulnerable was only in the Disturbed broadleaf forest type.

The Introduced American Bullfrog was encountered in a few of the water bodies within the study area.

5.4.3.3 Mammalian Survey

5.4.3.3.1 Bat Survey

Thirteen species of bats were detected (Appendix 13.8), three of these were endemic. The trophic guilds were: frugivore (2), piscivore (1), and insectivore (8) and nectarivore (2).

The piscivore bat *Noctilio leporinus* was detected around ponds located in the habitat type Fields: Herbaceous Crops. These ponds are regularly found in pastures where they provide water for livestock. Freshwater fish are present in some ponds, and the fish-eating bats could be foraging for fish and freshwater insects.

Artibeus jamaicensis, one of the two known frugivores in Jamaica, was observed roosting in an old underground drain that runs under Santa Cruz (Figure 5-47). Only a few were observed in the field, although several chewed-up almonds were observed. The Jamaican fruit-eating bat emits 3 low-intensity FM pulses when flying and perching and is considered a whisper bat, which is very challenging for most recorders (Ortega and Castro-Arellano 2001). Additionally, they use sight and not echolocation to find food which makes detection challenging.

Four of the eight insectivorous species of bats detected forage in forested areas; these are *Tadarida brasiliensis*, *Molossus molssus, Eumops glaucinus* and *Nyctinomops macrotus*. The other 4 forage in open areas.

Ten species of bats were recorded in Peru Cave. Three of these species were recorded from this cave only; these were *Erophylla sezekorni, Glossophaga soricina, Ariteus flavescens*, the latter is endemic.

Figure 5-47 Artibeus jamaicensis encountered roosting in the large drain in Santa Cruz

While 13 species of bats were recorded during this study, Genoways et al. (2005) recorded fifteen of Jamaica's 21 species in the parish of St Elizabeth. Genoways work was in caves, where they were captured for identification. *Eumops glaucinus* was detected in the study area but was not recorded by Genoways et al. (2005).

5.4.3.3.2 Other Mammals

The other mammals encountered include dogs, goats, donkeys, cats, mongooses, and rats. Of note, farmers reported that they had observed the mongoose going in the ponds to catch the introduced American Bullfrog.

The Jamaica Coney was not detected, and several members of the communities interviewed all stated that they were not aware of, or ever noticed the coney.

5.4.3.4 Bird Survey

5.4.3.4.1 General Trends

Eighty-four of Jamaica's 184 species of birds were observed: 66 residents, 18 migrants, 3 introduced. The resident species include 18 of Jamaica's 31 endemics (Appendix 13.9 and 13.10) The birds observed in the study were typical of dry forests and most of the species were observed in the Secondary Forest and fields.

A number of wetland birds were observed, including the Blue-winged Teal, Lesser Yellowlegs, Cattle Egret, Little Blue Heron, Great Blue Heron, Glossy Ibis, Northern Jacana, Common Moorhen, Killdeer, Limpkin and Green Heron. The Blue-winged Teal, Northern Jacana, Common Moorhen, and Killdeer were observed at both temporary and permanent ponds. The other wetlands birds were observed associated with flooded pasture lands, wetlands, and livestock water troughs.

There were a number of forest-dependent species such as the Crested Quail Dove, Jamaica Becard, Yellow-shouldered Grassquit, Rufous-tailed Flycatcher and Jamaican Pewee. The Crested Quail Dove is listed as Near-threatened by the IUCN.

Seven nocturnal birds were observed, these were the Jamaican Owl, Barn Owl, Antillean Nighthawk, Limpkin, Yellow-crowned Night-Heron, Black-crowned Night-Heron and Northern Potoo.

5.4.3.4.2 Seasonal Variation

A total of 79 bird species were recorded in the winter season (January- April); 15 migrants, 3 introduced and 61 resident species. Eighteen of the 61 residents were endemic.

Winter migrants arrive as early as September and begin their return to the North in April. The migrants in the study consist mainly warblers. Other migrants such as the Caribbean Martin, Northern Waterthrush, Louisiana Waterthrush, Ovenbird, Blue-winged Teal, Barn Owl and Lesser Yellowlegs were observed. Distinctive holes on a few trees indicated that the winter migrant Yellow-bellied Sapsucker had visited. A large flock of Caribbean Martin (<200), were observed on power lines near to a swamp in January (Figure 5-48). According to Sutton et al (2009) this species is a summer migrant which may arrive as early as February and generally associated with this type of habitat.

A total of 66 bird species were recorded in the summer (June - July). The number of resident and introduced species (60 and 2 respectively) were similar to the numbers in the winter (61 and 3). However, there were only 5 migrants in summer compared to 18 in winter.

The five migrant species in the summer include 3 species regarded as summer migrants: Black Whiskered Vireo, Gray King Bird and Antillean Nighthawk. The other two migrants were: the Barn Swallow, typically observed in Aug-Nov and Jan-Apr; and Lesser Yellowlegs normally observed Aug- May, (Downer, Sutton, and Rey-Millet 1990) . These birds were observed in June 2021.

Figure 5-48: Large flock of Caribbean Martin observed roosting on Power lines

5.4.3.4.3 Special Conservation Status

The Crested Quail Dove, White-crowned Pigeon, and the Jamaican Parakeet, listed as Near-threatened by the IUCN, were the only species of special conservation status observed during the assessment.

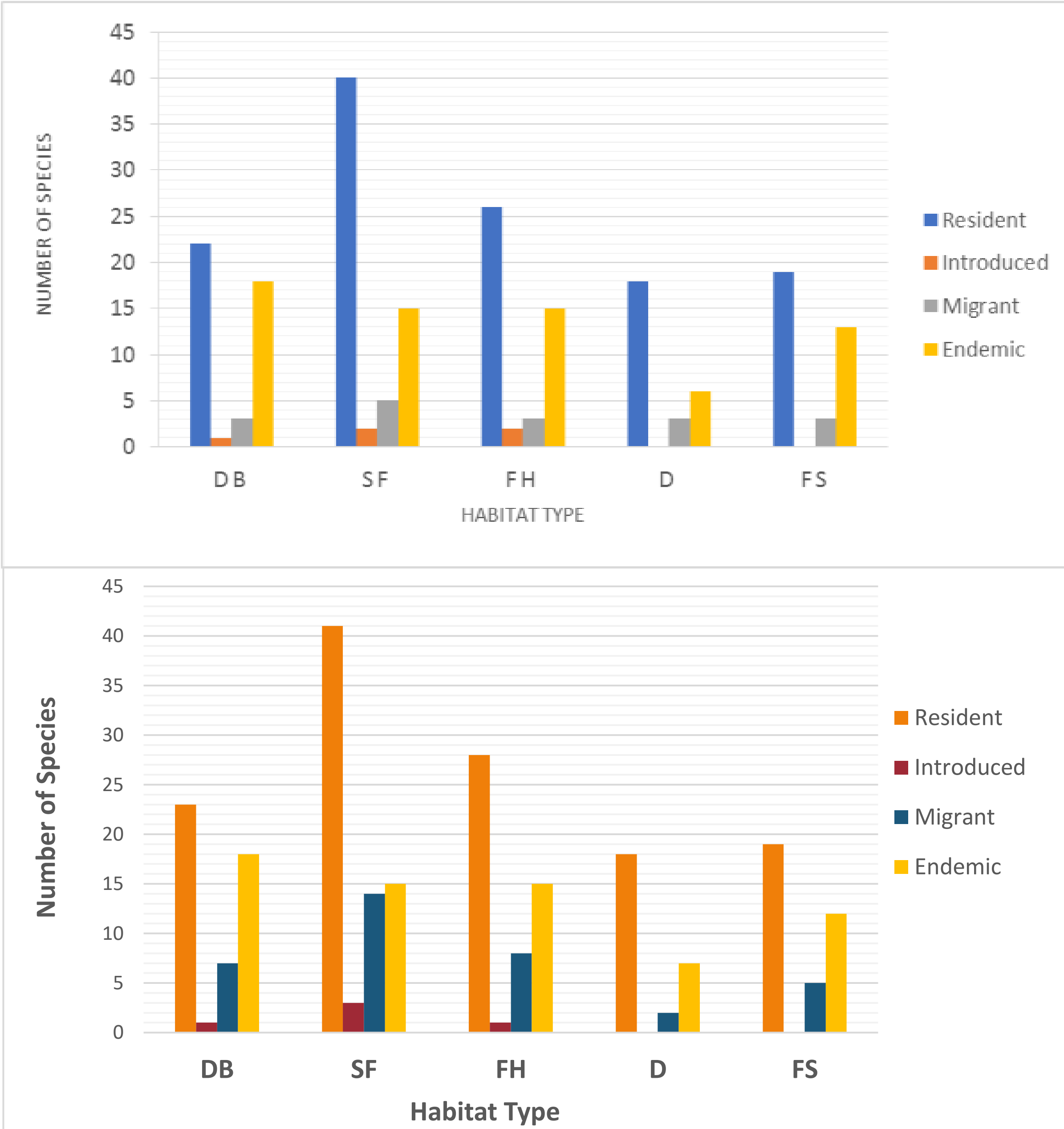


Figure 5-49 Above: birds observed during the summer season. Below: birds observed during the winter season. Resident = non-endemic resident.
Habitat Type: DB- Disturbed broadleaf forest; SF - Secondary Forest and fields; FH - Fields: Herbaceous crops; D - Developed Areas; FS- Fields and Secondary Forests.

5.4.3.5 Invertebrates

5.4.3.5.1 Arthropods

Over 250 species of insects were collected. One hundred and ninety species from 7 orders are listed here; these are dominated by the *Coleoptera* (17), *Hymenoptera* (16) and *Diptera* (15). Other Arthropods include spiders, millipedes, pseudoscorpions, and Opiliones.

The Arthropod population of the Disturbed Broad Leaf Forest was the most diverse (69 species), followed by Fields: Herbaceous crops (63) and Secondary Forest and fields (61). The population in the Built Area (21 species) and the Fields and Secondary Forests (34) was much lower. Very few species occurred in high numbers, i.e., few species were coded as being Abundant or Dominant (Figure 5-50).

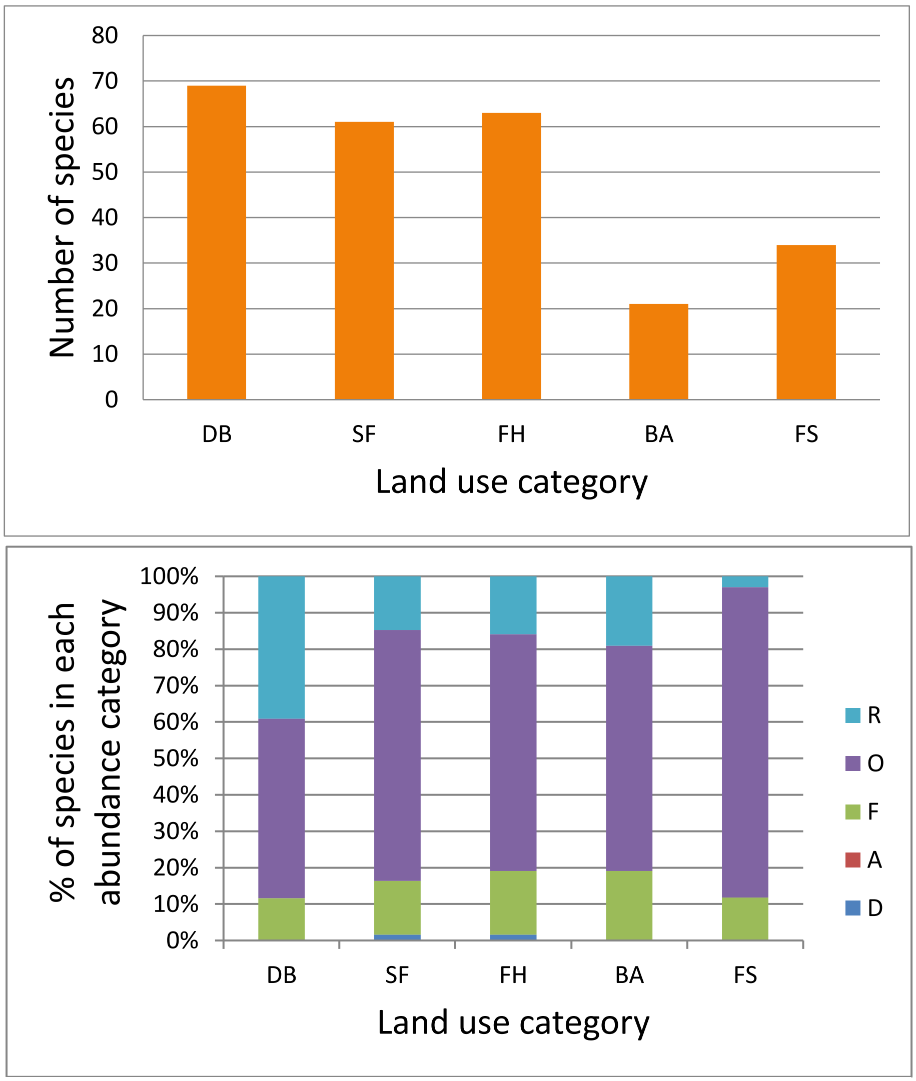


Figure 5-50: The number of Arthropod Species in each land use category. Below - Percentage of species in each abundance category. DB – Distributed broadleaf forest; SF – Secondary Forest and fields; FH – Field Herbaceous crops; D – Developed Areas; FS – Field and Secondary Forests. The DAFOR: D = Dominant; A = Abundant; F = Frequent; O – Occasional; R = Rare

5.4.3.5.2 Butterflies

Forty-two species of butterflies were recorded from 5 families. The dominant family was the *Nymphalidae*, 19 species, followed by the *Pieridae*, 10 species. There were 7 endemic species and 6 endemic subspecies.

Four species of swallowtails (*Papiliondae*) were recorded, 1 endemic species, 1 endemic subspecies, and 2 introduced. *Heraclides andraemon* was introduced from Cuba in the 1940's and is a pest of citrus; *Papilio demoleus* was introduced from the far east in 2006 and is well documented as an invasive species attacking citrus.

Of note is the endemic swallowtail *Protographium marcellinus* (Figure 5-51). One specimen was sighted in May, in the Broad leaf forest of Phantiland, base of the Don Figuero Mountains, **(Longitude: 77° 36' 43.062'' W Latitude: 18° 2' 47.989' N).** However, a reliable resident described swarms occurring occasionally. The larval food plant *Oxandra lanceoloata* (black lancewood) was fairly common in the forest and it is likely that a breeding population exists in this area. This species was recorded from St Elizabeth (Turner and Turland 2017). *P. marcellinus* is listed as Vulnerable by the IUCN (Collins and Morris 1985)

Figure 5-51 Protographium marcellinus

Figure 5-52 Top: The highly invasive, predatory flatworm attacking a land snail. Bottom left: Endemic Jamaican wasp excavating a nest in open soil left by loss of vegetation during summer. Bottom right: Thelidomus aspera is an early colonizer of disturbed habitats

5.4.3.5.3 Land Snails

Twenty-eight species of land snails from 11 families were recorded. Many of the species are generally associated with disturbed areas; two such species were *Thelidomus aspera* and *Zachrysia provisoria.*

Thelidomus aspera is a very common, endemic species (Figure 5-52). Across Jamaica it occurs in both forested areas and in disturbed areas even old bauxite mines. Usually found on tree trunks it is probably one of the first snail species to recolonize disturbed areas.

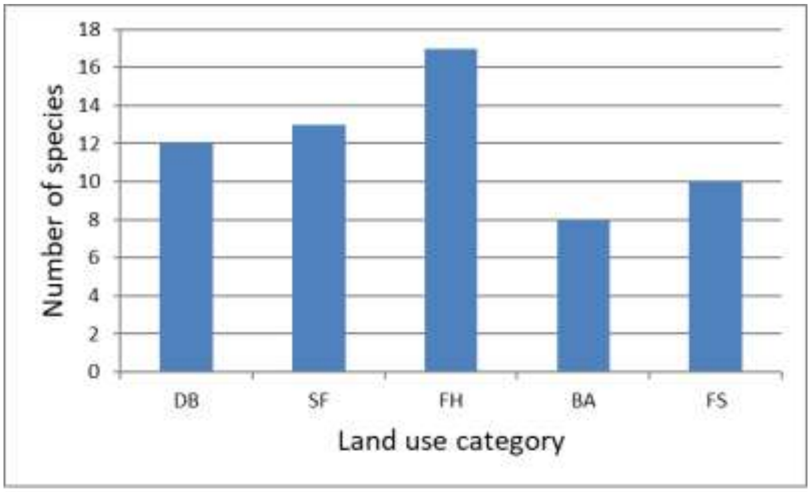
Zachrysia provisoria (Cuban brown snail) was also widespread in the study site. This snail is a native of Cuba that has expanded its range to Florida and many Caribbean islands. It is considered moderately invasive, as an agricultural pest, and is now well established in Jamaica.

The highest diversity was recorded in Fields: Herbaceous crops, 12 species; and the lowest in the Built Area and in the Fields and Secondary Forests. Most species however, occurred in low population numbers, i.e., categorised as Rare(R) (Table 5-12).

DB: Disturbed Broadleaf Forest, SF: Secondary Forest and Fields, FH: Fields: Herbaceous Crops etc, BA: Built Areas, FS: Fields & Secondary Forests

Table 5-12; Land snails documented in Outer Valley Section of SEPL 541

FAMILY	SCIENTIFIC NAME	LAND USE CATEGORY				
		DB	**SF**	**FH**	**BA**	**FS**
Camenidae	*Thelidomus aspera*		D	R	D	D
	Zachrysia provisoria	O	F	F	F	F
	Eurycratera jamaicensis	R				
Orthalicidae	*Orthalicus undatus jamaicensis*		D	R	O	R
Pleurodontidae	*Pleurodonte lucerna*	R	D	R		O
	Pleurodonte valida		O			
	Pleurodonte invalida	R		O	R	O
	Pleurodonte anomala	R				
Sagdidae	*Sagda spei*		O	O		R
	Hyalosagda arboreoides			O		
	Sagda sp.		R			R
	Sagda jayana			R		
	Sagda grandis	R				
Bulimulidae	*Drymaeus immaculatus*		R	R	R	R
Neocyclotidae	*Cyclochittya chittyi*	D	F	F	R	R
Urocoptidae	*Urocoptis brevis*		R			
	Geoscala seminuda				R	
	Spirostemma inusitatum	R			D	
	Urocoptis aspera.	R				
	Urocoptis nobilior	F				
Helicinidae	*Helicinia neritella neritella*	R	O			
	Lucidella aureola aureola		*D*	F		F
	Lucidella foxi		O	O		
	Eutrochatella pulchella			O		
	Alcadia major	R		R		
Annulariidae	*Annularia fimbriatula*			R		
Succineidae	*Succinea contorta*			R		
Subulinidae	*Subulina octona*			D		



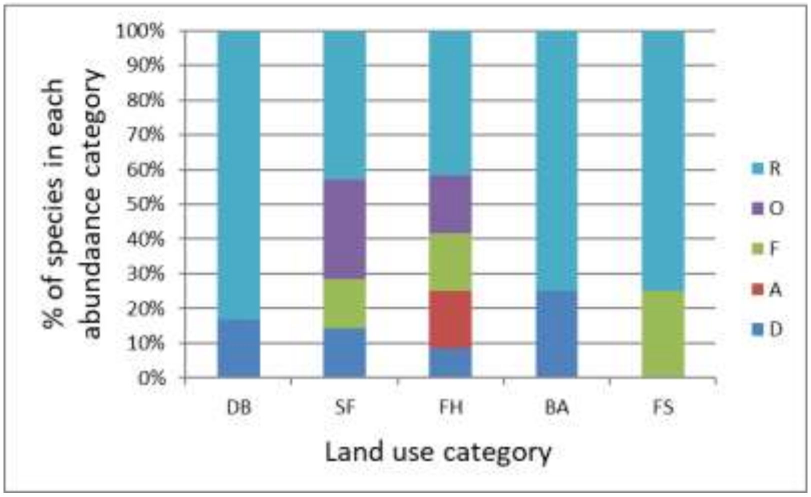


Figure 5-53: Above - The number of land snail species observed in each land use category.
Below - Percentage of species in each abundance category.
DB - Distributed broadleaf forest; SF - Secondary Forest and fields; FH – Fields: Herbaceous crops; D - Developed Areas; FS – Fields and Secondary Forests.
The DAFOR: D = Dominant; A = Abundance; F = Frequent; O – Occasional; R – Rare

5.4.4 Peru Cave

5.4.4.1 Introduction

Forty-Four caves have been reported in the parish of St. Elizabeth. The most significant one in the study site is the Peru Cave, known for its impressive geological features, inclusive of spectacular stalactites and stalagmites; it is one of the top four famous caves in the parish (St. Elizabeth Municipal Corporation 2016). The Peru cave is located relatively close to Goshen, and is known by the locals as "Rat Bat Hole". A rapid assessment of the cave was carried out by the EIA team guided by four locals from the nearby community. We wish to emphasize all the cave openings known to the residents.

5.4.4.2 Rapid Assessment

The local guides pointed indicated that there are many openings to Peru cave; Fincham (1997) concurred and suggested that these might lead to multiple cave networks in proximity. The team was unable to explore all the cave openings known by the community members. The caves visited by the team are indicated in Figure 5-54.

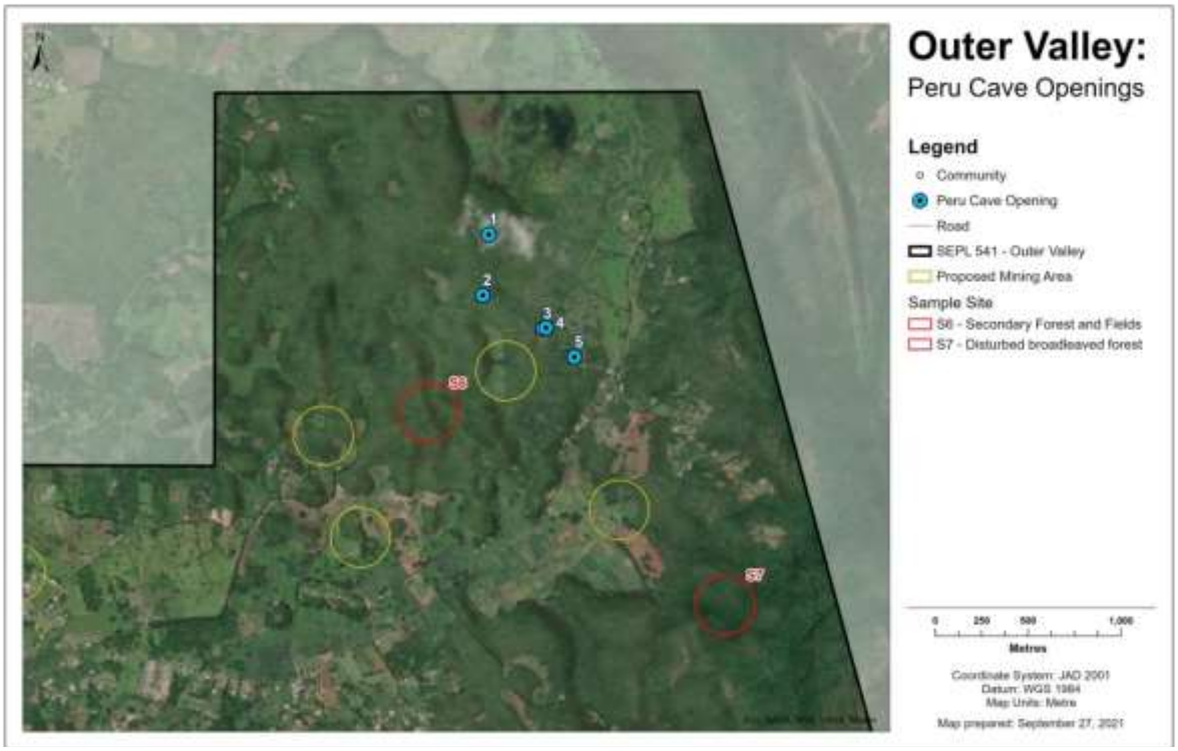


Figure 5-54: Entrance to the Peru Cave, Proposed mining areas and Forest areas

Table 5-13:Coordinates of the Entrances to the Peru Cave

Cave	Coordinates
Cave 1 Main Cave entrance	Lat. 18.075689°, Long. 77.620495°
Cave 2 The secondary cave entrance	Lat. 18.072734°, Long. 77.620786°.
Cave 3 Entrance	Lat. 18.071121°, Long. 77.617735°.
Cave 4 Entrance	Lat. 18.071154°, Long. 77.617572°.
Cave 5 Entrance	Lat. 18.069747°, Long. 77.616121°.

5.4.4.3 Cave 1

Main Cave entrance

The main cavern is located about 500 m from the road. It is the main cave known by the community members. Several large caverns are present in this area; the main cavern is accessible without the use of a rope. The main chamber is approximately 25 m high (Fincham 1997)

Cave features such as stalactites, stalagmite, columns and flowstones can be seen inside (Figure 5-55). Throughout the cave there were areas that had water dripping from the ceiling. It is the main area used by community members and visitors to the area. Several bottles and plastic bags were observed in the cave.

Figure 5-55:The main entrance and a large cavern in Cave 1

Figure 5-56: Cave features encountered in the caverns of Cave 1

Figure 5-57: Members of the team along with local guides in the main cave

5.4.4.4 Cave 2

The secondary cave entrance is located 150 m from the dirt road (Figure 5:58). The cave entrance is located in a hole about an 8 m drop to the opening on the ground. A rope is needed to rappel down the hole to get to the cave entrance.

Figure 5-58: Entrance to Cave 2

5.4.4.5 Cave 3

This entrance is located about 60 m from the dirt road. A rope is needed to rappel approximately 8 m down into the cave.

Figure 5-59: Entrance to Cave 3

5.4.4.6 Cave 4

Cave 4 is located about 80 m from the dirt road. The community members stated that they normally feel a cold breeze coming out of the cave entrance. A rope is needed to rappel down the hole to get to the cave entrance.

Figure 5-60: Entrance to Cave 4

5.4.4.7 Cave 5

This cave is located about 10 m from the dirt road. It was not easy to ascertain how deep the entrance was as the hole was very narrow.

Figure 5-61: Entrance to Cave 5

Figure 5-62: Bats observed in section of Cave 1

5.4.4.8 Cave Fauna

Bats, frogs, birds, and rats were observed in cave. Bats were by far the dominant animals and they have a significant impact of the ecology of the caves as guano is the main substrate for the cave ecosystem.

Bats – Hundreds of bats were observed in the caverns in Cave 1. They were observed in the caverns that were pitched black (light 0.01 lx). The temperature was 30 °C and humidity 71%.

The density of bats was very high compared to other Jamaican caves visited by the team. Reports quoted by Fincham (1997) also noted the many bats in the caverns.

The bat species were recorded by using the handheld bat detector, AnabatWalk. It is possible that not all bat species present in the cave complexes were identified. A more detailed bat assessment is needed to confirm if other species are present. This will require more specialized equipment and because of the complexity and difficulty will likely need support from professional cave explorers.

Ten species (1 endemic) of bats were classified from the acoustic recordings from Cave 1 (Figure 5-62). Five species were classified using the Auto-ID from Kaleidoscope Pro, and another five were identified using a bat Call Library from Windsor research Centre, Jamaica.

Figure 5-63: Feather from a barn owl

Figure 5-64: A rat observed in the cave

<u>Other Vertebrates</u>

Cave swallows *Petrochelidon fulva*- They were observed at the mouth of Cave 1, which was well lit. They were observed nesting on the roof of the cave.

Barn owl *Tyto alba* - The feathers were observed on the ground at the mouth of Cave 1.

Rat *Ratus ratus* - One large rat was seen scavenging in the main cavern, where several bats were observed

Frogs -The Jamaican Rockfrog*, Eleutherodactylus cundalli* was recorded in the Peru cave. (Figure 5-65) This species is endemic to Jamaica and is listed as Near Threatened by the IUCN.

Figure 5-65: Jamaican Rockfrog, Eleutherodactylus cundalli

<u>Invertebrates</u>

Cave crickets, millipedes, whip scorpions, cockroaches earwigs, flies, isopods and land snails were observed in the main cavern.

Crickets

The cave cricket *Uvaroviella cavicolla* occurred in relatively high numbers. Members of the team have visited several of Jamaica's caves but have never encountered such numbers (Figure 5-66)

Figure 5-66: Cave cricket Uvaroviella cavicolla

Fly

The Mycetophilid fly *Neoditomyia farri* was also documented. This species is endemic to Jamaica. This species is predaceous and traps flying insects in hanging web. (Figure 5-67). This species occurs in other caves such as Dromily and Windsor caves, often in very high numbers making is difficult for cavers using headlamps. While the species is common in Peru caves the numbers do not approach those in caves such as Windsor.

Figure 5-67: Fishing lines" of the larvae of the fly Neoditomyia farri

<u>Whipscorpions</u>

The amblypygid *Phrynus* is widespread in Jamaican caves where crickets occur, as it is a predator on these cave crickets (Figure 5-68).

Figure 5-68: Whipscorpion Phrynus sp

Spiders

Gaucelmus cavernicola (originally classified as *Theridionexus cavernicolus*) is the only species of spider observed. The species is widely distributed in the tropics. However, the Peru cave population is significant as this is the "type locality" for the species. Type locality is the place where the specimens used in the description of a new species was found.

Cockroaches

Two species of cockroaches were recorded.
Periplaneta americana (American cockroach) was the most common.
Pycnoscelus surinamensis (Surinam Cockroach), was relatively rare. It belongs to the Family Blaberidae which are ovoviviparous (Figure 5-69)

Figure 5-69: (Surinam Cockroach) Pycnoscelus surinamensis

Earwigs

Two species of earwigs were recorded amongst the guano.
Marava jamaicana (Rehn and Hebbard) was the most common.
A second species was not identified.

Millipedes

One millipede, *Caraibodesmus pictus* (Chelodesmidae) was recorded (Figure 5-70)

Figure 5-70: Millipede, Caraibodesmus pictus

Land Snails

Many species of land snails were recorded. These include *Pleurodonte aspera, Pleurodonte lucerne, Pleurodonte invalida Eucrochella pulchella Sagda spei and Eurycratera jamaicensis*. These species are not cave specialist but rather would have accidentally entered the caves.

Figure 5-71: Land snails shells are often well preserved. Eurycratera jamaicensis is an endemic species

Isopods

Isopods occurred both in the outer and deep regions of the caves. These are detritus feeders associated with the guano (Figure 5-72).

Figure 5-72: Isopods (wood louse)

5.4.4.9 Human Activities in the Cave

Guano collection - The communities member visits the caves mainly to get bat guano for farming. The guano is said by the community members as a good source of fertilizers. They normally get bat guano from the main cavern and a few of the other cave entrances. However, they don't frequently visit the other areas as they have to use a rope to access the caves.

Recreational - the community members occasional cook food and engage in recreational activities at the mouth of Cave 1. The field guides had mentioned that they have been doing that since they were children, and it is the norm for community members to visit the area.

Tours - the community members facilitate small tours to the caves. There are graffiti on the cave wall, where people place their names and the year, they visited the cave.

Garbage – Bottles and plastic bags left behind by visitors were observed particularly in the mouth of Cave 1 and areas where guano is collected. There is need for the community engaged to deal with this.

Figure 5-73: Writing observed on a section of the cave wall

5.4.5 Aquatic Habitats

There was no major river system within the study site. A number of systems occur adjacent to the site including the Braes River. The major aquatic systems were temporary ponds and wetlands which changed in size in relation to rainfall (Figure 5-74). Water birds were observed associated with these habitats (See section 5.4.3). The freshwater fish tilapia (*Oreochromis niloticus), (*Figure 5-75*)* occurred in many of these ponds. A number of freshwater insects such as members of the Belastomatidae, Dytiscidae, and Geridae were also collected (Figure 5-76).

Figure 5-74: A temporary wetland

Figure 5-75: Oreochromis niloticus, silver perch, a type of tilapia. Common all over Jamaica. Introduced from a southern US source via the GOJ/USAID aquaculture project in 1978/79

Livestock often use these water bodies, as a result the water is often murky and anoxic, and thus limit the diversity of organisms inhabiting them (Figure 5-61).

Figure 5-76: Above - An example of the small ponds in the study site; size has shrunk considerably during the dry season. Below - Footprints of livestock at the edge of the pond; water is murky and full of algae. Below Right - footprints of birds indicate that bird

5.4.6 Anthropogenic Impact

The entire area is heavily impacted by human activity. Historically there has been a number of well-developed towns and districts, the largest of which is Santa Cruz. Outside of these developed areas there are several major human activities; these include agriculture (crops and livestock), deforestation related to agriculture and charcoal burning and uncontrolled garbage disposal (see Figures 5-77 to 5-85) Some of these are chronicled below.

Agriculture – crops

A significant amount of the agriculture is small farming. There is major water shortage for a significant part of the year, hence the farms are often transient and the land is left fallow (Figure 5-77). As a result, each farmer might use several plots of land over the years, resulting in significant acreage being cleared. Such areas are often prone to erosion. Fire is often used to aid in the clearing of the land with disastrous impacts, especially if it becomes uncontrolled (Figure 5-77).

Figure 5-77: Soil erosion may result when soils are left exposed as a result of excessive grazing, fire or other poor agricultural practices.

Livestock

There are very few well maintained cattle farms. Most cattle are held on what is best described as "free range". These cattle roam freely over large acreage of forests, and open fields and have the potential to negatively affect the nature of vegetation (Figure 5-83)

Charcoal Burning

Charcoal production is a common activity. Bigger trees, and some species such as logwood *(Haematoxylum campechianum*), are preferentially harvested. The local people indicated that very little charcoal is utilized in local households; most of it goes into Jamaica's "Jerk industry". Some charcoal burners cut the trees in such a way to allow for regrowth, however, this is not always the case (Figure 5-81).

Figure 5-78: Evidence of the use of fire to clear agricultural lands

Figure 5-79: Above - Large areas may be cut for farming and the trees used for charcoal burning. Below - Burning sometimes cause massive die-off of some fauna, e.g., land snails

Figure 5-80 This well-established charcoal burning site is almost 200 m long, and is associated with several other neighbouring sites from which trees are harvested.

Figure 5-81: Neglected farms are often occupied by the invasive logwood. Top - young logwood plants in the process of invading farm. Below - mature" logwood forest"

Figure 5-82 Top & Centre: Cattle are generally allowed to roam freely through this landscape. Below: A network of miles of barbed wire fencing is used to retain the cattle on these "free ranges"

Figure 5-83 Uncontrolled disposal of garbage is common throughout the site



Figure 5-84 A number of resources are harvested from the naturally occurring vegetation. Above: Logwood wood fence posts are valued for their longevity. Below: Thatch palm leaves are used for roofing, brooms and craft.

5.4.6.1 Human Activities in Peru Cave

Guano Collection

Community members visits the caves mainly to get bat guano for farming. The guano is said to be a good fertilizer. They normally get bat guano from the main cavern and a few of the other cave entrances. However, they don't frequently visit the other areas as they have to use a rope to access the caves.

Recreational

The community members occasional cook food and engage in recreational activities at the mouth of Cave 1. The field guides had mentioned that they have been doing that since they were children, and it is the norm for community members to visit the area.

Tours

The community members facilitate small tours to the caves. There are graffiti on the cave wall, where people place their names and the year, they visited the cave.

Garbage

Bottles and plastic bags left behind by visitors were observed particularly in the mouth of the Cave (the recreational area) and areas where guano was collected.

5.4.7 Impact of the Development of Fauna and Flora

5.4.7.1 Potential Impacts

The proposed mining activities will have a negative impact on the flora. Mining is a highly destructive activity and will involve complete vegetation loss in areas selected to be mined. Because the area has been heavily impacted by humans for decades/centuries there are few species of high conservation status present, therefore every effort should be made to conserve the remaining populations. The special conservation cases identified are examined below. However, the loss of any fauna or flora should be minimised. The impact of mining can be reduced if the following recommendations are followed.

Most of the proposed mining areas are located in Fields: Herbaceous Crops etc.: the land use category that showed relatively low diversity and endemism. Many of the species observed in these habitats are classified as very common or commonly occurring species that are widely distributed across Jamaica. These are generally opportunists, colonizing cleared areas.

5.4.7.2 Mitigation Measures

- The ore bodies occur mainly in areas covered by Fields: Herbaceous crops, fallow, cultivated vegetables (91.4 %). These lands should be rehabilitated to a at least grasslands, however, establishment of forests will improve the ecological services. Even in the midst of these fields a few large trees remain. Efforts should be made to retain the larger trees, especially those that support other plants, such as climbers, bromeliads and orchids.

Table 5-14: Distribution of different land use categories on potential mining sites

Land Use Categories	**Orebody Area (acres)**	**%**
Buildings and other infrastructures	10.56	1.5
Fields and Secondary Forest	6.73	1.0
Fields: Herbaceous crops, fallow, cultivated vegetables	630.72	91.4
Secondary Forest and Fields	41.85	6.1
Disturbed broadleaved forest (Secondary Forest)	0.00	0.0
TOTAL	689.86	100.0

These trees will aid in soil retention/ reduction of the risk of erosion, as the root systems of the trees will consolidate soil particles. The presence of these trees will also aid in maintaining fauna diversity in the area.

Secondary forest occurs on 7% of the ore bodies. It is important during the rehabilitation that these areas, or at least equivalent acreage, be restored to some level of forest and not just grassland.

- Clear cutting of the limestone hills in these areas should be avoided as much as possible. These hills often occur as islands in the midst of the fields and where practical, a buffer zone of 30 m should be placed them. For the land use category Secondary Forest and Fields (118 total species, 20 endemic plants), most of the diversity as well as endemics were observed on the limestone hills. Mining can occur in the areas classified as Secondary Forest and fields, but should be limited to the fields/abandoned farms/pastures.
- Transportation of invasive species should be properly managed. The clearing process may involve mass transportation of materials which may include vegetative material and seeds, thus increasing the potential for spreading of invasive species such as bamboo (*Bambusa vulgaris)* and logwood (*Haematoxylum campechianum)*. This material will be used for rehabilitation of the mining sites; at the end of the process the storage site should be inspected by an independent consultant to certify that no invasive species are left behind.

Other steps to control such spread should include:

i. Establishment of a concretized drying areas for bamboo and logwood, where the cut shoots can be allowed to dry out and lose their ability to regenerate.

ii. Explore the possibility of drying and using the cut IAS such as logwood. Utilizing a wood chipper/shredder to process invasive plant, reducing them to material that is easy to handle, dry store. The resulting woodchips/mulch would have countless possible applications/uses.

- Any caves/sinkholes which are encountered should be examined for the presence of bats. If a colony of bats is encountered the matter should be reported to NEPA such that appropriate actions can be decided.

5.4.7.3 Specific Conservation Issues

5.4.7.3.1 Fresh Water Turtles

The freshwater turtle (*Trachemys terrapen*) occurs in ponds in the area. Turtles should be removed from any ponds which are to be disturbed, and relocated to appropriate ponds.

5.4.7.3.2 Jamaica Laughing Frog

The Jamaica Laughing Frog, *Osteopilus ocellatus,* is listed as Near Threatened by the IUCN. This species is dependent on bromeliads, *Hoenbergia* spp. The number of bromeliads is very limited due largely to the shortage of large trees. Large trees with *Hoenbergia* should be preserved as much as possible. If it is not possible to preserve a particular tree the bromeliads should be relocated to an appropriate site. A protocol for the relocation of bromeliads is provided in Appendix 13.14

5.4.7.3.3 Orchids

Orchids occur mainly on large trees (DBH >35 cm). If it is not possible to preserve a tree the orchid should be relocated to an appropriate site (see Appendix 13.14)

5.4.7.3.4 Plants to be relocated

The following five species of bromeliads should be relocated: *Hohenbergia polycephala, Tillandsia balbisiana, T. fasciculata, T. flexuosa* and *T. recurvata.*

The following two species of orchids should be relocated*: Brassavola cordata and Oeceoclades maculate.*

5.4.7.3.5 Blue Swallowtail Butterfly

Protographium marcellinus is listed as Vulnerable by the IUCN. Turner and Truland (2017) pointed out "the outlook for the continued survival of this spectacular endemic Blue Swallowtail is not favourable." This species was recorded in the Broadleaf Forest on the base of the Don Figuerero Mountain, this area is not slated to be mined, but there is the possibility that other breeding sites exists. If such areas are identified, then NEPA should be consulted and care must be taken to ensure minimum disturbance.

5.4.7.3.6 Peru Cave Complex

The Peru caves occur outside the areas to be mined; however, cave ecosystems are known to be very sensitive. The caves should be monitored during mining of the sites closest to the caves to see if there is any direct and indirect impact of the mining on the bats or other fauna in the cave complex.

5.5 Heritage

5.5.1 Background

There are archaeological remains distributed within the outlined area of SEPL 541. While there may have been some habitation of the area during by the Taino and pre-Taino people of Jamaica, little remains in the area from these groups. Similarly, evidence of the historic Spanish activity in the area has been mostly lost to time and development. The names of certain areas are the main lingering reminder of the Spanish occupation of Jamaica and this area of St. Elizabeth. Most of the archaeological sites identified in the area are from the period of English colonization in Jamaica, both before and after emancipation. Such sites include plantation houses, other historic houses, churches, and other remnants of the plantations and pens that existed in the area during the 18th and 19th centuries.

Other archaeological remains found in the area are difficult to date, such as historic graves. Also, where more modern archaeological remains exist in the area they have been noted. The area in general has seen much development in recent decades and so some of the archaeological remains in the area have been destroyed or removed previously to make room for development.

5.5.2 Approach

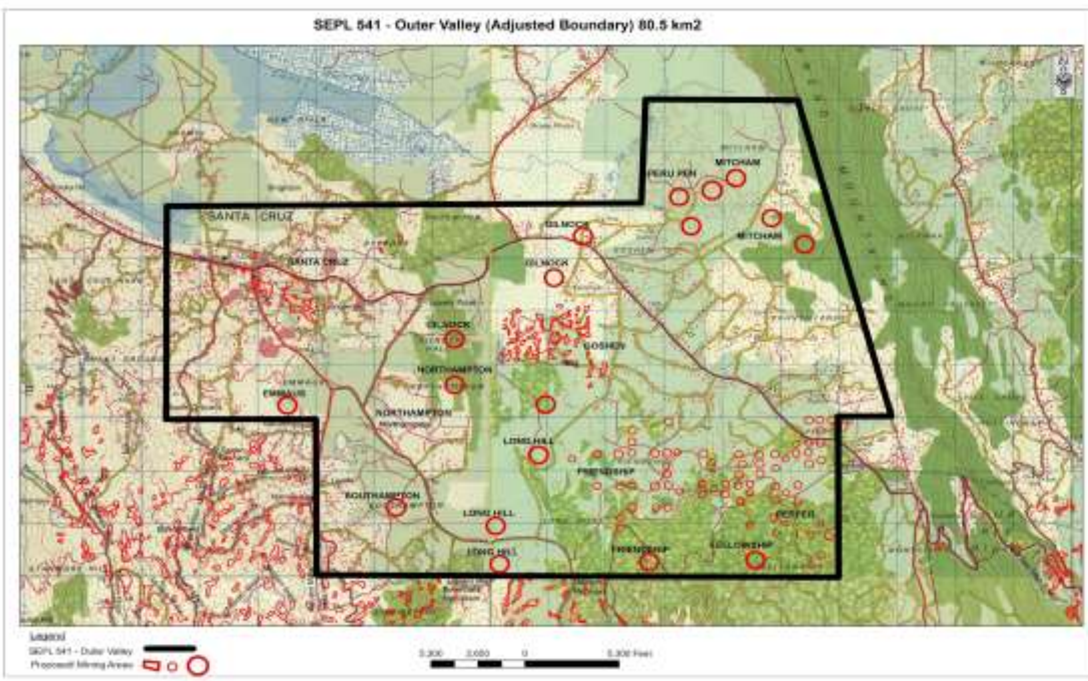


Figure 5-85:Boundary of the Outer Valley Section of SEPL 541

The Archaeological Impact Assessment (AIA) was done in accordance with the JNHT's standards and guidelines for Archaeological Impact Assessment and following NEPA EIA TOR. The study was commissioned in partial fulfilment of an Environmental Impact Assessment (EIA) required by the National Environmental Planning Agency (NEPA).

The objective of this assessment was to identify resources with archaeological significance within the study area, and to describe the risk that the proposed mining activity would have on these resources. The presented findings can then be used by the relevant national regulatory bodies to make informed decisions on any future mining activities in the area. The assessment also outlines steps that could be taken to mitigate, manage, and monitor the effects of future mining in the area.

A field survey of the area encompassed in Outer Valley section of SEPL 541 was concluded by Angelique Mullings and Dr. Ivor Conolley during about 4 weeks in April and May, 2021. Walking surveys and windshield observations were used to find and document archaeological assets in the given area as much as is possible. Also, local residents were consulted to help identify potential archaeological assets.

5.5.2.1 Identification of Archaeological Assets

It is anticipated that a number of historical, archaeological and other cultural heritage assets within the area proposed for development, a multi-faceted approach was employed to identify inventory.

1. Archival Research - This is a thorough review of all available written and graphic primary and secondary information relating to the area. It helps to identify the likely character, extent and relative quality and or quantity of actual or potential archaeological, architectural and ethnographic resources present. It includes relevant historical documents, journals and books, maps, plans, wills, deeds, ledgers, correspondence and other contemporary data found in the nation’s repositories such as the Island Records Office, National Archives, National Library of Jamaica, University of Technology (UTECH), University of the West Indies (UWI) and private collections. Websites were also consulted.

2. Aerial Photograph / Satellite Image Analysis - Both types of aerial images were analyzed with the view of detecting soil or vegetation anomalies or marks that may be indicative of buried archaeological features.

3. Field Walk Survey - In this technique, the investigating team spread across the site, combing the property from end to end in search of artefacts assemblages and other small features not identified by the previous techniques. Artefact assemblages are sometimes indicators of buried assets. The technique is very useful in identifying the location and presence of graves, undocumented Taino and enslaved African settlement and burial grounds.

4. <u>Interviews</u> - These were conducted as another strategy employed to bridge the cultural heritage elements data gap. Community members were subjectively selected, in particular the older (senior) citizens, and asked about their recollection of the site's spatial attributes. This method was particularly helpful in identifying the locations of grave sites, desuetude vernacular buildings and plantation vestiges inundated by dense vegetation cover. It was also helpful in ascertaining the function and past adoptive reuse of some ruins; essentially it was useful to the researchers in understanding the diverse and complex cultural heritage profile of the property.

5.5.2.2 General Land Use

A significant portion of the study area is residential, clustered in Santa Cruz and following the main road between Pepper and Santa Cruz. There is also significant residential land use south of Santa Cruz, encompassing the communities of Leeds, Emmaus, Northampton and Southampton.

There is a large tract of agricultural land between the communities of Goshen and Santa Cruz. Another area of agricultural land stretches from Goshen towards Peru Pen. Smaller areas of agricultural land are dotted around the study area.

There are large areas that remain forested, such as most of the Peru, Friendship, and Fellowship areas.

There are clusters of settlements throughout the study area, especially along the main roads. In these settlements land is used for housing, recreation, industries, businesses, and burials.

5.5.3 Historical and Archaeological Background

5.5.3.1 Pepper

The community known as Pepper is situated on land that was the Pepper Pen. The earliest filing from the estate is from 1741 when Joseph Dickinson was listed as the deceased owner and the estate is then under the ownership of his heirs. At that time Duncan McCorquodale was listed as the overseer. Starting in 1829 the property was joined with the neighboring Bonavista estate to create the Pepper and Bonavista property.

During the mid-1700s the pen mostly produced rum, sugar, mahogany and some livestock. On the 1763 Simpson and Craskell map of Cornwall, Pepper Pen was shown to have a cattle mill. After 1762 the focus shifted to livestock and other animals, with the production/reaping of some copper, mahogany and cotton. The highest total number of enslaved people recorded in the plantation was 608 in 1811, but then in 1832 125 enslaved people were recorded on the plantation, the lowest recorded number. However, most years of filings for the pen do not list the number of enslaved people on the estate.

In 1835 a claim was made by Messrs. Dickinson & Harman, as owner-in-fee for compensation from the British government for the emancipation of the 303 formerly enslaved workers attached to those the Pepper and Bonavista Pens. £5596 0s 8d was awarded for this claim. Throughout the history it was owned by the same Dickinson family that owned the Appleton and Barton estates further north in St. Elizabeth.

After emancipation the Pepper area remained important for cattle rearing and rearing race horses was emphasized.

A dairy farm was established in Pepper in the 20th century that has since fallen into ruin. However, cows are still reared in the area. Some small-scale farming is also done.

The community grew throughout the 20th century, aided by the ease of transport as the main A2 road between Mandeville and Santa Cruz passes through the community.

Figure 5-86: Plan 1 showing the buildings associated with the Pepper Pen and local landholdings

Figure 5-87: Remnants of the buildings seen in Plan 1

Figure 5-88: Remnants of the buildings seen in Plan 1.

5.5.3.2 Phantillands

A cave is present in the Phantillands area. While it is important as a landmark in the community, no artefacts have ever been reported to be found at the site.

Phantillands Pen was owned by the McCorquodale family (of which Duncan McCoruodale, overseer of Pepper Pen, was a member). The pen was named after a place of origin for the family in Scotland. John McCorquodale is the first owner listed.

The property produced sugar, rum and molasses. On the 1763 Simpson and Craskell map of Cornwall, Phantillands was shown to have a cattle mill.

In the record of the estate there were 150 enslaved people in 1821 and this number went down to about 66 in 1832. The property was as much as 3000 acres. The estate was registered to Henry Rhodes Morgan in 1835, he received a claim of £1410 9s 8d.

A community has developed on the land previously belonging to the pen which still has the Phantillands name.

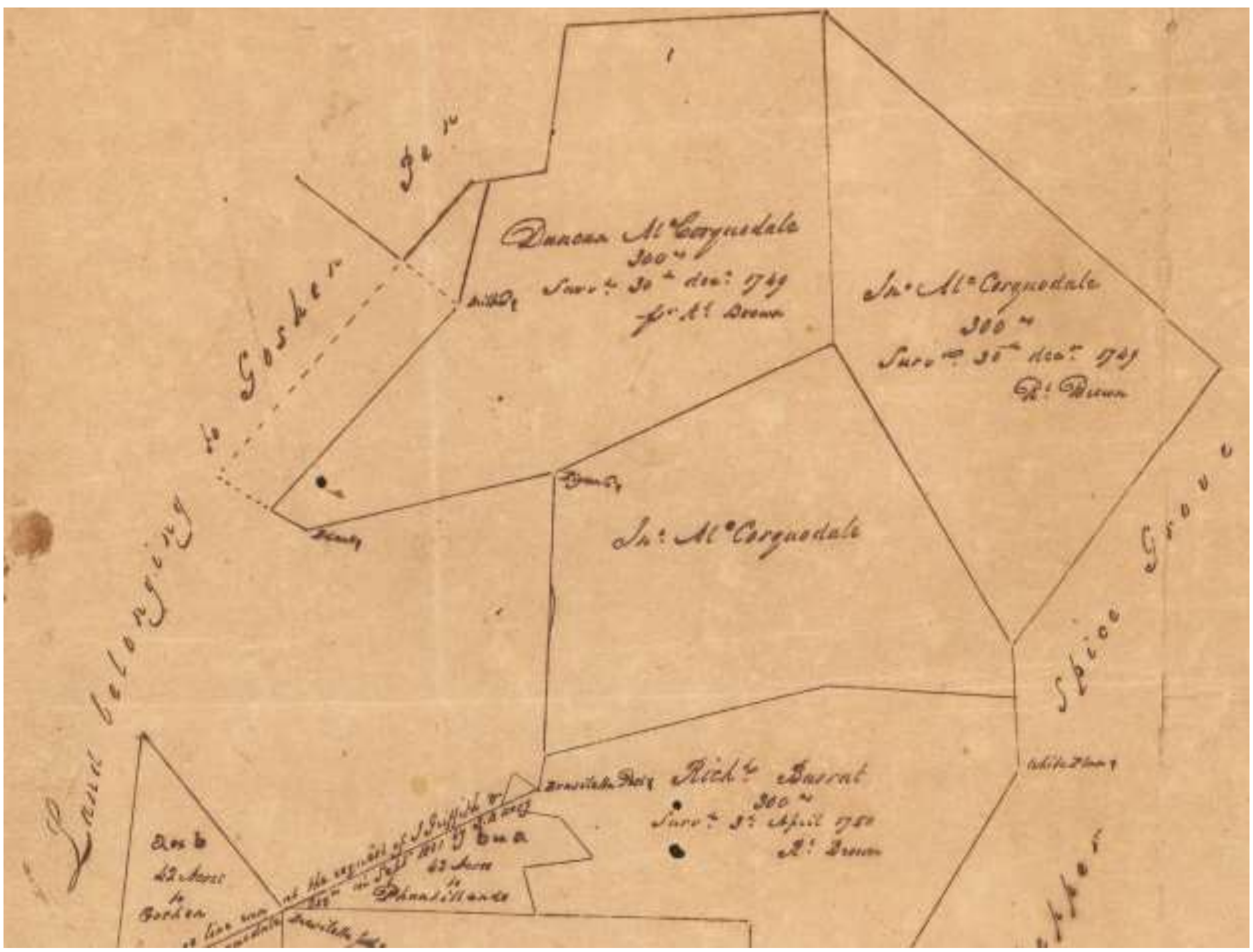


Figure 5-89: Plan 2 showing land belonging to Duncan McCorquodale.

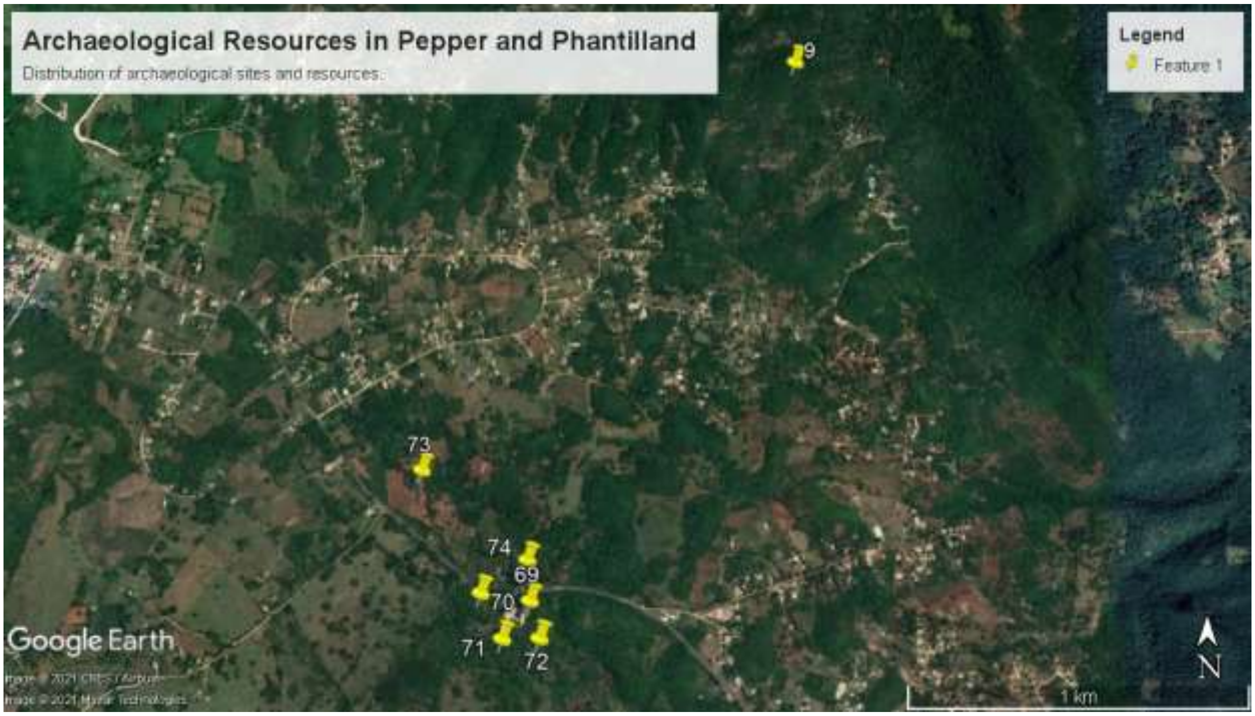


Figure 5-90: Distribution of archaeological sites and remains identified in the Pepper and Phantillands areas

5.5.3.3 Mitcham

Mitcham Pen was first owned by Andrew Wright from the 1790s who named the property after his hometown in England. The pen dealt in livestock, and other activities like cart hire, pasturage and household furniture.

The awarded claim for Mitcham Pen was £1,222 7s 0d to Andrew Wright, John Pusey Wint, Edmund Francis Green, John Salmon junior, George Roberts. Some of those who had been enslaved on the estate moved to the area that is now Balaclava after emancipation.

The community of Mitcham developed on the lands of what was Mitcham Pen. In the 50s the first bakery of the community was started, now there are a few different shops and more homes.

Figure 5-91: A view from the Mitcham Greathouse

Figure 5-92: Part of the remaining wall and foundation of the Mitcham Greathouse

5.5.3.4 Peru

A cave in the Peru area was described to the late Jamaican archaeologist James Lee as a Taino burial cave, however no burial remains were found on his visit to the cave. There are no records of burial remains or any other artefacts being found at the cave.

Peru Pen was first owned by John Heath up to 1786. It started as a coffee plantation which also dealt in livestock, but focused almost entirely on livestock and logwood after

The claim associated with the estate was for £441 14s 0d in 1835.

The land continued to be used for livestock and logging. The Greathouse continued to be occupied by the Calder family who owned other properties in the parish.

In the 20th century a factory was established in the area. With paved roads leading to it and an associated pump house.

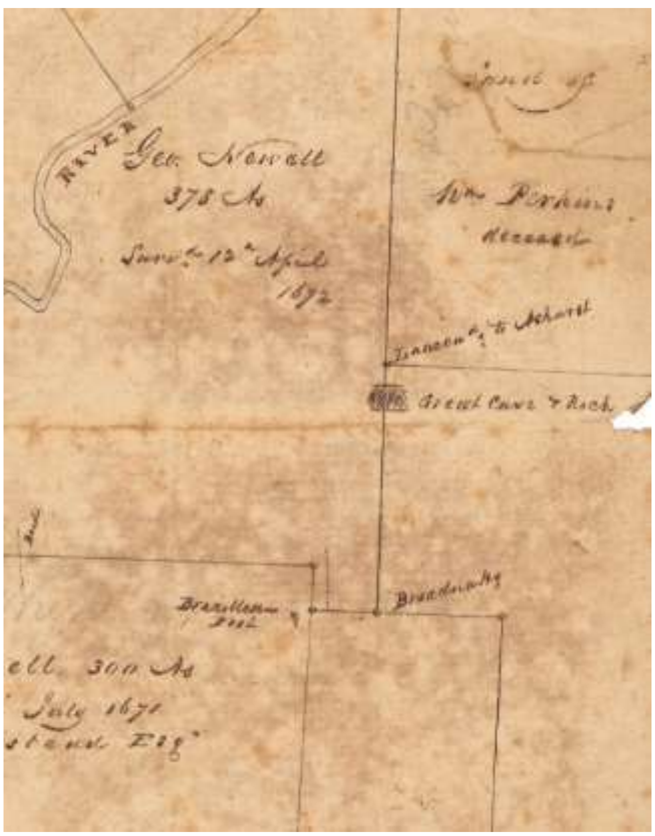


Figure 5-93: Plan 3 showing Peru Cave or the 'Great Cave' from the late 1700s.

Figure 5-94: Some of the overgrown stone walls of the ruins of the Peru Greathouse.

Figure 5-95: Distribution of archaeological sites and remains identified in the Mitcham and Peru areas

5.5.3.5 Goshen and Longhill

Goshen and Longhill Pens were owned and administered together for many years. Goshen Pen was first owned by Francis George Smythe the senior and stayed in the family until emancipation. The pens produced livestock, and sometimes sugar, cotton, and logwood. Goshen Pen was well known for supplying animals to other areas. It was 3,917 acres. Longhill Pen was less profitable. Barry Higman wrote of Goshen in 1781; "Goshen sold thirty-nine steers, three bulls, seventy six cows, twelve heifers, some calves, twenty five horses, twenty five mares, twenty eight mules and a filly."

The number of enslaved workers on Goshen estate increased until emancipation. There were 421 enslaved persons on the estate in 1832.

A claim was granted in 1836 for £7616 17s 0d for the Goshen and Longhill Pens.

During slavery but also after emancipation, Goshen was well known for breeding race horses, and there was a race track in the area in the 1800s. By the 1870s there were 15 breeding farms in the Goshen area. At this time James M. Farquharson, Justice of the Peace in St Elizabeth, was the attorney for Goshen and Longhill Pens.

Today Goshen is a growing community with a Moravian church and post office. A new NHT housing scheme is being constructed in the area. There is also a cemetery in the area along the road to Peru.

Figure 5-96: Dry stone walls along the narrow road connecting Longhill and Goshen.

Figure 5-97: Goshen Cemetery

5.5.3.6 Gilnock Hall

The late Jamaican Archaeologist James Lee mentioned picking up a Taino artefact on the side of the road in the Gilnock Hall area and marked the area beside the road that heads north to Brae's River.

The Gilnock Hall estate from which the area gets its name was first owned by Matthew Crawford by the 1790s. The property functioned as a livestock pen like those around it.

The property was owned by Duncan Roberts in the 1820s and 1830s. He was awarded the claim of £1684 7s 11d.

Duncan Robertson built the Anglican Church at Gilnock Hall which is still used.

By the 1800s a race track was created at Gilnock. Horse racing and polo remained important sports in the area into the mid to late 20th century.

Figure 5-98: Plan 4 showing land ownership in the Gilnock Hall area in the late 1700s.

Figure 5-99: St. Andrew's Anglican Church in Gilnock.

Figure 5-100: Remains of the Gilnock Hall Greathouse, referred to as 'Little Yard' by a local resident.

Figure 5-101: one of the plantation era buildings in Gilnock Hall which is still occupied. The group of buildings in this area was referred to as 'Big Yard' by a local resident.

Figure 5-102: Distribution of archaeological sites and remains identified in the Goshen and Gilnock areas.

Figure 5-103: Distribution of archaeological sites and remains identified in the Longhill area.

5.5.3.7 Longwood

The Longwood estate was relatively small compared to the surrounding properties. There were 20-30 enslaved people associated with the estate throughout the years that there are records for the plantation activities. The associated claim for this estate was awarded to Henry Coote and Martha Delaroche (nee Shepherd) for £487 8s 9d.

A housing development was built in the area in the 20th century. Longwood is now a residential area.

5.5.3.8 Santa Cruz

The town of Santa Cruz was named after the Santa Cruz mountains to the south east of the town. The name of the mountains comes from the Spanish settlers to the area in the early 16th century who named them ‘Las Montes de la Santa Cruces’ which means ‘Santa Cruz Holy Cross’. The Santa Cruz name is therefore a remnant of the Spanish occupation in the area.

After the British invaded Jamaica in 1655, Spanish resistance led by the last Spanish governor of Jamaica Don Cristobal Arnaldo de Ysassi, continued a war to try to regain control of the island. In that same year Ysassi and his forces took refuge for a time in the Santa Cruz mountains and made use of the livestock reared in the Santa Cruz area while fighting the British in other areas of the parish such as Black River.

The Santa Cruz Park Pen and Mexico estates were in the area now taken up by the town of Santa Cruz. The first listed owner for both properties is John Harriet who owned them in the late 1700s and died by 1783.

Santa Cruz as a market town developed in part because of the sale of the livestock grown on the many pens in the area during and after the period of slavery in Jamaica. The area became known for its cows and horses and so helped supply communities both in and out of the parish with animals. Also, a main road was established linking the area to Gutters and over to areas of Manchester, helping with transportation to the town. Over time several businesses, a court house, several churches, and eventually a high school were established in the town and residential areas surrounding the commercial districts have grown.

Figure 5-104: The center of Santa Cruz.

Figure 5-105: Distribution of archaeological sites and remains identified in the Santa Cruz area

5.5.3.9 Emmaus

The Emmaus region is named after the Emmaus Pen. The first owner of this pen on record is William Christopher Smalling who also owned at least 4 other estates in St. Elizabeth.

5.5.3.10 Leeds

The Leeds community is named after the Leeds estate owned by William Carter in the 1800s. there were 70 enslaved people associated with this estate in 1820 but this number declined until emancipation.

5.5.3.11 Northampton

Northampton Pen mostly reared livestock. The foundations of the stone Greathouse and the stone gateway still exist, though the house is now overgrown. The nearby community is still known as Northampton.

Figure 5-106: Some of the remaining structures of the Northampton Greathouse.

Figure 5-107: Distribution of archaeological sites and remains identified in the Northampton and Leeds areas

5.5.3.12 Southampton

The Southampton Pen, like most of the other properties in the area, reared livestock. Duncan Robertson of Gilnock Hall was associated with this estate and received some of the claim after emancipation for compensation.

5.5.3.13 Friendship

The Friendship estate was owned by the Watt family during the early 1800s into the 1830s. The property was used for animal rearing.

Figure 5-108: Plan 5 showing the extent of the Fellowship and Friendship estates and the Friendship Greathouse

5.5.3.14 Fellowship

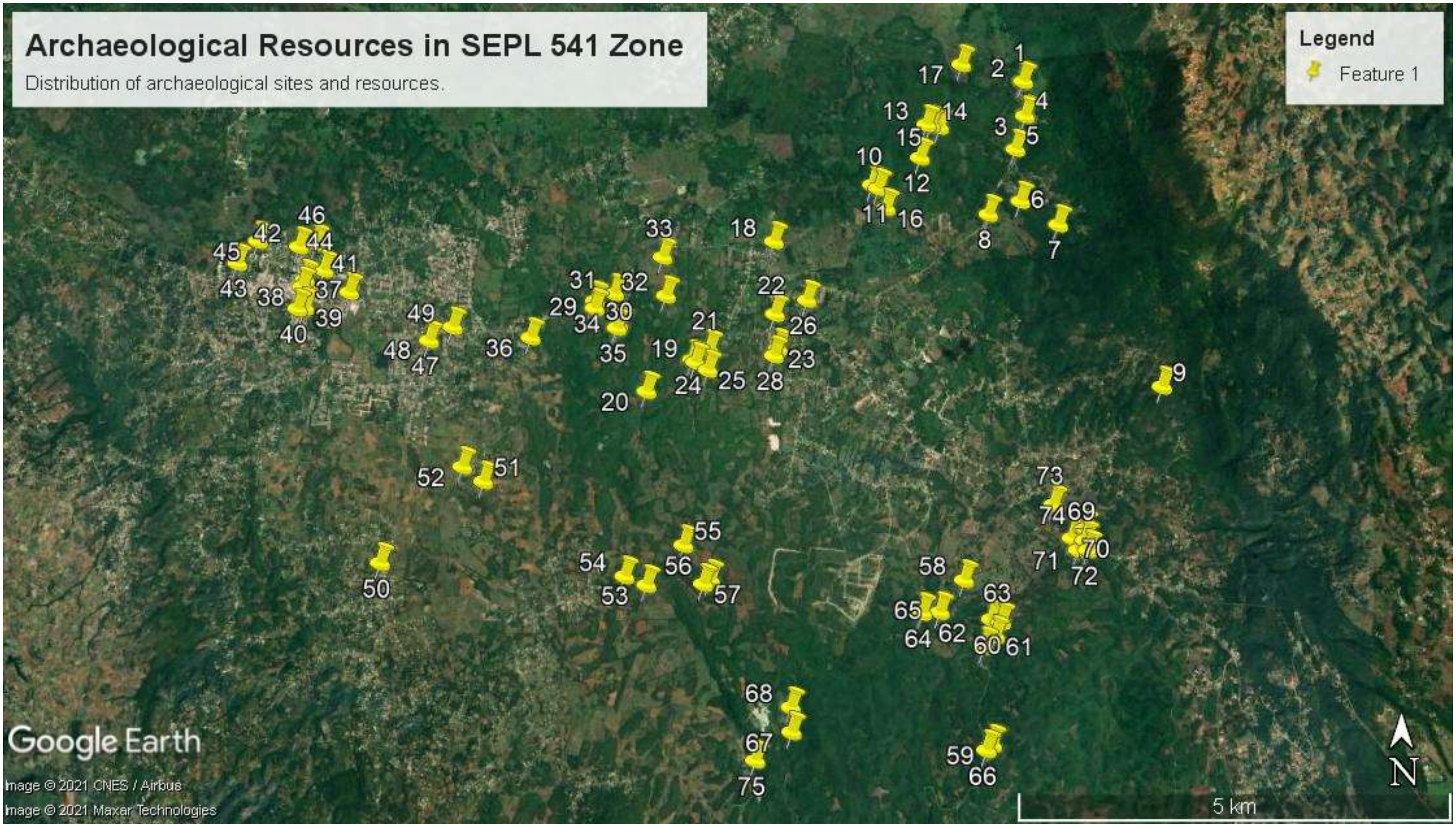
The Fellowship estate was owned by the Hewitt family and originally called Cashew.

In the second half of the 20th century the Alpart company became more active in the region to mine bauxite. A private railway were established to allow for transportation of bauxite from Fellowship where mining was taking place. The remnants of this railway can still be found today.

Figure 5-109: Remains of a retaining wall built along the railway in Fellowship

Figure 5-110: Distribution of archaeological sites and remains identified in the Friendship and Fellowship areas

5.5.4 Inventory of Archaeological Resources



Spatial Distribution of Archaeological Resources

5.5.5 Inventory of Identified Archaeological Resources

Table 5-15: Inventory of Identified Archaeological Resources

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
1	 	Mitcham Greathouse	Mitcham	77° 36.774	18° 04.580'	Cut stone foundation for large plantation house. Large modern concrete tank attached.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
2		Modern House Ruins	Mitcham	77° 36.774	18° 04.580'	Block and steel house built adjoining the plantation-era Mitcham Pen House.
3		Dry Stone Wall	Mitcham	77° 36.816	18° 04.226'	
4		Stone Gateway Ruins	Mitcham	77° 36.800'	18° 04.297'	Two large stones in the dry stone wall that may have once been a gateway in Mitcham Pen estate.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
5		Stone and Brick Oven	Mitcham	77 36.847'	18 04.120'	Stone structure with brick lined oven space. Built in the 1950s according to the current inhabitant of the associated house for baking breads.
6		Dry Stone Wall	Mitcham	77° 36.832’	18° 03.764'	
7		Dry Stone Wall	Mitcham	77° 36.832'	18° 03.764'	

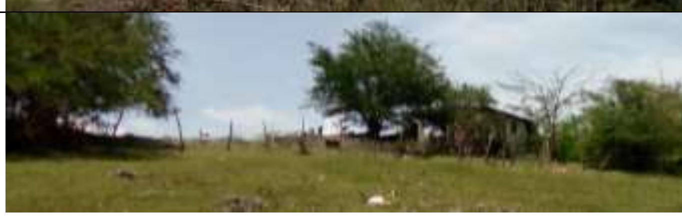
No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
8		Pump Station	Mitcham	77° 37.071'	18° 03.671'	Concrete block and steel building covering water pump, may be well noted on historic maps.
9		Phantillands Cave	Phantillands			
10		Factory Ruins	Peru	77° 37.892'	18° 03.859'	Ruins of a large concrete block and steel building and factory machinery.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
11		Modern Building Ruins	Peru	77° 37.854'	18° 3.840'	Small concrete block and steel building ruin.
12	 	Peru Greathouse Ruins	Peru	77° 37.568'	18° 4.058'	Remains of the cut stone walls and foundations of the Peru Pen house and an ancillary building (possibly a coach house). On the west side of the main building is an 8-sided large tank.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
						
13		Dry Stone Wall	Peru	77° 37.599'	18° 3.998'	
14		Dry Stone Wall	Peru	77° 37.515'	18° 04.283'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
15		Modern Concrete Trough	Peru	77° 37.515'	18° 04.283	Modern concrete block animal trough.
16		Ponds	Peru	77° 37.794'	18° 3.722'	3 ponds that may have been used in the activities of Peru Pen.
17		Peru Cave	Peru	183500	158500	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
18		Goshen Cemetery	Goshen	77° 38.554'	18° 3.518'	Dozens of modern concrete graves.
19		Remains of Dry Stone Wall and Wooden Structure	Goshen	77° 39.159'	18° 02.644'	
20		Disused Airstrip	Goshen	77° 39.521'	18° 02.540'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
21		Disused Animal Trough	Goshen	77° 39.016'	18° 2.763'	Ruins of a modern concrete block animal trough.
22		Metal Tank	Goshen	77° 38.780'	18° 2.999'	Rusted metal water tank on a metal stand.
23		Vernacular House	Goshen	77° 38.566'	18° 2.754'	House with stone foundation, nog walls and a zinc roof. A stone and concrete water tank is on the property to the north of the house.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
24		Disused Animal Trough	Goshen	77° 39.168'	18° 2.659'	
25		Metal Tank and Concrete Trough	Goshen	77° 39.059'	18° 2.613'	
26		Goshen Moravian Church	Goshen	77° 38.358'	18° 3.088'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
						
27	Seventh Day Adventist Church		Goshen			
28		Pond	Goshen	77° 38.591'	18° 2.709'	
29		St. Andrew's Anglican Church	Gilnock Hall	77° 39.865'	18° 3.025'	Large stone church building built in 1831. with a front tower

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
30		Cemetery for St. Andrew's Anglican Church	Gilnock	77° 39.866'	18° 3.076'	Dozens of historic and modern graves.
31	 	Stone Gateway	Gilnock	77° 39.725'	18° 3.124'	Old stone curved walls forming gateway associated with Gilnock Hall estate.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
32	 	Gilnock Hall Greathouse	Gilnock	77° 39.372'	18° 3.099'	Ruins of a large 2-storey, cut-stone house associated with Gilnock Hall Estate.
33		Modern Building Ruins	Gilnock	77° 39.389'	18° 3.368'	Concrete block and steel building.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
34	 	Plantation-era House Complex	Gilnock	77° 39.698'	18° 2.907'	2 cut-stone buildings associated with Gilnock Hall Estate. Both buildings include modern concrete block additions.
35		Plantation-era Building with standing chimney	Gilnock	77° 39.704'	18° 2.892'	Small cut-stone plantation-era building with standing chimney.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
36		Stones for Historic Gateway	Gilnock	77° 40.302'	18° 2.850'	Cut stone gateway.
37		Clock Tower	Santa Cruz	77° 41.927'	18° 3.230'	Modern working clock tower erected in 2008. A stone etching says it was erected in memory of Irving Hanson by the Rotary Club.
38		Vernacular Shop Building (bar)	Santa Cruz	77° 41.949'	18° 3.181'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
39		Court House	Santa Cruz	77° 41.924'	18° 3.032'	Stone building with modern concrete additions and associated buildings.
40	 	Building Ruins Behind Court House	Santa Cruz	77° 41.976'	18° 3.023'	Ruins of 2 small buildings in the parking lot of the court house. One with a nog walls, the other with concrete block and steel walls.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
41		St. Elizabeth Technical High School	Santa Cruz	77° 41.606'	18° 3.152'	Modern school buildings made of concrete block and steel near the centre of the town. The school was founded in 1961.
42		St. Croix Catholic Church	Santa Cruz	77° 41.980'	18° 3.445'	Roman Catholic church building.
43		Sharon Baptist Church	Santa Cruz	77° 42.418'	18° 3.327'	Stone church building. There is an associated cemetery to the north of the church building with modern graves.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
44		St. Matthew's Anglican Church	Santa Cruz	77° 41.795'	18° 3.284'	Large church building with metal roof and associated cemetery with modern graves.
45		Infirmary	Santa Cruz	77° 42.277'	18° 3.474'	Cluster of modern concrete block and steel buildings with zinc roofs.
46		Emmaus Well	Santa Cruz	77° 41.862'	18° 3.467'	Metal pipe that descends into the earth to meet the original stone walls of the historic well.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
47		Historic and Modern Graves	Longwood	77° 41.039'	18° 2.807'	A cluster of about a dozen graves beside the road.
48		Modern and Historic Graves	Longwood			
49		Historic and Modern Graves	Longwood	77° 40.869'	18° 2.894'	About a dozen graves on a plot surrounded by a stone wall.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
50		Victorian-era House	Leeds	77° 41.332'	18° 1.316'	Blue walls with a zinc roof.
51	 	Northampton Greathouse	Northampton	77° 40.632'	18° 1.847'	Ruins of the large house associated with the Northampton estate. Columns still stand toward the front of the house. There is evidence of more modern concrete additions to the house.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
52		Stone Gateway	Northampton	77° 40.789'	18° 1.958'	Stone curved walls and gateway painted white with the word 'Northampton' painted on.
53		Stone tank	Longhill	77° 39.493'	18° 1.165'	2 stone water tanks lined with cement.
54		Dry Stone Wall	Longhill	77° 39.643'	18° 1.226'	

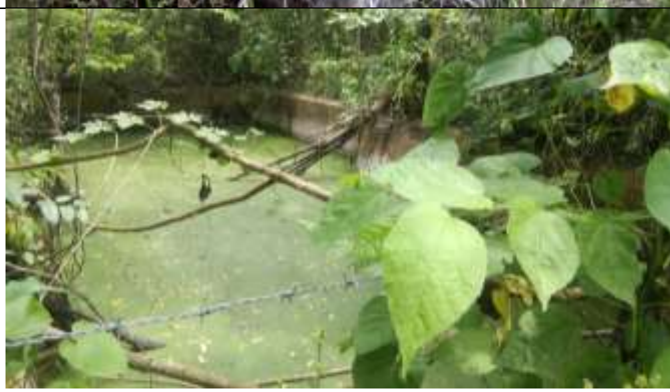
No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
55		Dry Stone Wall	Longhill	77° 39.186'	18° 1.530'	
56		Dry Stone Wall	Longhill	77° 39.061'	18° 1.203'	
57		Pond	Longhill	77° 39.096'	18° 1.169'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
58		Modern House Ruins	Fellowship	77° 37.273'	18° 1.213'	Ruins of a concrete block and steel house with blue walls built for resettlement of persons for bauxite mining.
59		Stone and Concrete Tank and Barbecue	Fellowship	77° 36.996'	18° 0.150'	A cut stone and concrete flat platform and attached open water tank.
60		Train Track Remains	Fellowship	77° 37.092	18° 0.932'	Concrete retaining walls along the channel made for the train tracks. Some of the wooden train tracks are still in place.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
	 					
61		JISCO Alpart Well	Fellowship	77° 37.048'	18° 0.834'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
62		JISCO Alpart Well	Fellowship	77° 37.126'	18° 0.764'	
63		Metal Pipes	Fellowship	77° 37.006'	18° 0.928'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
64		Train Track Remains	Fellowship			
65		Limestone Karst	Fellowship	77° 37.435'	18° 1.004'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
66		Concrete Tank	Fellowship	77° 37.127'	18° 0.100'	
67	 	Friendship Greathouse	Friendship	77° 38.460'	18° 0.149'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
						
68		Road and Metal Cable Remains	Friendship	77° 38.468'	18° 0.252'	
69		Dairy Farm Complex	Pepper	77° 36.416'	18° 1.476'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
	 					
70		Building Ruins on Dairy Farm	Pepper	77° 36.505'	18° 1.476'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
						
71		Concrete Structure on Dairy Farm Property	Pepper	77° 36.469'	18° 01.409'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
						
72		Structure on Dairy Farm	Pepper	77° 36.395'	18° 01.406'	

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
73	 	Pepper Greathouse	Pepper	77° 36.641'	18° 1.719'	Ruins of the cut stone walls of the Pepper plantation great house. The remains of other buildings are in the area.
74		Modern House Ruins	Pepper	77° 36.418'	18° 1.542'	Concrete block and steel house ruins.

No.	Picture	Site	District	X-Coord.	Y-Coord.	Comments/Description
75	 	St. James Anglican Church	Mount Hermon	77° 38.725'	18° 0.022'	Cut-stone church building with graves on site.

5.5.6 Archaeological Impacts and Mitigation

5.5.6.1 Impact Assessment

Table 5-16: Potential Impact on the Archaeological Resources Identified

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
Pepper	**Negative impacts;** The Pepper Greathouse ruins could be damaged by mining activity or the construction of haulage roads.	X		X			X	Delineate a boundary around the Greathouse site and protect the site by designating it Protected National Heritage under the JNHT Act.
	Potential Dust and Noise Pollution.		X	X	X	X		
Mitcham	**Negative impacts;** The 1950s stone and brick oven in town could be damaged given its proximity to the road.	X		X	X		X	Avoid driving haulage trucks and heavy machinery on the main road through Mitcham beyond the location of the identified potential mining areas.
	The Mitcham Greathouse will likely remain unharmed because	X		X	X		X	

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
	of its position on top of a hill and away from highlighted mining zones. However, driving or using heavy machinery on the property could damage the house remains.							
	Dust and noise pollution.		X	X	X	X		
Gilnock Hall	**Negative impacts;**							
	The Gilnock cemetery will be threatened by the proposed mining in the area.	X		X			X	Delineate a zone that encompasses the area of the cemetery to be left unmined. Compensate persons for damage to property.
	Dust and noise pollution.		X	X	X	X		
	Positive impacts;							
	Rehousing of willing persons.	X		X		X	X	

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
Peru	**Negative impacts;** The Peru Greathouse is in close proximity to one of the highlighted areas for mining. Excavation and extraction, along with moving heavy machinery through the area could pose a risk to the house, although the house sits on top of a hill and so could be spared from these effects. **Positive impact;** Improved vehicular access to the area.	X X		X X	X	X	X	Delineate a boundary around the Greathouse and protect the site by designating it Protected National Heritage under the JNHT Act. Flag these areas to prevent any unintended disturbance to the remains there.
Santa Cruz	**Negative Impact** Important landmarks in the	X		X			X	Delineate zones around the Court House, St. Elizabeth Technical High

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
	town with heritage significance, like the Court House, would be threatened by mining in the town and the heavy equipment needed for this activity. Destruction of modern businesses and homes in the potential mining areas identified. Dust and noise pollution. Potential damage from heavy machinery.	X X	X	X X X	X	X	X X	School, to be spared from mining activity. Compensation to persons for damage to private property.

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
Emmaus	**Negative Impact** Potential noise and dust pollution. Destruction of modern homes in area.	 X	 X	 X X	 X	 X	 X	 Compensation to persons for damage to private property.
Northampton	**Negative Impact** The historic Northampton Greathouse could be damaged by mining activities in the area.							 Designate the site a Protected National Heritage site to protect it from being damaged by mining activities, especially the potential creation of haulage roads in the area.
Southampton	**Negative Impact** Potential dust and noise pollution. Destruction of modern homes in area.	 X	 X	 X X	 X	 X	 X	 Compensation to persons for damage to private property.
Friendship	**Negative Impact** The Friendship historic Greathouse complex would be vulnerable to	 X		 X			 X	 Delineate a boundary around the Greathouse and protect the site by designating it Protected

Resource ID	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
	damage if haulage roads were built in the area to access nearby mining sites. **Positive Impact;** Improved vehicular access to the area.	X		X	X	X		National Heritage under the JNHT Act.
Fellowship	**Negative Impact;** The remains of the railway in the area could be destroyed in the mining process. The historic barbeque and tank in the area could be damaged by nearby mining. **Positive impact;** Improved vehicular access to the area.	X X X		X X X	X	X	X X	

5.5.7 Cumulative Impact

5.5.7.1 Archaeological Research Value

It is important to understand the potential cumulative impact on archaeological sites in the SEPL 541 area. The material remains in the area provide valuable information on the history of the area and the history of key stages in Jamaica's history. Many of the sites in the area help to demonstrate the nature of Jamaican society under English colonial rule and during the period of slavery. Other remains showcase important aspects of the culture of the area in more recent years. For example, some of the more modern ruins help to demonstrate different industrial and economic activities carried out in the area in recent decades. The value that can be obtained from the presence of, and examination of, archaeological sites in the area must not be underestimated or ignored. Therefore, it is important that JISCO Alpart does not jeopardize these resources if mining proceeds in the area.

5.5.7.2 Authenticity

The area that SEPL 541 covers has seen much development in recent decades and so many historic buildings have been destroyed or changed to make way for new homes and other buildings. However, there are still material remains and practices that have existed for generations among the communities in this area. For example, the strong tradition of rearing livestock on the gently sloping land in much of this area dates back several generations. Much of the land highlighted as potential mining areas is currently used to graze animals and so the loss of this land (even temporarily) could impact the authenticity of the local culture.

Also, the displacement of persons from mining areas could have an impact on the demographics of the area, which would affect the current community layouts and sizes.

5.5.7.3 Mitigation

Here are methods that could be used to mitigate any potential negative impact of future mining activity on archaeological resources in the area.

- Where an isolated archaeological asset of high significance is located too far from a cluster, it must be delineated and protected under the JNHT Act.
- All archaeological resources outside communities must be clearly flagged and colour-coded indicating whether it is to be preserved or relocated.
- Where the declaration process of a site or an area has commenced no mining activity is allowed in that space as a Preservation Notice will be placed there by the JNHT.
- Under the JNHT Act, 1985, a Stop Order shall be placed on any work that is in breach the Act to protect and preserve heritage assets as National Monument or National Heritage.
- Where there is unreported accidental find of significant archaeological resources, the JNHT will place a Stop Order on development on the site in order to conduct its own

investigation and recording of the find and a determination reached to preserved that find in-situ or ex-situ.

- A detailed recording of all sites determined to be altered or relocated must be done before work commences.
- Construction of service roads and other bauxite mining facilities are to be monitored by a qualified archaeologist.
- A schedule of construction works should be prepared and presented to the JNHT.
- The use of explosives is prohibited in the vicinity of sensitive archaeological assets designated protected National Heritage or in the process of being designated Protected National Heritage.

5.6 Socio-economic Environment

The Socio-demographic and cultural environmental survey and attitude and perception inventory were conducted and administered in parts of the Outer Valley Section of SEPL 541 (Goshen, Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship and Fellowship) (Figure 5-111)

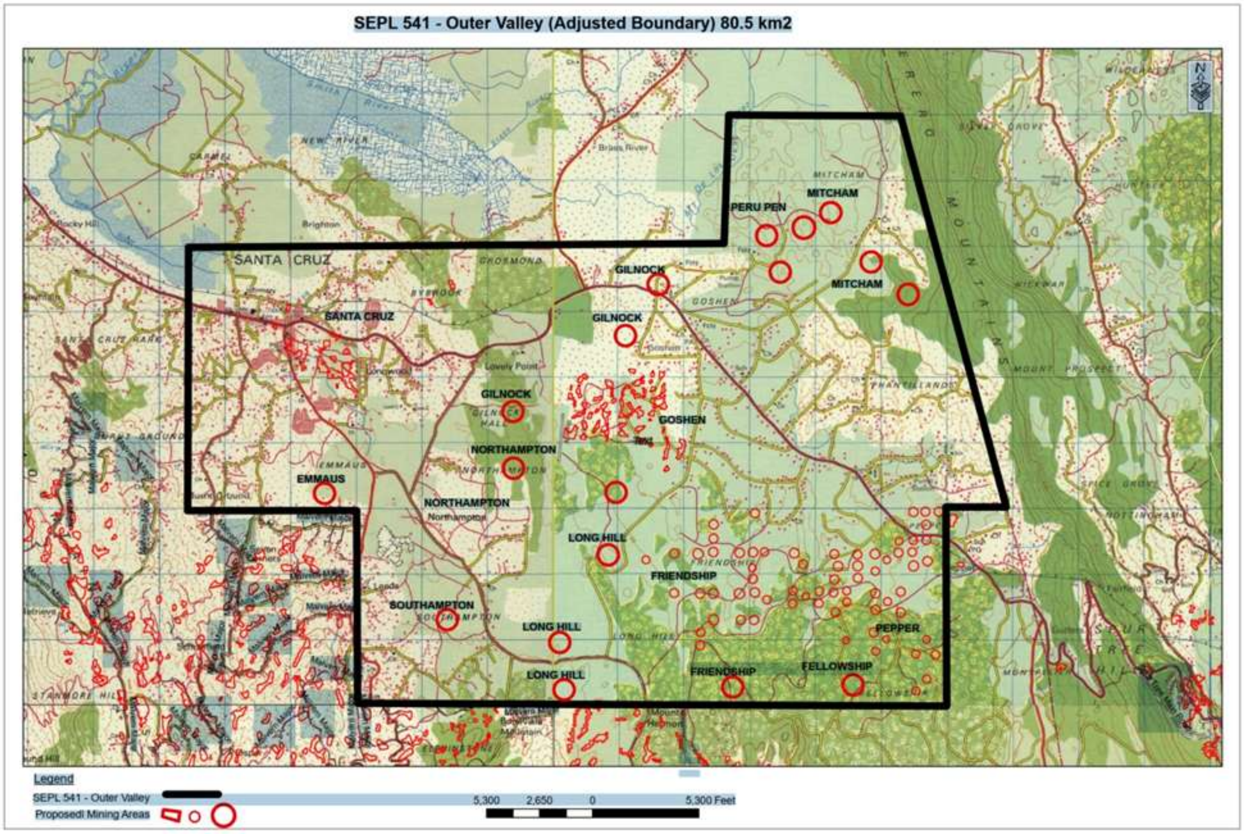


Figure 5-111:Map Showing boundary of the Outer Valley project area

<u>Population</u>

The overall population or St. Elizabeth is 146670. This is obtained by averaging statistics from the Social Development Commission (SDC), Statistical Institute of Jamaica (STATIN) and the Planning Institute of Jamaica (PIOJ) for selected years between 2011 to 2012. The population for the entire Outer Valley section of SEPL-541 (Figure 5-111) is approximately 25,341, with Santa Cruz, Peppers and Goshen, contribute 61%, 19% 12% respectively (Figure 5-112). The other communities within Outer Valley section of SEPL-541, collectively represent the balance of the population ranging from 1% (North Hampton, Emmaus, Southampton, Fellowship and Long Hill) to 0.4% (Friendship), Gilnock and Mitcham contribute 0.8% respectively, (Figure 5-112).

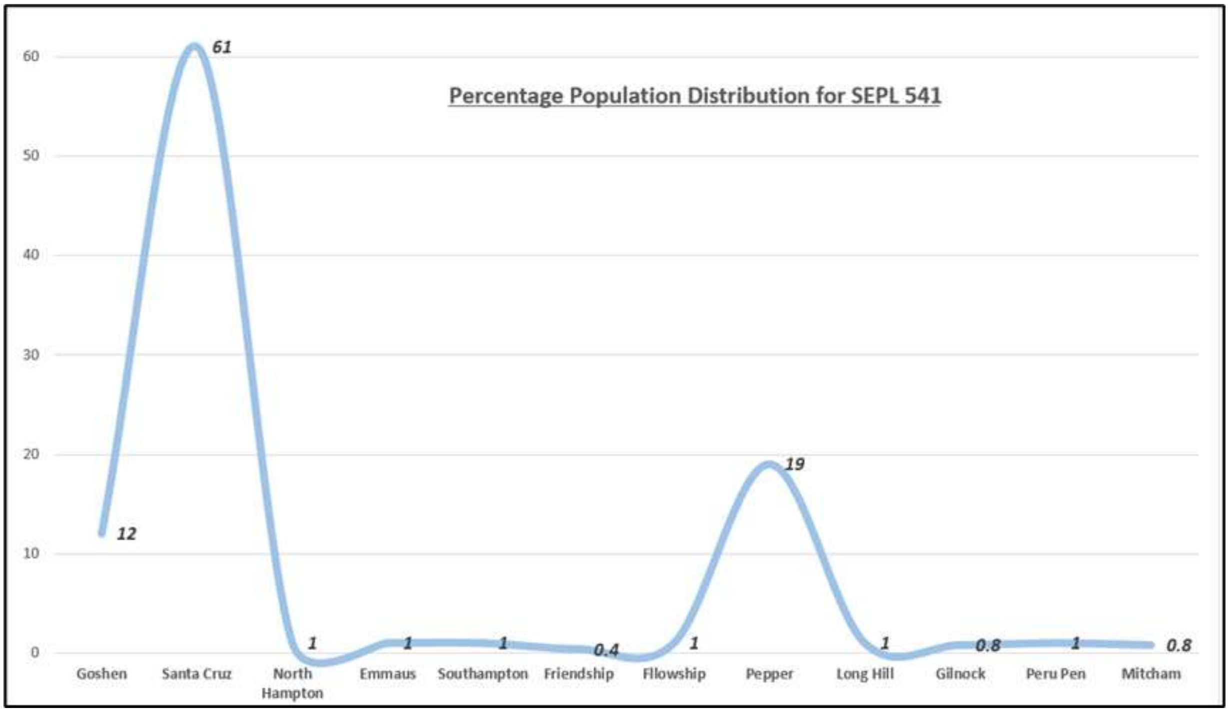


Figure 5-112: Combined percentage population distribution for project area (Source: STATIN, PIOJ &SDC)

The combined population of the communities (Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship and Fellowship) where data was collected for the extant report accounts for approximately 40% of the Goshen population (figure 5-113). ***(Note the Goshen is use to refer collectively to the seven communities above)*** Peru Pen with a sample size of 9% is followed by Mitcham and Gilnock (7.5% each), then by Northampton (7%) and Peppers and Friendship with 5% and 4%, respectively. These areas where the samples were collected for both the socio-demographic surveys and attitude and perception inventory, accounts for 49% of the Goshen's total population. These all account for approximately 1,125 persons. The other communities in the Goshen area account for the remaining population within the Special Exclusive Prospecting License for Outer Valley proposed mining area. Santa Cruz, has the largest population of 15,769[1], within the SEPL area. Unfortunately, there are not available breakdown population/demographic data for the individual communities.

[1] STATIN and SDC, 2018

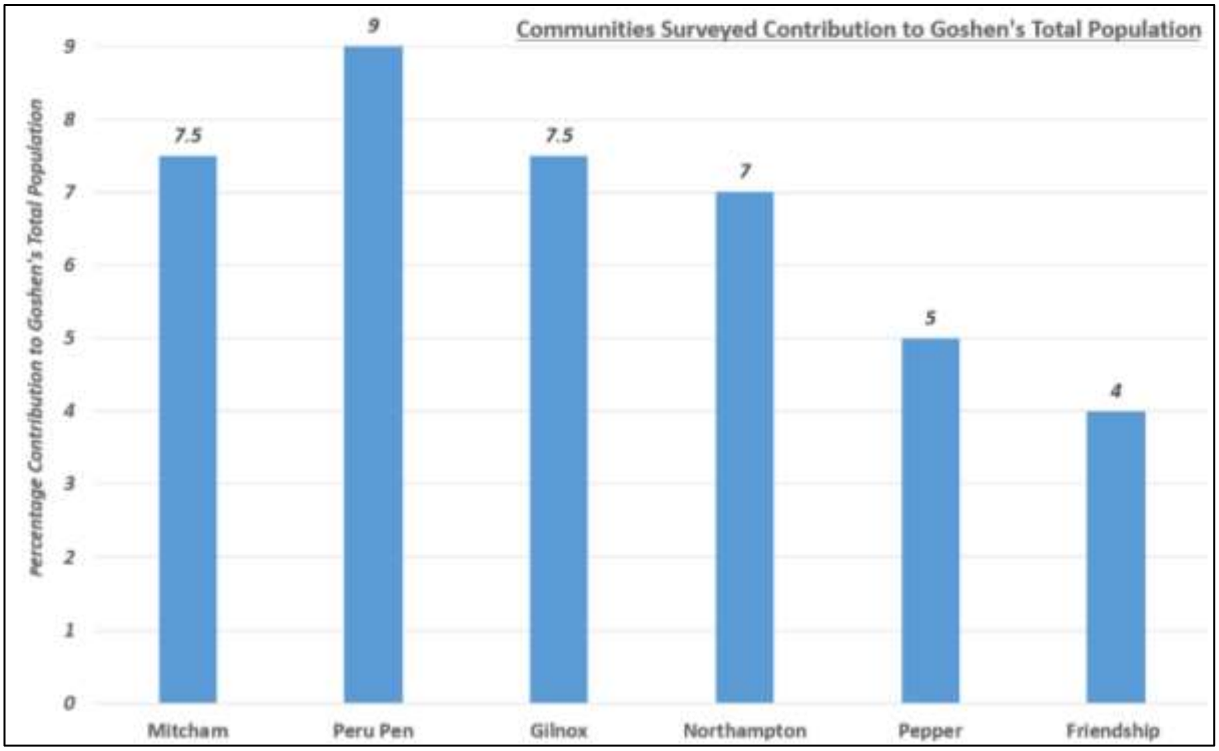


Figure 5-113: Population distribution of sample selected compared to Goshen's total population

Figure 5-114: Drone photo of part of the Goshen area (Mitcham - Left & Gilnock - Right)

Early settlement in St. Elizabeth began in the Pedro Plains where the Tainos, the first known inhabitants of Jamaica, occupied the coastline and lead a simple life. Though the original Tainos died by the 17th century, persons of Taino descent from Surinam came to settle in the parish in the 18th century and their descendants are there to this day.

When the Spanish were defeated in 1655, the slaves who did not manage to flee to Cuba, retreated to the impenetrable Cockpit Country, which included parts of St. Elizabeth. These fleeing slaves became known the Maroons and, today, St. Elizabeth remains home to the Maroons of Accompong, one of the most famous Maroon towns in Jamaica.

St. Elizabethans also played an instrumental role in the Sam Sharpe Rebellion of 1831. It is documented that about 20 to 40 percent of the slave population fought in that uprising.

This little town of Black River, now the parish capital, can boast its popularity in the 19th and early 20th centuries as a fishing spot, colourful balls and banquets – often held at 'Court-house' and its annual circus that attracted visitors from far and wide.

Black River, among the oldest towns in the island, is reportedly the first to have received electricity. The Leydens brothers were among the earliest settlers in the parish, and they are said to have imported Jamaica's first motorcar.

Though the social scene has changed significantly, the parish has forged ahead in agricultural production, providing the bulk of Jamaica's vegetable and fruit provisions. The Black River supports an important shrimp and freshwater fishery. And best of all, St. Elizabeth's diverse geographical patterns make for a landscape as rich and varied as the heritage of its people.

<u>Geographical Location</u>

St. Elizabeth lies to the southwest end of Jamaica, bordered on the north by St. James and Trelawny, on the south by the Caribbean Sea, on the west by the parish of Westmoreland and on the east by Manchester. The northern and north-eastern sections of the parish are mountainous, while an extensive plain occupies the central and southern districts. Running through this plain from north to south is the Santa Cruz range of mountains which terminates at the southern extreme with a 1,600-foot precipice. It is on this N-S plain where the communities of interest and the 80.5km^2 Outer Valley SEPL-541 are located (Figure 1). The communities of interest to this investigation are located within this plain. All equally spread from Mitcham diagonally down to Southampton. With only Emmaus, Fellowship, Friendship and Peppers breaking this North-East to South-West diagonal formation. The second-tier urban centre of Santa Cruz is located to the far West of the area away from the cluster of communities under direct interest. However, Santa Cruz, serves as the commercial capita for these communities.

<u>Main Towns</u>

St. Elizabeth has several towns of importance. These are Black River, Santa Cruz, Malvern, Junction and Balaclava. Other organized towns within the parish are Maggoty, Lacovia, Bull Savanna, Southfield, Newell, New Market, Siloah and Middle Quarters.

The main communities in and around the project area are; Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship, Long Hill, Southampton, Phantillands, and Fellowship.

5.6.1 Data Collection Instruments and Methodology

Collecting the socio-demographic and cultural environmental data included the use of a mixture of thirty (30) predetermined choice questions and thirty (30) Attitude and Perception items. Completing the socio-demographic Survey required respondents or surveyor to indicate by a tick, in the appropriate box their particular response for an item choice. Each item has an average of three options based off the nature of the item and the required response. The Attitude and Perception survey required respondents to decide if they; Agree, Disagree or were Uncertain of their perception and attitude towards a particular item.

Both data collection instruments amounted to sixty (60) items that were used to capture sensitive and important socio-demographic and cultural information to populate the EIA report and to assist in analysing the potential and anticipated environmental impacts of the proposed mining activities on the communities within the SEPL 541 Outer Valley project area and the correlation of those perceived impacts on the sociodemographic and cultural environment of the communities.

Photographic information and evidences were collected using a DiJi MINI 2 V1.0 Drone and the camera of an iPhone XR Version iOS 14.6. These photographs are used as supporting graphic evidences to the quantitative and qualitative socio-demographic and cultural environmental data and information. Microsoft Excel 2016 (2016 MSO-16.0.6729.1014-64bits), was used to collate the data and prepare graphs showing the variables under investigation.

A total of two hundred and twenty (220) questionnaires were administered, however ten (10) were discarded for errors and anomalies. Surveyors were trained in interview and survey administration techniques (Figure 5-109 Right), before they went out into the field to administer the instruments to residents (Figure 5-115 Left).

Traditional face to face collection method was employed. With the need to abide by safety and health guidelines, social distancing and mask wearing protocols were observed by all Surveyors, while in the field.

Figure 5-115: Left - Explaining Survey Instrument. Right - Field data collection in progress

Figure 5-116: Moving through sections of the Goshen Community

5.6.2 Land Use Dynamics

The predominant land uses are Mixed (50%) and Residential (48%). Lands being used for various informal purposes, open/common spaces and ruinate accounts for 2%.

None of the land parcels are reported to be exclusively for agriculture. Thirty-four (34%) and eight (8%) percent of residents disclosed that they have tombs and a water-well on their land. The next 65% and 90%, respectively said they have neither and the remaining (1 and 2%) would rather not say. The proposed lands for mining within the SEPL-541, will predominantly include ruinate and idled agricultural lands.

5.6.3 Socio-Demographic Dynamics of Area

Averaging population data from field[2] survey, STATIN, PIOJ and SDC, the entire SEPL-541 accounts for a population of approximately 25,341 persons with a density of 314.7/km^2, which is higher than the national average of 274.9/km^2. The Santa Cruz area, has the relatively highest population density (129.5/km^2) within. The population density for all the other communities accounts for 49/km^2

5.6.3.1 Gender Distribution

The sample consisted of 50%, 37% and 12.9% persons who identify themselves as males, females and rather not say, respectively (Figure 5-117). The gender distribution captured by the survey, is somewhat comparable with that of the Social Development Commission (SDC) for project area, which indicates that 52% and 48% of the population are males and females, respectively.

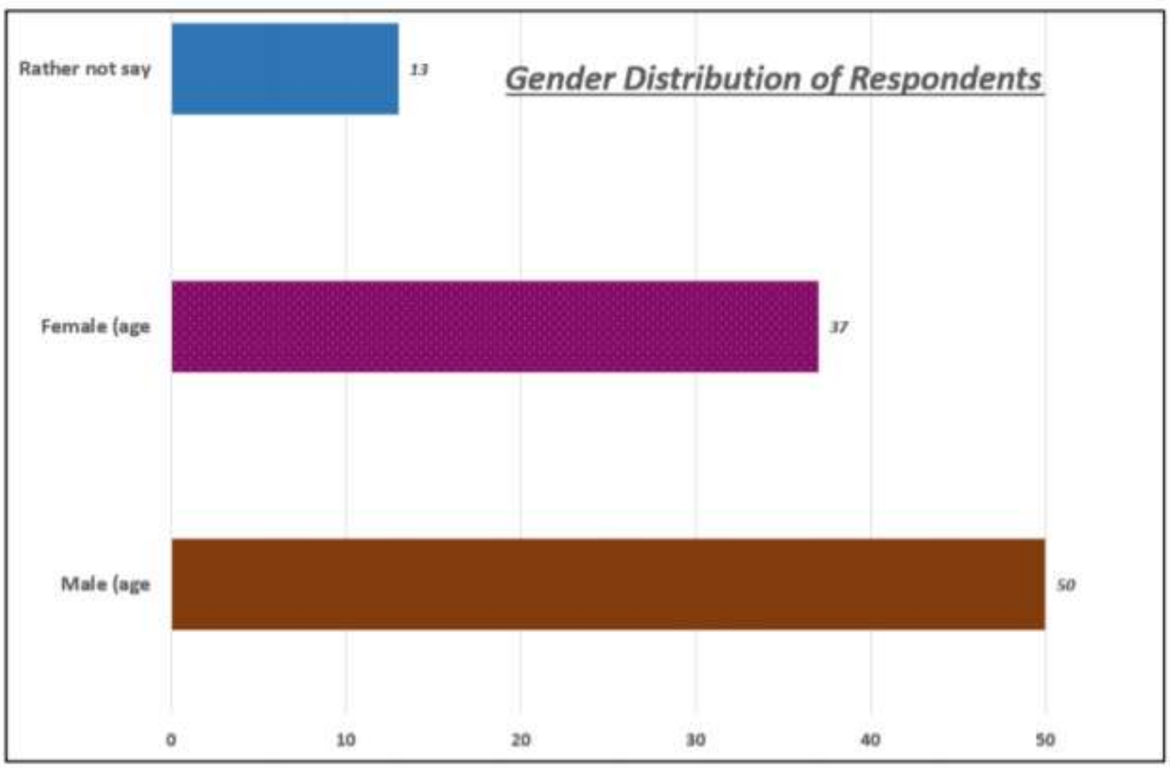


Figure 5-117: Gender distribution of respondents

[2] sample

5.6.3.2 Employment, Skills, and Education Status

Additionally, 28% of respondents were employed, 33% were self-employed and notably, 39% were unemployed. These statistics also aligned with the SDC's community profile for the area. The data shows that levels of unemployment, employment and self-employment area are 39%, 28% and 33% respectively. However, the majority of respondents, 66%, reported that they possess a skill, while the remaining 32% and 2% had no skills and were not sure of their skills status, respectively. The SDC estimates that for the communities sampled in this study 74.2% of the persons in each household are without formal academic qualifications.

Perusal of (Figure 5-118) reveals that the highest educational qualification among 48% of respondents was a high school diploma, it is most likely the case that residents possess low skill levels. This is further reinforced by the fact that the SDC's community profile outlines that 74% of households in the area are headed by individuals without some formal academic qualifications. It is also not surprising that the community profile also reveals that 30% of household are headed by unemployed persons.

Majority of respondents accounting for 47% achieved secondary education level, while 16% were trained in some vocational areas and tertiary level programmes, respectively. The remaining 21% were exposed to other educational programmes that were mainly informal but still sufficient enough to allow them to be engaged in some semblance of economic activities (Figure 5-118). Some of these include; shop keeping, *higglering* or vending, trading and loading public transportation in the town of Santa Cruz. Further analysis revealed a high level of adult and youth employment. None of the respondents reported that they were temporary employed.

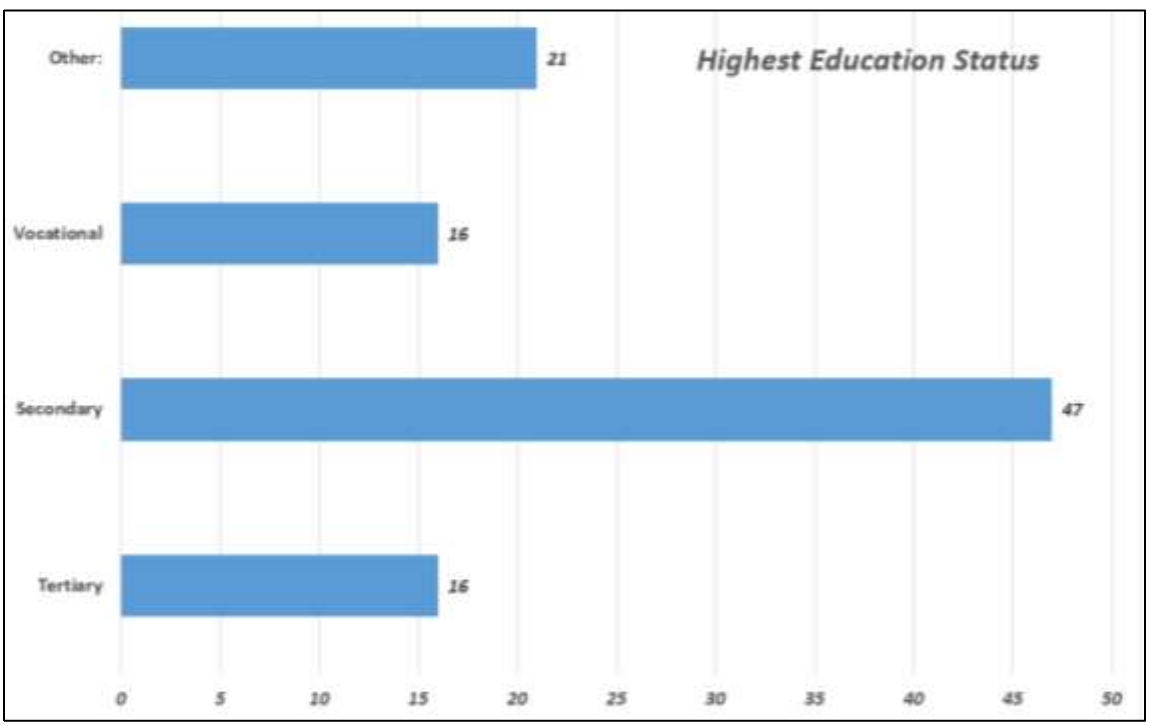


Figure 5-118: Educational Profile Status

5.6.3.3 Family and Household Size, Gender and Class Composition

Further breakdown of the gender distribution of total household surveyed revealed that of the total persons (~800) per household (PPH) covered within the survey, 49% are female and 51% are male (Figure 5-119). Additionally, household/family sizes (PPH) ranges from 68% from zero (0 to 4), 24% from (5 to 8) and the remaining 8% (>8) PPH. This indicates a relatively dominant average household size (0 to 4PPH) in the area. Further data interpretation indicates that adults (25 to 64 years old) are the dominant class, accounting for 72% of the sample. This is equally followed by seniors and youths (10 each) and then my children (0 to 14 years old), accounting for 5% of the sample (Figure 5-119).

While there is relatively balanced distribution (2% difference) of male and female gender in the sample, this balance is not represented in the age/class category shown in Figure 5-119. Males are the dominant gender in the children and adult categories, with a 25% and 17% difference in favour of males, while females are the dominant gender in the youths (11%) and seniors (32%), representing a slighter smaller dominance than the males in the other categories. There is also a higher life expectancy rate among females than males.

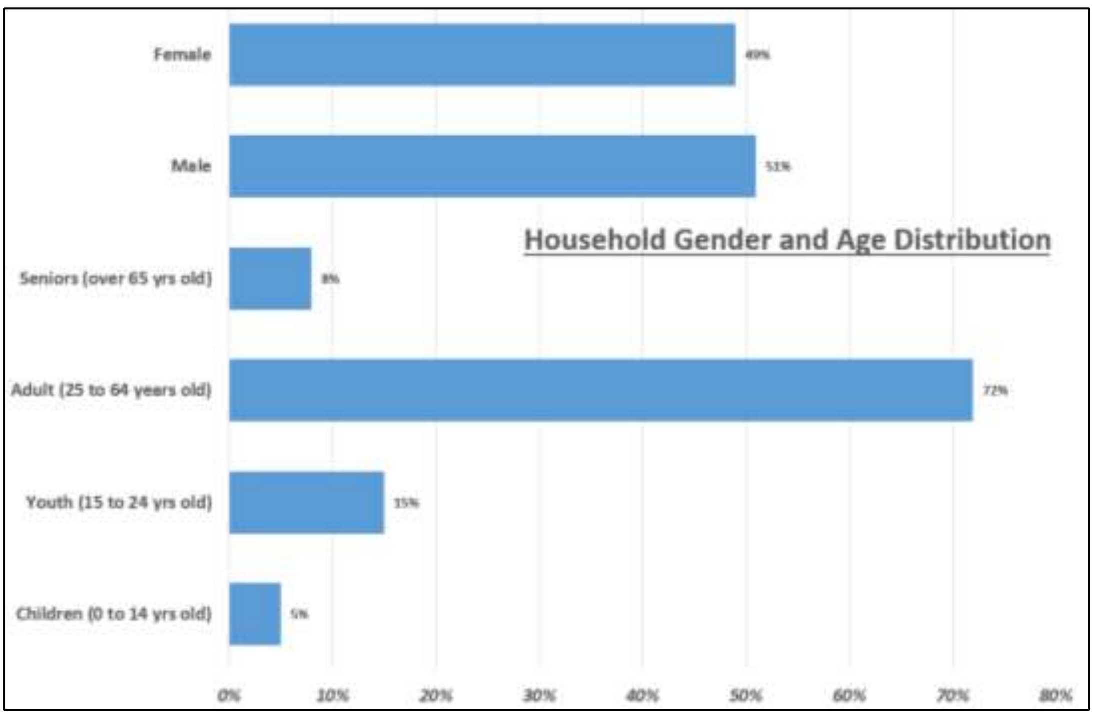


Figure 5-119: Total household age/class and gender Distribution

5.6.4 Tenure in Community

Of the total sample size approximately sixty-nine (69%) are native (born and bred) in the community. Migrants to the community accounts for 30% of the sample and the others are long term (over 6 months) and short term (two weeks) visitors.

5.6.5 Land and House (Property) Tenure Dynamics

Land tenure is across the island is a complex socio-economic phenomenon associated with the legal and political realities of the day. The same is also true of land tenure in the project area. St. Elizabeth has often been cited as one with the highest number of unregistered parcels. To this end, through systematic land registration, the National Land Agency has sought to conduct field investigations to examine the nature of land tenure rights within the parish, in an attempt to increase the rates of land registration.

The survey reveals that ownership is the most dominant tenure status, accounting for just about 53% of lands. This is followed by those living on family lands (31%), a moderate rental market of 12% and 2% lease. The remaining 1% occupy lands with various informal and alternative tenure arrangements (Figure 5-120).

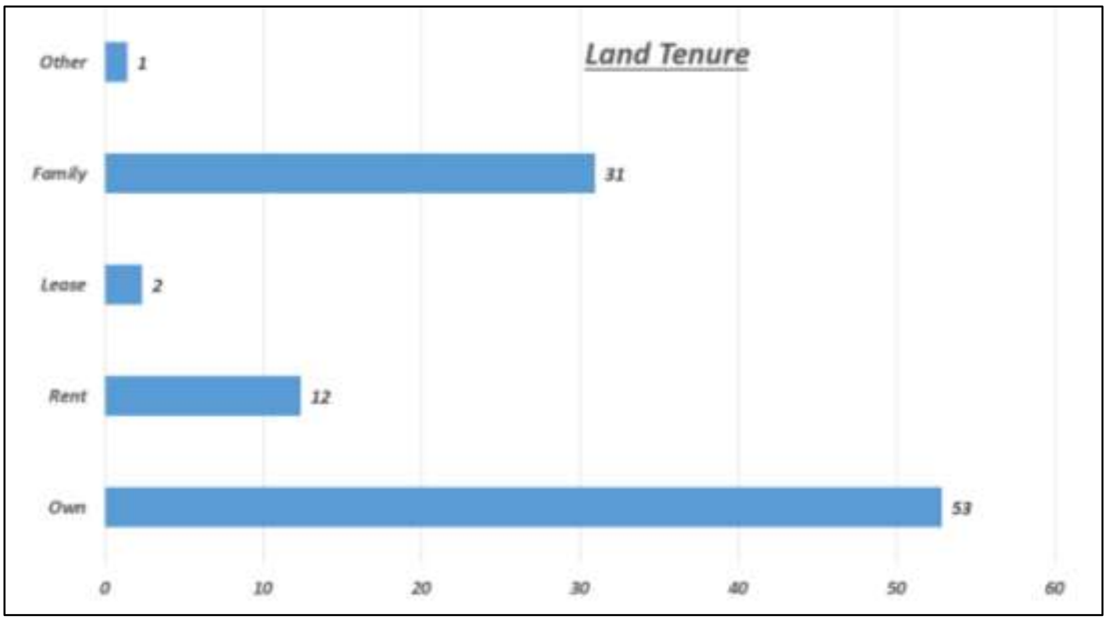


Figure 5-120: Land Tenure for communities in the Project area

The high level of unregistered parcels also has to be overlaid with the displacement of owners in the parish due to bauxite mining. In many instances, the properties that are acquired by the mining companies are without formal and legal titles. Likewise, many properties to which residents are relocated are unregistered (Pickersgill, 2015 cited in the Gleaner, 2015). Thus, it may be the case that a notable number of property owners in the parish may have purchased their lands informally and therefore, are not the registered owners on title. It may also be the case that a substantial number of individuals are in possession of land through family land tenure and may only be able to obtain formal tenure because they're have been persons in possession for a vast number of years.

Thus, when acquiring properties in the study area, mining companies are to explore the idea of entering into partnership with the National Land Agency and through that partnership enter into negotiations with the informal owners and informal occupiers of properties in Goshen and its environs, where lands will be acquired and used to relocate residents, to have their tenures regularized through systematic land registration prior to the acquisition of properties. Within the wider Goshen community 91% of respondents own the land on which they live; 7.5% live on rented land; 1.5% live for free[3].

5.6.5.1 Remote Land Tenure

The survey south to ascertain the prevalence of land ownership by residents outside of the community and also other lands owned within the community. Results reveal that approximately 20% of residents own lands in other parishes and 2% would not disclose of they did or not. The remaining 78% declared that they did not own other lands in other parishes.

With respect to ownership of other parcel of lands within the community, other than the parcel they currently inhabit, eighty-two (82%) said they did not own other parcels within the community, 12% affirmed that they in fact owned parcels within the community and 6% would rather not say if they did or not.

5.6.5.2 House and Land Size and Material of Construction

Fifty-five percent (55%) of residents live in dwellings with two to four bedrooms (Figure 5-121). The survey reveals that seventy-seven (77%) percent of residents live in houses where concrete is the dominant material of outer wall and 87% of which were concrete homes with zinc roofs. Additionally, 20% have outer wall consisting of concrete and timber, 2% timber only and 1% with other *"make shift"* material.

[3] Goshen Summary Profile (sdc.gov.jm)

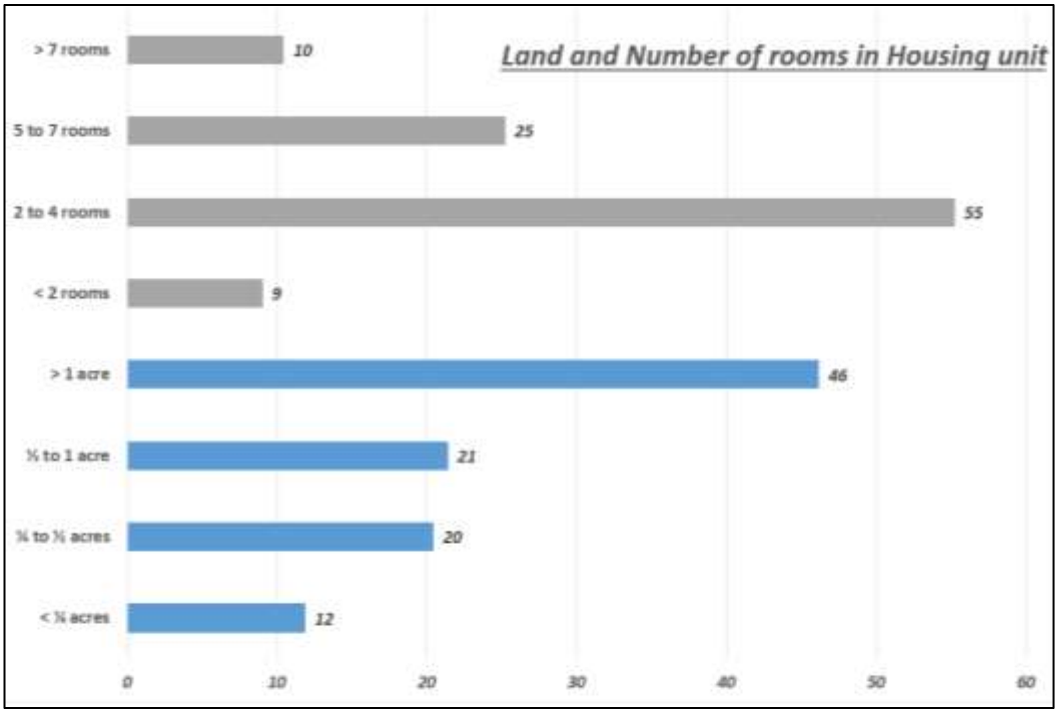


Figure 5-121: Number of rooms in house (House Size) and Land size (acreage)

It is also noteworthy that 61% of properties consisted of land and 1 building. The SDC estimates that 88.7% dwellings are constructed from concrete whilst 10.6% are made from board and other make shift material

Land sizes occupied by households include those more than one-acre accounting for 46% of holdings, while holdings from a half to one-acre accounts for 21%, a quarter ($^{1}/_{4}$) to half ($^{1}/_{2}$) acre accounts for 20% and those land holdings less that quarter ($^{1}/_{4}$) acre accounts for 12%. The relationship between number of rooms and land size is shown on Figure 5-121

5.6.5.3 Mode of Land Acquisition

Land acquisition means are shown in (Figure 5-122). Intergenerational (inheritance) land ownership accounts for 43% of land acquisitions. This is followed by purchase without and with mortgage at 31% and 13% respectively. Other means of land acquisition accounts for 10% and the remaining lands acquired as gifts accounts for 3% (Figure 5-122))

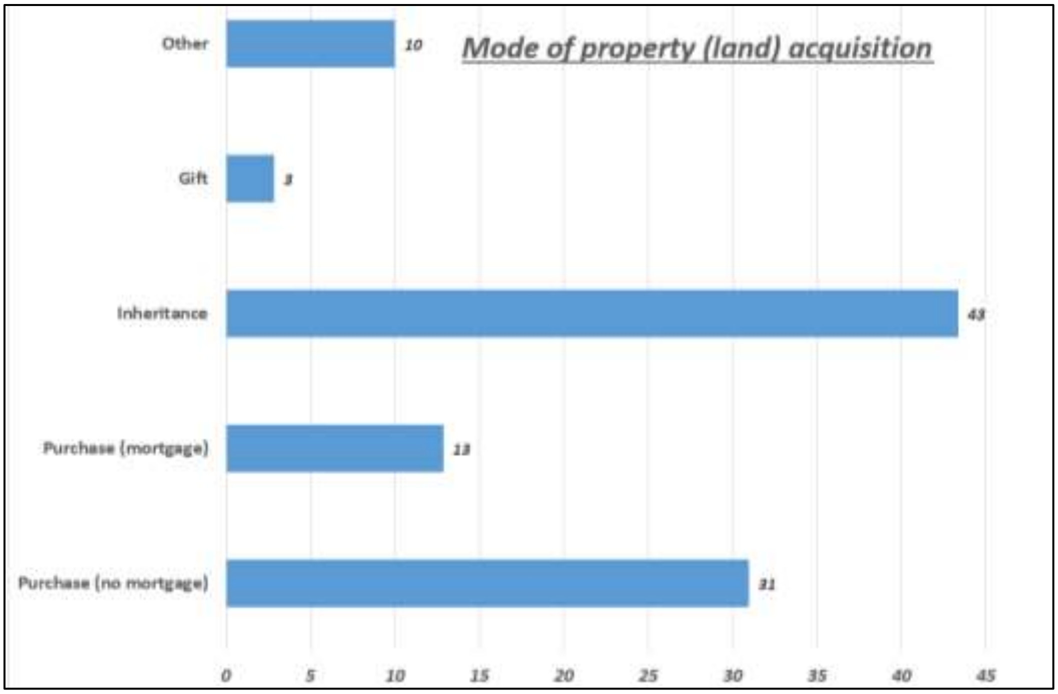


Figure 5-122: Mode of property (land) acquisition

5.6.6 Land and Housing Concerns and Vulnerability Issues

5.6.6.1 Locational Vulnerability

There are a number of location and structural concerns associated with the land and housing unit, respectively. However, the survey revealed that the vulnerability issues associated with location are low. Approximately 38% of the sample reported that there are vulnerability issues associated with the community's location and ecological and geological characteristics. The locational vulnerability issues included; flooding, hurricane, drought, earthquakes, and infestation. This is a small percentage compared with the sixty-percent (60%), who reported that there are no vulnerability issues associate with the community. A small two (2%) percentage were not sure of any known vulnerability issues.

Site visits revealed that there are some areas of ponding (Figure 5-123 - Left). This occurs both along roadways and in other areas of the communities. These ponds serve mainly as sources of water for cattle and goats and for irrigation of crops nearby, they are not suitable for domestic use or any other human use outside of agriculture. There were no evidences of landslide, soil creep or erosion. The communities have dense to semi-dense canopy and houses are mainly aligned with the meandering of the roadway and shadowed and covered by vegetation, which should shield them from storm forced winds. Some inland houses lack vehicular access and an only be accessed as a pedestrian or by bicycle or motor-bike.

Figure 5-123: Left Image - Ponding in Community. Right Image – portion of large limestone outcrop evidence of low vulnerability to landslide.

5.6.6.2 Physical and Structural Concerns and Condition of Housing Stock

Approximately 200 housing units were identified in the survey, with varying physical conditions (Figure 5-124). (Figure 5-112) already shows the distribution of housing units based off their room capacity. However, apart from the number of rooms, there are also concerns about the physical (functional) condition of the housing unit, in relation to its functionality and providing social and economic benefits to the resident.

Housing units vary by size (Figure 5-124 and 5-125), type of material for outer wall and roofing, use (multiple or single use) and access and availability to functional services (water, electrification, sewage, off and onsite sewage disposal and internet and communication services). Information derived from the SDC indicates that 88% of dwellings were concrete, while 10.6% were made of board. Sixty percent of respondents reported their properties were not vulnerable to flooding and land slippage.

Figure 5-124: Two extreme ends of the housing stock in the community

Figure 5-125: Right - Differences in roofing and housing size. (NB organic settlement layout).

Leaking roof (20%), pest infestation (31%) and lack of proper indoor-toilet facility (4%) are just some of the concerns of quality of housing stock in the communities. Additionally, 14% of the respondents and households reports general structural faults (wall cracks, broken windows and general aging) and inconveniences (pests such as rodents, insects, Rat Bat etc.), with 31% reporting that they are consistently plagued with building defects (Figure 5-126).

Insect pests include wasps, ants, termites and mosquitoes. The wasps belong to the genus Polistes (commonly called Red Wasp or Paper Wasp). Termites (commonly called white ants or duck ants) nest on trees while others prefer cool subterranean conditions. These termites infest dead trees and other timber structures such as houses in the community. Field inventory recoded at least four different species of mosquitos in the area including Aedes aegypti. These breed in the various still water retention areas in the community such as the open tanks and rain-water catchment facilities used by residents. Mosquitos are known to spread Dengue Fever, Chikungunya, Zika fever and other disease agents.

Bats (commonly called Rat Bats) establish roasts in some houses. The adult bats can be nuisances, and the guano is particularly messy and destructive. Survey recorded four species of bats which are potential users of human habitations. While lizards are harmless to humans and their possessions, they are generally regarded as a nuisance species to many households, especially, female headed households.

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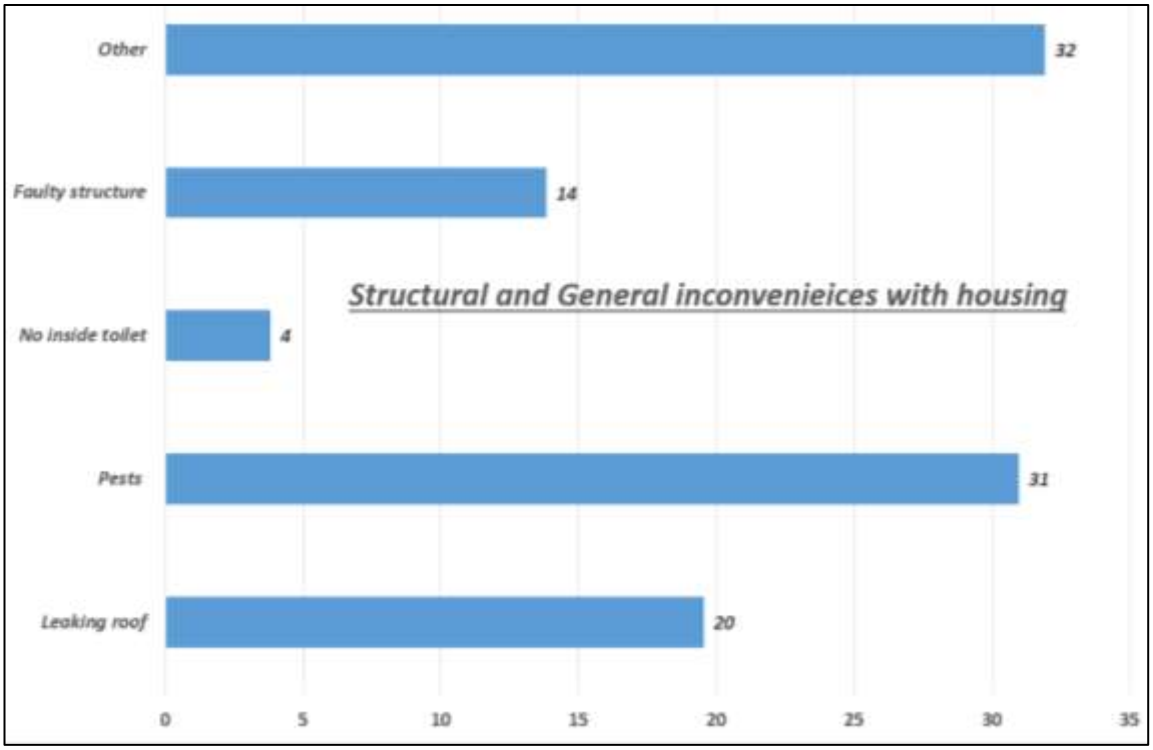

Figure 5-126: Structural and functional concerns with dwelling Units.

5.6.7 Levels of Deprivation (Community Services, Infrastructure and Amenities)

Levels of deprivation refers to the extent to which the community is deprived of basic and essential social and physical infrastructure and services, such as; potable water, sewage and waste management, telecommunication and internet services, electricity/energy, road, drainage, street signage and open spaces and political representation (Figure 5-127) etc.

For the communities surveyed, 70% of residents have access to public provided piped water and 97% have access to electricity-based lighting. Communication services such as Telephone are available to approximately 96% of residents, of which 33% utilizes both traditional land lines and cellular phone services. With respect to garbage collection services, 52.2% have their garbage burnt and picked up by trucks contracted by the National Solid Waste Management Authority (NSWMA). Liquid waste or sewage is disposed of by way of septic tanks and absorption pit toilet for 54% of residents

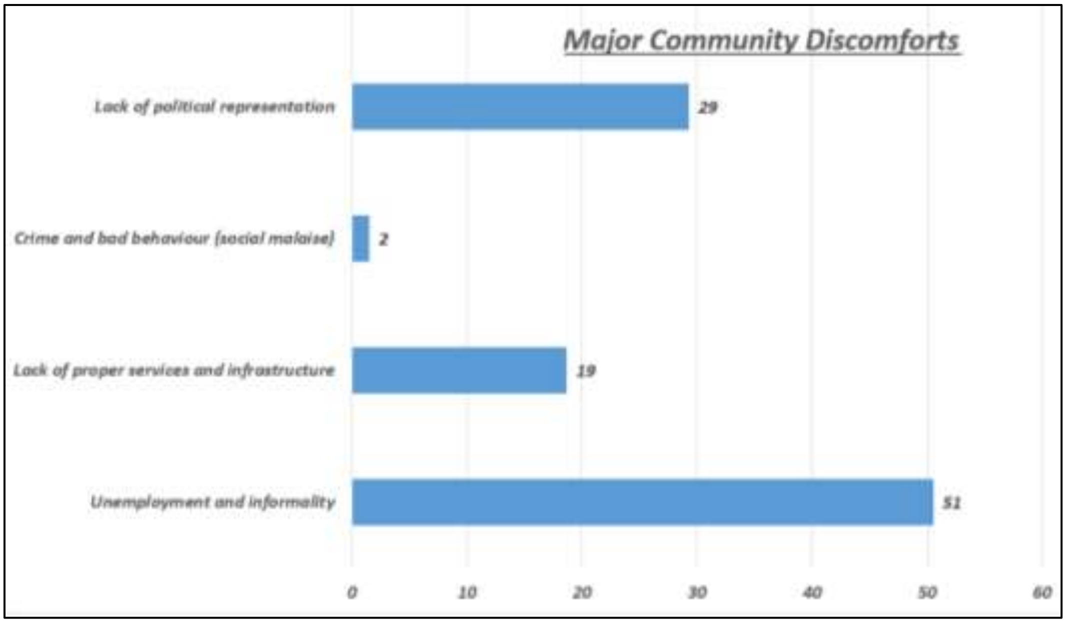

Figure 5-127: Selected community concerns associate with infrastructure and services

These are infrastructure and their related services (19%) that assist in making life “livable” for the residents. Added to these are also the non-physical services such as political and governance representation (29%), security and emergency, health and educational and spiritual services, which also contribute to healthy livelihood. Evidences of poor water provision (Figure 5-128), unpaved road, which are a dust nuisance in dry seasons (Figures 5-129)

The lack of these infrastructure and services are caused by poor and ineffective political representation and governance (29%) and unemployment (51%). These cumulatively results in crime and social malaise (2%), which is prevalent in Goshen and other similar communities in the area (Figure 18). Similarly, the SDC lists the following as major concerns among residents;

1. Poor representation by elected political leaders
2. Low water pressure or no water supply
3. Low skill levels
4. High levels of adult unemployment
5. High levels of youth unemployment

5.6.7.1 Electricity/Power and Telecommunication Services

The Jamaica Public Service Company (JPS Co.) is the major supplier of electricity to the communities, accounting for over 99% of power supply. Those using other sources and mixed sources, such as JPS and Solar, Solar only and Other are all 0.5%. Additionally, 97% of residents rely on electricity for lighting (Social Development Commission, 2011).

Telecommunication services are provided by the two dominant suppliers in the area, FLOW (68%) and Digicel (24%). Other providers provide have 9% of the supply market for internet The SDC

(2011) also reported that 96% of residents have access to telephone service with 33% of residents having access to mobile phones and landline service.

5.6.7.2 Source of Water

The main source of water for potable/domestic use is the NWC (63%), followed by rainwater harvesting (49%). The remaining sources include private wells (4%), such the one shown in Figure 122 and from other sources, such as river and water private trucks etc. (1%). The survey reveals that approximately 70% of residents in in the project area have piped water in their homes. This is clustered mainly in the communities of Peru Pen and Gilnock.

Figure 5-128: Community water catchment facility in Mitcham

5.6.7.3 Transportation Infrastructure and Services

Motorised and pedestrianized traffic maneuver the community via roadways. Majority of roadways in the communities (Mitcham, Peru Pen, Gilnock, Northampton, Pepper, Friendship and Fellowship) are served with unpaved roads (Figure 5-112). As such it is extremely difficult to navigate through these communities.

Figure 5-129: Example of the dominant road surface condition throughout the Project area

During the rainy season, residents have to contend with flooding and flooded roads, and during the wet/rainy season, they have to content with dust. Most respondents, 72%, also highlighted that they relied on public transportation, mainly motor cares taxis as their main means of navigating the communities, the remaining rely on private motor vehicle (27%) and other (1%) means of transportation other than public taxis and private motor vehicle.

5.6.7.4 Solid and Sewage Waste Disposal and Management

The National Solid Waste Management Agency (NSWMA) is generally responsible for the overall (collection and disposal) of waste in the communities. In those areas where the survey was conducted, approximately 52.2% of residents rely on the NSWMA collects their solid waste. This is inconformity with figures from the SDC (2011), where a similar percentage of 52.2% rely on the NSWMA to dispose of their waste. The remaining residents, either burn (48%) and 1% uses other means of disposal, such as burial, as a form of composting and recycling.

Soak away sewage pits are the dominant form of disposal of sewage, with 95% of respondents indicating that they use this method of sewage waste disposal. Three percentage (3%) use septic tank and the remaining 1% use other means of disposal. The high rate to soak away disposal methods is cause for concern given the high number of residents who rely on local wells for water.

5.6.7.5 Community Health and Cohesiveness (Participation)

The survey recorded that 88% of residents do not belong to any community group and club, 12% answered affirmatively. Respondents with underlying or active health concerns accounts for 44%, with 51% declaring that they did not have any. The remaining 4% and 1% were not sure and would rather not say, respectively, if they have any underlying health conditions.

5.6.8 Perception and Attitude Inventory

This section of the report measures and interprets the attitude and perception of the residents towards bauxite mining and other related activities. The overall and total average for those respondents agreeing is 105, compared with 65.5 and 47.9 for disagree, and uncertain, respectively. There are 14 positive items, 13 negative and 03 neutral items. The responses from residents are important in informing community engagement developing and formulating early mitigation measures against perceived negative impacts, as well as informing enhancement strategies of those impacts that will benefit the community and the ecological resources of the communities.

5.6.8.1 Attitude and Perception towards Negative Items

When the items' totals are assessed based on all three options (Agree, Disagree and Uncertain), significantly more respondents (48%) seem to disagree. For example, for the negative item "*Disregard for graves/tombs*", 46% disagree that bauxite mining does not have disregard for tombs and graves. Similarly, 35% agree and 18% are uncertain of the effects of bauxite mining give considerations to graves and tombs. Conversely, with negative item "*ill health*", 66% agree, with the item, while 20% disagree and 4% is uncertain that bauxite mining contributes to ill health (Figure 5-113). Another important and significant item "affect water quality". For this item the percentage distributions are 40% agree, 55% disagree and 5% are uncertain. This means that respondents largely disagree with the assertion that bauxite mining affects air quality.

There are approximately 29% more (greater percentage) disagree respondents among the negative items, compared with 71% agree responses. Analytically, a significantly larger portion of respondents are in agreement with the responses that are associate with these items. The associated items are; Open pit Mining, Affect water quality, Disregard for graves/tombs and Reduction in local business (Figure 5-130).

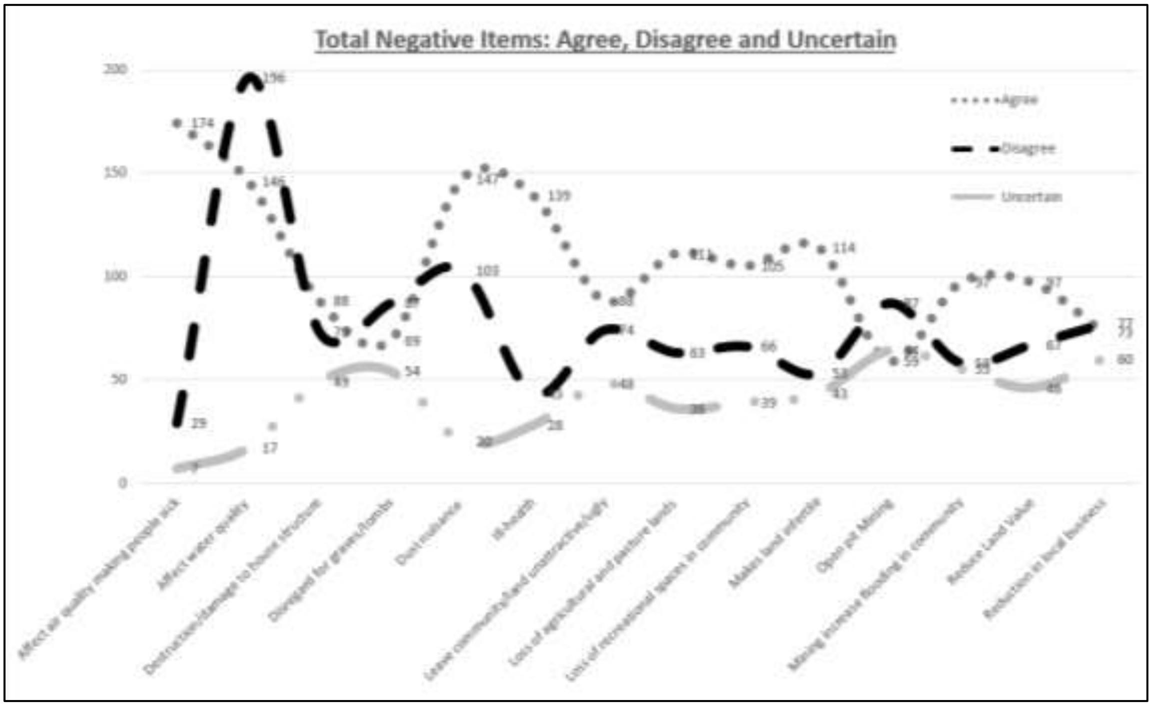

Figure 5-130: Total Negative items agree, disagree and uncertain.

5.6.8.2 Attitude and Perception towards Positive Items

When compared with (Figure 5-130), the Positive Items in (Figure 5-131), all record significantly larger percentage respondents agreeing with the positive items. The thirteen (13) positive items, for example, with regards to bauxite mining and its operations do you agree that it is; Beneficial to community (64%), Beneficial to country (76%), better infrastructure [(roads, water electricity) 51%], Restore lands (farming) and infrastructure (roads) (51%) and Support community businesses and functions (53%) and employment opportunities (71%) – (Figure 5-131). The large and significant (*perception and attitude*) contribution to providing employment opportunities puts Bauxite mining operations as having significant potential to form the economic base of the communities.

A total of 45.2%, more of the total respondents generally agree with the thirteen positive items. This is compared with 23.2% and 22.6% of those disagree and uncertain, respectively. This supports the assertion that more of the respondents have a more positive attitude and perception of bauxite mining and its operations than those with negative and uncertain perceptions and attitudes. The graph in (Figure 5-131), with the raw data also supports this assertion.

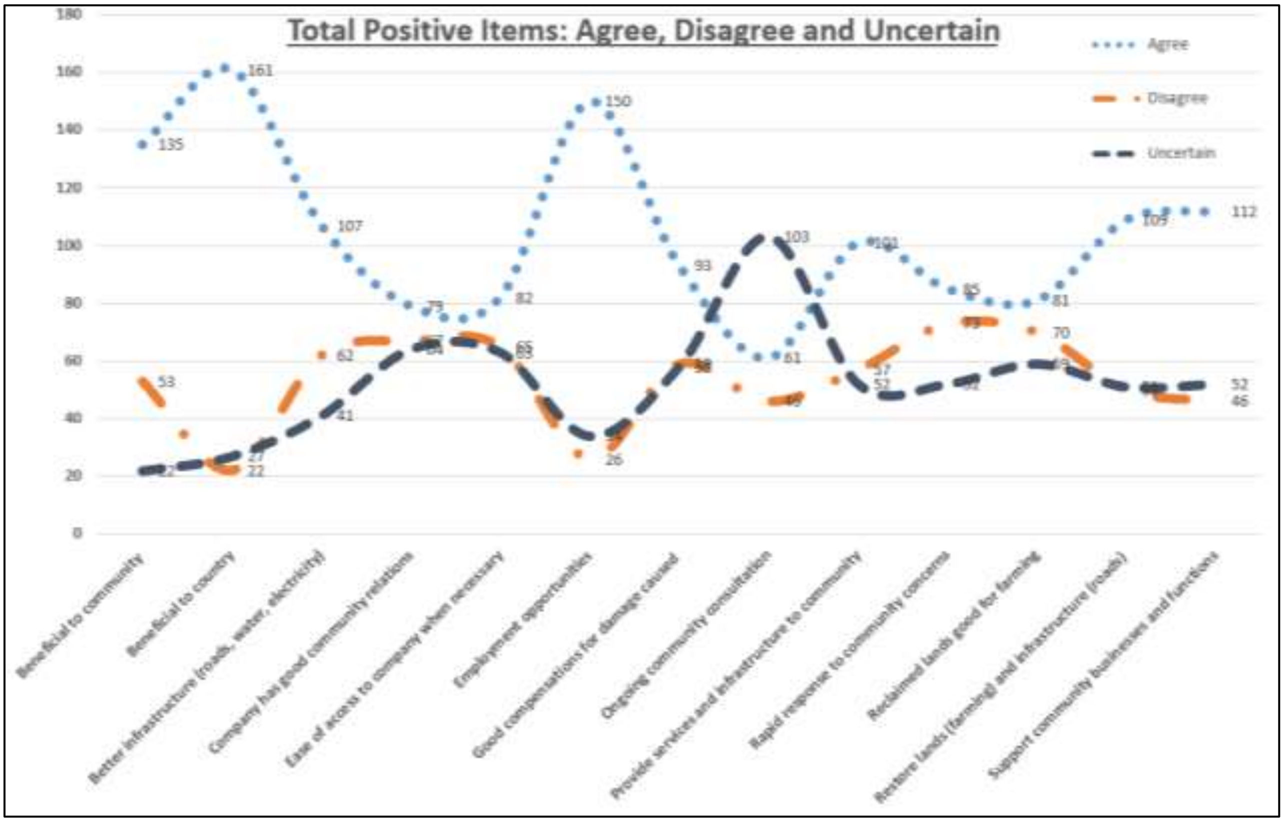

Figure 5-131: Total Positive items agree, disagree and uncertain.

5.6.8.3 Attitude and Perceptions towards Neutral Items

Three neutral items are identified in the attitude and perception inventory; Farm and Business Resettlement, Increase migration to community and Relocation/resettlement (house and family). These are neutral because they have the potential to be perceived equally as both bad and good for the community and residents. For all three items, all respondents agreed more than they disagree and were uncertain.

5.6.8.4 All items: Cumulative Attitude and Perception

The viewpoints of respondents revealed some notable positive and negative perceptions and attitude of bauxite mining in the study area. It was observed that 83% of respondents perceive bauxite mining operations adversely affected the air quality in the community. In light of this, it is not alarming that the majority of respondents (54% and 66% respectively) indicated bauxite mining leads to dust nuisance and contribute to the poor health of residents.

In February 2020, residents of adjoining communities such as Myersville, Nain and Folly among others, reported the health and environmental challenges emerging from the dust nuisance caused by bauxite mining in the areas. One resident lamented that "*dust has been affecting us* *for almost 30 years now...*" (The Gleaner, 2020), but fortunately the majority of respondents (51%) of respondents indicated they were not diagnosed with any underlying chronic illness.

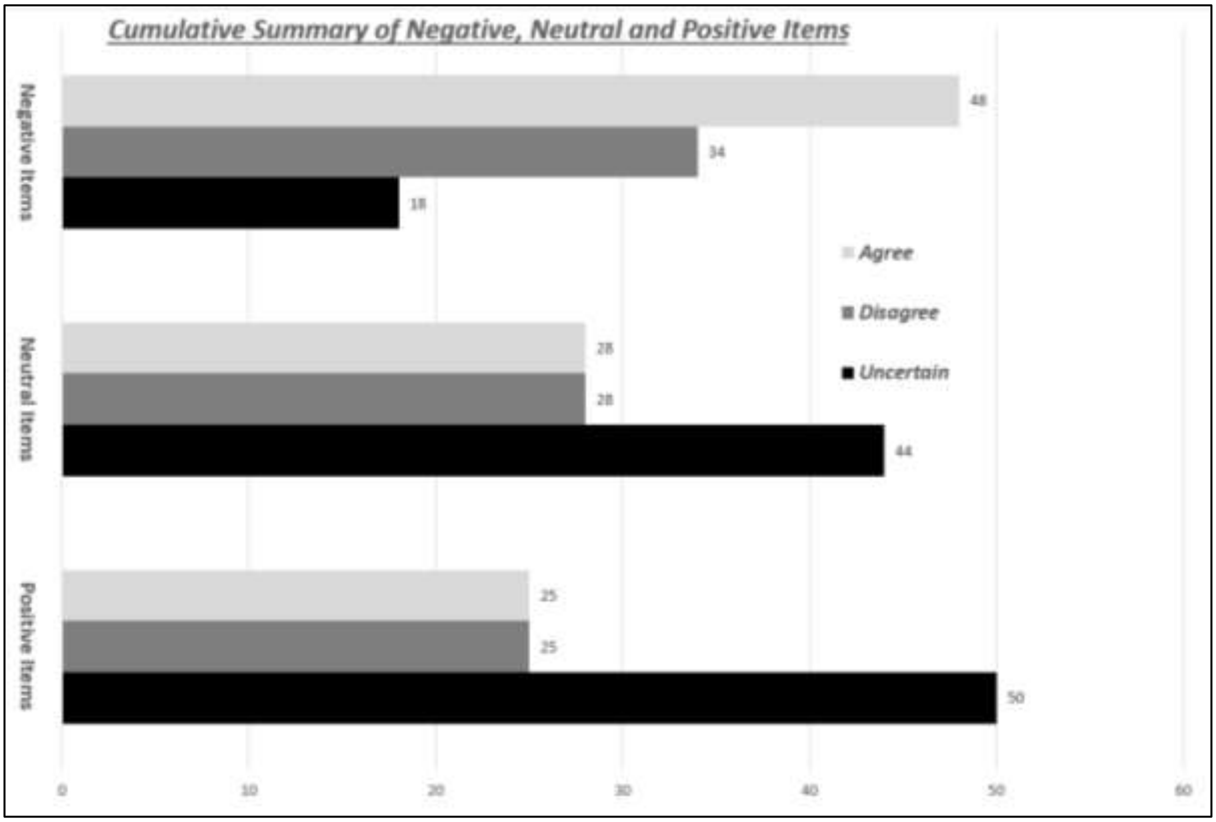

Figure 5-132: Cumulative summary comparison of all positive, neutral and negative items

Other negative perceptions and attitudes of bauxite mining (on the community) were also noted in both (Figures 5-131 and 5-132). In this respect, 44% respondents are under the perception and attitude that bauxite company pay good compensations for damage caused. Conversely, it was also perceived by 29% of residents that the bauxite company had ongoing consultation with the community prior to the commencement of mining activities.

This perception increases the positive attitude of the respondents towards bauxite mining and the company in general. It was also noted that a relatively even percentage of respondents, 40% and 35%, agreed and disagreed (respectively) that the bauxite company responded quickly to the concerns of residents. A similar distribution of respondents that agreed and disagreed was also seen when examining respondent's views on the item "E*ase of access to company when necessary".* It must be reinforced that a larger percentage of respondents have a more positive (attitude and perception) towards bauxite mining (Figure 5-132)

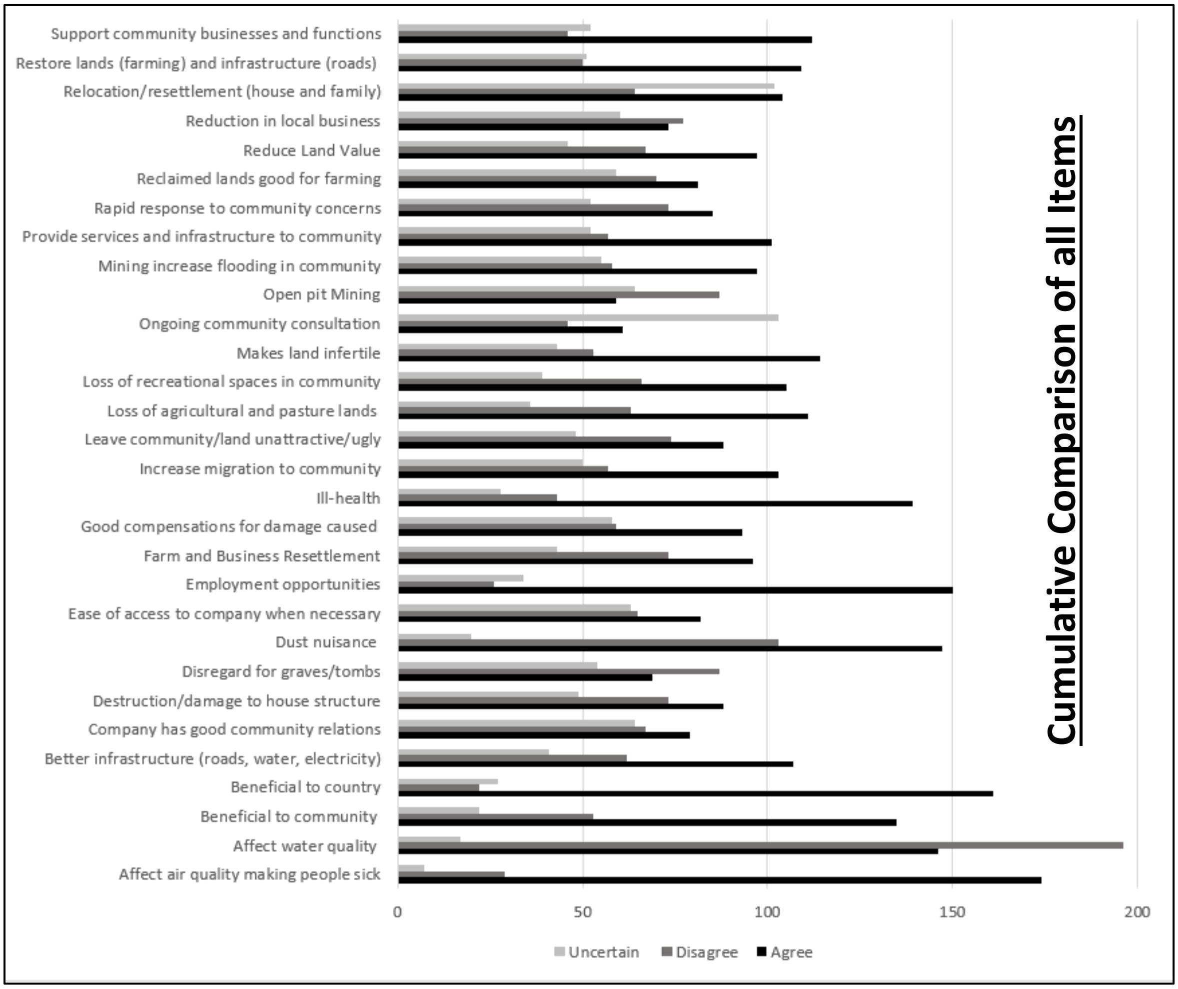

Figure 5-133: Cumulative comparison assessment of all items

Given the above, it is evident that despite the health and environmental concerns associated with bauxite mining resident obtained benefits from mining operations. Thus, it is not alarming that a notable percentage of respondents, reported that bauxite mining is beneficial for the community (64%) and country (77%), increased employment opportunities (71%), resulted in better infrastructure in the community (51%) and supported local business enterprises (53%). Similarly, Myers (2018) highlighted that the residents of Nain were happy with the resumption of bauxite mining since its suspension in 2009.

In terms of the agricultural sector, 53% of respondents maintained that mining operations result in a loss of agricultural and pastureland, while 54% indicated it makes land infertile. There were also mixed views on whether reclaimed lands were good for farming as 39% and 33% of respondents agreed and disagreed respectively with the statement *Reclaimed lands are good for farming*.

It should also be of interest that only 39% of respondents stated residents were resettled by the bauxite company after their properties were compulsorily acquired. It was also seen that:

1. 46% of respondents expressed bauxite mining reduced their land values and increased flooding in the community,
2. 42% maintained that it leaves their community unattractive and causes damage to the structure of their homes,
3. 50% stated it leads to a loss of recreational space in the community;
4. 51% disagreed that it increased migration to the community.

5.6.9 Impact Identification, Assessment and Analysis

5.6.9.1 Impact Identification

The potential impacts of the proposed mining activity on the socio-demographic assets and receptors of the communities are identified, assessed and analyzed based off their; direction, duration, magnitude, extent and significance. All elements are interconnected and contribute to the general and specific analysis of the potential impacts identified.

The base effect of these impacts on the ecological and social systems will eventually disrupt important derived and dependent economic activities, which will in turn affect the social sustainability of the community and its ecological assets. This impact is as much localised as it is regional.

Evidently, there are perceived and possible negative and positive socio-economic effects if actual mining took place in the communities assessed. The safest option to avert and manage these impacts are *"no action"* scenario. However, this option is relevant only after leveraging all the economic, social, ecological and physical and spatial dimensions of the proposal to mine. However, the economic benefits were dominant.

The *Attitude and Perception* towards Positive Items exposes the fact that generally the community overwhelmingly have a positive attitude and perception of proposed mining in the area. This is specially so with regards to the economic benefits and those benefits associated with having investments in improved physical infrastructure and social services.

The major concern of the effects on air quality in the community can be averted by adopting dust control measures and constantly monitoring air quality standards. Apart from this, there is strong support for the project and residents are willing to cooperate with the authorities to ensuring that the systems implemented to protect their interest (including options for relocation) are properly managed and executed.

5.6.9.1.1 Negative Impact

The negative effect on water quality and the dust nuisance are among the highest perceived negative impacts of the proposed activity. Secondly, is the loss of agricultural and pasture lands, ill health associated with dust and increase migration to the community. There are also perceived negative impact on community aesthetics and the loss of community recreational spaces.

5.6.9.1.2 Positive Impact

There are generally greater positive reactions to the proposed mining project from residents, than negative. Amongst the highest perceived agree positive impacts are increased opportunities for employment, economic benefits to the country, effects on community businesses, investments in community physical infrastructure and the restoration of mined out lands for pasture and agricultural lands.

5.6.9.1.3 Resilience Building and Mitigation

The history of mining in Jamaica stretches over sixty (60) years. Over these decades, the industry has embarked on a number of successful initiatives to mitigate the negative impacts of pre, post and during mining activities on affected communities. Over these decades, the levels of expertise in the industry have improved and increased. The replication of these mitigation initiatives has been successful, due mainly to the similarities in the ecological and socio-demographic of the locations, where mining and restoration has taken place.

One of the most positive effects of bauxite mining has been the restoration of mined out lands to productive farming activities. Soils where bauxite is located are frequently devoid of essential nutrients for productive plant growth, due to their high concentration of aluminum. The rehabilitation process usually incorporates soil fertility measures to improve the soil’s productivity content.

Bauxite communities are traditionally endowed with proper physical and social infrastructure, inclusive of roads, drains, water, street lighting and signage etc. Investments by Bauxite Companies in such infrastructure have improved communities’ resilience to natural hazards, that would have otherwise been vulnerable to disasters from these hazards. Additionally, strategic and sustainable land management in bauxite mining communities, have reduced the incidences of spatial informalities, such as squatting in such communities.

Additionally, the cadre of expertise among local labourers and experts has increases significantly since the early days of the industry. Increase in education and training of locals to work in various capacities in the industry has been a significant plus for communities and their families.

6 PUBLIC PARTICIPATION

Introduction

In keeping with agreed Terms of Reference of the EIA, public participation was incorporated in the process through meetings held with community members and Stakeholders within and in proximity to the Outer Valley section of SEPL 541.

The socio-economic survey that has been carried out in the area (see section 5.6) was also used as a method to inform the constituents about the proposed project and obtain feedback on their perception of the proposed development. Key stakeholders such as members of the political directorate (Member of Parliament, Caretaker, Councilor CBO and NGO were contacted by letter/email/telephone.

Process

Public meetings will be held in accordance with the Guidelines for Conducting Public Presentation at a time and location that will be agreed and signed off with the National Environment and Planning Agency. The agenda will include, presentation of the findings of the EIA. All documents will be made available to the public. In addition to this, JISCO Alpart has committed to holding additional public meetings should this become necessary to ensure communities and stakeholders are adequately informed about the project.

7 Impact Identification and Assessment/Analysis of Potential Impacts

This section presents an evaluation of the likely impacts on the environment as described in section 4 of this EIA. One of the key objectives of the EIA is identification of potential impacts and recommend appropriate mitigation measures in order and in so doing provide guidance JISCO Alpart to ensure environmentally and socially sound management of the Project during its entire lifecycle. The description of the existing conditions of the local environment provides a comprehensive data collection and analysis of the baseline conditions at the Project site. The baseline data enables the identification of the main socio-environmental factors that might be associated with Project activities. The interaction between the Project activities and the environmental and social baseline conditions of the ecosystem at the Project site is at the core of the EIA.

The EIA is designed to forecast the positive and negative effects that may occur to the receiving environment. The early identification of impacts that may occur in the area leads to a reduction of the risk of future adverse environmental effects, and permits the proposal of mitigation guidelines/measures to avoid, reduce or remediate significant adverse effects. The EIA also acknowledges potential socio-economic impacts, and predicts the effect on people and communities occurring as a result of the Project.

In this section, key biological, physical, and human receptors are selected from the baseline data. The impacts of the Project activities on each of these “Valued ecosystem Components” are evaluated using a significance ranking process.

Definitions:

An environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from a facility's activities, products, or services.

Potential impacts identified as being associated with the implementation of the project are divided into the following categories:

- ❖ Physical environment
- ❖ Natural Hazards
- ❖ Biological
- ❖ Heritage
- ❖ Human/Social/Cultural
- ❖ Public Health

An assessment of the identified potential impacts is presented below

Table 7-1: Ranking of Environmental Impacts

No.	Attribute	Character of Attribute	Description
1.	Significance	Major/Significant	Impacts are expected to be permanent and non-reversible or partially on a national scale and/or have international significance or result in legislative non-compliance its use or valuation by the community
		Moderate	Impacts are for the duration of the activity, reversible and will affect only a limited number of persons.
		Minor	Impacts are short term and reversible
		Insignificant	No impact is expected
		unknown	There is insufficient data on which to assess significance.
2.	Impact	Positive	Effects are beneficial
		Negative	Effects are detrimental
3.	Duration	Short	Impact will be for the duration of a limited period such as the pre-construction and construction phases of the project. A timeframe of one year or less.
		Medium	The impact will have effect for over a year but is still of limited duration.
		Long Term	The effects will be felt for more than one year.
4.	Type	Direct	Caused by the Project and occur simultaneously with Project activities.
		Indirect	Associated with the Project and may occur at a later time or wider area
		Cumulative	Combined effects of the Project with other existing/planned activities
5.	Reversibility	Reversible	Environment can be restored to pre-project state within reasonable time when activities cease without any significant intervention.
		Irreversible	Environment cannot be restored naturally to pre-project state within reasonable time when activities cease.
6.	Mitigatability	Mitigatable	Environmental impact that can be eliminated or significantly reduced with intervention of human actions

		Non-Mitigatable	Environmental impact that cannot be eliminated or significantly reduced with intervention of human actions

7.1 Project Impact Assessment & Mitigation

Table 7-2: Impacts and Mitigations

Activities	**Potential Impact**	**Mitigation**	**Duration/Nature**	**Impact After Mitigation**
7.1.1 Physical				
Haul Road Construction: Site Clearance and removal of overburden material Harvesting of material for road construction Transport of material for road construction Spreading and compaction of material Crossing over public roads	- Fugitive Dust impacting air quality - Contamination of groundwater and well - Damage to underground pipeline - Aesthetics -Soil erosion -Increased turbidity in water bodies	• Minimize the size of cleared area; periodic wetting; wearing of PPE on site . • Cover any overburden stockpile • Buffer area around wells (30M) • Search and detect for underground pipe before site clearing/mining and create buffer zone • Design haul roads to camber the roads to control runoff away from areas that threaten to erode or result in substantial turbid surface runoff to adjacent marine waters. • Monitor areas of exposed soil during periods of heavy rainfall to ensure erosion can be addressed where necessary • Stockpile material must be covered or wetted to prevent wind erosion • Wet Access Roads • Trucks with materials must be covered to prevent fugitive dust emissions • Trucks must not be overloaded to prevent spillage to the environment • Immediate clean-up of spilled material	Moderate/Negative/Short term/Direct/ Reversible/Mitigatable Moderate/negative/short term Minor/negative/short term	Minor/Negative Minor negative insignificant

Activities	Potential Impact	Mitigation	Duration/Nature	Impact After Mitigation
		• Where haul roads cross public roads erect warning signs on roads and utilise flag persons to control traffic at crossings. •		
Heavy Equipment Operation	- Air pollution from vehicular emissions. -Greenhouse gas emission -Soil and water contamination from oil and other Chemical use -Noise from excavating, general mining activities	• Proper maintenance of vehicle and equipment. • Use fuel efficient and properly maintained vehicle and heavy equipment • Fuel and other onsite oil storage facilities must be properly bunded and maintained. • Emergency and Spill Response plans must be established • No routine maintenance activities should be done on site • Restrict drilling and blasting and noisier activities to normal working hours • Inform residents to be potentially affected of the pending activities • Conduct noise monitoring during noisy operations to ensure stipulated Noise levels are not exceeded off site • Limit operating hours	Short term/ Direct/Reversible/ Mitigatable	Minor/Negative Moderate
	Dust from excavation during mining	• Stop mining operations during dry and windy conditions. • Implement Air Quality Monitoring Programme for Total Suspended Particulates and ensure compliance to standards.	Short Term/ Direct/ Reversible/Mitigatable	Minor
	Increased bauxite mining, alumina production and red mud output.	The most environmentally friendly technology must be utilized for residue disposal in order to eliminate possibility of seepage into groundwater	Long Term/Direct Reversible/Mitigatable	Major
Workers on Site	- Generation of solid waste	• Establish proper garbage receptacle and disposal.	Short term/ Direct/Reversible/ Mitigatable	Minor

Activities	Potential Impact	Mitigation	Duration/Nature	Impact After Mitigation
	-Human waste generation - Water demand and supply	• Proper temporary sanitary facility with good servicing Proposed training of workers on site on safety, proper solid waste management and use of bins		
Water Supply to the site (Trucking and Tanks)	Vehicular Emissions to air	Utilise well maintained trucks. Schedule minimum amount of truck loads.	Short term/ Direct/Reversible/ Mitigatable	Minor
Drainage	Run-off going to sensitive receptors and private property	Utilise surveyor's report and camber pits such that run off flows to lowest section of pits.	Moderate/Negative/ short/direct/ irreversible/mitigatable	Minor
Sewage Treatment & Disposal	Improper disposal of sewage	Only certified suppliers where Portable toilets are utilised.	Minor/Negative/Medium Term/direct/ irreversible/mitigatable	Minor
Solid Waste	Improper Solid Waste Disposal	Dispose of solid waste in an approved manner. E.g., Remove solid waste to refinery for disposal	Minor/Negative/ short/direct/ irreversible/mitigatable	Minor
Waste Water/Trade Effluent	Improper disposal of waste water and trade effluent	Prohibit Maintenance activities that would generate waste water/trade effluent	Minor/Negative/ short/direct/ irreversible/mitigatable	Minor
Power Supply	Burning of fossil fuels	Ensure that emission from power generation is in compliance with air discharge license.	Minor/Negative/ short/direct/ irreversible/mitigatable	Moderate
Communications	Communications will be by way of two-way radio and cell phones	Use approve/licensed service providers.	Insignificant/Positive/ short/direct/ reversible/mitigatable	Minor
Transport Systems and supporting infrastructure - installation of cable belt	Generation of noise.	• Service tools and equipment to reduce noise. • Limit work to set operating times • Carry out noise monitoring	Moderate/Positive/ short/direct/ reversible/mitigatable	Minor
7.1.2 Natural Hazards				
All activities	For the reasons stated in the preceding sections, this project will be vulnerable to natural disasters such as hurricanes, earthquakes, flooding and drought.	• Ensure compliance with existing Emergency Response Plans.	Long term/Negative/ Indirect/Irreversible/ mitigatable	Major

Activities	Potential Impact	Mitigation	Duration/Nature	Impact After Mitigation
7.1.3 Biological				
All activities	- Loss of vegetation, Habitat and Bio-Diversity - Damage to aquatic life from soil washed into water bodies - Habitat Fragmentation - Loss of Fauna	• Carry out detailed Flora/Fauna Study and follow detailed mitigative actions as outlined. • Reserve as much buffer as possible • Carry out progressive rehabilitation. • Limit Site clearance to working footprints so as to retain as much of the original vegetation for as long as possible.	Moderate/Negative/Short term/Direct/ Reversible/Mitigatable	Moderate
7.1.4 Socio-Economic				
All Activities	Employment of skilled labourers and equipment operators Commercial activity (potential Increase) Displacement/Relocation of residents Disruption/Contamination of water supply especially for rainwater harvesting Loss of livelihood (eg Farmers currently farming on leased land)	Employment to be done as per project guidelines and laws of Jamaica Minimise mining where there are houses Ensure that the interest of residents is protected during relocation by adhering to established procedures There must be no disturbance of existing water supply as water supply pipelines must be preserved. Where rainwater harvesting is disrupted alternative water supply must be provided. Legal tenants on Alpart owned land must be given adequate notice so that growing crops at the time can be reaped before mining. Purchasing of lands must be done according to established procedures.	Short term Long term	Major/positive Major/positive
7.1.5 Heritage				
Site Clearance	- Possible damage of cultural artefacts	Site clearance to be done keeping a keen eye out for potential	Long term/Irreversible	Minor/negative

Activities	Potential Impact	Mitigation	Duration/Nature	Impact After Mitigation
		artefacts, which if found will be secured.	Short Term/Irreversible	Major/Positive
7.1.6 Public Health Issues of Concern				
All activities	Fugitive dust from operations may trigger upper respiratory reactions to workers and community residents.	Minimising dusting by wetting and suspension of activities in extremely dry or windy conditions. Vigilance in enforcing the provision and use of required PPE	Short term/Irreversible	Major/positive
7.1.7 Risk Assessment				
Public crossing over the boundary into mining operations Trucking during extreme conditions such as heavy rain	Encounter with heavy equipment or truck Human or animal falling int mine pits Skidding of trucks or other such incident	Proper and adequate signage to keep out and danger and vigilance of Security Fencing of high-risk areas Vigilance in monitoring operating conditions: weather, truck loading and other aspects that could cause adverse incident like overturn of truck		

8 IMPACT MITIGATION

The impacts listed in Section 7.0, address potential negative/positive effects of the project. The mitigation measures which have developed based on the unique characteristics of the study area and the findings from the various investigations are also included in the matrix presented in Section 7.0. Compliance with regulatory requirements and the application of best practice should ensure minimum adverse long-term effect from the project.

At the end of each applicable sections of this report, impacts have been identified and mitigation measures recommended based on the findings from the specific study. The recommended mitigation measures are presented below.

8.1 GENERAL

Bauxite mining by nature inherently poses significant positive and negative environmental and social impacts. During the course of conducting this environmental impact assessment, several potential impacts were identified and evaluated. It is to be noted that with proper management and mitigation most of the identified impacts are reversible once proper rehabilitation is carried out after completion of mining activities.

The general categories of potential impacts include:

- Change in land use
- Displacement of flora and fauna
- Aesthetics (visual impact)
- Dislocation of persons
- Noise and Air pollution

The general mitigation measures to avoid, reduce or prevent the identified impacts include:

- Development of a comprehensive mining plan which is informed by current accurate data and incorporate the application of best practice with most efficient technology.
- Maintaining adequate buffer between sensitive areas/infrastructure.
- As much as possible avoid mining in or very close to populated of built-up areas.
- Where unavoidable undertake proper relocation/compensation of persons or other items of conservation significance such as endemic flora and fauna.
- Implement a robust system of monitoring during operation.
- Develop and implement appropriate risk management and emergency response plan.
- Ensure prompt rehabilitation of mined out areas in compliance with regulatory requirements.
- Establish good community relation and communication channel with stakeholders.

8.2 WATER RESOURCES

While no formal study has been done on the impacts of bauxite mining on water resources in Jamaica there has been no recorded detection of quality or quantity issues resulting from the mining of bauxite. The Water Resources Authority (WRA) maintains monitoring networks for ground (over 1800 sites) and surface water (over 130 gauging stations) systems across the island. Surface water systems draining bauxite mining areas on both the north and south coast as well as groundwater systems tapping the White Limestone Formation with which the bauxite deposits across the island are associated are regularly monitored.

The updated Water Quality Atlas 2019, published by the WRA, showed that, to the date of publication, bauxite mining along the south coast of the island did not cause or result in any contamination of either groundwater or surface water resources in the Rio Minho or Black River Hydrologic Basins, which Basins are spread across the South Coast of Jamaica and include the areas subjected to bauxite mining.

8.2.1 Wells Within Outer Valley Section of SEPL 541

The larger ore body deposits are located to the southeast within the Outer Valley section of SEPL 541 between Long Hill, Northampton, Southampton Goshen. Smaller deposits are located in the Pepper area and just south of Santa Cruz

The NWC well at Southampton, one of the sources of water for Santa Cruz, has one large deposit nearby as well as the Long Hill well, the source of water for the Essex Valley and Junction. There is a small deposit in the vicinity of the Pepper monitoring wells and the JISCO Pepper well field. There are no proposed mining sites in close proximity to the NWC's Mandeville wells - Pepper 1, 2 and 3. The deposits around the JISCO Pepper wells are all upgradient of the NWC's Mandeville water supply wells at Pepper and mining these deposits may be impactful on these wells.

Mining of bauxite close to the wells may remove or loosen the overburden leaving the upper part of the steel casing of the well exposed and susceptible to damage. In order to address this risk a buffer zone of at least 30 metres around wells or other such infrastructure is recommended.

The construction of haul roads to move the bauxite mined to the plant will require the compaction of the road surface using heavy duty equipment the vibrations of which may impact the casing of the wells even to the point of the casing being shaken out of verticality. If a pump is installed in the well this may affect the pump operations and the sustainable production of water. In addition, the road surface may be blacktopped using heavy oil and runoff from the road surface may compromise water quality especially via sinkholes and fractures in the highly permeable Newport Limestone Formation. **It is important that caves, sinkholes and other solution features be identified close to each deposit to be mined, and prior to mining being started so that buffer zones can be established to prevent possible incursions into the groundwater.**

Consideration must also be given to the fact that an occurrence upgradient of a well or group of wells may have an impact on that/those well/wells. This is especially important in relation to the NWC's Pepper wells (Pepper 1, 2, 3 wells) that provide water to the Greater Mandeville Area, Santa Cruz and Essex Valley-Junction water supply (Southampton, Santa Cruz 1 and 2 and Long Hill wells) and Pepper water supply (Phantilands well). It is recommended that a minimum distance or buffer between wells and the mining areas be established to prevent any impact on wells and water supply. This should include all wells whether in production or not. The protection of monitoring wells must also be given priority as the data record needs to be extended to measure impacts of the mining operations and the longer the record the greater the confidence in the analysis of the data.

There are pipelines laid across the area of SEPL 541 that transmits and distributes water to towns and communities such as Santa Cruz, Pepper, Junction and Mandeville and to industries such as the JISCO Nain bauxite plant. These pipelines were laid before the advent of digital systems that recorded the locations, type, diameter and other criteria and in many instances the exact locations are not known. Where pipelines are located through or within bauxite deposits, the mining of bauxite may result in damage to the pipelines. This would disrupt water supply to citizens and pose a risk to health and sanitation through contaminants entering ruptured pipelines. **It is recommended that where available the pipeline routes be obtained from the NWC and SEMC and if not available then the mining areas be scanned to detect possible pipelines before mining takes place.**

The mining of bauxite deposits identified within the SEPL 541 is made more difficult by the high level of groundwater development that has taken place over the past 70 years since Kaiser drilled the Pepper well and the number of wells constructed. Planning and preparation of detailed mining plans with emergency actions to be taken if there is an emergency can minimize the risks to water resources and the water infrastructure within the Outer Valley section of SEPL 541.

8.3 AIR QUALITY

The moisture content of bauxite is relatively high (20% – 30%) as a result the generation of dust during mining is very low. Trucks will be used to transport the bauxite from the mine pit to the stockpile using haul road that are generally not pave and this activity has the potential of generating significant amount of dust.

A dust monitoring and control plan must be implemented to include:

- ❖ Safety and Mining officers monitor the dusting situation. Water is used as a dust suppressant and trucking is halted if the dusting is considered excessive.
- ❖ Maximum speed limit (40km/hr) to be mandated on the haul roads and adequate signs erected. Security patrols monitor and enforce same.
- ❖ Maintain system and equipment and apply water (wetting) of haul road as needed.
- ❖ Ensure the truck are covered and not overloaded to avoid spillage along the haul road.
- ❖ All unsealed surfaces will be regularly wetted (water truck) with the frequency determined in response to visual observations and daily climatic conditions.
- ❖ The number of exposed surfaces at any point during the life of the operations will be minimized. The timing of land clearing and stripping will be undertaken in accordance with the framework of the mine plan.
- ❖ Haul roads will be maintained by graders and water trucks.
- ❖ Dust generating activities will be minimized or avoided during dry and windy conditions.
- ❖ Stockpiles will be maintained in tight zones and watered down where necessary.

8.4 NOISE

The vast majority of ore bodies are located in isolated areas away from population (receptors) and as such noise impact is expected to be minimal. Nevertheless, noise control measures should be employed as follows:

- All mining equipment must be serviced and maintained to obtain optimal operating conditions and where possible fitted with noise reducing devise (silencer/muffler).
- Excess backup alarms will be limited while considering safety as a priority.
- Community Meetings will be held with residents to get feedback on noise levels.
- Noise levels Must be measured in surrounding communities and appropriate actions taken.
- Mining time will be limited to day time hours and six days per week.
- Where noise from mining operation could impact places of worship, mining activities are to be suspended during times of worship.

8.5 LAND USE AND HABITAT LOSS

The nature of bauxite is such that it involves the extensive land clearing and removal of topsoil in order to access the mineral which may be found between 1 – 30 metres below surface. The project will therefore result in significant loss of land use and natural habitat for both flora and fauna.

The orebodies where mining will occur within the project area are all currently disturbed site, which are mainly grasslands and field. The habitat loss is therefore not as significant.

The mandatory regulatory required rehabilitation once mining is completed will also ensure that in the long term the habitat is restored.

8.6 Safety Programme

Worker Safety will be managed using the JISCO Alpart Safety Program. All employees or the relevant contractor/sub-contractor will be equipped with proper personal protective equipment (PPE) as required for working on Alpart premises including; safety glasses, mono-goggles, face shield, hard hats, steel-toed rubber safety boots, ear protection, leather gloves and the like. Dust masks shall be worn when working in dusty conditions. The relevant safety program will be in place for all employees to observe Alpart's Safety Rules and perform their work in a safe manner throughout the execution of the job. Alpart's Safety Rules will be communicated during scheduled safety orientation sessions and daily Job Safety Analysis or Job Safety Plans will be done prior to any field activity.

8.7 Mine Closure

8.7.1 Decommissioning

The mine closure plan will have two components - Progressive or concurrent mine closure and final mine closure or decommissioning. Progressive mine closure will include the restoration done continually during the period of the mining operations, whereas final mine closure or decommissioning includes activities towards end of life of the mines. Decommissioning will be managed according to the various closure elements which are detailed below:

8.7.1.1 Mined-Out Land

Mined out land will be restored for future use. Details of reclamation and rehabilitation are outlined below. Mined out land will be restored as per the requirements of the Mining Act. The Mines and Geology Division of the Ministry of Transportation and Mining is the chief regulatory agent responsible for the acceptance and certification of mined out lands.

8.7.1.2 Water Quality Management

Alpart will continue to monitor water quality in the area from wells, streams and other water features within the mining area.

8.7.1.3 Air Quality Management

During the decommissioning stage and for one year after Alpart will continue to carry out air quality monitoring using Hi-volume and PM10 stations.

8.7.1.4 Infrastructure

The haul roads will be assessed as to future utilization. If a decision is made to decommission, it will be rehabilitated by covering with topsoil and planting appropriate vegetation. The conveyor belt will be decommissioned by dismantling and relocation of the structures. Support facilities and other infrastructure like electrical transmission line, water line, water works, sewer line, telephone cables will be relocated.

8.7.1.5 Disposal of Mining Equipment

The decommissioning of mining equipment will involve removal and relocation of equipment such as excavators and graders.

8.7.1.6 Safety and Security

The area will remain under the surveillance of Alpart's security organization.

8.7.1.7 Disaster Management and Risk Assessment

Possible natural hazards that may affect the area are described in section 5.3. Any such incident affecting the area during or after the decommissioning area will be addressed using the Alpart emergency response procedures.

8.7.1.8 Care and Maintenance

The area will be reviewed and assessed every three years. Repair and rehabilitation will be carried out as required.

8.7.2 Rehabilitation

Jamaica has taken a legislative approach to restoration of land after bauxite is extracted. JISCO Alpart is bound legally by the Mining Regulations to ensure that land is restored after mining. After a pit is certified mined out by the Commissioner of Mines and permission is given to rehabilitate, it is shaped, the topsoil replaced and grass planted depending on the end use. This restored land in many instances is used for farming and many farmers have established successful crops on this land. Restored land has to be certified by a team led by the Commissioner of Mines and includes the Jamaica Bauxite Institute.

The Reclamation Goal is to:

- Restore mined out lands to comparable levels of pre-mined productivity.
- Assist in developing economic programmes on rehabilitated lands to benefit local farmers and communities.
- Develop mined-out lands into modern resettlement communities.
- Incorporate restored land into the overall development plans of the parish.

Management of Process:

VII. Alpart Mines Management personnel will visit all mined-out Bauxite pits.

VIII. If satisfied that there is no additional bauxite that can be harvested from the pit, a request is made of the Commissioner of Mines, Mines and Geology Department, to have their Mining Inspector visit the pit and declare it Mined Out.

IX. The Commissioner of Mines will issue a Mined-Out Certificate for that pit. Alpart then has three years to have the pit reshaped, topsoiled, revegetated, and brought to a condition where it can be Certified Restored.

X. Alpart will issue a contract to a private Reclamation Contractor (for Reshaping and Topsoiling of the pit) and a Rehabilitation Contractor (for the revegetation, fencing, fertilizing and management of the pit until it is ready to be assessed for Restoration Certification.

XI. The Commissioner of Mines is then invited to inspect the pit and issue a Restoration Certificate.

XII. This is then forwarded to the GIS and Accounts Department and the Restoration Liability is removed from the books.

Reclamation Process:

VIII. Alpart reclaims its mined-out pits using private contractors and equipment to do reclamation (backfilling, reshaping and relaying of topsoil) on a per acre or cubic meter of earth moved payment basis.

IX. Alpart endeavors at all times to reshape its mined-out pits to a bowl shape with gentle slopes. Alpart does not leave shear faces.

X. Prior to mining, the orebody surveyed and drilled at 15m (50 ft.) intervals to determine the boundaries of the bauxite and its depth and quality.

XI. The 61cm (2 ft.) of topsoil that was removed from the surface of the orebody and stockpiled outside of the pit mining area is reused in the rehabilitation of the pit after mining

XII. Where adequate material cannot be generated from the perimeter of the orebody to achieve the necessary slopes and configuration, then material is generated elsewhere and trucked to the orebody.

XIII. A mix of rock rejects and bauxite (which can contain up to 20 % bauxite) is sometimes trucked from the screening and cable belt load stations for fill material. Reclamation reports a swell factor of up to 2.5 to 1 after reshaping. The reshaped pits do not retain water for any period of time and natural sinkholes are not blocked in the reclamation process, but the pit is shaped whenever possible to channel run-off water to these natural drainage points.

XIV. Topsoiling is usually, but not always, done immediately after reshaping. The Rehabilitation contractor takes over at this point.

Rehabilitation

VII. Prior to the start of the rainy periods, the land is ploughed, using a contracted farm tractor, and the area is de-stoned manually. Organic manure (where available) is spread manually and grass is also cut and planted manually. These manual tasks are done on contract.
VIII. Cut grass is transported to the planting sites by the Contractor.
IX. Alpart perimeter fences all of its rehabilitation lands. Fencing is by Contract, and the materials (fence posts, barbed wire, etc.) are transported to the various sites by tractor.
X. During the maintenance period (12 – 18 months depending on rainfall), a top dressing of inorganic N.P.K. fertilizer is used to promote vegetation growth and more organic fertilizer is added where necessary.
XI. The restored pits are inspected by the Inspectorate Branch of the Mines and Geology Department (Commissioner of Mines) and the Jamaica Bauxite Institute and approved if it meets or exceeds Government standards.
XII. A Restoration Certificate is then issued by the Commissioner of Mines.

8.8 Flora and Fauna

Mining is a highly destructive activity and will involve complete vegetation loss in areas selected to be mined. Because the area has been heavily impacted by humans for decades/centuries there are few species of high conservation status present, therefore every effort should be made to conserve the remaining populations. The special conservation cases identified are examined below. However, the loss of any fauna or flora should be minimised. The impact of mining can be reduced if the following recommendations are followed.

Most of the proposed mining areas are located in Fields: Herbaceous Crops etc.: the land use category that showed relatively low diversity and endemism. Many of the species observed in these habitats are classified as very common or commonly occurring species that are widely distributed across Jamaica. These are generally opportunists, colonizing cleared areas. The following is recommended to minimise the impact on flora and fauna:

> The ore bodies occur mainly in areas covered by Fields: Herbaceous crops, fallow, cultivated vegetables (91.4 %). These lands should be rehabilitated to a at least grasslands, however, establishment of forests will improve the ecological services. Even in the midst of these fields a few large trees remain. Efforts should be made to retain the larger trees, especially those that support other plants, such as climbers, bromeliads and orchids.
>
> These trees will aid in soil retention/ reduction of the risk of erosion, as the root systems of the trees will consolidate soil particles. The presence of these trees will also aid in maintaining fauna diversity in the area.
>
> Secondary forest occurs on 7% of the ore bodies. It is important during the rehabilitation that these areas, or at least equivalent acreage, be restored to some level of forest and not just grassland.

- Clear cutting of the limestone hills in these areas should be avoided as much as possible. These hills often occur as islands in the midst of the fields and where practical, a buffer zone of 30 m should be placed them. For the land use category Secondary Forest and Fields (118 total species, 20 endemic plants), most of the diversity as well as endemics were observed on the limestone hills. Mining can occur in the areas classified as Secondary Forest and fields, but should be limited to the fields/abandoned farms/pastures.

- Transportation of invasive species should be properly managed. The clearing process may involve mass transportation of materials which may include vegetative material and seeds, thus increasing the potential for spreading of invasive species such as bamboo (*Bambusa vulgaris)* and logwood (*Haematoxylum campechianum)*. This material will be used for rehabilitation of the mining sites; at the end of the process the storage site should be inspected by an independent consultant to certify that no invasive species are left behind.

  Other steps to control such spread should include:

  iii. Establishment of a concretized drying areas for bamboo and logwood, where the cut shoots can be allowed to dry out and lose their ability to regenerate.

  iv. Explore the possibility of drying and using the cut IAS such as logwood. Utilizing a wood chipper/shredder to process invasive plant, reducing them to material that is easy to handle, dry store. The resulting woodchips/mulch would have countless possible applications/uses.

- Any caves/sinkholes which are encountered should be examined for the presence of bats. If a colony of bats is encountered the matter should be reported to NEPA such that appropriate actions can be decided.

8.8.1 Specific Conservation Issues

8.8.1.1 Fresh Water Turtles

The freshwater turtle (*Trachemys terrapen*) occurs in ponds in the area. Turtles should be removed from any ponds which are to be disturbed, and relocated to appropriate ponds.

8.8.1.1.1 Jamaica Laughing Frog

The Jamaica Laughing Frog, *Osteopilus ocellatus,* is listed as Near Threatened by the IUCN. This species is dependent on bromeliads, *Hoenbergia* spp. The number of bromeliads is very limited due largely to the shortage of large trees. Large trees with *Hoenbergia* should be preserved as much as possible. If it is not possible to preserve a particular tree the bromeliads should be relocated to an appropriate site. A protocol for the relocation of bromeliads is provided in Appendix 13.14

8.8.1.1.2 Orchids

Orchids occur mainly on large trees (DBH >35 cm). If it is not possible to preserve a tree the orchid should be relocated to an appropriate site (see Appendix 13.14)

8.8.1.1.3 Plants to be relocated

The following five species of bromeliads should be relocated: *Hohenbergia polycephala, Tillandsia balbisiana, T. fasciculata, T. flexuosa* and *T. recurvata.*

The following two species of orchids should be relocated*: Brassavola cordata and Oeceoclades maculate.*

8.8.1.1.4 Blue Swallowtail Butterfly

Protographium marcellinus is listed as Vulnerable by the IUCN. Turner and Truland (2017) pointed out "the outlook for the continued survival of this spectacular endemic Blue Swallowtail is not favourable." This species was recorded in the Broadleaf Forest on the base of the Don Figuerero Mountain, this area is not slated to be mined, but there is the possibility that other breeding sites exists. If such areas are identified, then NEPA should be consulted and care must be taken to ensure minimum disturbance.

8.8.1.1.5 Peru Cave Complex

The Peru caves occur outside the areas to be mined; however, cave ecosystems are known to be very sensitive. The caves should be monitored during mining of the sites closest to the caves to see if there is any direct and indirect impact of the mining on the bats or other fauna in the cave complex.

8.9 HERITAGE (ARCHAEOLOGICAL)

The area that SEPL 541 covers has seen much development in recent decades and so many historic buildings have been destroyed or changed to make way for new homes and other buildings. However, there are still material remains and practices that have existed for generations among the communities in this area. For example, the strong tradition of rearing livestock on the gently sloping land in much of this area dates back several generations. Much of the land highlighted as potential mining areas is currently used to graze animals and so the loss of this land (even temporarily) could impact the authenticity of the local culture.

Methods that could be used to mitigate any potential negative impact of future mining activity on archaeological resources in the area.

- Where an isolated archaeological asset of high significance is located too far from a cluster, it must be delineated and protected under the JNHT Act.

- All archaeological resources outside communities must be clearly flagged and colour-coded indicating whether it is to be preserved or relocated.
- Where the declaration process of a site or an area has commenced no mining activity is allowed in that space as a Preservation Notice will be placed there by the JNHT.
- Under the JNHT Act, 1985, a Stop Order shall be placed on any work that is in breach the Act to protect and preserve heritage assets as National Monument or National Heritage.
- Where there is unreported accidental find of significant archaeological resources, the JNHT will place a Stop Order on development on the site in order to conduct its own investigation and recording of the find and a determination reached to preserved that find in-situ or ex-situ.
- A detailed recording of all sites determined to be altered or relocated must be done before work commences.
- Construction of service roads and other bauxite mining facilities are to be monitored by a qualified archaeologist.
- A schedule of construction works should be prepared and presented to the JNHT.
- The use of explosives is prohibited in the vicinity of sensitive archaeological assets designated protected National Heritage or in the process of being designated Protected National Heritage.

8.10 Dislocation

Based on the location of the ore bodies no displacement of residential plots is anticipated. The lands slated for mining are predominantly owned by JISCO. In the event displacement and the need for relocation become apparent as mining progresses; established compensation process and procedure must be followed which seeks to ensure that affected parties are no worst off.

Tennant farmers who are currently occupying lands owned by JISCO may be impacted and possible dislocated. In such event these tenant farmers should be given adequate notice and, where possible relocated to suitable alternative sites and compensated for any lost of crops.

9 RESIDUAL IMPACTS

Residual impacts are defined as those impacts that remain after implementation of mitigation measures.

Section 7 of this EIA provides the identification and assessment of the environmental impacts and their associated mitigating measures required. However, there may be some impacts which may still remain as residual impacts even after the mitigation and abatement measures have been integrated during the course of implementing the Proposed Project. In this section, a more detailed assessment of these impacts is done. The ultimate purpose is to provide information to implement further mitigation measures if it is practical to do so.

The following table outlines the criteria used to assess environmental impacts in terms of minor, moderate, or major impact after mitigation measures have been applied. Residual impacts apply to the ecological and socio-economic aspects of the project.

	Ecological Residual Impacts	**Socio-economic Impacts**	**Focus Area For Further Mitigation**
Major	The rehabilitation process may introduce new plant and animal species in the area and may not totally re-establish pre-mining habitats and biodiversity. The rehabilitation process may not replace the type of trees present prior to mining.	Loss of real estate value due to mining in the area.	JISCO Alpart will place focus on minimising the footprint of the mining area and ensuring that the rehabilitation process is done in a way to minimise these effects.
Moderate	Changes in drainage patterns may affect aquatic ecosystems	Temporary Loss of agricultural lands. Loss of trees that are used for charcoal burning	Rehabilitation goals will facilitate agriculture as an end use. It is well established that crops do well on mined out lands if properly managed. Ensure that buffer zones to protect water features are adhered to.

Minor	Changes in the shape of the land will introduce new ecological environments and species in the area which may disturb the balance of the present ecosystem.	Aesthetics - the area will look different.	Ensure that there is a robust community relations programme to maximise benefits to the community. Ensure that jobs are offered to the community. JISCO Alpart should carry out a flora/fauna study at least three-year post rehabilitation to determine which species have been retained in the area and identify new species.

10 Analysis of Alternatives

The following alternatives have been analyzed for the project:

- The No Action Alternative
- The Proposed Project on a Different Scale
- Location

10.1 Alternative No. 1 – No Action:

The "No Action" alternative presents the scenario where the status quo remains, it assesses the case where the project as proposed or any variation is not undertaken. In such case the lands proposed for the project (Outer Valley section of SEPL 541) or any possible alternative location would remain in its existing state.

By doing nothing there would not be any of the impacts identified throughout this report, there would be no dislocation of flora and fauna; the risk to water quality, air quality and loss of land use would be avoided. The natural and built environment within the proposed project are and its surrounding would remain unchanged.

SEPL 541 Outer Valley contains in excess of 17 million Crude Wet tons of mineable bauxite ore of the composition required by the refinery and would satisfy between eight-to-ten-year mining operations.

If the "No Action option is pursued, and the bauxite in the Outer Valley section of SEPL 541 is not mined the Refinery will not have access to the bauxite ore needed to operate the plant.

Based on recent feasibility study for the proposed refinery modernization and upgrade, with an estimated investment of $1.1 billion USD the project would not be viable resulting in the refinery not reopening. The JISCO Alpart is the largest on the island and when reopened would be responsible for approximately 50% of Jamaica's refinery capacity. If the refinery does not reopen there would be significant losses in foreign exchange earnings (~USD $1 billion per year); a loss of employment for about 2000 job and by extension other negative socio-economic impacts.

10.2 Alternative No. 2 – The Proposed Project on a Different Scale

The Refinery is currently being modernized and expanded. The operational plan for bauxite to feed the modernized plant includes the opening of a new mining areas in addition to the current active mines in Special Mining Lease, SML 167. The decision was taken to obtain the additional tonnage of bauxite for the bauxite reserves in SEPL 541 since JICSO was already been granted this SEPL. In order to commence mining in an area with a SEPL, application must be made to the relevant authority to convert the SEPL to a SML. The first consideration was to convert the entire SEPL 541 (see Figure 10-1) to a SML, however given the extremely large size of this area and the complex biodiversity and multiple developed areas; it was decided to reduce the boundary to the Outer Valley Section of SEPL 541 (see Figure 10-2).

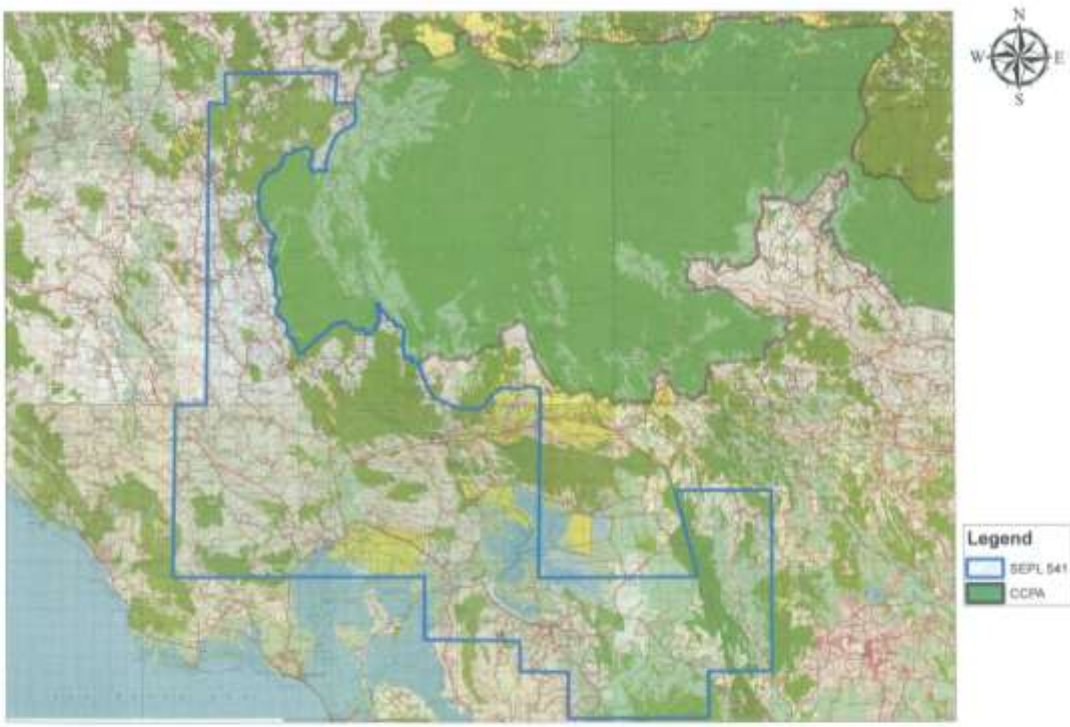

Figure 10-1: Map Showing the entire area of SEPL 541

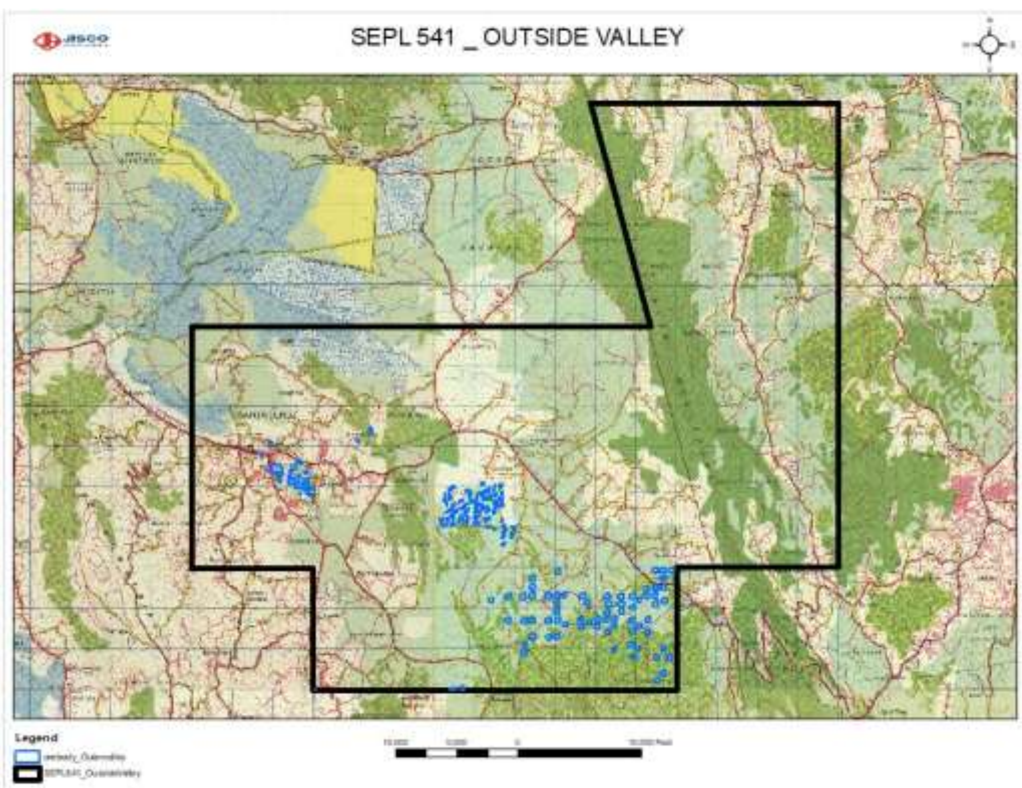

Figure 10-2: Initial Outer Valley Section SEPL 541 Boundary

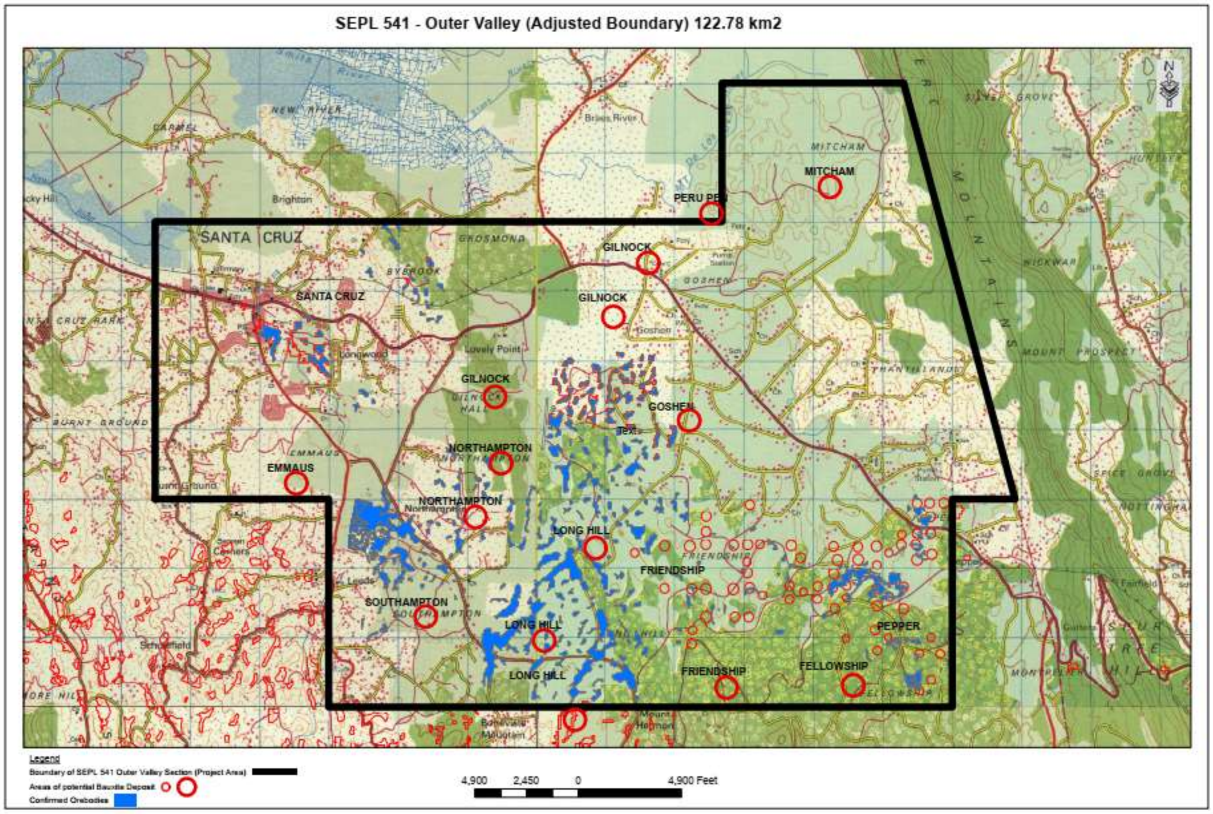

Figure 10-3: Final Boundary for SEPL Outer Valley section of SEPL541

Further investigation revealed the inclusion of very sensitive biodiversity, complex ecosystems and significant residential development within the boundary of Figure 10-2.

It was finally decided to go with the existing boundary as in Figure 10-3. The selected boundary is dominated by highly disturbed land, lower population density, lands already owned by JISCO and has adequate quantity and quality of bauxite to support the upgraded refinery for at least 10 years. The selected boundary ensures minimum environmental and social impact.

10.3 Alternative No. 3 – An Alternative Location:

The Outer Valley section of SEPL (Figure 10-1) adjoins the northern boundary of SML 167 where mining infrastructure is already in place and mining is currently in progress. This location allows for progression of mining activities into SEPL 541 with minimum additional infrastructure and hence greater efficiency lower environmental impact. The location has the tonnage and quality of bauxite noted above and is in close proximity to the JISCO Alpart refinery, which will also minimize impact during operations.

Exploration has already been completed for the Outer Valley Section of SEPL 541 and the data obtained confirm the quality and quantity of bauxite to be suitable for processing at the refinery. To identify alternative suitable would require new exploration at extensive cost and time, making the project not viable.

Approximately 92% of the ore bodies identified in the Outer Valley section of SEPL541 are associated with significantly disturbed vegetation (Fields: Herbaceous Crops etc) with relatively low diversity and endemism. Hence this location presents a very low impact on endemic and sensitive flora and fauna.

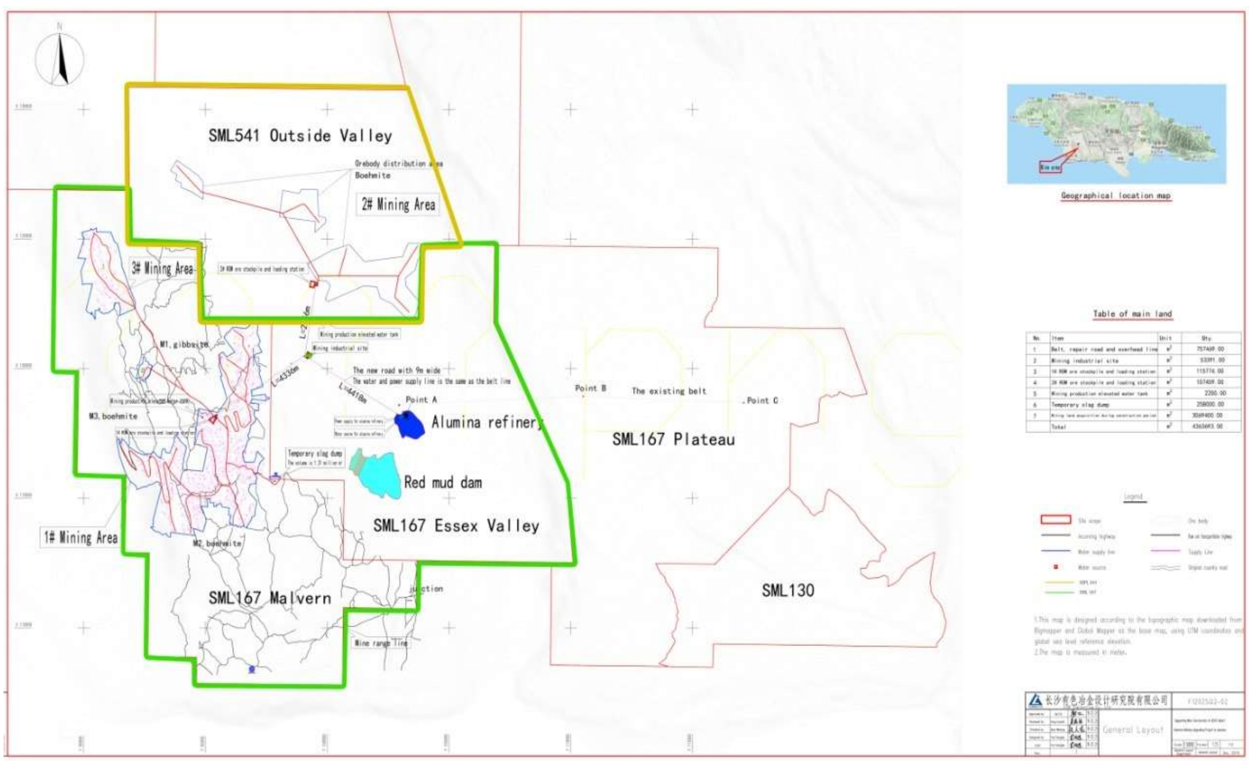

Figure 10-4: Map Showing SML 167 in Relation to the Outer Valley section of SEPL 541

11 ENVIRONMENTAL MONITORING AND MANAGEMENT

Mining introduces various environmental aspects at all stages of the project. Construction of haul roads will generate dust and noise from equipment. There will also be removal of trees and vegetation. Changes in water run-off and drainage in the surrounding area can cause increases in parameters such as total dissolved solids. Any solid waste generated will be sent to the refinery for disposal, however this must be accounted for. It is therefore essential that comprehensive environmental monitoring be put into place.

An environmental monitoring and management plan has been developed that will cover each stage of the project – construction, operation and decommissioning and closure. The program will be a part of the general Apart Environmental Monitoring Programme which is currently implemented by suitably qualified personnel. The Program will be coordinated by Andrew Smith, the Environmental Team Leader who holds a first degree in Environmental technology. New staff undergo a period of training by experienced team members. The programme is geared at taking measurements needed to assess mitigation measures and long-term minimization of negative impacts which are identified.

Sampling Programme

Environmental Monitoring

Environmental monitoring of the stockpiling area before and after the beginning of operations will employ the following strategies:

1. Utilization of weather data from the refinery to support other forms of monitoring data collected and assist in determining appropriate mitigation measures.
2. Installation of a Hi-Volume TSP and PM10 samplers in the prescribed areas. These areas include:

- Communities in which mining will be done.
- Communities through which haul roads will traverse.
- Communities close to bauxite stockpiles.

These sampling stations will be established as per the requirements set out by NEPA's Air Quality Monitoring Guideline Document. Each site identified will be subjected to the approval of the required regulatory agencies.

3. Conduct noise level survey in the communities in the surrounding communities.

4. Conduct monthly environmental audits of the activities and the surrounding infrastructure.

In the event of bauxite spillage, Alpart will ensure that proper clean-up exercise is conducted.

Environmental Monitoring – Haul Road Construction

The Environmental monitoring associated with the construction and rehabilitation of the haul roads will employ the following strategies before and after the start of operations:

- Utilization of weather data to support other forms of monitoring data collected and assist in determining appropriate mitigation measures.
- Installation of two Hi-Volume TSP samplers in the prescribed communities where haul road construction and rehabilitation are being done.
- Conduct noise surveys in the nearby communities.
- Conduct weekly environmental audits of the construction and rehabilitation activities.

Environmental Monitoring – Mining and Haulage of Bauxite

Environmental monitoring for the mining of the bauxite ore bodies will employ the following strategies:

- Utilization of weather data from the station to be installed at the refinery to support other forms of monitoring data collected and assist in determining appropriate mitigation measures.
- Installation of a Hi-Volume TSP and PM10 samplers in the prescribed communities.

These sampling stations will be established as per the requirements set out by NEPA's Air Quality Monitoring Guideline Document. Each site identified will be subjected to the approval of the Jamaica Bauxite Institute, National Environment & Planning Agency, and the Environmental Health Unit of the Ministry of Health.

- Conduct noise level surveys in the nearby communities.
- Conduct monthly audits of the activities and the surrounding infrastructure.

In the event of bauxite spillage, Alpart will ensure that proper clean-up exercise is conducted.

Table 11-1: The sampling programme for the mining, haulage are as follows.

No.	Activities to be Monitored	Parameters for Monitoring	Equipment Used	Frequency of Monitoring Recommended	Reference Standards
1.	Construction, Operations, decommissioning/closure	Weather data (WS, WD, RH, Rainfall, Temp. BP)	Weather station	Continuous	N/A

2.		Particulate matter sampling	TSP / PM10	24 hrs (once every six days)	THE NATURAL RESOURCES CONSERVATION AUTHORITY ACT The Natural Resources Conservation Authority (Air Quality) Regulations, 2006
3.		Noise level	Noise Level meter	Weekly	National Noise Standards for Jamaica

Sampling stations will be established upwind and downwind. A control station will be established upwind at a suitable distance. Reports will be sent to NEPA on a monthly basis.

Monitoring Report

The Environmental Monitoring Report will include:

1. Summary of the data collected in the form of tables and graphs.
2. Discussion of results in relation to the activities on the site and highlighting any trends which exceed the applicable standards.
3. Recommendations with respect to mitigative measures where these are needed.
4. Appendices will be used for raw data, photographs if necessary.

Meteorological Monitoring

The weather conditions during all aspects of the bauxite mining process will be monitored, with the collection of meteorological data. This data will include the following parameters: rainfall, temperature, wind speed and direction, relative humidity, barometric pressure. Meteorological data will be collected from a meteorological station at the refinery in order to adequately cover the different activities associated with this project.

Description of Meteorological Instruments

1) **Wind Speed and Direction Monitor**

The RM Young Model 05103-5 Wind monitor is used to measure wind speed and direction. It is designed to meet the Prevention of Significant Deterioration (PSD) requirements specified by EPA.

Propeller rotation produces an alternating current sine wave signal with frequency proportional to WD. The WD vane position is transmitted by a 10K ohm precision conductive potentiometer. The output signal is interfaced directly to the data acquisition system for an output proportional to WD.

2) Climatronics Tipping Bucket Rain Gauge

The Climatronics Tipping Bucket Rain Gauge, P/N 100508, consists of an 8-inch diameter funnel-shaped collection housing. The opening of the funnel has a precise diameter which regulates the flow of water to prevent spillage during heavy rainfall. The collection apparatus is balanced on a horizontal support shaft positioned directly under the funnel opening. The apparatus is designed to collect 0.25 mm of water at which point the weight of the water causes the collector to tip. When the apparatus tips, the swinging motion passes a magnet across a frictionless reed switch causing a momentary closure of the switch. This contact closure sends a signal to the data acquisition system which records the closure as a rainfall event.

3) The HMP45C Temperature Relative Humidity Probe

The HMP45C Temperature Relative Humidity Probe contains a Platinum Resistance Temperature detector and a Vaisala HUMICAP 180 capacitive relative humidity sensor. It is installed in a radiation shield on the tilt down tower.

4) Barometric Pressure Gauge

The Vaisala Pressure Transmitter, Model PTB101B is fabricated from two pieces of silicon, with one piece acting as a pressure sensitive diaphragm and the other acting as a rigid support plate. Pressure variations deflect the sensitive diaphragm and change the sensor's capacitance. This capacitance is measured and linearised, and an analogue voltage output indicates the ambient pressure.

Calibrations and System Performance Audits

Performance audits and calibration exercises will be conducted on the meteorological instruments by an independent auditor, wherein quantitative transfer standards are used to compare and calibrate the field instruments. This exercise is complemented by internal verification checks conducted by JISCO Alpart's Environmental group.

The calibration of the particulate matter samplers is conducted by members of the Alpart Environmental Group using Pre- certified Graseby G2535 calibration Kit.

The noise level meter is calibrated annually by the Manufacturer.

Particulate Sampling

Particulate sampling will be conducted by High Volume Air samplers. These samplers are recommended for the sampling of large volumes of air for the collection of suspended particulate matter. The physical design of the sampler is based on the aerodynamic principles which result in the collection of particles 0 – 100 microns. The PM10 sampler operates on a similar principle, except that this sampler uses a series of buffers, nozzles and an impaction chamber to separate larger particles, thereby collecting only particles 10 microns or less.

Noise Level Measurement

Noise level measurement readings will be collected using a Quest Sound Pro Handheld Sound Level Meter.

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13 APPENDICES

13.1 AIR QUALITY DATA

13.1.1 PM10 Monitoring Results

Goshen PM10 Monitoring Results

Item	Date	Concentration	
1	15-Sep-20	**14.93**	MICROGRAMS/CUBIC METER
2	21-Sep-20	**7.47**	MICROGRAMS/CUBIC METER
3	24-Sep-20	**11.69**	MICROGRAMS/CUBIC METER
4	27-Sep-20	**11.01**	MICROGRAMS/CUBIC METER
5	30-Sep-20	**11.63**	MICROGRAMS/CUBIC METER
6	3-Oct-20	**24.97**	MICROGRAMS/CUBIC METER
7	6-Oct-20	**10.71**	MICROGRAMS/CUBIC METER
8	9-Oct-20	**6.67**	MICROGRAMS/CUBIC METER
9	12-Oct-20	**12.61**	MICROGRAMS/CUBIC METER
10	18-Oct-20	**11.87**	MICROGRAMS/CUBIC METER
11	21-Oct-20	**8.32**	MICROGRAMS/CUBIC METER
12	24-Oct-20	**4.53**	MICROGRAMS/CUBIC METER
13	27-Oct-20	**21.97**	MICROGRAMS/CUBIC METER
14	30-Oct-20	**17.38**	MICROGRAMS/CUBIC METER
15	2-Nov-20	**9.67**	MICROGRAMS/CUBIC METER
16	11-Nov-20	**7.47**	MICROGRAMS/CUBIC METER
17	13-Nov-20	**7.04**	MICROGRAMS/CUBIC METER
18	16-Nov-20	**40.94**	MICROGRAMS/CUBIC METER
19	20-Nov-20	**4.34**	MICROGRAMS/CUBIC METER
20	23-Nov-20	**8.75**	MICROGRAMS/CUBIC METER
21	26-Nov-20	**16.83**	MICROGRAMS/CUBIC METER
22	29-Nov-20	**15.73**	MICROGRAMS/CUBIC METER
23	12/2/2020	**21.42**	MICROGRAMS/CUBIC METER
24	5-Dec-20	**19.15**	MICROGRAMS/CUBIC METER
25	8-Dec-20	**10.22**	MICROGRAMS/CUBIC METER
26	11-Dec-20	**16.22**	MICROGRAMS/CUBIC METER
27	14-Dec-20	**18.30**	MICROGRAMS/CUBIC METER
28	17-Dec-20	**18.30**	MICROGRAMS/CUBIC METER
29	20-Dec-20	**12.73**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
30	23-Dec-20	**13.22**	MICROGRAMS/CUBIC METER
31	26-Dec-20	**9.55**	MICROGRAMS/CUBIC METER
32	29-Dec-20	**12.30**	MICROGRAMS/CUBIC METER
33	1-Jan-21	**19.28**	MICROGRAMS/CUBIC METER
34	4-Jan-21	**16.52**	MICROGRAMS/CUBIC METER
35	7-Jan-21	**21.48**	MICROGRAMS/CUBIC METER
36	10-Jan-21	**19.83**	MICROGRAMS/CUBIC METER
37	13-Jan-21	**23.07**	MICROGRAMS/CUBIC METER
38	16-Jan-21	**24.54**	MICROGRAMS/CUBIC METER
39	19-Jan-21	**24.97**	MICROGRAMS/CUBIC METER
40	22-Jan-21	**32.19**	MICROGRAMS/CUBIC METER
41	25-Jan-21	**23.25**	MICROGRAMS/CUBIC METER
42	28-Jan-21	**32.74**	MICROGRAMS/CUBIC METER
43	31-Jan-21	**25.76**	MICROGRAMS/CUBIC METER
44	3-Feb-21	**25.58**	MICROGRAMS/CUBIC METER
45	6-Feb-21	**33.65**	MICROGRAMS/CUBIC METER
46	9-Feb-21	**28.21**	MICROGRAMS/CUBIC METER
47	12-Feb-21	**22.15**	MICROGRAMS/CUBIC METER
48	15-Feb-21	**24.97**	MICROGRAMS/CUBIC METER
49	18-Feb-21	**27.96**	MICROGRAMS/CUBIC METER
50	21-Feb-21	**14.07**	MICROGRAMS/CUBIC METER
51	24-Feb-21	**14.14**	MICROGRAMS/CUBIC METER
52	27-Feb-21	**21.23**	MICROGRAMS/CUBIC METER
53	2-Mar-21	**12.61**	MICROGRAMS/CUBIC METER
54	5-Mar-21	**15.18**	MICROGRAMS/CUBIC METER
55	8-Mar-21	**21.97**	MICROGRAMS/CUBIC METER
56	11-Mar-21	**6.91**	MICROGRAMS/CUBIC METER
57	14-Mar-21	**11.38**	MICROGRAMS/CUBIC METER
58	17-Mar-21	**18.05**	MICROGRAMS/CUBIC METER
59	20-Mar-21	**13.52**	MICROGRAMS/CUBIC METER
60	23-Mar-21	**10.04**	MICROGRAMS/CUBIC METER
61	26-Mar-21	**11.01**	MICROGRAMS/CUBIC METER
62	29-Mar-21	**30.11**	MICROGRAMS/CUBIC METER
63	1-Apr-21	**17.01**	MICROGRAMS/CUBIC METER
64	7-Apr-21	**12.97**	MICROGRAMS/CUBIC METER
65	10-Apr-21	**12.30**	MICROGRAMS/CUBIC METER
66	13-Apr-21	**20.99**	MICROGRAMS/CUBIC METER
67	16-Apr-21	**7.65**	MICROGRAMS/CUBIC METER
68	19-Apr-21	**38.18**	MICROGRAMS/CUBIC METER
69	22-Apr-21	**25.94**	MICROGRAMS/CUBIC METER
70	25-Apr-21	**21.78**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
71	28-Apr-21	**18.05**	MICROGRAMS/CUBIC METER
72	1-May-21	**10.52**	MICROGRAMS/CUBIC METER
73	4-May-21	**30.04**	MICROGRAMS/CUBIC METER
74	7-May-21	**21.11**	MICROGRAMS/CUBIC METER
75	10-May-21	**36.90**	MICROGRAMS/CUBIC METER
76	13-May-21	**20.68**	MICROGRAMS/CUBIC METER
77	16-May-21	**63.82**	MICROGRAMS/CUBIC METER
78	19-May-21	**43.08**	MICROGRAMS/CUBIC METER
79	28-May-21	**21.29**	MICROGRAMS/CUBIC METER
80	31-May-21	**12.48**	MICROGRAMS/CUBIC METER
81	3-Jun-21	**21.45**	MICROGRAMS/CUBIC METER
82	6-Jun-21	**27.07**	MICROGRAMS/CUBIC METER
83	9-Jun-21	**39.09**	MICROGRAMS/CUBIC METER
84	12-Jun-21	**50.80**	MICROGRAMS/CUBIC METER
85	15-Jun-21	**47.47**	MICROGRAMS/CUBIC METER
86	18-Jun-21	**33.66**	MICROGRAMS/CUBIC METER
87	21-Jun-21	**53.64**	MICROGRAMS/CUBIC METER
88	24-Jun-21	**21.33**	MICROGRAMS/CUBIC METER
89	27-Jun-21	**13.81**	MICROGRAMS/CUBIC METER
90	30-Jun-21	**43.4**	MICROGRAMS/CUBIC METER
91	6-Jul-21	**14.43**	MICROGRAMS/CUBIC METER
92	9-Jul-21	**18**	MICROGRAMS/CUBIC METER
93	12-Jul-21	**14.8**	MICROGRAMS/CUBIC METER
94	15-Jul-21	**39.03**	MICROGRAMS/CUBIC METER
95	18-Jul-21	**33.29**	MICROGRAMS/CUBIC METER
96	21-Jul-21	**32.74**	MICROGRAMS/CUBIC METER
97	24-Jul-21	**22.75**	MICROGRAMS/CUBIC METER
98	27-Jul-21	**63.44**	MICROGRAMS/CUBIC METER
99	30-Jul-21	**45.38**	MICROGRAMS/CUBIC METER
100	2-Aug-21	**40.38**	MICROGRAMS/CUBIC METER
101	5-Aug-21	**35.94**	MICROGRAMS/CUBIC METER
102	8-Aug-21	**33.29**	MICROGRAMS/CUBIC METER
103	11-Aug-21	**34.53**	MICROGRAMS/CUBIC METER
104	14-Aug-21	**42.29**	MICROGRAMS/CUBIC METER
105	17-Aug-21	**31.07**	MICROGRAMS/CUBIC METER
106	23-Aug-21	**58.45**	MICROGRAMS/CUBIC METER
107	26-Aug-21	**57.58**	MICROGRAMS/CUBIC METER
108	29-Aug-21	**56.9**	MICROGRAMS/CUBIC METER
109	1-Sep-21	**49.44**	MICROGRAMS/CUBIC METER
110	4-Sep-21	**40.51**	MICROGRAMS/CUBIC METER
111	7-Sep-21	**25.09**	MICROGRAMS/CUBIC METER

Santa Cruz PM10 Monitoring Results

Item	Date	Concentration	
1	12-Aug-20	**25.41**	MICROGRAMS/CUBIC METER
2	15-Aug-20	19.24	MICROGRAMS/CUBIC METER
3	18-Aug-20	**15.69**	MICROGRAMS/CUBIC METER
4	21-Aug-20	**42.35**	MICROGRAMS/CUBIC METER
5	15-Sep-20	**18.62**	MICROGRAMS/CUBIC METER
6	18-Sep-20	27.78	MICROGRAMS/CUBIC METER
7	21-Sep-20	18.37	MICROGRAMS/CUBIC METER
8	24-Sep-20	**16.75**	MICROGRAMS/CUBIC METER
9	27-Sep-20	**16.50**	MICROGRAMS/CUBIC METER
10	30-Sep-20	**13.51**	MICROGRAMS/CUBIC METER
11	3-Oct-20	**23.11**	MICROGRAMS/CUBIC METER
12	6-Oct-20	**9.34**	MICROGRAMS/CUBIC METER
13	9-Oct-20	**7.29**	MICROGRAMS/CUBIC METER
14	12-Oct-20	**14.45**	MICROGRAMS/CUBIC METER
15	15-Oct-20	**17.69**	MICROGRAMS/CUBIC METER
16	18-Oct-20	**17.94**	MICROGRAMS/CUBIC METER
17	21-Oct-20	**6.23**	MICROGRAMS/CUBIC METER
18	24-Oct-20	**81.40**	MICROGRAMS/CUBIC METER
19	27-Oct-20	**13.08**	MICROGRAMS/CUBIC METER
20	30-Oct-20	**19.06**	MICROGRAMS/CUBIC METER
21	11-Nov-20	**17.09**	MICROGRAMS/CUBIC METER
22	13-Nov-20	**11.33**	MICROGRAMS/CUBIC METER
23	16-Nov-20	**27.88**	MICROGRAMS/CUBIC METER
24	23-Nov-20	**13.54**	MICROGRAMS/CUBIC METER
25	26-Nov-20	**20.83**	MICROGRAMS/CUBIC METER
26	29-Nov-20	**15.38**	MICROGRAMS/CUBIC METER
27	12/2/2020	**17.77**	MICROGRAMS/CUBIC METER
28	5-Dec-20	**19.05**	MICROGRAMS/CUBIC METER
29	8-Dec-20	**4.84**	MICROGRAMS/CUBIC METER
30	11-Dec-20	**15.50**	MICROGRAMS/CUBIC METER
31	14-Dec-20	**19.67**	MICROGRAMS/CUBIC METER
32	17-Dec-20	**21.14**	MICROGRAMS/CUBIC METER
33	20-Dec-20	**18.38**	MICROGRAMS/CUBIC METER
34	23-Dec-20	**18.01**	MICROGRAMS/CUBIC METER
35	26-Dec-20	**14.09**	MICROGRAMS/CUBIC METER
36	29-Dec-20	**12.25**	MICROGRAMS/CUBIC METER
37	1-Jan-21	**15.32**	MICROGRAMS/CUBIC METER
38	4-Jan-21	**14.34**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
39	7-Jan-21	**22.42**	MICROGRAMS/CUBIC METER
40	10-Jan-21	**11.82**	MICROGRAMS/CUBIC METER
41	16-Jan-21	**32.35**	MICROGRAMS/CUBIC METER
42	19-Jan-21	**34.92**	MICROGRAMS/CUBIC METER
43	22-Jan-21	**14.95**	MICROGRAMS/CUBIC METER
44	28-Jan-21	**19.63**	MICROGRAMS/CUBIC METER
45	31-Jan-21	**15.27**	MICROGRAMS/CUBIC METER
46	3-Feb-21	**20.61**	MICROGRAMS/CUBIC METER
47	9-Feb-21	**23.07**	MICROGRAMS/CUBIC METER
48	12-Feb-21	**26.75**	MICROGRAMS/CUBIC METER
49	15-Feb-21	**27.54**	MICROGRAMS/CUBIC METER
50	21-Feb-21	**18.82**	MICROGRAMS/CUBIC METER
51	24-Feb-21	**18.39**	MICROGRAMS/CUBIC METER
52	27-Feb-21	**23.37**	MICROGRAMS/CUBIC METER
53	2-Mar-21	**7.93**	MICROGRAMS/CUBIC METER
54	5-Mar-21	**17.03**	MICROGRAMS/CUBIC METER
55	11-Mar-21	**8.67**	MICROGRAMS/CUBIC METER
56	14-Mar-21	**20.23**	MICROGRAMS/CUBIC METER
57	17-Mar-21	**17.03**	MICROGRAMS/CUBIC METER
58	20-Mar-21	**24.60**	MICROGRAMS/CUBIC METER
59	23-Mar-21	**10.64**	MICROGRAMS/CUBIC METER
60	26-Mar-21	**24.66**	MICROGRAMS/CUBIC METER
61	29-Mar-21	**23.00**	MICROGRAMS/CUBIC METER
62	1-Apr-21	**17.90**	MICROGRAMS/CUBIC METER
63	7-Apr-21	**10.59**	MICROGRAMS/CUBIC METER
64	10-Apr-21	**20.11**	MICROGRAMS/CUBIC METER
65	13-Apr-21	**23.74**	MICROGRAMS/CUBIC METER
66	16-Apr-21	**26.20**	MICROGRAMS/CUBIC METER
67	19-Apr-21	**24.78**	MICROGRAMS/CUBIC METER
68	22-Apr-21	**27.95**	MICROGRAMS/CUBIC METER
69	25-Apr-21	**17.29**	MICROGRAMS/CUBIC METER
70	28-Apr-21	**19.19**	MICROGRAMS/CUBIC METER
71	1-May-21	**14.21**	MICROGRAMS/CUBIC METER
72	4-May-21	**12.24**	MICROGRAMS/CUBIC METER
73	7-May-21	**16.79**	MICROGRAMS/CUBIC METER
74	10-May-21	**16.79**	MICROGRAMS/CUBIC METER
75	13-May-21	**29.58**	MICROGRAMS/CUBIC METER
76	16-May-21	**30.07**	MICROGRAMS/CUBIC METER
77	19-May-21	**31.73**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
78	22-May-21	**25.95**	MICROGRAMS/CUBIC METER
79	25-May-21	**12.24**	MICROGRAMS/CUBIC METER
80	28-May-21	**22.82**	MICROGRAMS/CUBIC METER
81	31-May-21	**20.54**	MICROGRAMS/CUBIC METER
82	3-Jun-21	**21.28**	MICROGRAMS/CUBIC METER
83	6-Jun-21	**20.36**	MICROGRAMS/CUBIC METER
84	9-Jun-21	**27.86**	MICROGRAMS/CUBIC METER
85	12-Jun-21	**42.31**	MICROGRAMS/CUBIC METER
86	15-Jun-21	**44.52**	MICROGRAMS/CUBIC METER
87	18-Jun-21	**42.06**	MICROGRAMS/CUBIC METER
88	21-Jun-21	**47.05**	MICROGRAMS/CUBIC METER
89	24-Jun-21	**19.93**	MICROGRAMS/CUBIC METER
90	27-Jun-21	**17.4**	MICROGRAMS/CUBIC METER
91	30-Jun-21	**48.64**	MICROGRAMS/CUBIC METER
92	6-Jul-21	**13.78**	MICROGRAMS/CUBIC METER
93	9-Jul-21	**21.71**	MICROGRAMS/CUBIC METER
94	12-Jul-21	**26.07**	MICROGRAMS/CUBIC METER
95	15-Jul-21	**38.01**	MICROGRAMS/CUBIC METER
96	18-Jul-21	**33.58**	MICROGRAMS/CUBIC METER
97	21-Jul-21	**30.87**	MICROGRAMS/CUBIC METER
98	24-Jul-21	**80.07**	MICROGRAMS/CUBIC METER
99	27-Jul-21	**70.85**	MICROGRAMS/CUBIC METER
100	30-Jul-21	**45.63**	MICROGRAMS/CUBIC METER
101	2-Aug-21	**70.29**	MICROGRAMS/CUBIC METER
102	5-Aug-21	**27.55**	MICROGRAMS/CUBIC METER
103	8-Aug-21	**47.35**	MICROGRAMS/CUBIC METER
104	11-Aug-21	**38.56**	MICROGRAMS/CUBIC METER
105	17-Aug-21	**28.6**	MICROGRAMS/CUBIC METER
106	23-Aug-21	**46.18**	MICROGRAMS/CUBIC METER
107	29-Aug-21	**145.81**	MICROGRAMS/CUBIC METER
108	4-Sep-21	**66.11**	MICROGRAMS/CUBIC METER
109	10-Sep-21	**25.77**	MICROGRAMS/CUBIC METER

Northampton PM10 Monitoring Results

Item	Date	Concentration	
1	12-Aug-20	**25.54**	MICROGRAMS/CUBIC METER
2	15-Aug-20	19.77	MICROGRAMS/CUBIC METER
3	18-Aug-20	**10.29**	MICROGRAMS/CUBIC METER
4	21-Aug-20	**38.91**	MICROGRAMS/CUBIC METER
5	18-Sep-20	25.1	MICROGRAMS/CUBIC METER
6	21-Sep-20	14.12	MICROGRAMS/CUBIC METER
7	24-Sep-20	**14.87**	MICROGRAMS/CUBIC METER
8	27-Sep-20	**4.14**	MICROGRAMS/CUBIC METER
9	30-Sep-20	**12.74**	MICROGRAMS/CUBIC METER
10	6-Oct-20	**8.66**	MICROGRAMS/CUBIC METER
11	9-Oct-20	**9.92**	MICROGRAMS/CUBIC METER
12	12-Oct-20	**13.37**	MICROGRAMS/CUBIC METER
13	15-Oct-20	**16.00**	MICROGRAMS/CUBIC METER
14	18-Oct-20	**12.30**	MICROGRAMS/CUBIC METER
15	21-Oct-20	**6.02**	MICROGRAMS/CUBIC METER
16	24-Oct-20	**11.99**	MICROGRAMS/CUBIC METER
17	27-Oct-20	**18.83**	MICROGRAMS/CUBIC METER
18	30-Oct-20	**18.45**	MICROGRAMS/CUBIC METER
19	11-Nov-20	**12.82**	MICROGRAMS/CUBIC METER
20	13-Nov-20	**10.45**	MICROGRAMS/CUBIC METER
21	23-Nov-20	**8.07**	MICROGRAMS/CUBIC METER
22	26-Nov-20	**22.77**	MICROGRAMS/CUBIC METER
23	29-Nov-20	**14.01**	MICROGRAMS/CUBIC METER
24	12/2/2020	**16.76**	MICROGRAMS/CUBIC METER
25	5-Dec-20	**16.20**	MICROGRAMS/CUBIC METER
26	8-Dec-20	**13.89**	MICROGRAMS/CUBIC METER
27	11-Dec-20	**14.07**	MICROGRAMS/CUBIC METER
28	14-Dec-20	**19.83**	MICROGRAMS/CUBIC METER
29	17-Dec-20	**23.33**	MICROGRAMS/CUBIC METER
30	20-Dec-20	**13.89**	MICROGRAMS/CUBIC METER
31	23-Dec-20	**21.77**	MICROGRAMS/CUBIC METER
32	26-Dec-20	**12.82**	MICROGRAMS/CUBIC METER
33	29-Dec-20	**9.88**	MICROGRAMS/CUBIC METER
34	1-Jan-21	**38.22**	MICROGRAMS/CUBIC METER
35	4-Jan-21	**16.01**	MICROGRAMS/CUBIC METER
36	7-Jan-21	**39.23**	MICROGRAMS/CUBIC METER
37	10-Jan-21	**19.45**	MICROGRAMS/CUBIC METER
38	13-Jan-21	**21.70**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
39	16-Jan-21	**23.96**	MICROGRAMS/CUBIC METER
40	19-Jan-21	**23.21**	MICROGRAMS/CUBIC METER
41	22-Jan-21	**21.33**	MICROGRAMS/CUBIC METER
42	25-Jan-21	**20.06**	MICROGRAMS/CUBIC METER
43	28-Jan-21	**23.36**	MICROGRAMS/CUBIC METER
44	31-Jan-21	**18.26**	MICROGRAMS/CUBIC METER
45	3-Feb-21	**24.66**	MICROGRAMS/CUBIC METER
46	6-Feb-21	**61.87**	MICROGRAMS/CUBIC METER
47	9-Feb-21	**29.01**	MICROGRAMS/CUBIC METER
48	12-Feb-21	**23.98**	MICROGRAMS/CUBIC METER
49	18-Feb-21	**26.65**	MICROGRAMS/CUBIC METER
50	21-Feb-21	**18.33**	MICROGRAMS/CUBIC METER
51	24-Feb-21	**18.08**	MICROGRAMS/CUBIC METER
52	27-Feb-21	**23.48**	MICROGRAMS/CUBIC METER
53	2-Mar-21	**20.31**	MICROGRAMS/CUBIC METER
54	5-Mar-21	**25.59**	MICROGRAMS/CUBIC METER
55	8-Mar-21	**14.97**	MICROGRAMS/CUBIC METER
56	11-Mar-21	**8.14**	MICROGRAMS/CUBIC METER
57	14-Mar-21	**16.40**	MICROGRAMS/CUBIC METER
58	17-Mar-21	**17.52**	MICROGRAMS/CUBIC METER
59	20-Mar-21	**17.08**	MICROGRAMS/CUBIC METER
60	23-Mar-21	**12.18**	MICROGRAMS/CUBIC METER
61	26-Mar-21	**12.86**	MICROGRAMS/CUBIC METER
62	29-Mar-21	**26.65**	MICROGRAMS/CUBIC METER
63	1-Apr-21	**17.02**	MICROGRAMS/CUBIC METER
64	7-Apr-21	**13.05**	MICROGRAMS/CUBIC METER
65	10-Apr-21	**8.63**	MICROGRAMS/CUBIC METER
66	13-Apr-21	**19.57**	MICROGRAMS/CUBIC METER
67	16-Apr-21	**23.73**	MICROGRAMS/CUBIC METER
68	19-Apr-21	**50.32**	MICROGRAMS/CUBIC METER
69	22-Apr-21	**34.04**	MICROGRAMS/CUBIC METER
70	25-Apr-21	**20.56**	MICROGRAMS/CUBIC METER
71	28-Apr-21	**17.95**	MICROGRAMS/CUBIC METER
72	1-May-21	**15.65**	MICROGRAMS/CUBIC METER
73	4-May-21	**16.71**	MICROGRAMS/CUBIC METER
74	7-May-21	**16.96**	MICROGRAMS/CUBIC METER
75	10-May-21	**29.07**	MICROGRAMS/CUBIC METER
76	13-May-21	**31.25**	MICROGRAMS/CUBIC METER
77	16-May-21	**15.90**	MICROGRAMS/CUBIC METER

Item	Date	Concentration	
78	19-May-21	**32.99**	MICROGRAMS/CUBIC METER
79	22-May-21	**32.18**	MICROGRAMS/CUBIC METER
80	25-May-21	**24.41**	MICROGRAMS/CUBIC METER
81	28-May-21	**20.62**	MICROGRAMS/CUBIC METER
82	31-May-21	**15.84**	MICROGRAMS/CUBIC METER
83	3-Jun-21	**18.82**	MICROGRAMS/CUBIC METER
84	6-Jun-21	**38.95**	MICROGRAMS/CUBIC METER
85	9-Jun-21	**33.42**	MICROGRAMS/CUBIC METER
86	12-Jun-21	**41.25**	MICROGRAMS/CUBIC METER
87	15-Jun-21	**37.27**	MICROGRAMS/CUBIC METER
88	18-Jun-21	**42.74**	MICROGRAMS/CUBIC METER
89	21-Jun-21	**45.16**	MICROGRAMS/CUBIC METER
90	24-Jun-21	**39.82**	MICROGRAMS/CUBIC METER
91	27-Jun-21	**13.6**	MICROGRAMS/CUBIC METER
92	30-Jun-21	**47.52**	MICROGRAMS/CUBIC METER
93	6-Jul-21	**19.26**	MICROGRAMS/CUBIC METER
94	9-Jul-21	**18.45**	MICROGRAMS/CUBIC METER
95	12-Jul-21	**26.65**	MICROGRAMS/CUBIC METER
96	15-Jul-21	**49.45**	MICROGRAMS/CUBIC METER
97	18-Jul-21	**30.19**	MICROGRAMS/CUBIC METER
98	21-Jul-21	**55.85**	MICROGRAMS/CUBIC METER
99	24-Jul-21	**58.46**	MICROGRAMS/CUBIC METER
100	27-Jul-21	**69.76**	MICROGRAMS/CUBIC METER
101	30-Jul-21	**46.84**	MICROGRAMS/CUBIC METER
102	2-Aug-21	**30.87**	MICROGRAMS/CUBIC METER
103	5-Aug-21	**42.06**	MICROGRAMS/CUBIC METER
104	8-Aug-21	**47.15**	MICROGRAMS/CUBIC METER
105	11-Aug-21	**34.04**	MICROGRAMS/CUBIC METER
106	23-Aug-21	**8.01**	MICROGRAMS/CUBIC METER
107	29-Aug-21	**76.84**	MICROGRAMS/CUBIC METER
108	4-Sep-21	**33.98**	MICROGRAMS/CUBIC METER
109	10-Sep-21	**28.7**	MICROGRAMS/CUBIC METER

Mitcham PM10 Monitoring Results

Item	Date	Concentration	
1	15-Sep-20	19.59	Microgram/Cubic Meter
2	18-Sep-20	18.53	Microgram/Cubic Meter
3	21-Sep-20	4.69	Microgram/Cubic Meter
4	24-Sep-20	**11.52**	Microgram/Cubic Meter
5	27-Sep-20	**11.89**	Microgram/Cubic Meter
6	9-Oct-20	**5.64**	Microgram/Cubic Meter
7	12-Oct-20	**11.72**	Microgram/Cubic Meter
8	15-Oct-20	**12.02**	Microgram/Cubic Meter
9	18-Oct-20	**10.86**	Microgram/Cubic Meter
10	21-Oct-20	**7.55**	Microgram/Cubic Meter
11	24-Oct-20	**8.34**	Microgram/Cubic Meter
12	27-Oct-20	**15.89**	Microgram/Cubic Meter
13	30-Oct-20	**15.46**	Microgram/Cubic Meter
14	11-Nov-20	**9.45**	Microgram/Cubic Meter
15	13-Nov-20	**12.39**	Microgram/Cubic Meter
16	16-Nov-20	**18.53**	Microgram/Cubic Meter
17	20-Nov-20	**7.05**	Microgram/Cubic Meter
18	23-Nov-20	**11.04**	Microgram/Cubic Meter
19	26-Nov-20	**16.19**	Microgram/Cubic Meter
20	29-Nov-20	**13.62**	Microgram/Cubic Meter
21	12/2/2020	**13.07**	Microgram/Cubic Meter
22	5-Dec-20	**12.94**	Microgram/Cubic Meter
23	8-Dec-20	**10.12**	Microgram/Cubic Meter
24	11-Dec-20	**12.39**	Microgram/Cubic Meter
25	14-Dec-20	**12.94**	Microgram/Cubic Meter
26	17-Dec-20	**13.00**	Microgram/Cubic Meter
27	20-Dec-20	**6.07**	Microgram/Cubic Meter
28	23-Dec-20	**13.56**	Microgram/Cubic Meter
29	26-Dec-20	**7.55**	Microgram/Cubic Meter
30	29-Dec-20	**9.94**	Microgram/Cubic Meter
31	1-Jan-21	**26.38**	Microgram/Cubic Meter
32	4-Jan-21	**14.60**	Microgram/Cubic Meter
33	7-Jan-21	**18.22**	Microgram/Cubic Meter
34	10-Jan-21	**16.99**	Microgram/Cubic Meter
35	13-Jan-21	**17.67**	Microgram/Cubic Meter
36	16-Jan-21	**12.39**	Microgram/Cubic Meter
37	19-Jan-21	**13.56**	Microgram/Cubic Meter
38	22-Jan-21	**20.43**	Microgram/Cubic Meter

Item	Date	Concentration	
39	25-Jan-21	**20.49**	Microgram/Cubic Meter
40	28-Jan-21	**18.96**	Microgram/Cubic Meter
41	31-Jan-21	**16.07**	Microgram/Cubic Meter
42	3-Feb-21	**18.83**	Microgram/Cubic Meter
43	6-Feb-21	**24.72**	Microgram/Cubic Meter
44	9-Feb-21	**15.34**	Microgram/Cubic Meter
45	12-Feb-21	**22.94**	Microgram/Cubic Meter
46	15-Feb-21	**18.83**	Microgram/Cubic Meter
47	18-Feb-21	**12.94**	Microgram/Cubic Meter
48	21-Feb-21	**14.60**	Microgram/Cubic Meter
49	24-Feb-21	**9.39**	Microgram/Cubic Meter
50	27-Feb-21	**20.30**	Microgram/Cubic Meter
51	2-Mar-21	**23.86**	Microgram/Cubic Meter
52	5-Mar-21	**13.13**	Microgram/Cubic Meter
53	8-Mar-21	**11.53**	Microgram/Cubic Meter
54	11-Mar-21	**3.99**	Microgram/Cubic Meter
55	14-Mar-21	**15.34**	Microgram/Cubic Meter
56	17-Mar-21	**17.67**	Microgram/Cubic Meter
57	20-Mar-21	**18.40**	Microgram/Cubic Meter
58	23-Mar-21	**12.70**	Microgram/Cubic Meter
59	26-Mar-21	**21.04**	Microgram/Cubic Meter
60	29-Mar-21	**22.39**	Microgram/Cubic Meter
61	1-Apr-21	**18.89**	Microgram/Cubic Meter
62	7-Apr-21	**12.76**	Microgram/Cubic Meter
63	10-Apr-21	**12.94**	Microgram/Cubic Meter
64	13-Apr-21	**18.04**	Microgram/Cubic Meter
65	16-Apr-21	**15.58**	Microgram/Cubic Meter
66	19-Apr-21	**43.62**	Microgram/Cubic Meter
67	22-Apr-21	**49.93**	Microgram/Cubic Meter
68	25-Apr-21	**18.59**	Microgram/Cubic Meter
69	28-Apr-21	**17.67**	Microgram/Cubic Meter
70	1-May-21	**12.51**	Microgram/Cubic Meter
71	4-May-21	**10.37**	Microgram/Cubic Meter
72	7-May-21	**15.46**	Microgram/Cubic Meter
73	10-May-21	**4.36**	Microgram/Cubic Meter
74	13-May-21	**27.18**	Microgram/Cubic Meter
75	16-May-21	**17.11**	Microgram/Cubic Meter
76	19-May-21	**31.04**	Microgram/Cubic Meter
77	22-May-21	**24.91**	Microgram/Cubic Meter

Item	Date	Concentration	
78	25-May-21	**26.99**	Microgram/Cubic Meter
79	28-May-21	**20.73**	Microgram/Cubic Meter
80	31-May-21	**27.60**	Microgram/Cubic Meter
81	3-Jun-21	**17.73**	Microgram/Cubic Meter
82	6-Jun-21	**16.38**	Microgram/Cubic Meter
83	9-Jun-21	**35.21**	Microgram/Cubic Meter
84	12-Jun-21	**50.73**	Microgram/Cubic Meter
85	15-Jun-21	**33.8**	Microgram/Cubic Meter
86	18-Jun-21	**39.57**	Microgram/Cubic Meter
87	27-Jun-21	**29.87**	Microgram/Cubic Meter
88	30-Jun-21	**42.57**	Microgram/Cubic Meter
89	6-Jul-21	**17.61**	Microgram/Cubic Meter
90	9-Jul-21	**20.67**	Microgram/Cubic Meter
91	12-Jul-21	**24.17**	Microgram/Cubic Meter
92	15-Jul-21	**29.51**	Microgram/Cubic Meter
93	18-Jul-21	**17.79**	Microgram/Cubic Meter
94	21-Jul-21	**19.63**	Microgram/Cubic Meter
95	24-Jul-21	**19.69**	Microgram/Cubic Meter
96	27-Jul-21	**65.21**	Microgram/Cubic Meter
97	30-Jul-21	**21.35**	Microgram/Cubic Meter
98	2-Aug-21	**63.25**	Microgram/Cubic Meter
99	5-Aug-21	**30.49**	Microgram/Cubic Meter
100	8-Aug-21	**36.19**	Microgram/Cubic Meter
101	11-Aug-21	**31.41**	Microgram/Cubic Meter
102	14-Aug-21	**43.8**	Microgram/Cubic Meter
103	17-Aug-21	**26.93**	Microgram/Cubic Meter
104	20-Aug-21	**47.91**	Microgram/Cubic Meter
105	23-Aug-21	**48.83**	Microgram/Cubic Meter
106	26-Aug-21	**51.34**	Microgram/Cubic Meter
107	29-Aug-21	**18.46**	Microgram/Cubic Meter
108	1-Sep-21	**15.21**	Microgram/Cubic Meter
109	4-Sep-21	**48.95**	Microgram/Cubic Meter
110	7-Sep-21	**32.02**	Microgram/Cubic Meter
111	10-Sep-21	**21.9**	Microgram/Cubic Meter

13.2 Noise Monitoring Data

The below data set covers the period January – March 2021. The full data set from July 2020 – July 2021 has previously been submitted to the National Environmental Planning Agency.

Noise Level Readings for Outer Valley Section of SEPL 541

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Goshen	1/8/2021	10:00am	48	45	72.5	Car passing at High	18 02' 15N 077 38'24W
Goshen	1/8/2021	10:05am	39	37.1	49.5		18 01'54N 077 38'34W
Goshen	1/8/2021	10:55am	35.1	34.0	37.2		18 03'07N 077 38'51W
Lower Northampton	1/8/2021	11:50am	Grinder in background	39	45		18 02'08N 077 40'40W
Lower Northampton	1/8/2021	11:53am	38.5	36.8	40.5		18 02 03N 077 40'27W
Northampton	1/8/2021	12:00	44.5	43.0	48.7		18 01'10N 077 40'02W
Northampton	1/8/2021	12:03pm	60.2	59.4	66.5	Rooster at High.	18 01'32N 077 39'50W
Mitcham	1/8/2021	10:25am	35	33	59.8		18 03'56N 077 36'59W
Mitcham	1/8/2021	10:27am	33.3	31.8	36.3		18 04'08N 077 36'50W
Santa Cruz	1/8/2021	11:05am	51	48.8	53.9	Car passing at High	18 03'06N 077 41'24W
Santa Cruz	1/8/2021	11:07am	39.8	39.5	41.5		18 02'59N 077 41'27W
Santa Cruz	1/8/2021	11:37am	36.1	35.5	42.5		18 02'46N 077 41'30W
Goshen	1/11/2021	1200pm	43.4	42.9	49.8		18 02' 15N 077 38'24W
Goshen	1/11/2021	12:12	40.4	38.8	46.2		18 01'54N 077 38'34W
Goshen	1/11/2021	11:12	36.0	35.0	39.7		18 03'07N 077 38'51W
Lower Northampton	1/11/2021	10:12	39	38	40.1		18 02'08N 077 40'40W
Lower Northampton	1/11/2021	10:15	32.5	31.4	33.6		18 02 03N 077 40'27W
Northampton	1/11/2021	9:52	43.5	39.0	46		18 01'10N 077 40'02W
Northampton	1/11/2021	10:00	42.5	33.7	47.6		18 01'32N 077 39'50W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Mitcham	1/11/2021	11:23	41	38.8	49		18 03'56N 077 36'59W
Mitcham	1/11/2021	11:25	Convo in Background	39.2	50.9		18 04'08N 077 36'50W
Santa Cruz	1/11/2021	10:50	35.2	34.4	36.3		18 03'06N 077 41'24W
Santa Cruz	1/11/2021	10:57	39.8	39.5	48.9	Car at High	18 02'59N 077 41'27W
Santa Cruz	1/11/2021	11:00	37.1	34.9	38.8		18 02'46N 077 41'30W
Goshen	1/21/2021	9:28am	45	43	75.2	Truck at High	18 02' 15N 077 38'24W
Goshen	1/21/2021	9:35	36	35.2	39		18 01'54N 077 38'34W
Goshen	1/21/2021	10:24	39.6	37.5	42.0		18 03'07N 077 38'51W
Lower Northampton	1/21/2021	11:21	37.4	36.3	38.3		18 02'08N 077 40'40W
Lower Northampton	1/21/2021	11:23	Radio in Background.	51.3	54.1		18 02 03N 077 40'27W
Northampton	1/21/2021	11:30	Radio in Background.	50.0	55.8		18 01'10N 077 40'02W
Northampton	1/21/2021	11:36	42.4	41.1	52.2	Bike at High	18 01'32N 077 39'50W
Mitcham	1/21/2021	10:02	32.8	32.5	33		18 03'56N 077 36'59W
Mitcham	1/21/2021	10:05	Radio in Background.	35.6	44.5		18 04'08N 077 36'50W
Santa Cruz	1/21/2021	10:35	41	40	47.1		18 03'06N 077 41'24W
Santa Cruz	1/21/2021	10:37	38.7	38.5	39	Car at High	18 02'59N 077 41'27W
Santa Cruz	1/21/2021	11:10	36.2	35	39.1		18 02'46N 077 41'30W
Goshen	1/26/2021	11:19	48.8	43.6	58.5		18 02' 15N 077 38'24W
Goshen	1/26/2021	11:45	51	50	64		18 01'54N 077 38'34W
Goshen	1/26/2021	11:33	weed wacker	42.9	46.5		18 03'07N 077 38'51W
Lower Northampton	1/26/2021	10:40	Radio in Background.	54	60		18 02'08N 077 40'40W
Lower Northampton	1/26/2021	10:45	41	40.9	42.0		18 02 03N 077 40'27W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Northampton	1/26/2021	10:27	48.8	47.0	61.5	Car at High	18 01'10N 077 40'02W
Northampton	1/26/2021	10:30	49	48	56.0	Rooster at High	18 01'32N 077 39'50W
Mitcham	1/26/2021	12:01	44.8	43	45		18 03'56N 077 36'59W
Mitcham	1/26/2021	12:05	41.5	41.1	42.1		18 04'08N 077 36'50W
Santa Cruz	1/26/2021	10:58	40	39.3	41.9		18 03'06N 077 41'24W
Santa Cruz	1/26/2021	11:06	63	60	65.4	Car at High	18 02'59N 077 41'27W
Santa Cruz	1/26/2021	11:10	41.2	40	41.4		18 02'46N 077 41'30W
Goshen	2/1/2021	12:33	Radio in Background.	45.6	54.9		18 02' 15N 077 38'24W
Goshen	2/1/2021	12:37	Convo in Back.	35.4	39.6		18 01'54N 077 38'34W
Goshen	2/1/2021	10:21	47.6	47.3	48.3		18 03'07N 077 38'51W
Lower Northampton	2/1/2021	10:53	38	37	39		18 02'08N 077 40'40W
Lower Northampton	2/1/2021	10:55	42	41.7	45.0		18 02 03N 077 40'27W
Northampton	2/1/2021	11:15	Radio in Background.	66.0	68		18 01'10N 077 40'02W
Northampton	2/1/2021	11:20	34.4	32.2	53.1		18 01'32N 077 39'50W
Mitcham	2/1/2021	12:10	35.6	34	37.7		18 03'56N 077 36'59W
Mitcham	2/1/2021	12:15	31.3	30.2	32.6		18 04'08N 077 36'50W
Santa Cruz	2/1/2021	10:32	53	41.7	57	Car at High	18 03'06N 077 41'24W
Santa Cruz	2/1/2021	10:35	44	40	47		18 02'59N 077 41'27W
Santa Cruz	2/1/2021	10:46	44	43.1	46		18 02'46N 077 41'30W
Goshen	2/8/2021	10:35	45	38	79	car horn at high	18 02' 15N 077 38'24W
Goshen	2/8/2021	10:39	Chickens in back	45.3	57	motorcycle at high	18 01'54N 077 38'34W
Goshen	2/8/2021	11:25	37.0	36.0	46.3		18 03'07N 077 38'51W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Lower Northampton	2/8/2021	12:12	37	34	39.3		18 02'08N 077 40'40W
Lower Northampton	2/8/2021	12:15	32.3	31.2	35.0		18 02 03N 077 40'27W
Northampton	2/8/2021	2:50	Radio in Background.	60.0	63		18 01'10N 077 40'02W
Northampton	2/8/2021	2:55	52	48	61.0		18 01'32N 077 39'50W
Mitcham	2/8/2021	10:58	39	38	44		18 03'56N 077 36'59W
Mitcham	2/8/2021	11:02	44.3	42.1	49.7		18 04'08N 077 36'50W
Santa Cruz	2/8/2021	11:37	51	50	55	Car at High	18 03'06N 077 41'24W
Santa Cruz	2/8/2021	11:40	35	34	39		18 02'59N 077 41'27W
Santa Cruz	2/8/2021	11:48	35	34	36		18 02'46N 077 41'30W
Goshen	2/18/2021	10:00	Power Saw in Back	44	45		18 02' 15N 077 38'24W
Goshen	2/18/2021	10:05	Radio in Background.	44.6	56.2		18 01'54N 077 38'34W
Goshen	2/18/2021	12:06	Power Tool in Back.	44.0	45.9		18 03'07N 077 38'51W
Lower Northampton	2/18/2021	12:45	49.2	47.5	50.7		18 02'08N 077 40'40W
Lower Northampton	2/18/2021	12:48	65	64.3	66.2		18 02 03N 077 40'27W
Northampton	2/18/2021	11:34	Convo in back.	53.0	55		18 01'10N 077 40'02W
Northampton	2/18/2021	11:39	50.2	48.3	60.4	Car at High	18 01'32N 077 39'50W
Mitcham	2/18/2021	10:28	50	45	53		18 03'56N 077 36'59W
Mitcham	2/18/2021	10:30	59.1	56.8	66.9		18 04'08N 077 36'50W
Santa Cruz	2/18/2021	12:18	54.1	53.2	55.2	Car at High	18 03'06N 077 41'24W
Santa Cruz	2/18/2021	12:19	44	43	49		18 02'59N 077 41'27W
Santa Cruz	2/18/2021	11:22	49.3	48.1	53		18 02'46N 077 41'30W
Goshen	2/22/2021	10:00	Radio in Background.	45.3	54		18 02' 15N 077 38'24W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Goshen	2/22/2021	10:05	Radio in Background.	43.8	49.7		18 01'54N 077 38'34W
Goshen	2/22/2021	10:52	Radio in Background.	42.9	45.7		18 03'07N 077 38'51W
Lower Northampton	2/22/2021	11:29	38.4	37.2	41.5		18 02'08N 077 40'40W
Lower Northampton	2/22/2021	11:31	44.1	38	48.0		18 02 03N 077 40'27W
Northampton	2/22/2021	11:37	Convo in back.	49.8	55.8		18 01'10N 077 40'02W
Northampton	2/22/2021	11:42	48.1	44.8	68.1	Motorcycle at High	18 01'32N 077 39'50W
Mitcham	2/22/2021	10:24	35.5	34.9	38.7		18 03'56N 077 36'59W
Mitcham	2/22/2021	10:30	31.4	32.8	34.9		18 04'08N 077 36'50W
Santa Cruz	2/22/2021	11:04	50.2	48	55.4	Car at High	18 03'06N 077 41'24W
Santa Cruz	2/22/2021	11:06	43.8	40.1	44.7		18 02'59N 077 41'27W
Santa Cruz	2/22/2021	11:18	34.8	33.1	41.1		18 02'46N 077 41'30W
Goshen	3/1/2021	9:41	37.8	36.1	40.8		18 02' 15N 077 38'24W
Goshen	3/1/2021	9:45	35.8	34.1	37.2		18 01'54N 077 38'34W
Goshen	3/1/2021	10:49	39.0	38.0	42.0		18 03'07N 077 38'51W
Lower Northampton	3/1/2021	11:25	40.1	39.0	50.8		18 02'08N 077 40'40W
Lower Northampton	3/1/2021	11:27	37.9	36.0	52.8		18 02 03N 077 40'27W
Northampton	3/1/2021	11:35	Radio	50.0	65.0	Car at High	18 01'10N 077 40'02W
Northampton	3/1/2021	11:38	Radio	45.6	47.9		18 01'32N 077 39'50W
Mitcham	3/1/2021	10:24	40.1	39.0	44.8		18 03'56N 077 36'59W
Mitcham	3/1/2021	10:25	Convo.	35.5	52.0		18 04'08N 077 36'50W
Santa Cruz	3/1/2021	11:00	59.0	54.0	81.0	Car at High	18 03'06N 077 41'24W
Santa Cruz	3/1/2021	11:02	Car Engine Running.	52.0	54		18 02'59N 077 41'27W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Santa Cruz	3/1/2021	11:11	40.1	38.0	45		18 02'46N 077 41'30W
Goshen	3/12/2021	10:15	Radio	53.7	55.9		18 02' 15N 077 38'24W
Goshen	3/12/2021	10:20	Radio	42.9	46.8		18 01'54N 077 38'34W
Goshen	3/12/2021	11:16	Convo.	46.7	50.0		18 03'07N 077 38'51W
Lower Northampton	3/12/2021	12:02	45.2	38.4	50.0	Rooster	18 02'08N 077 40'40W
Lower Northampton	3/12/2021	12:05	41.6	33.7	44.5		18 02 03N 077 40'27W
Northampton	3/12/2021	12:09	59.1	50.0	66.2	Motorcycle at high	18 01'10N 077 40'02W
Northampton	3/12/2021	12:13	43.6	35.3	56.7	Dog at High	18 01'32N 077 39'50W
Mitcham	3/12/2021	10:44	51.1	47.7	70.0	Motorcycle at high	18 03'56N 077 36'59W
Mitcham	3/12/2021	10:49	Radio	44.5	56.0		18 04'08N 077 36'50W
Santa Cruz	3/12/2021	10:28	51.2	50.1	52.7	Car at High	18 03'06N 077 41'24W
Santa Cruz	3/12/2021	11:30	47.5	39.0	54.9		18 02'59N 077 41'27W
Santa Cruz	3/12/2021	11:51	35.2	34.8	36.1		18 02'46N 077 41'30W
Goshen	3/15/2021	9:33	Radio	36	41	rooster	18 02' 15N 077 38'24W
Goshen	3/15/2021	9:40	radio	38.8	45.1		18 01'54N 077 38'34W
Goshen	3/15/2021	10:37	38.0	36.0	41.7		18 03'07N 077 38'51W
Lower Northampton	3/15/2021	11:45	whipper	41.8	43.4		18 02'08N 077 40'40W
Lower Northampton	3/15/2021	11:48	35.5	35.4	35.6		18 02 03N 077 40'27W
Northampton	3/15/2021	11:55	53.6	51.4	65.8		18 01'10N 077 40'02W
Northampton	3/15/2021	12:00	31.5	47.3	56.8		18 01'32N 077 39'50W
Mitcham	3/15/2021	10:00	radio	42.0	43.0		18 03'56N 077 36'59W
Mitcham	3/15/2021	10:05	40.1	38.7	48.8		18 04'08N 077 36'50W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Santa Cruz	3/15/2021	10:45	dogs	66.0	84.9	car horn	18 03'06N 077 41'24W
Santa Cruz	3/15/2021	10:50	36	35.0	37.1		18 02'59N 077 41'27W
Santa Cruz	3/15/2021	11:32	36.6	35.1	39.4		18 02'46N 077 41'30W
Goshen	3/25/2021	12:15	radio	40.6	50.8	hammer	18 02' 15N 077 38'24W
Goshen	3/25/2021	1:00	machinery	45	48.7		18 01'54N 077 38'34W
Goshen	3/25/2021	1:10	43.8	42.1	44.9		18 03'07N 077 38'51W
Lower Northampton	3/25/2021	10:47	33.2	32.9	34.1		18 02'08N 077 40'40W
Lower Northampton	3/25/2021	10:44	41.5	38.6	48.7		18 02 03N 077 40'27W
Northampton	3/25/2021	10:21	whipper	40.0	51.0		18 01'10N 077 40'02W
Northampton	3/25/2021	10:27	42.2	39.5	69.8	dog	18 01'32N 077 39'50W
Mitcham	3/25/2021	12:32	32	31.8	32.6		18 03'56N 077 36'59W
Mitcham	3/25/2021	12:40	35.8	31.3	40.9		18 04'08N 077 36'50W
Santa Cruz	3/25/2021	11:00	38.2	35.8	42.1		18 03'06N 077 41'24W
Santa Cruz	3/25/2021	11:44	61.2	55.8	73.6	truck	18 02'59N 077 41'27W
Santa Cruz	3/25/2021	12:00	36	35.7	38.1		18 02'46N 077 41'30W
Goshen	3/30/2021	8:40	52	48.1	64.6	convo	18 02' 15N 077 38'24W
Goshen	3/30/2021	8:42	48.2	45.1	73.8	bike	18 01'54N 077 38'34W
Goshen	3/30/2021	9:11	39.0	37.7	39.4		18 03'07N 077 38'51W
Lower Northampton	3/30/2021	9:20	54.4	52.4	60.2	car	18 02'08N 077 40'40W
Lower Northampton	3/30/2021	9:25	40	37.0	49.6		18 02 03N 077 40'27W
Northampton	3/30/2021	9:51	radio	32.8	39.8		18 01'10N 077 40'02W
Northampton	3/30/2021	9:55	36.7	36.2	67.6	bike	18 01'32N 077 39'50W

Community	Date	Time	Background	Low Reading	High Reading	Comments	Coordinates
Mitcham	3/30/2021	8:54	39.1	33.1	63.3	car	18 03'56N 077 36'59W
Mitcham	3/30/2021	8:56	34	45	55.0	car	18 04'08N 077 36'50W
Santa Cruz	3/30/2021	9:37	whipper	35.0	40.0		18 03'06N 077 41'24W
Santa Cruz	3/30/2021	10:19	38	44.0	56		18 02'59N 077 41'27W
Santa Cruz	3/30/2021	10:25	48	46.6	50.2		18 02'46N 077 41'30W

13.3 PM10 Sampler Calibration Sheets

13.3.1 Goshen

ALUMINA PARTNERS OF JAMAICA

Doc. No.: ENV- F-008
Revision No.: 3
Revision Date: July 11, 2008
Issue Date: January 16, 2008

High-Volume Calibration for VFC

Location: Goshen

VFC Serial No.: P6962

Date: 29/3/21

Calibrated by: Sanjay Graple

Temperature: 29.6

Barometric Pressure: 29.66

P_f: 21.5 (inches H_2O)

Calculations

Barometric Pressure Conversion

29.66 mbars ⟶ 753.4 mmHg

$$P_f = \frac{21.5}{13.61} \times 25.4 = 40.12 \text{ mmHg}$$

$$\text{Pressure Ratio} = 1 - \left[\frac{40.12}{753.4}\right] = 0.946$$

From Lookup Table = 1.152

$$Q_{Std} = 1.152 \times \frac{753.4}{760} \times \frac{298}{302.6} = 1.136 \text{ m}^3/\text{min}$$

$$\text{m}^3/\text{min} = 40.1 \text{ cfm(ft}^3/\text{min)}$$

13.3.2 Mitcham

ALUMINA PARTNERS OF JAMAICA

Doc. No.: ENV- F-008
Revision No.: 3
Revision Date: July 11, 2008
Issue Date: January 16, 2008

High-Volume Calibration for VFC

Location: MITCHAM

VFC Serial No.: P3853

Date: 14/9/2020

Calibrated by: AW\SG

Temperature: 32.8

Barometric Pressure: 29.74 mHg

P_f: 24 (inches H_2O)

Calculations

Barometric Pressure Conversion

29.74 ~~mbars~~ inHg → 755.4 mmHg

$$P_f = \frac{24}{13.61} \times 25.4 = 44.79 \text{ mmHg}$$

$$\text{Pressure Ratio} = 1 - \left[\frac{44.79}{755.4}\right] = 0.941$$

From Lookup Table = 1.148

$$Q_{Std} = 1.148 \times \frac{755.4}{760} \times \frac{298}{306} = 1.111 \text{ m}^3/\text{min}$$

1.111 m^3/min = 39.2 cfm(ft^3/min)

13.3.3 North Hampton

ALUMINA PARTNERS OF JAMAICA

Doc. No.: ENV- F-008
Revision No.: 3
Revision Date: July 11, 2008
Issue Date: January 16, 2008

High-Volume Calibration for VFC

Location: North Hampton
VFC Serial No.: P6470

Date: 23/2/21
Calibrated by: S. Gayle

Temperature: 31°C
Barometric Pressure: 29.44

P_f: 23.5 (inches H_2O)

Calculations

Barometric Pressure Conversion

29.44 mbars → 747.78 mmHg

$P_f = \frac{23.5}{13.61} \times 25.4 = 43.86$ mmHg

$\text{Pressure Ratio} = 1 - \left[\frac{43.86}{747.78}\right] = 0.941$

From Lookup Table = 1.152

$Q_{Std} = 1.152 \times \frac{747.78}{760} \times \frac{298}{304} = 1.117$ m^3/min

$m^3/min = 1.117$ cfm(ft^3/min) 39.5

13.3.4 Santa Cruz

ALUMINA PARTNERS OF JAMAICA

Doc. No.: ENV- F-008
Revision No.: 3
Revision Date: July 11, 2008
Issue Date: January 16, 2008

High-Volume Calibration for VFC

Location: Santa Cruz

VFC Serial No.: P6277

Date: 23/2/21

Calibrated by: Sanjay Gayle

Temperature: 29.0

Barometric Pressure: 29.73

P_f: 24.4 (inches H_2O)

Calculations

Barometric Pressure Conversion

29.73 mbars → 756.67 mmHg

$$P_f = \frac{24.4}{13.61} \times 25.4 = 45.5 \quad \text{mmHg}$$

$$\text{Pressure Ratio} = 1 - \left[\frac{45.5}{756.67}\right] = 0.940$$

From Lookup Table = 1.149

$$Q_{Std} = 1.149 \times \frac{756.67}{760} \times \frac{298}{302} = 1.129 \quad m^3/min$$

$$m^3/min = \cancel{1.129}\ 39.9 \quad cfm(ft^3/min)$$

13.4 Water Quality Monitoring Data

January - December 2020

N.I.O – Not in Operation; PPM – Parts per Million

Pepper NWC

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Guideline
pH		no sample	7.6	no sample	7.20	7.3	7.38	7.39	7.5	7.23	7.57	n.i.o	7.57	7.00 - 8.40
Sodium	ppm	no sample	7.2	no sample	7.04	7.2	7.15	7.00	7.5	7.60	6.02	n.i.o	6.68	4.5 - 12
Chloride	ppm	no sample	13.6	no sample	12.98	13.3	9.19	10.60	10.8	10.72	10.64	n.i.o	10.64	5.0 - 20
Hardness	ppm	no sample	240.0	no sample	184.00	244.0	220.00	200.00	224.0	216.00	276.00	n.i.o	232.00	127.0 - 381.0
Sulphate	ppm	no sample	13.3	no sample	15.21	15.6	9.46	11.12	11.1	10.35	10.59	n.i.o	11.02	3.0 - 10.0

Southampton NWC

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Guideline
pH		no sample	7.9	no sample	8.03	8.0	7.87	7.85	7.8	7.88	7.90	7.7	7.70	7.00 - 8.40
Sodium	ppm	no sample	4.5	no sample	4.56	4.6	4.57	4.43	4.7	4.77	3.74	3.3	3.49	4.5 - 12
Chloride	ppm	no sample	10.2	no sample	3.73	3.8	6.06	7.09	7.0	7.29	6.95	7.8	7.29	5.0 - 20
Hardness	ppm	no sample	156.0	no sample	144.00	200.0	180.00	240.00	192.0	7.29	236.00	244.0	260.00	127.0 - 381.0
Sulphate	ppm	no sample	5.7	no sample	6.30	6.3	2.39	2.89	2.9	7.29	2.77	2.8	2.80	3.0 - 10.0

Penny Cooke Well

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Guideline
pH		no data	no data	no data	no data	no data	no data	no data	no data	no data	7.3	7.2	7.2	7.00 - 8.40
Sodium	ppm	no data	no data	no data	no data	no data	no data	no data	no data	no data	2.9	14.2	10.9	4.5 - 12
Chloride	ppm	no data	no data	no data	no data	no data	no data	no data	no data	no data	3.8	4.0	5.3	5.0 - 20
Hardness	ppm	no data	no data	no data	no data	no data	no data	no data	no data	no data	254.0	260.0	280.0	127.0 - 381.0
Sulphate	ppm	no data	no data	no data	no data	no data	no data	no data	no data	no data	9.2	4.8	8.4	3.0 - 10.0

Braes River

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Guideline
pH		no data	7.7	no data	no data	no data	no data	7.8	7.9	7.8	7.2	7.2	7.2	7.00 - 8.40
Sodium	ppm	no data	5.3	no data	no data	no data	no data	3.8	3.2	2.2	2.8	2.8	3.2	4.5 - 12
Chloride	ppm	no data	9.8	no data	no data	no data	no data	6.3	4.8	5.4	5.2	6.2	6.6	5.0 - 20
Hardness	ppm	no data	220.0	no data	no data	no data	no data	208.0	188.0	220.0	220.0	200.0	256.0	127.0 - 381.0

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Guideline
Sulphate	ppm	no data	7.6	no data	no data	no data	no data	4.0	3.9	3.5	4.0	5.1	5.0	3.0 - 10.0

Mt De Las U Vas

pH		no data	8.0	no data	7.9	7.8	7.8	7.7	7.9	7.7	8.2	7.6	7.6	7.00 - 8.40
Sodium	ppm	no data	5.8	no data	5.2	1.9	5.3	5.3	4.7	4.8	2.8	2.9	3.7	4.5 - 12
Chloride	ppm	no data	11.1	no data	11.0	10.3	6.1	6.5	5.3	4.8	4.2	6.1	6.3	5.0 - 20
Hardness	ppm	no data	152.0	no data	212.0	252.0	216.0	248.0	160.0	184.0	180.0	244.0	252.0	127.0 - 381.0
Sulphate	ppm	no data	9.8	no data	10.3	10.4	13.3	6.6	10.6	4.1	3.2	4.6	5.0	3.0 - 10.0

Pepper Govt 1

pH		no data	7.7	no data	7.5	7.4	7.5	7.5	7.7	7.4	7.4	7.4	7.4	7.00 - 8.40
Sodium	ppm	no data	7.3	no data	7.9	7.5	7.4	7.4	7.7	7.7	6.1	6.2	7.3	4.5 - 12
Chloride	ppm	no data	12.9	no data	12.4	12.5	8.4	9.8	9.6	9.7	9.3	9.5	9.7	5.0 - 20
Hardness	ppm	no data	120.0	no data	176.0	160.0	160.0	192.0	192.0	208.0	212.0	224.0	260.0	127.0 - 381.0
Sulphate	ppm	no data	8.0	no data	9.1	9.1	9.1	5.4	5.4	5.4	5.4	5.1	5.1	3.0 - 10.0

Pepper Govt 2

pH		no data	7.6	no data	7.6	7.4	7.5	7.5	7.7	7.5	7.7	7.2	7.3	7.00 - 8.40
Sodium	ppm	no data	8.3	no data	7.2	7.0	7.2	7.0	7.7	7.7	6.0	5.9	6.6	4.5 - 12
Chloride	ppm	no data	10.9	no data	10.6	10.7	6.8	7.9	7.8	7.9	7.7	8.0	8.0	5.0 - 20
Hardness	ppm	no data	100.0	no data	146.0	140.0	172.0	180.0	192.0	192.0	248.0	224.0	224.0	127.0 - 381.0
Sulphate	ppm	no data	6.6	no data	7.8	7.5	6.4	3.9	4.0	3.9	3.9	4.0	4.0	3.0 - 10.0

Pepper Govt 3

pH		no data	n.i.o	no data	7.5	7.3	7.5	7.6	7.7	7.4	7.3	7.4	7.4	7.00 - 8.40
Sodium	ppm	no data	n.i.o	no data	11.0	9.9	10.3	10.3	11.9	11.8	9.5	8.2	8.6	4.5 - 12
Chloride	ppm	no data	n.i.o	no data	12.6	12.7	8.8	10.1	10.1	10.2	9.7	10.0	9.9	5.0 - 20
Hardness	ppm	no data	n.i.o	no data	180.0	212.0	192.0	220.0	204.0	208.0	240.0	236.0	248.0	127.0 - 381.0
Sulphate	ppm	no data	n.i.o	no data	8.9	8.9	8.8	5.2	5.2	5.2	5.2	5.2	5.1	3.0 - 10.0

January - September 2021 N.I.O – Not in Operation; PPM – Parts per Million

Pepper NWC

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.56	7.6	7.60	7.56	7.6	7.58	7.60	7.6	7.60	7.00 - 8.40
Sodium	ppm	7.74	8.3	7.70	7.70	6.9	7.68	7.66	7.7	8.45	4.5 - 12
Chloride	ppm	10.81	10.9	10.15	10.10	12.9	13.20	10.24	10.4	16.36	5.0 - 20
Hardness	ppm	212.00	220.0	216.00	228.00	220.0	226.00	208.00	220.0	152.00	127.0 - 381.0
Sulphate	ppm	11.31	12.1	11.70	11.49	13.8	14.00	11.49	11.2	11.38	3.0 - 10.0

Southampton NWC

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.64	7.7	7.67	7.65	7.6	7.56	7.54	7.6	7.60	7.00 - 8.40
Sodium	ppm	5.07	5.3	4.70	4.93	4.3	4.19	4.34	4.9	6.73	4.5 - 12
Chloride	ppm	6.80	6.9	6.63	7.07	9.6	9.47	9.44	7.2	7.20	5.0 - 20
Hardness	ppm	176.00	236.0	204.00	204.00	240.0	220.00	216.00	240.0	178.00	127.0 - 381.0
Sulphate	ppm	2.84	2.8	2.80	2.76	5.2	4.88	2.86	2.9	5.60	3.0 - 10.0

Penny Cooke Well

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.4	7.1	no sample	no sample	no sample	no sample	no sample	no sample	no sample	7.00 - 8.40
Sodium	ppm	8.4	9.5	no sample	no sample	no sample	no sample	no sample	no sample	no sample	4.5 - 12
Chloride	ppm	5.6	8.4	no sample	no sample	no sample	no sample	no sample	no sample	no sample	5.0 - 20
Hardness	ppm	290.0	276.0	no sample	no sample	no sample	no sample	no sample	no sample	no sample	127.0 - 381.0
Sulphate	ppm	8.3	8.0	no sample	no sample	no sample	no sample	no sample	no sample	no sample	3.0 - 10.0

Braes River

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.00 - 8.40
Sodium	ppm	4.2	4.3	4.0	6.4	5.7	3.5	3.7	6.4	3.0	4.5 - 12
Chloride	ppm	6.3	6.3	6.1	6.0	8.9	6.1	6.4	6.1	5.6	5.0 - 20
Hardness	ppm	208.0	252.0	204.0	264.0	196.0	266.0	204.0	264.0	112.0	127.0 - 381.0
Sulphate	ppm	4.9	4.9	6.6	6.5	7.3	4.1	3.9	4.7	10.8	3.0 - 10.0

Mt De Las U Vas

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.2	7.4	7.4	7.3	7.4	7.4	7.4	7.4	7.5	7.00 - 8.40
Sodium	ppm	3.4	2.2	5.8	5.9	5.4	4.7	2.8	5.9	4.7	4.5 - 12
Chloride	ppm	6.9	9.2	7.9	7.9	10.3	7.5	7.6	7.1	6.6	5.0 - 20
Hardness	ppm	212.0	252.0	252.0	216.0	252.0	196.0	238.0	266.0	136.0	127.0 - 381.0
Sulphate	ppm	5.0	6.3	8.1	8.0	10.0	6.7	6.7	8.4	6.8	3.0 - 10.0

Pepper Govt 1

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.3	7.4	7.3	7.3	7.4	7.3	7.4	7.3	7.4	7.00 - 8.40
Sodium	ppm	8.1	8.3	8.0	8.2	7.3	7.2	8.4	8.2	7.4	4.5 - 12
Chloride	ppm	9.4	9.5	9.1	9.1	12.1	10.9	9.4	9.6	11.9	5.0 - 20
Hardness	ppm	208.0	232.0	192.0	204.0	248.0	208.0	216.0	244.0	160.0	127.0 - 381.0
Sulphate	ppm	5.0	5.1	5.1	5.0	7.9	9.1	5.2	5.0	5.6	3.0 - 10.0

Pepper Govt 2

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.2	7.2	7.3	7.3	no acess	7.2	7.3	7.2	7.3	7.00 - 8.40
Sodium	ppm	7.6	9.8	7.1	7.4	no acess	6.5	7.4	7.4	6.7	4.5 - 12
Chloride	ppm	7.5	7.6	7.3	7.4	no acess	11.0	7.6	7.5	8.6	5.0 - 20
Hardness	ppm	224.0	236.0	156.0	200.0	no acess	144.0	212.0	238.0	120.0	127.0 - 381.0
Sulphate	ppm	4.4	3.8	3.8	3.8	no acess	9.4	3.9	317.0	4.1	3.0 - 10.0

Pepper Govt 3

		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Guideline
pH		7.3	7.4	7.4	7.4	7.4	7.4	7.4	7.5	7.4	7.00 - 8.40
Sodium	ppm	10.0	4.9	9.9	10.0	9.4	8.9	9.0	9.1	12.0	4.5 - 12
Chloride	ppm	9.6	9.6	9.3	9.2	12.2	11.5	9.5	9.7	11.3	5.0 - 20
Hardness	ppm	200.0	232.0	172.0	272.0	272.0	180.0	240.0	228.0	174.0	127.0 - 381.0
Sulphate	ppm	5.0	5.1	5.0	4.9	7.8	7.4	5.1	5.1	5.3	3.0 - 10.0

13.5 PLANTS RECORDED FROM OUTER VALLEY SECTION OF SEPL 541

DB: Disturbed Broadleaf Forest, SF: Secondary Forest and Fields, FH: Fields: Herbaceous Crops etc, BA: Built Areas, FS Fields & Secondary Forests

IUCN Status Key

NA: Not Assessed, NT**:** Near Threatened, DD**:** Data Deficient, LC**:** Least Concern, VU**:** Vulnerable **EN:** Endangered, EW: Extinct in the Wild

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Acanthaceae	*Oplonia armata**		Occasional in woodland on limestone	NA	R				
	Ruellia tuberosa	Duppy Gunshot	Very common in pastures and waste places and on roadside banks	NA		O		A	
	Asystasia gangetica		Rather common in gardens, occasionally escaping	NA			O		
Agavaceae	*Agave sisalana*	Sisal	Cultivated	NA			R		
	Agave sobolifera	May Pole	Locally abundant on well-drained hillsides	NA					R
Anacardiaceae	*Comocladia pinnatifolia*	Maiden Plum	Common in thickets and woodlands on limestone hills	NA	D	A	O		F
	*Comocladia velutina**	Velvet-leaved Maiden Plum	Locally common from St. Andrew to St. Elizabeth along south coast on arid limestone	NT		R			
Anacardiaceae	*Mangifera indica*	Mango	Cultivated and naturalized	DD	R	O	O	O	
	Metopium browei	Burn Wood	Common in thickets and open woodlands on rocky limestone	LC	F	A			O
	Spondias mombin	Hog Plum	Common, mostly along roadsides and field margins	LC			O		
	Spondias purpurea	Jamaican Plum	Occasional in cultivation and in hedgerows and along roadsides	LC			F	R	
Annonaceae	*Annona jamaicensis**		Occasional in pasture margins and woodlands on limestone in the central parishes	VU		R			
	Annona muricata	Sour Sop	Commonly cultivated	LC	R		O		

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Annonaceae	*Annona squamosa*	Sweet Sop	Commonly cultivated, escaping near habitations and along roadsides and pasture margins	LC			O		
	Oxandra lanceolata	Black Lancewood	Occasional in woodland on limestone mostly in the central and western parishes	LC		R			
	*Xylopia muricata**	Lance Wood	Generally distributed in woodlands on limestone in the central parishes	NA		R			
Apocynaceae	*Allamanda cathartica*	Yellow Allamanda		NA			F		
	Echites umbellata	Deadly Nightshade	Common in thickets and at woodland margins	NA		F			
	Urechites lutea	Deadly Nightshade	Common in fields, dunes and mangrove margins and also on fences, hedges and walls	NA		A	F		
Araceae	*Philodendron lacerum*		Common climbing on rocks or epiphytic in trees, sometimes terrestrial or in swamps	NA				O	F
	Pistia stratiotes	Pond Lilly	Locally abundant floating in ponds and sluggish streams	LC					F
	Syngonium auritum	Three Finger	Very common on trees, rocks and sheltered banks	NA					
	Xanthosoma sagittifolium	Calaloo	Commonly cultivated	NA			O		O
Araliaceae	*Oreopanax capiatus*	Oreopanax	Very common in secondary and marginal woodlands in moderately wet areas	NA		O			
	*Schefflera troyana**		Rather rare, in woodland margins on rocky limestone in central and west-central parishes	VU			R		
Arecaceae	*Coccothrinax jamaicensis**	Silver Thatch	Common mainly in limestone areas along the south coast	NA	R			R	
	Cocos nucifera	Coconut	Cultivated and naturalized	NA			R	O	
	Roystonea princeps	Royal Palm	Uncommon and rather local, restricted to the western parishes	NT			O		
	*Thrinax parviflora**	Broom Thatch	Very common in the central and western parishes, on well drained limestone	NA	O	F			F

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Aristolochiaceae	*Aristolochia odoratissima*		Rare (St. Andrew, St. Elizabeth), in thickets and on walls and fences	NA		R			
	Bidens pilosa	Spanish Needle	A common weed of roadsides and waste places	NA		A	A	A	A
	Bidens reptans	Red bloom Spanish needle	Common on open or shady banks and in woodland margins and thickets	NA				O	
Asteraceae	*Parthemium hyterophorus*	Dog-Flea Weed	Common along roadsides and in shady or open waste places	NA		O	O		
Asteraceae	*Emilia javanica*	Cupid's Shaving Bush	Common as a weed of open ground and well drained waste places	NA			F	F	
	Conyza canadensis	Canadian Fleabane	Common on roadside banks and in rough pastures	NA		O		F	
	Crescentia cujete	Calabash	Common along roadside and in old pasture	LC			F	O	
	Spathodea campanulata	African Tulip	Commonly planted	LC		F	O		
	Tabebuia platyantha		Sparsely scattered through the central and western parishes	NT	O	O		A	
Bignoniaceae	*Tabebuia riparia*	White Cedar	Rather common, especially in the southern parishes in thickets and open woodlands on limestone	NA					
	*Tabebuia riparia**		Rather common, especially in the southern parishes in thickets and open woodlands on limestone	NA		R	R	O	R
	Tabebuia rosea	Pink Poui	Commonly cultivated, ornamental	LC				O	
	Tecoma stans		Locally abundant on cut-over limestone hillsides and waste sandy places	LC			O		
Blechnaceae	*Blechnum jamaicensis*			NA	O				
Bombacaceae	*Ceiba pentandra*	Silk Cotton Tree	Occasional, perhaps mostly planted	LC	R			R	R
Boraginaceae	*Cordia brownei*	Black sage	Common in thickets and woodlands and on roadside banks	NA		R			

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	*Cordia bullata**		Widespread on limestone rocks in secondary open woodland and thickets	NA		R			
	Cordia gerascanthus	Spanish Elm	Common on limestone hills mostly in dry areas	NA			F	R	
	Cordia humilis		Very common on limestone or shale on rocks in thickets and open woodlands	NA		R			R
	*Cordia macrophylla**	Man Jack	Occasional, rather widespread, in thickets and secondary woodlands	NA	R	R			
Bromeliaceae	*Ananas comosus*	Pineapple	Widely grown in Jamaica	NA				O	
	Hohenbergia polycephala		Common in the central parts of the island, on trees or sometimes on shaded limestone rocks	NA	R				
	Tillandsia balbisiana		Common except areas of high rainfall	NA	O	O			O
	Tillandsia fasciculata		Common gregarious epiphyte at chiefly low elevations	LC	R	O		R	O
	Tillandsia flexuosa		Widespread but uncommon	NA		O			O
	Tillandsia recurvata	Old Man's Beard	Common epiphyte, also often growing on electric and telephone wires	NA			O	R	
Burseraceae	*Bursera simaruba*	Red Birch	Common in woodland on limestone	LC	A	A			A
Cactaceae	*Hylocereus triangularis**	God Okra	Locally common, in thickets, on rocks and on large old trees	LC	O	A			O
	Opuntia jamaicensis	Prickly Pear Tree	Locally common in coastal parts of southern parishes, on arid limestone or gravel	NA			R		
Caesalpiniaceae	*Bauhinia divaricata*	Bull Hoof	Common in thickets and open woodlands on limestone, mostly in rather dry or well-drained areas	LC	F			O	F
	Bauhinia purpurea	Poor Man's Orchid	Common ornamental	LC				O	
	Cassia nictitans		Frequent in central and eastern parishes	LC	O				
	Delonix regia	Poinciana	Commonly cultivated and occasionally naturalized	LC	O		O	F	
	Haematoxylum campechianum	Log Wood	Common on exposed limestone hillsides in dry secondary thickets	LC	A	D	A	A	A

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Cannabaceae	*Canabis sativa*	Ganja	Cultivated	NA			R		R
	Capparis flexuosa	Bottle-cod Root	Common in thickets, mainly arid areas of the south coast	NA		R			
Casuarinaceae	*Casuarina equisetifolia*	Willow	Common, mostly in sandy coastal areas and often planted	LC			R		
Clethraceae	*Clethra occidentalis*	Soap Wood	Rather common in eastern parishes at middle and higher elevations, occasional in central parishes	NA		R			
Clusiaceae	*Calophyllum calaba*	Santa Maria	Common in woodland on limestone	NA		O			
	Clusia flava	Card Gum	Common as epiphyte or also terrestrial in woodland on limestone	LC	R	F			
	Clusia rosea	Balsam Fig	Common, especially in western parishes	LC	O	O			
Combretaceae	*Terminalia catappa*	West Indian Almond	Commonly planted and naturalized	LC			R	O	
Commelinaceae	*Commelina diffusa*	Water Grass	A common weed od cultivations, waste places and pastures	LC	O		O	O	O
	Rhoeo spathacea	Mosses in the Bushes	Common, on limestone banks and in rocky thickets and woodland margins	NA	O	F		F	
Convolvulaceae	Ipomoea tiliacea	Wild Potato	Very common in woodland and thicket margins and rough grassy places	LC		A			
	Merremia dissecta	Know You	Cultivated and widely escaped on to fences and in thickets and waste grounds	NA		O			
Crassulaceae	*Bryophyllum pinnatum*	Leaf of Life	Common on pathside and roadside banks	NA		O	R		O
Cyperaceae	*Cyperus flavus*		Occasional on grassy banks and moist open savanna	NA		R			R
	Eleocharis mutata	Scallion Grass	Frequent in boggy pastures and swamps	LC		O			O
	Cyperus pedunculatus		Occurs in sandy areas	LC					0
Euphorbiaceae	*Acidoton urens*	Mountain Dog	Common except in extreme eastern parishes, in woodlands and thickets on limestone	NA	A	F			O

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	Alchornea latifolia	Corn Wood	Common in woodlands and thickets	LC		O			
	Ateramnus lucidus	Crab Wood	Common in thickets on limestone, rocky and sandy soils	NA		R			
	Codiaeum variegatum	Garden Croton	Commonly cultivated	LC			F	R	
	Croton eluteria	Cascarilla Bark	Common, in thickets and woodlands on limestone	NA		R			
	Croton linearis	Wild Rosemary	Very common, mainly on coastal limestone rocks but also inland on well drained calcareous or serpentine soil	NA	O	A	A		D
	Manihot esculenta	Cassava	Cultivated locally in heavier soils	DD		O		O	
	*Omphalea triandra**	Pop Nut	Frequent in wet or moderately wet woodland on limestone	NA	O	O			
	Phyllanthus nutans		Common and widespread, in rocky woodlands and on well drained slopes in limestone or shale area	LC		F			
	Sapium jamaicense	Milk Wood	Frequent, in sheltered valleys	NA		R			O
Fabaceae	*Abrus precatorius*	John Crow Bead	Common in thickets, hedgerows and on fences, mostly in rather dry places	NA		A	A		F
	Arachis hypogaea	Peanut		NA		A			
	Brya ebenus	West Indian Ebony	Locally common, in thickets and pastures on limestone hills	NA	R				
	Centrosema pubescens		Common in waste places, rough pastures and thickets	NA		R			
	Centrosema virginianum		Common in waste places, rough pastures and thickets	NA			O		O
	Mucuna pruriens	Cowitch	Frequent in cultivations, thickets and woodland margins	LC		A		F	F
	Piscidia piscidia	Dog Wood	Common in thickets and woodlands on limestone hills	NA	O	O	A		
	Sesbania grandiflora	Baby Boots	Occasional in cultivation or as an escape	NA					R

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Lauraceae	*Nectandra antillana*	Long-leaved Sweetwood		NA		A	O	O	
	Nectandra coriacea	Small-leaved Sweet Wood	Common in woodland and woodland margins on limestone	NA	A	A			
	Persea americana	Pear	Common in cultivation	LC	R				
Liliaceae	*Asparagus setaceus*		Cultivated and occasionally escaped	NA			R		R
	Dracaena sp.	Snake Plant	Common ornamental	NA				F	
Loranthaceae	*Phoradendeon piperoides*	Missletoe	Occasional on trees and shrubs in the central parishes	NA		O	O		
Malpighiaceae	*Bunchosia media*		Very common in thickets and open woodlands on limestone	NA	O				
	Malpighia glabra	Wild Cherry	Very common in rough pastures, thickets and rocky grounds	LC			R		
	Malpighia punicifolia	West Indian Cherry	Uncommon in wild state, common in cultivation at low elevations	NA				R	
Melastomataceae	*Miconia dodecandra*		Widely distributed, on wooded hillsides and in moist thickets	LC	R				
Meliaceae	*Cedrela odorata*	Cedar	Common in places where noteably planted, especially in pastures and along roadsides	VU	R				
	*Guarea swartzii**	Alligator Wood	Frequent in mostly rather wet and sheltered woodlands on limestone or shale	NA					R
Mimosaceae	*Adenanthera pavonia*	Red Bead	Rather common, planted as shade tree and naturalized	NA		F	O		
	Albizia lebbeck	Woman's Tongue	Locally common, naturalized in open secondary woodlands	LC		R			
	Calliandra portoricensis		Common in secondary thickets and in open woodlands, mostly on limestone	NA	R			D	
	Leucaena leucocephala	Lead Tree	Common along roadsides and in sandy waste places and thickets	NA		A	F	A	A
	Mimosa pudica	Shame Old Lady	A common weed of pastures and open stabilized waste places	LC		A	F		A

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	Prosopis juliflora	Cashaw	Locally common in low pastures in arid area and on sand and shingle dunes	NA		F	A		
	Samanea saman	Guango	Common in inhabited areas and in old pastures where planted	LC	O	A	A	A	R
Moraceae	*Artocarpus altilis*	Breadfruit	Common in cultivation, but mostly at lower elevations in suffiently rainy areas	LC			R	R	
	Brosimum alicastrum	Breadnut	Locally common, especially in western parishes, in woodland on limestone	LC	A	A		O	A
	Cecropia peltata	Trumpet Tree	Common, especially on recently cleared forested land	LC	O	O	R	O	R
	Ficus benjamina	Chinese Banyan	Common ornamental	LC			O	R	
	Ficus perforata	Cherry Fig	Common as an epiphyte or in woodlan margins on limestone	NA		R			O
	Ficus pertusa	Strangler Fig	Very common as epiphyte or in rocky woodland margins	LC		O		R	O
	Trophis racemosa	Ramoon	Frequent in woodlands on limestone	LC	O	O			O
Musaceae	*Musa paradisiaca*	Plantain	Commonly cultivated	NA			O		
	Musa sapientum	Banana	Commonly cultivated	NA			O	R	
Myrsinaceae	*Ardisia dictyoneura**		Occasional in the central and western parishes, in woodland on limestone	NA					
Myrtaceae	*Eugenia biflora*		On wooded hillsides, chiefly limestone	LC	A	F			O
	*Eugenia disticha**	Rod Wood	In moist thickets, wooded hillsides and pastures, chiefly in Western half of the island	NA		A	R	F	
	Pimenta dioica	Pimento	Common on wooded hillsides	LC	R		O		
	Psidium guajava	Guava	Common in pastures and wayside thickets, sometimes cultivated	LC		A	F		O
Nyctaginaceae	*Bougainvillea sp.*		Commonly cultivated	NA					O
	Pisonia aculeata	Cockspur	Common in secondary thickets and woodland margins mostly on limestone	LC	O	F	O	O	O

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
Oleaceae	*Linociera domingensis*	Iron Wood	Widely distributed but not common, in woodlands in limestone or shale	NA		R			R
Onagraceae	*Ludwigia peruviana*		Rather common in boggy pastures, ditches and along stream banks and pond margins	NA		R			O
Orchidaceae	*Brassavola cordata*	Lady of the Night	Common as an epiphyte on large, often isolated trees and in woodlands	NA	R				
	Oeceoclades maculata	African spotted orchid		LC	F	F	F		
Papaveraceae	*Bocconia frutescens*	Celandine	Frequent in secondary thickets and low woodlands or weed in clearings	LC		R			
Passifloraceae	*Passiflora edulis*	Passion Fruit	Cultivated and naturalized	NA		R	O		
	Passiflora maliformis	Sweet Cup	Cultivated and naturalized	NA					
	Passiflora suberosa		Common in thickets and waste places	NA		O			
Phytolaccaceae	*Petiveria alliacea*	Guinea Hen Weed	Locally very common as a weedof semi-shaded roadsides and rough well drained undisturbed ground	NA		O	A	F	
Piperaceae	*Piper amalago*	Jointer	Very common, on gully banks, roadsides and in thickets and woodlands on limestone	LC	A	F			A
	*Piper nigrinodum**	Black Jointer	Occasional mostly in the central parishes, in woodland and pasture margins on limestone	NA	F	A			A
	*Piper verrucosum**		Occasional, in the central parishes, in open woodlands on craggy limestone	NT		R			
Poaceae	*Bambusa vulgaris*	Common Bamboo	Introduced from Asia	NA		A			R
	Chusquea abietifolia	Climbing Bamboo	Locally abundant in thickets and open woodlands	NA	O	F			R
	Panicum maximim	Guinea grass	Very common in rough pastures, ditches and sheltered thickets	NA		A	D	A	
	Panicum reptans		Occasional on roadside banks and in low pastures	LC			O		

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	Stenotapharum secundatum	Crab Grass	Common in pastures on heavy poorly drained soils or on sand or coral limestone	NA	R	O	F	A	
	Zea mays	Corn	Cultivated	LC			A		F
	Zoysia tenuifolia		Common, widely distributed	NA		D	A	D	A
Polygonaceae	*Coccoloba longifolia**		Common in woodland on limestone	NA	O				O
	*Coccoloba plumieri**	Mountain Grape	Occasional in moist savannas, thickets and woodlands on limestone in the central and western parishes	NT		R			
	*Coccoloba zebra**		Rather rare (Manchester, St. Ann, Port.), in woodland on limestone	NA					R
Pteridaceae	*Adiantum tenerum*	Brittle Maidenhair Fern		NA	O	R			
Quiinaceae	*Quiina jamaicensis**	Mountain Bay	Locally common in north-western parishes, in woodland on limestone	NT					O
Rhamnaceae	*Auerodendron jamaicense**	Turtle fat	Occasional in coastal woodland on limestone and on old sand dunes	VU		R			
	*Ziziphus Chloroxylon**	Cog Wood	Generally distributed but much less common than hitherto, in woodland on limestone	NA					R
Rubiaceae	*Casasia longipes**		Uncommon in the central parishes	NT	R	R			
	Faramea occidentalis	Wild Coffee	Common in shady woodlands on limestone	NA		A		O	F
	Morinda citrifolia	Noni	Locally common in open areas near the sea, cultivated inland	NA				O	
	*Portlandia grandiflora**	Bell Flowers	Fairly common, on limestone rocks and cliffs in thickets and open woodlands	NT		R			F
	Psychotria nervosa	Wild Coffee	Very common, in well drained thickets and woodland margins	LC	A	A			
	Borreria verticillata	Wild Scabious	Common on lower and highest elevations, on open waste ground and stony hills	LC					R
Rutaceae	*Citrus aurantifolia*	Lime	Commonly cultivated	NA			R	R	
	Citrus sinensis	Sweet Orange	Commonly cultivated	NA		R	R		

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	Citrus vulgaris	Siville Orange	Commonly cultivated	NA		R	R		
	Fagara elephantiasis	Yellow Sanders	Common, mostly in central and western parishes, in open woodland	LC		O	R		O
	Fagara martinicensis	Prickly Yellow	Common, especially in secondary formations	NA	F	A	O	O	F
	Peltostigma pteleoides	Cantoo	Very rare (St. Elizabeth), in woodland on limestone	NA	R				
	*Spathelia sorbifolia**	Mountain Pride	Rather common in open thickets or woodlands on well drained shale or limestone	NA	F	O			
Sapindaceae	*Allophylus cominia*		Common on well drained slopes and in woodlands and thickets on limestone	LC	F	O			O
	Allophylus jamaicensis		Occasional in the central and western parishes, in woodland on limestone	NA		O			
	Blighia sapida	Ackee	Commonly cultivated and naturalized	LC			O	O	
	Cupania glabra	Wild Ackee	Common, in thickets and secondary woodlands on limestone	LC		A	R		
	Exothea paniculata	Wild Guinep	Occasional in the central parishes, in woodland on limestone	LC	R				
	Matayba apetala	Coby Wood	Widely distributed in rough pastures, secondary woodlands and thickets	NA	F	O	O	R	
	Melicoccus bijugatus	Guinep	Common along roadsides and in secondary thickets and woodlands	LC	R			O	
Sapotaceae	*Bumelia nigra**	Red Bullet	Rather common in central and western parishes, in pastures and woodland margins on limestone	NA	R	R			
	Bumelia salicifolia	White Bullet	Common in woodlands and thickets on limestone	NA	R	R			
	Chrysophyllum cainito	Star Apple	Common, mostly along roadsides and in pastures	NA	O	R		R	
	*Micropholis rugosa**	Beef Apple	Occasional in central and western parishes, mostly in open situations on limestone	NT		R			
Simaroubaceae	*Picrasma excelsa*	Bitter Wood	Locally common in hill pastures, relict woodlands and along roadsides	VU	R	R	O		

Family	Scientific Name	Common Name	Range	IUCN STATUS	DB	SF	FH	BA	FS
	Simarouba glauca	Bitter Damson	Common in woodland on limestone	LC		O	O		F
Smilacaeae	*Smilax balbisiana*	Chainy Root	Very common in open woodlands and thickets	NA	R	R			R
	Smilax regelii	Sarsiparillia	Cultivated, now widely distributed	NA		R			
Solanaceae	*Datura suaveolens*	Angel's Trumpet	Occasional, mostly cultivation in hill gardens	LC		R		R	
	Solanum erianthum	Wild Susumber	Frequent, in thickets and steep banks on limestone	NA		O	O		O
	Solanum torvum	Susumber	Common in woodland clearings, thickets and waste places	NA			R		
Sterculiaceae	*Guazuma ulmifolia*	Bastard Cedar	Very common along roadsides, in pastures and open secondary woodlands	LC		O	R	O	O
Thelypteridaceae	*Thelypteris Serra*	Jamaican Maiden Fern		NA					
Tiliaceae	*Truimfetta semitriloba*	Bur Weed	Very common, a weed of roadsides, rough pastures and thickets	NA		F	A	A	F
Urticaceae	Pilea microphylla*	Baby Puzzle	Rather common locally on walls and pathside rocks in damp shaded places	NA		R			
Verbenaceae	*Clerodendrum thomsoniae*	Rice and Peas	Cultivated ornamental	NA			F	F	
	Lanatana reticulata		Rather common in rocky thickets and woodland margins on limestone	NA			A		
	Lantana camara	Wild Sage	Very common in rough pastures, waste places and thickets	NA		A		F	A
	*Lantana jamaicensis**		Local (Manch., St. Elis., Trel., St. Ann), in thickets and woodland margins on limestone hills	NA		R			
	Lantana urticifolia	Black Sage	Locally common in the drier parts of the southern parishes, in thickets on limestone gravel or sand	NA		R			
Vitaceae	*Cissus sicyoides*	Soldier Wiss	Very common on trees, walls, fences and in thickets	NA			F		F
	Vitis tiliifolia	Water With	Occasional, on banks, fences and over trees in woodland on limestone	NA		R			

13.6 Reptiles recorded in SEPL 541

Family	Scientific Name	Common Name	Range	IUCN	Comments	Disturbed Broadleaf Forest	Secondary Forest And Fields	Fields: Herbaceous Crops Etc	Built Areas	Fields & Secondary Forests
Dactyloidae	*Anolis garmani*	Jamaican Giant Anole	End	LC	Crown giant, typically found in the canopy	O		R	O	R
	Anolis lineatopus	Jamaican Brown Anole	End	LC	Trunk to ground anole. Widespread, occurring in all parishes. Tolerant of disturbance.	A	D	D	A	D
	Anolis grahami	Jamaican Turquoise Anole	End	LC	Trunk to crown anole. Widespread, occurring in all parishes. Tolerant of disturbance.	O		O	O	O
	Anolis opalinus	Jamaican Opal-bellied Anole	End	LC	Found in most parishes. Tolerant of minimal disturbance.	O		R	O	O

Family	**Scientific Name**	**Common Name**	**Range**	**IUCN**	**Comments**	**Disturbed Broadleaf Forest**	**Secondary Forest And Fields**	**Fields: Herbaceous Crops Etc**	**Built Areas**	**Fields & Secondary Forests**
	Anolis sagrei	Cuban Brown Anole	Int	LC	It is now found in multiple areas in Jamaica.			O	O	
	Anolis valencienni	Jamaican Twig Anole	End	LC	Found in most parishes. Tolerant of minimal disturbance.	R		R	O	
Gekkonidae	*Hemidactylus mabouia*	House Gecko	Int	LC	It is now found in multiple areas in Jamaica.	R		R	O	O
Sphaerodactylidae	*Aristelliger praesignis*	Jamaican Croaking Gecko	End	LC	Typically found in dry coastal forests in dying logs or tree stumps	O	O	O	O	O
	Sphaerodactylus argus	West Caribbean Ocellated Geckolet	End	LC	Found in most parishes. Tolerant of minimal disturbance.	R		R	R	O
	Sphaerodactylus parkeri	Southern Jamaica Banded Geckolet	End	EN	Found in dry forests on the	R		R		

Family	Scientific Name	Common Name	Range	IUCN	Comments	Disturbed Broadleaf Forest	Secondary Forest And Fields	Fields: Herbaceous Crops Etc	Built Areas	Fields & Secondary Forests
					southern coast. Not typically found in disturbed areas.					
Anguidae	*Celestus crusculus*	Jamaican Brown Galliwasp	End	LC	Widespread, occurring in most parishes. Commonly found in gardens and agricultural areas as well as well-preserved forests.		R	R		
*Boidae	*Chilabothrus subflavus*	Jamaican Yellow Boa	End	VU	Historically found in most parishes. Declining population due to habitat loss, invasive predators, and					

Family	Scientific Name	Common Name	Range	IUCN	Comments	Disturbed Broadleaf Forest	Secondary Forest And Fields	Fields: Herbaceous Crops Etc	Built Areas	Fields & Secondary Forests
					human persecution.					
Colubridae	*Hypsirhynchus callilaemus*	Jamaican Red Ground snake	End	LC	Widespread, occurring in most parishes. Commonly found in gardens and agricultural areas as well as well-preserved forests.			R		
Typhlopidae	*Typhlops jamaicensis*	Jamaican Blind snake	End	LC	Found in most parishes. Tolerant of minimal disturbance, e.g., gardens and agriculture.	R				R
*Tropidophiidae	*Tropidophis jamaicensis*	Thunder snake	End	NE	Three species reported in Jamaica.					

Family	Scientific Name	Common Name	Range	IUCN	Comments	Disturbed Broadleaf Forest	Secondary Forest And Fields	Fields: Herbaceous Crops Etc	Built Areas	Fields & Secondary Forests
					Tropidophis stullae reported in the southern section of Jamaica.					
Emydidae	*Trachemys terrapen*	Jamaican Sliders	Nat	VU	Found in many different areas in Jamaica and on a few islands in the Bahamas.			R		

Notes:
1. Range: - Resident: Int: Introduced; Nat: Native; End. Endemic; End.Ss: endemic subspecies; Uk: unknown
2. IUCN Status: - CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient; NE: Not Evaluated
3. DAFOR: - D – Dominant; A – Abundant; F – Frequent; O – Occasional; R – Rare
4. * Reported in the area but not observed

13.7 Amphibians recorded in SELP 541

Family	Scientific Name	Common Name	Range	IUCN	Comments	DB	SF	FH	D	FS
Eleutherodactylidae	*Eleutherodactylus gossei*	Jamaican Forest Frog	End	LC	Found throughout Jamaica.	O	O	A	O	F
	Eleutherodactylus johnstonei	Lesser Antillean Frog	Int	LC	It is tolerant to disturbance and found throughout Jamaica.	A	A	D	D	D
	Eleutherodactylus planirostris	Cuban Flat-headed Frog	Int	LC	It is tolerant to disturbance and found throughout Jamaica.	R	O	O	O	O
Hylidae	*Osteopilus ocellatus*	Jamaican Laughing Treefrog	End	NT	It occurs in a variety of habitat types, including developed but rural areas.	O				
Ranidae	*Lithobates catesbeianus*	American Bullfrog	Int	LC	Occurs primarily in ponds and river.		O			
Bufonidae	*Rhinella marina*	Cane toad & Bull frog	Int	LC	It is tolerant to disturbance and found throughout Jamaica.	O	O	O	O	R

Notes:

1. Range: - Resident: Int: Introduced; Nat: Native; End. Endemic; End.Ss: endemic subspecies; Uk: unknown
2. IUCN Status: - CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient; NE: Not Evaluated
3. DAFOR: - D – Dominant; A – Abundant; F – Frequent; O – Occasional; R – Rare

13.8 The bat species reported in the parish of Hanover by (Genoways , et al. 2005) and the species which were observed in the study

SPECIES	**Common name**	**Diet**	**IUCN**	**Range**	**Roost**	**Foraging Behaviour**	**Reported in St Elizabeth**	**DB**	**SF**	**FH**	**D**	**FS**
Artibeus jamaicensis	Jamaican Fruit Bat	Frugivore	LC	Native	Cave, man-made structure, foliage	Fruit Feeder: trees in forested and disturbed area	Yes			X	X	X
Noctilio leporinus	Fishing Bat	Piscivore	LC	Native	Cave, crevice, Tree hollow	Slow-moving water surface; along edge and open fields	Yes			X		
Moormops blainvillei	Antillean Ghost-faced Bat	Insectivore	LC	Native	Obligate cave	semi-cluttered space; fluttering hunter	Yes	X		X		
Pteronotus parnellii	Parnell's Mustached Bat	Insectivore	LC	Native	Obligate cave	Highly cluttered space;	Yes	X				X

SPECIES	Common name	Diet	IUCN	Range	Roost	Foraging Behaviour	Reported in St Elizabeth	DB	SF	FH	D	FS
						fluttering hunter						
Pteronotus macleayii	MacLeay's Mustached Bat	Insectivore	LC	Native	Obligate cave	Background-cluttered space; fluttering hunter	Yes	X	X	X	X	X
Pteronotus quadridens	Sooty Mustached Bat	Insectivore	LC	Native	Obligate cave	Background-cluttered space	Yes	X	X	X	X	
Monophyllus redmani	Leach's Single Leaf Bat	Nectarivore	LC	Native	Obligate cave	Nectar Feeder: trees in forested and disturbed area	Yes					
Molossus molssus	Pallas' Mastiff Bat	Insectivore	LC	Native	Cave, man-made structures	Open-space, aerial awking	Yes			X	X	X

SPECIES	Common name	Diet	IUCN	Range	Roost	Foraging Behaviour	Reported in St Elizabeth	DB	SF	FH	D	FS
Macrotus waterhousii	Big-eared Bat	Insectivore	LC	Native	Cave, man-made structure	Cluttered space	Yes					
Glossophaga soricina	Pallas' Long-tongued Bat	Nectarivore	LC	Native	Cave, man-made structure	Nectar Feeder: trees in forested and disturbed area	Yes					
Ariteus flavescens	Jamaican Fig-eating Bat	Frugivore	LC	Endemic	Tree crown	Fruit Feeder: trees in forested and disturbed area	Yes					
Natalus jamaicensis	Jamaican Funnel-eared Bat	Insectivore	CE	Endemic	Obligate cave	Cluttered space; fluttering hunter	Yes					
Eptesicus fuscus	Big Brown Bat	Insectivore	LC	Native	Obligate cave		Yes					

SPECIES	Common name	Diet	IUCN	Range	Roost	Foraging Behaviour	Reported in St Elizabeth	DB	SF	FH	D	FS
Tadarida brasiliensis	Free-tailed Bat	Insectivore	LC	Native	Cave,man-made structures	Open-space, aerial awking	Yes	X	X	X	X	X
Nyctinomops macrotus	Big Free-tailed Bat	Insectivore	LC	Native	Cave, crevices		Yes			X		
Eumops glaucinus	Wagner's Bonneted Bat	Insectivore	LC	Native	Cave,man-made structures	Open-space, aerial awking	No			X	X	

*The table was generated from information from Genoways et al 2005, Koenig 2015, IUCN Red List 2019, and Wikipedia 2019.

13.9 THE BIRDS OBSERVED DURING SUMMER PERIOD

Num	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
1	American Kestrel	*Falco sparverius*	*Resident*	LC	R	O	R	O	R
3	Antillean Nighthawk	*Chordeiles gundlachii*	*Migrant*	LC	R	R	R	R	R
4	Antillean Palm-Swift	*Tachornis phoenicobia*	*Resident*	LC	O	F	F	O	O
6	Bananaquit	*Coereba flaveola*	*Resident*	LC	O	F	O	O	F
7	Barn Owl	*Tyto alba*	*Resident*	LC		R	R		
8	Barn Swallow	*Hirundo rustica*	*Migrant*	LC		R			
12	Black-crowned Night-Heron	*Nycticorax nycticorax*	*Resident*	LC		O			
13	Black-faced Grassquit	*Melanospiza bicolor*	*Resident*	LC	O	O	O	O	O
14	Black-necked Stilt	*Himantopus mexicanus*	*Resident*	LC		R			
22	Caribbean Dove	*Leptotila jamaicensis*	*Resident*	LC	O	O	O		O
24	Cattle Egret	*Bubulcus ibis*	*Resident*	LC	R	F		O	R
25	Cave Swallow	*Petrochelidon fulva*	*Resident*	LC		O	R		
30	Common Ground Dove	*Columbina passerina*	*Resident*	LC	O	O	R		
31	Common Moorhen	*Gallinula chloropus*	*Resident*	LC		R	R	O	O
33	Crested Quail-Dove	*Geotrygon versicolor*	*Endemic*	NT	R				

Num	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
34	European Starling	*Sturnus vulgaris*	*Introduced*	LC		R	R		
35	Glossy Ibis	*Plegadis falcinellus*	*Resident*	LC		R			
37	Grasshopper Sparrow	*Ammodramus savannarum*	*Resident*	LC		R	R		
39	Gray Kingbird	*Tyrannus dominicensis*	*Migrant*	LC	F	A	A	A	F
40	Great Blue Heron	*Ardea herodias*	*Resident*	LC		R			
41	Great Egret	*Ardea alba*	*Resident*	LC		O	R		
42	Greater Antillean Bullfinch	*Melopyrrha violacea*	*Resident*	LC	R	R			R
44	Greater Antillean Grackle	*Quiscalus niger*	*Resident*	LC	O	F	F	F	O
46	Green Heron	*Butorides virescens*	*Resident*	LC		O			
47	Green-rumped Parrotlet	*Forpus passerinus*	*Introduced*	LC	A	R	R		
48	Jamaican Becard	*Pachyramphus niger*	*Endemic*	LC	O	O	R		
51	Jamaican Elaenia	*Myiopagis cotta*	*Endemic*	LC	R	R			
52	Jamaican Euphonia	*Euphonia jamaica*	*Endemic*	LC	O	O	O	R	O
53	Jamaican Lizard-Cuckoo	*Coccyzus vetula*	*Endemic*	LC	R	R	R		R
54	Jamaican Mango	*Anthracothorax mango*	*Endemic*	LC	O	O	R	O	O
55	Jamaican Oriole	*Icterus leucopteryx*	*Resident*	LC	O	O	R	O	O

Num	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
56	Jamaican Owl	*Pseudoscops grammicus*	*Endemic*	LC	R	R	R		R
57	Jamaican Pewee	*Contopus pallidus*	*Endemic*	LC	R	O	R		R
59	Jamaican Tody	*Todus todus*	*Endemic*	LC	O	R	R		R
60	Jamaican Vireo	*Vireo modestus*	*Endemic*	LC	R	R	R		O
61	Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	LC	O	F	O	O	O
63	Killdeer	Charadrius vociferus	*Resident*	LC		R	R		
64	Lesser Yellowlegs	*Tringa flavipes*	*Migrant*	LC		R			
65	Limpkin	*Aramus guarauna*	*Resident*	LC		R			
67	Little Blue Heron	*Egretta caerulea*	*Resident*	LC		R			
68	Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	LC	O	O	O	R	O
72	Mangrove Cuckoo	*Coccyzus minor*	*Resident*	LC		O	R		
74	Mourning Dove	*Zenaida macroura*	*Resident*	LC		R			
75	Northern Mockingbird	*Mimus polyglottos*	*Resident*	LC	O	O	O	F	O
77	Northern Potoo	*Nyctibius jamaicensis*	*Resident*	LC	R				
80	Northern Jacana	Jacana spinosa	*Resident*	LC		R			
81	Jamaican Parakeet	*Eupsittula nana*	*Endemic*	NT	F	F	O	A	O
82	Orangequit	*Euneornis campestris*	*Endemic*	LC	R				
92	Red-tailed Hawk	*Buteo jamaicensis*	*Resident*	LC		R			

Num	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
96	Ruddy Quail-Dove	*Geotrygon montana*	*Resident*	LC	R				
97	Rufous-tailed Flycatcher	*Myiarchus validus*	*Endemic*	LC	R		R		
99	Sad Flycatcher	*Myiarchus barbirostris*	*Endemic*	LC	R	O	R		R
103	Smooth-billed Ani	*Crotophaga ani*	*Resident*	LC	O	F	O	O	O
104	Snowy Egret	*Egretta thula*	*Resident*	LC		R	R	R	
105	Stolid Flycatcher	*Myiarchus stolidus*	*Resident*	LC	R	R	R		
106	Streamertail	*Trochilus polytmus*	*Endemic*	LC	O	O	R	O	O
110	Turkey Vulture	Cathartes aura	*Resident*	LC	O	O	O	O	O
112	Vervain Hummingbird	*Mellisuga minima*	*Resident*	LC	R	O	R	R	O
114	White-chinned Thrush	*Turdus aurantius*	*Endemic*	LC	O	O	O	R	R
115	White-collared Swift	*Streptoprocne zonaris*	*Resident*	LC		O	O		
116	White-crowned Pigeon	*Patagioenas leucocephala*	*Resident*	NT	A	F	F	O	A
119	White-winged Dove	*Zenaida asiatica*	*Resident*	LC	F	O	O	O	O
126	Yellow-crowned Night-Heron	*Nyctanassa violacea*	*Resident*	LC		R			
127	Yellow-faced Grassquit	*Tiaris olivaceus*	*Resident*	LC	A	F		O	F

Num	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
128	Yellow-shouldered Grassquit	*Loxipasser anoxanthus*	*Endemic*	LC	O	O	R		R
131	Zenaida Dove	*Zenaida aurita*	*Resident*	LC	R	O	R	O	R

13.10 THE BIRDS OBSERVED DURING THE WINTER PERIOD

#	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
1	American Kestrel	*Falco sparverius*	*Resident*	LC	R	O	R	O	R
2	American Redstart	*Setophaga ruticilla*	*Migrant*	LC	O	O	O	O	O
4	Antillean Palm-Swift	*Tachornis phoenicobia*	*Resident*	LC	O	F	F	O	O
6	Bananaquit	*Coereba flaveola*	*Resident*	LC	O	F	O	O	F
7	Barn Owl	*Tyto alba*	*Resident*	LC		R	R	R	
8	Barn Swallow	*Hirundo rustica*	*Migrant*	LC		R			
10	Black-and-white Warbler	*Mniotilta varia*	*Migrant*	LC	R	R			R
12	Black-crowned Night-Heron	*Nycticorax*	*Resident*	LC		O			
13	Black-faced Grassquit	*Melanospiza bicolor*	*Resident*	LC	O	O	O	O	O
14	Black-necked Stilt	*Himantopus mexicanus*	*Resident*	LC		R			
16	Black-throated Blue Warbler	*Setophaga caerulescens*	*Migrant*	LC	R	R	R		
19	Blue-winged Teal	*Spatula discors*	*Migrant*	LC		R			
21	Cape May Warbler	*Setophaga tigrina*	*Migrant*	LC		O	R	O	R
22	Caribbean Dove	*Leptotila jamaicensis*	*Resident*	LC	O	O	O		O
23	Caribbean Martin	*Progne dominicensis*	*Migrant*	LC		D			
24	Cattle Egret	*Bubulcus ibis*	*Resident*	LC	R	F	O	O	R
25	Cave Swallow	*Petrochelidon fulva*	*Resident*	LC		O	O		

#	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
27	Chestnut Munia	*Lonchura atricapilla*	*Introduced*	LC		R			
30	Common Ground Dove	*Columbina passerina*	*Resident*	LC	O	O	R		
31	Common moorhen	*Gallinula chloropus*	*Resident*	LC		R	R		
32	Common Yellowthroat	*Geothlypis trichas*	*Migrant*	LC	R	R			
33	Crested Quail-Dove	*Geotrygon versicolor*	*Endemic*	NT	R				
34	European Starling	*Sturnus vulgaris*	*Introduced*	LC		R			
35	Glossy Ibis	*Plegadis falcinellus*	*Resident*	LC		R			
37	Grasshopper Sparrow	*Ammodramus savannarum*	*Resident*	LC		R			
40	Great Blue Heron	*Ardea herodias*	*Resident*	LC		R			
41	Great Egret	*Ardea alba*	*Resident*	LC		O	R		
42	Greater Antillean Bullfinch	*Melopyrrha violacea*	*Resident*	LC	R	R			R
43	Greater Antillean Elaenia	*Elaenia fallax*	*Resident*	LC		R			R
44	Greater Antillean Grackle	*Quiscalus niger*	*Resident*	LC	O	F	O	F	O
46	Green Heron	*Butorides virescens*	*Resident*	LC		R			

#	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
47	Green-rumped Parrotlet	*Forpus passerinus*	*Introduced*	LC	A	R	R		
48	Jamaican Becard	*Pachyramphus niger*	*Endemic*	LC	O	O	R		
51	Jamaican Elaenia	*Myiopagis cotta*	*Endemic*	LC	R	R			
52	Jamaican Euphonia	*Euphonia jamaica*	*Endemic*	LC	O	O	R	R	O
53	Jamaican Lizard-Cuckoo	*Coccyzus vetula*	*Endemic*	LC	R	R	R	R	R
54	Jamaican Mango	*Anthracothorax mango*	*Endemic*	LC	O	R	R	O	O
55	Jamaican Oriole	*Icterus leucopteryx*	*Resident*	LC	O	O	R	R	R
56	Jamaican Owl	*Pseudoscops grammicus*	*Endemic*	LC	R	R	R		R
57	Jamaican Pewee	*Contopus pallidus*	*Endemic*	LC	R	R	R		R
59	Jamaican Tody	*Todus*	*Endemic*	LC	O	R	R		
60	Jamaican Vireo	*Vireo modestus*	*Endemic*	LC	R	R	R		O
61	Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	LC	O	F	O	O	O
63	Killdeer	Charadrius vociferus	*Resident*	LC		R	R		
64	Lesser Yellowlegs	*Tringa flavipes*	*Migrant*	LC		R			
67	Little Blue Heron	*Egretta caerulea*	*Resident*	LC		R			
68	Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	LC	O	O	O	A	O
69	Louisiana Waterthrush	*Parkesia motacilla*	*Migrant*	LC		R			

#	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
72	Mangrove Cuckoo	*Coccyzus minor*	*Resident*	LC		R	R		
74	Mourning Dove	*Zenaida macroura*	*Resident*	LC		R			
75	Northern Mockingbird	*Mimus polyglottos*	*Resident*	LC	O	O	O	F	O
76	Northern Parula	*Setophaga americana*	*Migrant*	LC	R	O	O		R
77	Northern Potoo	*Nyctibius jamaicensis*	*Resident*	LC	R				
79	Northern Waterthrush	*Parkesia noveboracensis*	*Migrant*	LC		R			
80	Northern Jacana	Jacana spinosa	*Resident*	LC		R			
81	Jamaican Parakeet	*Eupsittula nana*	*Endemic*	NT	F	F	O	A	O
82	Orangequit	*Euneornis campestris*	*Endemic*	LC	R				
85	Ovenbird	*Seiurus aurocapilla*	*Migrant*	LC			R		
89	Prairie Warbler	*Setophaga discolor*	*Migrant*	LC	R	O	R		O
92	Red-tailed Hawk	*Buteo jamaicensis*	*Resident*	LC		R	R		
96	Ruddy Quail-Dove	*Geotrygon montana*	*Resident*	LC	R				
97	Rufous-tailed Flycatcher	*Myiarchus validus*	*Endemic*	LC	R		R		
99	Sad Flycatcher	*Myiarchus barbirostris*	*Endemic*	LC	R	R	R		R
103	Smooth-billed Ani	*Crotophaga ani*	*Resident*	LC	O	F	O	O	O
104	Snowy Egret	*Egretta thula*	*Resident*	LC		R			
105	Stolid Flycatcher	*Myiarchus stolidus*	*Resident*	LC	R	R	R		

#	Common Name	Scientific Name	Range	IUCN	DB	SF	FH	D	FS
106	Streamertail	*Trochilus polytmus*	*Endemic*	LC	O	O	R	O	O
110	Turkey Vulture	Cathartes aura	*Resident*	LC	O	O	O	O	O
112	Vervain Hummingbird	*Mellisuga minima*	*Resident*	LC	R	O	R	R	O
114	White-chinned Thrush	*Turdus aurantius*	*Endemic*	LC	O	O	O		R
115	White-collared Swift	*Streptoprocne zonaris*	*Resident*	LC		F	O		
116	White-crowned Pigeon	*Patagioenas leucocephala*	*Resident*	NT	A	F	F	O	F
119	White-winged Dove	*Zenaida asiatica*	*Resident*	LC	F	O	O	O	O
122	Yellow Warbler	*Setophaga petechia*	*Resident*	LC	R	R	R	R	
123	Yellow-bellied Sapsucker	*Sphyrapicus varius*	*Migrant*	LC	R		R		
126	Yellow-crowned Night-Heron	*Nyctanassa violacea*	*Resident*	LC		R			
127	Yellow-faced Grassquit	*Tiaris olivaceus*	*Resident*	LC	A	F	O	O	F
128	Yellow-shouldered Grassquit	*Loxipasser anoxanthus*	*Endemic*	LC	O	O	O	R	R
131	Zenaida Dove	*Zenaida aurita*	*Resident*	LC	R	O	R	O	R

13.11 Butterflies recorded from SEPL 541

Order: LEPIDOPTERA FAMILY	SCIENTIFIC NAMES	COMMON NAMES	STATUS, RANGE JAMAICAN DISTRIBUTION	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
HESPERIIDAE	*Chioides catillus churchi*	Church's Jamaican Skipper; Jamaican Long-tailed Skipper	End. Ss. not common, not abundant			O		
	Urbanus proteus domingo	Common Long-tailed Skipper	Southern U.S. to Uruguay, Argentina, West Indies, Bahamas			O		
	Pyrgus oileus	Tropical Checkered Skipper	Southern U.SA. to Argentina					
	Wallengrenia vesuria						O	
NYMPHALIDAE:	*Danaus gilippus jamaicensis*	Jamaican Queen	End. Ss.			O		
	Danaus plexippus	Monarch	Widespread, not common. Central America, Greater Antilles			O		
	Danaus eresimus	Eresimus; Soldier	Not widespread or common. Central America, Cuba, Hispaniola, Jamaica			R		
	Anartia jatrophae	White Peacock	Widespread and common. Southern US to Argentina	O		0		
	Calisto zangis	Jamaican Calisto; Jamaican Satyr	Endemic; Widespread and common. Forested and shady regions	O		F		
	Mestra dorcas	Jamaican Mestra	Endemic ; widespread, fairly common			F		
	Dione vanillae	The Tropical Silverspot	Widespread and very common	O	O		O	
	Dryas iulia delila	Julia	Endemic Ss.; widespread, common	O				
	Heliconius simulator	Jamaican Zebra Longwing ; Zebra	Endemic	F	O	O		

Order: LEPIDOPTERA FAMILY	SCIENTIFIC NAMES	COMMON NAMES	STATUS, RANGE JAMAICAN DISTRIBUTION	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
	Anaea portia	Jamaican Leaf butterfly; Jamaican Goatweed butterfly	Endemic; widespread, fairly common	O	O			
	Historis odius odius	Orion; Hard- fe- Dead	Widespread, not very common		O			
	Junonia zonalis	West Indian Buckeye	Bahamas, Cuba, Hispaniola, Caymans Islands, Jamaica					
	Junonia evarete			O	O			
	Euptoieta hegesia	Tropical Fritillary	Common; widespread, fairly common. Southern US to Argentina					
	Mestra dorcas	Jamaican Mestra; Dorcas	Endemic; widespread but not common;	O	O	O	O	
	Anea portia			O				
	Siproeta stelens			O				
PIERIDAE	*Anteos maerula*	Giant Brimstone; Maerula	Widespread, not very common. Southern US to Peru	O		O		
	Phoebis sennae	Cloudless Sulphur	Widespread and common. Southern US to Argentina	O	O			
	Ascia monuste	Great Southern White; Antillean Great White	N; widespread, common and pest of crucifers. Southern US to Argentina	O	O	O		
	Eurema daira	Poey's Barred Sulphur	Widespread and common. Southern US to Brazil	O		O		
	Eurema nise	Mimosa Yellow; Cramer's Little Sulphur	Widespread, common. Southern US to Argentina	O		O	O	
	Eurema elathea	Cramer's Barred Sulphur	Widespread, not common. Central America and Greater Antilles			O		
	Eurema proterpia			O				
	Eurema messalina			O				

Order: LEPIDOPTERA FAMILY	SCIENTIFIC NAMES	COMMON NAMES	STATUS, RANGE JAMAICAN DISTRIBUTION	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
	Eurema adamsi						O	
	Kricogonia lyside					O		
PAPILIONIDAE	*Heraclides andraemon*	Andraemon Swallowtail	Introduced from Cuba, 1940's; citrus pest. Greater Antilles	O		O	O	
	Papilio demoleus	Lime Swallowtail Butterfly	Introduced from S.E. Asia in 2006; Pest of citrus			O		
	Battus polydamas jamaicensis	Polydamas Swallowtail	End. Ss Southern US to Argentina	O				
	Protographium marcellinus	Jamaica's blue swallowtail	Endemic. Vulnerable, limited distribution				O	

13.12 Other Anthropods recorded from SEPL 541

FAMILY	SCIENTIFIC NAMES	COMMON NAMES AND COMMENTS	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
HEMIPTERA: Pyrrhocoridae	*Dysdercus andreae*	Cotton stainer, Love bug. Widespread, Americas Pest of Cotton		F	F		
Coreidae	*Catochinta sp.*			O			
Pentatomidae	*Thyanta sp.*				O		
	Loxa viridis	Stink bug	O	O			
	Nezara viridula	Stink bug			O		O
	Alcaeorrhyndius sp			O	O		
	Thyanta sp.					O	
Scutelleriidae	*Un-id. sp.*		O		O		
Chrysomelidae	*Pentispa collaris*						
Reduviidae	*Zelus sp.*						
	Emesa mantis	End.					
HOMOPTERA: Membracidae	*Un-id. sp. 1*						
Issidae	*Un-id. sp.*						
HOMOPTERA: CICADIDAE	*Odopoea sp.*	Cicada					
	Proarna sp.			R			
Cercopidae	*Prosapia sp.*			O			
Cicadellidae	*Texanaus sp.*				*O*		*O*
	Tylozygus sp				*O*		
Coccidae	*Icera purchasi*	Cottony cushion scale insect			*O*		
ORTHOPTERA: Tettigoniidae	*3 Un-id spp.*						
Acrididae	*Orphuella sp.*		F	F	F		R
HYMENOPTERA: VESPIDAE	*Polistes hunteri*			O			
	Polistes crinitus		O	O	*O*	*O*	*O*
APIDAE	*Apis mellifera*		F	F	*F*	*F*	*O*
	Centris crassipes		O		*O*		
	Centris decolorata				*O*		
	Mesocheria bicolor				*O*		
Xylocopinae	*Xylocopa mordax*			O	*O*		
Sphecidae	*Sphex jamaicensis*	Jamaican Digger Wasp		F			

FAMILY	**SCIENTIFIC NAMES**	**COMMON NAMES AND COMMENTS**	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb . B-leaf Forest	Built Area
		Endemic					
Sphecidae	*Sceliphron assimile*	Mud wasp			5		
	Trypoxylon texense	Mud wasp	0				
	Prionyx thomae		O		*O*		
Formicidae	*Camponotus sp.*	Carpenter ants	O	O	*O*	*O*	
	Phidole sp.	Black ants	O	O	*O*	*O*	*O*
	Solenopsis sp.			O			*F*
Megachilidae	*Megachile concina*	Leaf cutter bee	O	O			
	Megachile poyei	Leaf cutter bee	O	O	O		
COLEOPTERA: Coccinellidae	*Brachiacantha bistripustulata*	U.S., South and Central America					
Coccinellidae	*Azaya luteipes*						
Tenebrionidae	*Un-id. sp*						
Tenebrionidae	*Taurocera sp,*			O			
	Tarbela mutalis			O			
	Tauroceras sp.						O
Cerambycidae	*Oxymerus aculeatus lebasi*	A Brazilian Longhorn Beetle. West Indies and South America					
	Neoptychodes sp.		O			*O*	
Passalidae	*Paxillus sp.*					*O*	
COLEOPTERA: Elateridae	*Un-id. sp*						
Chrysomelidae	*Chalpeus sanguincollis*				O		
Scarabbaeidae	*Orniticelus cubiensis*	Down beetle	F	O	F	O	
	Hybosorus illigeri		O				O
	Cerea tetrica	News bug. Dung beetle	O		O		
	Paragymentis lanius	News bug. Bumble flower beetle	O	0			0
	Cerea vinosa	News bug. Dung beetle	O		O	O	
	Ligyrus forror	News bug. Dung beetle					
	Strategus simson		0		0		

FAMILY	SCIENTIFIC NAMES	COMMON NAMES AND COMMENTS	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
	Macraspsis tetradactyla				O		
Lycidae	*Thonalmus bicolor*			O			O
Lampyridae	*Photinus lucernuia*	Blinky			O		
Buprestidae	*Psiloptera torquata*					F	
Dystiscidae	*Thermonectus sp.*		O				
ISOPTERA	*Nasutitermes costalis*	Termites, Duck ants Widespread. Neotropical	O	O	O	O	
DIPTERA							
Tipulidae	*Limonia sp.*						
Sarcophagidae	*Oxysarcodexia peltata (Aldrich 1916)*					F	O
	uk					O	O
	Oxysarcodexia bakeri (Aldrich 1916)					F	O
	Oxysarcodexia sp 1	Possible new species				O	
	Sarcofahrtiopsis farri Dodge 1965					R	
Calliphoridae	*Chrysomya rufifacies (Maquart 1843)*	Hairy maggot blowfly	O			R	R
	Chrysomya megacephala (Fabricius 1794)	Oriental latrine fly Significant to public health and medical entomology		O		O	F
	Cochliomyia macellaria (Fabricius)	Secondary screwworm fly		O		O	F
	Lucilia lucigerens James 1971	End	R				R
	Lucilia sp Robineau-Desvoidy	Possible new species				O	
Tephritidae	*Drosophila melanogaster Meigen, 1830*	Fruit fly		O		O	O
Ulididae	*Unknown sp*					O	
Muscidae	*Synthesiomyia nudiseta (van der Wulp, 1883)*	Synathropic species, secondary agent of myasis				O	O
	Musca domestica Linnaeus	housefly	O			O	F
	Musca sp					O	

FAMILY	**SCIENTIFIC NAMES**	**COMMON NAMES AND COMMENTS**	Sec. Forest & Fields	Fields & Sec. Forest	Fields: Herb. crops etc.	Disturb. B-leaf Forest	Built Area
Phoridae	*Megaselia scalaria (Loew, 1866)*	Coffin fly					
CHELONETHIDA PSEUDO-SCORPION	*Tyrannochtuonius innoxius*		O			O	
	Tyrannochthonius sp.					O	
SPIDERS *Araneidae*	Argiope sp.	Orbweavers					
	Eustala sp.						
Thomisidae	*Misumonops sp.*	Crab spider					
	Selenops sp.	Crab spider					
OPILIONES Harvestmen Cosmeitidae	*Cynotesta sp.*						
ACARI	*Boophilus microplus*	Cattle tick Grass lice					
Spirobolida: Rhinocricidae	*Anadenobolus monilicornis*	Yellow-banded millipede; Jamaican Bumble bee Millipede; Caribbean; introduced to southeastern US	O	O	O	O	

13.13 Ecological Study Sites: GPS Coordinates and Habitat Type

Sample Site	Latitude	Longitude	Vegetation Type
1	18.05102358	-77.69698883	Developed areas
2	18.05202084	-77.69108309	Fields: Herbaceous crops etc
3	18.03382104	-77.66544428	Secondary forest and fields
4	18.04240813	-77.64922051	Fields: Herbaceous crops etc
5	18.05914672	-77.64453902	Fields: Herbaceous crops etc
6	18.06701127	-77.62355301	Secondary forest and fields
7	18.05771532	-77.60841983	Disturbed broadleaf forest
8	18.00972035	-77.65886084	Fields: Herbaceous crops etc
9	18.00353022	-77.63386293	Secondary forest and fields
10	18.00381923	-77.61648529	Disturbed broadleaf forest
11	18.01386534	-77.6095579	Secondary forest and fields

13.14 Transplanting of Epiphytes

Transplanting of Epiphytes – Bromeliads & Orchids

Damion Whyte & Adrian Thomas

1/27/2021

Introduction

Bromeliads (Bromeliaceae) and epiphytic orchids (Orchidiaceae) are flowering plant that are natives of tropical and subtropical areas. These families if plants are diverse, with several genera. An epiphyte lives on another plant for support, such as a tree, but it is not necessarily parasitic.

These epiphytes, particularly large ones that have the capacity to store water in their leaf bases, provide habitats for an ecosystem for several species of animals, which includes crabs, frogs, earthworms, amphipods and insects.

Methodology

Transplanting of bromeliads

The bromeliads, are to be transplanted to other areas mimicking their natural habitat, as best as possible. The movement of the plants will be done in three main phases.

Phase 1 – Mapping/Geotagging of the epiphytes

This phase will consist of the team geotagging (collecting GPS locations) of each epiphyte that is to be transplanted from the project area. The end product of this rapid assessment will be a map, which will comprehensively give a spatial snapshot of where all the epiphytes are located. This will also provide information on how best to distribute the epiphytes in their new habitat.

Data will also be collected on each tree with epiphytes. These data include: species, Diameter at Breast Height (DBH) and percentage the canopy cover. This data will help determine the most suitable trees for each epiphyte to be moved to.

Phase 2 – Survey of potential transfer site

The proposed relocation site will be assessed to ensure suitability for the species to be transferred. Parameters such as tree species, size and canopy cover will be assessed to increase the survival rate of the transplanted plants. Selected receptor trees will be tagged accordingly.

Phase 3 – Transplanting of the epiphytes

This phase will comprise of the removal of the epiphytes from the trees within the project area and transferring them to an appropriate alternative site. The epiphytes will carefully be removed from the trees with a masonry knife (for small sized plants - < 1m width) and a crowbar (for medium to large sized plants - >1m width). Excess material around roots will then be removed and the plants will be packed carefully and tightly in buckets and crates for transfer to the designated area. Extreme care will be taken to minimize disturbance of fauna possibly inside.

Removal process of bromeliads from trees

The removal of bromeliads from trees will be dependent on the height at which the plants are anchored. Bromeliads that are at low heights (ground level to 1m) will be removed and placed in buckets/crates for transfer. Plants that are anchored between 1m to 3m will accessed by ladder and will be removed and placed in buckets and lowered to the ground by a pulley. The plants that are present at heights above 4m will be accessed by a mechanical, aerial work platform (cherry picker), the plants will be removed from the trees, placed in buckets and placed on the platform to be lowered.

The aerial work platform will be a critical for carefully removing the bromeliads in the upper tree canopies with less damage to the plants; this method also provided some safety for the team members, as some bromeliads can be very heavy and cumbersome to handle. Accessibility for the aerial work platform should be carefully considered, there are some instances where an access road might have to be created. The team would therefore need an aerial work platform and a backhoe, both with their respective operators.

Figure 1. *Photograph showing an aerial work platform*

Mounting of bromeliads to trees

After removal from tress, the bromeliads will then be transferred to the planting site. The plants should be bound to the trees using binding wire and organic twine. Strips of nylon will also be used to help secure the plant tightly in place, without damaging the stem and leaves.

Similarly, to the removal process, replacement of plants might require ladders, aerial work platform, and pulley.

Large sized bromeliads, >1m width, will be relocated to tree similar in size to the parent plant, but it might be necessary to place some at a lower height. Trees of appropriate heights might not always be accessible, or suitable for attachment of the plants without excessive movement. Bromeliads tend to grow in colonies or clumps, between 3 to 20 plants growing very closely with roots and leaves overlapping. In the replanting exercise, a maximum of 5 plants will be planted adjacent to each other, as a measure to reduce stress on the newly transplanted bromeliads.

Where possible, the bromeliads will be placed in naturally occurring tree cavities. In some cases, the team will use wooden wedges mounted on the trees to provide additional support for the transplanted bromeliad – this will be done primarily with bigger and heavier bromeliads. Small to medium sized bromeliads will be relocated to higher section of the trees.

No fertilizer or insecticide will be applied to the plants, to avoid harming any existing fauna.

Post transplanting Maintenance

After the plants are transplanted, the team will be responsible for 2 weeks of post transplanting maintenance. This will consist of watering of the plants once every other day with a mist blower, this will reduce the possibility of the plants getting transplant shock.

It should be noted that it can take anywhere from one to six months for a transplanted bromeliad to naturally attach to a tree with its roots. This is highly dependent on the weather conditions and the size of the plant.

13.15 Inventory and Classification of Archaeological Resources

Inventory and Classification of Archaeological Resources						
No.	Site	District	X-Coord	Y-Coord	Comments/Description	Rating
1	Mitcham Greathouse	Mitcham	77° 36.774	18° 04.580'	Cut stone foundation for large plantation house. Large modern concrete tank attached.	HS
2	Modern House Ruins	Mitcham	77° 36.774	18° 04.580'	Block and steel house built adjoining the plantation-era Mitcham Pen House.	LS
3	Dry Stone Wall	Mitcham	77° 36.816	18° 04.226'		LS
4	Stone Gateway Ruins	Mitcham	77° 36.800'	18° 04.297'	Two large stones in the dry stone wall that may have once been a gateway in Mitcham Pen estate.	MS
5	Stone and Brick Oven	Mitcham	77 36.847'	18 04.120'	Stone structure with brick lined oven space. Built in the 1950s according to the current inhabitant of the associated house for baking breads.	MS
6	Dry Stone Wall	Mitcham	77° 36.832’	18° 03.764'		LS

7	Dry Stone Wall	Mitcham	77° 36.832'	18° 03.764'		LS
8	Pump Station	Mitcham	77° 37.071'	18° 03.671'	Concrete block and steel building covering water pump, may be well noted on historic maps.	LS
9	Phantillands Cave	Phantillands				HS
10	Factory Ruins	Peru	77° 37.892'	18° 03.859'	Ruins of a large concrete block and steel building and factory machinery.	LS
11	Modern Building Ruins	Peru	77° 37.854'	18° 3.840'	Small concrete block and steel building ruin.	LS
12	Peru Greathouse Ruins	Peru	77° 37.568'	18° 4.058'	Remains of the cut stone walls and foundations of the Peru Pen house and an ancillary building (possibly a coach house). On the west side of the main building is an 8-sided large tank.	HS
13	Dry Stone Wall	Peru	77° 37.599'	18° 3.998'		LS
14	Dry Stone Wall	Peru	77° 37.515'	18° 04.283'		LS

15	Modern Concrete Trough	Peru	77° 37.515'	18° 04.283	Modern concrete block animal trough.	LS
16	Ponds	Peru	77° 37.794'	18° 3.722'	3 ponds that may have been used in the activities of Peru Pen.	MS
17	Peru Cave	Peru	183500	158500		MS
18	Goshen Cemetery	Goshen	77° 38.554'	18° 3.518'	Dozens of modern concrete graves.	HS
19	Remains of Dry Stone Wall and Wooden Structure	Goshen	77° 39.159'	18° 02.644'		LS
20	Disused Airstrip	Goshen	77° 39.521'	18° 02.540'		LS
21	Disused Animal Trough	Goshen	77° 39.016'	18° 2.763'	Ruins of a modern concrete block animal trough.	LS
22	Metal Tank	Goshen	77° 38.780'	18° 2.999'	Rusted metal water tank on a metal stand.	LS

23	Vernacular House	Goshen	77° 38.566'	18° 2.754'	House with stone foundation, nog walls and a zinc roof. A stone and concrete water tank is on the property to the north of the house.	HS
24	Disused Animal Trough	Goshen	77° 39.168'	18° 2.659'		LS
25	Metal Tank and Concrete Trough	Goshen	77° 39.059'	18° 2.613'		LS
26	Goshen Moravian Church	Goshen	77° 38.358'	18° 3.088'		HS
27		Goshen				
28	Pond	Goshen	77° 38.591'	18° 2.709'		MS
29	St. Andrew’s Anglican Church	Gilnock Hall	77° 39.865'	18° 3.025'	Large stone church building built in 1831. with a front tower	HS
30	Cemetery for St. Andrew's Anglican Church	Gilnock	77° 39.866'	18° 3.076'	Dozens of historic and modern graves.	HS

31	Stone Gateway	Gilnock	77° 39.725'	18° 3.124'	Old stone curved walls forming gateway associated with Gilnock Hall estate.	MS
32	Gilnock Hall Greathouse	Gilnock	77° 39.372'	18° 3.099'	Ruins of a large 2-storey, cut-stone house associated with Gilnock Hall Estate.	HS
33	Modern Building Ruins	Gilnock	77° 39.389'	18° 3.368'	Concrete block and steel building.	LS
34	Plantation-era House Complex	Gilnock	77° 39.698'	18° 2.907'	2 cut-stone buildings associated with Gilnock Hall Estate. Both buildings include modern concrete block additions.	HS
35	Plantation-era Building with standing chimney	Gilnock	77° 39.704'	18° 2.892'	Small cut-stone plantation-era building with standing chimney.	HS
36	Stones for Historic Gateway	Gilnock	77° 40.302'	18° 2.850'	Cut stone gateway.	MS
37	Clock Tower	Santa Cruz	77° 41.927'	18° 3.230'	Modern working clock tower erected in 2008. A stone etching says it was erected in memory of Irving Hanson by the Rotary Club.	MS
38	Vernacular Shop Building (bar)	Santa Cruz	77° 41.949'	18° 3.181'		MS

39	Court House	Santa Cruz	77° 41.924'	18° 3.032'	Stone building with modern concrete additions and associated buildings.	HS
40	Building Ruins Behind Court House	Santa Cruz	77° 41.976'	18° 3.023'	Ruins of 2 small buildings in the parking lot of the court house. One with a nog wall, the other with concrete block and steel walls.	MS
41	St. Elizabeth Technical High School	Santa Cruz	77° 41.606'	18° 3.152'	Modern school buildings made of concrete block and steel near the centre of the town. The school was founded in 1961.	HS
42	St. Croix Catholic Church	Santa Cruz	77° 41.980'	18° 3.445'	Roman Catholic church building.	HS
43	Sharon Baptist Church	Santa Cruz	77° 42.418'	18° 3.327'	Stone church building. There is an associated cemetery to the north of the church building with modern graves.	HS
44	St. Matthew’s Anglican Church	Santa Cruz	77° 41.795'	18° 3.284'	Large church building with metal roof and associated cemetery with modern graves.	HS
45	Infirmary	Santa Cruz	77° 42.277'	18° 3.474'	Cluster of modern concrete block and steel buildings with zinc roofs.	LS
46	Emmaus Well	Santa Cruz	77° 41.862'	18° 3.467'	Metal pipe that descends into the earth to meet the original stone walls of the historic well.	MS

47	Historic and Modern Graves	Longwood	77° 41.039'	18° 2.807'	A cluster of about a dozen graves beside the road.	HS
48	Modern and Historic Graves	Longwood				HS
49	Historic and Modern Graves	Longwood	77° 40.869'	18° 2.894'	About a dozen graves on a plot surrounded by a stone wall.	HS
50	Victorian-era House	Leeds	77° 41.332'	18° 1.316'	Blue walls with a zinc roof.	HS
51	Northampton Greathouse	Northampton	77° 40.632'	18° 1.847'	Ruins of the large house associated with the Northampton estate. Columns still stand toward the front of the house. There is evidence of more modern concrete additions to the house.	HS
52	Stone Gateway	Northampton	77° 40.789'	18° 1.958'	Stone curved walls and gateway painted white with the word 'Northampton' painted on.	MS
53	Stone tank	Longhill	77° 39.493'	18° 1.165'	2 stone water tanks lined with cement.	MS
54	Dry Stone Wall	Longhill	77° 39.643'	18° 1.226'		LS

55	Dry Stone Wall	Longhill	77° 39.186'	18° 1.530'		LS
56	Dry Stone Wall	Longhill	77° 39.061'	18° 1.203'		LS
57	Pond	Longhill	77° 39.096'	18° 1.169'		MS
58	Modern House Ruins	Fellowship	77° 37.273'	18° 1.213'	Ruins of a concrete block and steel house with blue walls built for resettlement of persons for bauxite mining.	LS
59	Stone and Concrete Tank and Barbecue	Fellowship	77° 36.996'	18° 0.150'	A cut stone and concrete flat platform and attached open water tank.	MS
60	Train Track Remains	Fellowship	77° 37.092	18° 0.932'	Concrete retaining walls along the channel made for the train tracks. Some of the wooden train tracks are still in place.	MS
61	JISCO Alpart Well	Fellowship	77° 37.048'	18° 0.834'		LS
62	JISCO Alpart Well	Fellowship	77° 37.126'	18° 0.764'		LS

63	Metal Pipes	Fellowship	77° 37.006'	18° 0.928'		LS
64	Train Track Remains	Fellowship				MS
65	Limestone Karst	Fellowship	77° 37.435'	18° 1.004'		MS
66	Concrete Tank	Fellowship	77° 37.127'	18° 0.100'		LS
67	Friendship Greathouse	Friendship	77° 38.460'	18° 0.149'		HS
68	Road and Metal Cable Remains	Friendship	77° 38.468'	18° 0.252'		LS
69	Dairy Farm Complex	Pepper	77° 36.416'	18° 1.476'		LS
70	Building Ruins on Dairy Farm	Pepper	77° 36.505'	18° 1.476'		LS

71	Concrete Structure on Dairy Farm Property	Pepper	77° 36.469'	18° 01.409'		LS
72	Structure on Dairy Farm	Pepper	77° 36.395'	18° 01.406'		LS
73	Pepper Greathouse	Pepper	77° 36.641'	18° 1.719'	Ruins of the cut stone walls of the Pepper plantation great house. The remains of other buildings are in the area.	HS
74	Modern House Ruins	Pepper	77° 36.418'	18° 1.542'	Concrete block and steel house ruins.	LS
75	St. James Anglican Church	Mount Hermon	77° 38.725'	18° 0.022'	Cut-stone church building with graves on site.	HS

13.16 Waste Procedure

13.16.1 Purpose

Alpart produces a variety of wastes as a result of its operations. In keeping with its commitment to environmental protection & good housekeeping, this procedure is designed to ensure that environmentally sound practices are employed in the segregation, storage, transport & disposal of all wastes and that all regulatory, internal and corporate standards/guidelines are being met.

13.16.2 Scope

This procedure covers the management and disposal of all waste materials generated by the Alumina Refinery as well as Port Kaiser and Mines.

13.16.3 Definitions (as set out in the National Solid Waste Management Act. 2001)

Waste: Unwanted materials left over from a manufacturing process or anything for which the generator or holder has no further uses and which is discarded or released to the environment.

Industrial Waste: This is any unwanted material from an industrial operation, such as Alpart. It may be liquid, sludge, solid or hazardous waste.

Solid Waste: Includes medical & hazardous waste and:

- Refuse or sludge from a waste treatment facility, water supply plant, air pollution control facility and garbage;
- Solid, semi-solid or contaminated gaseous or liquid matter resulting from industrial, commercial, mining or agricultural operations or domestic activities: and
- Any contained substance or object which is or is intended to be, or required by law to be, disposed of, but does not include (a) suspended solid or dissolved material in sewage, (b) industrial discharges from pipelines conveying such waste.

(This includes a variety of wastes e.g., alumina dust, hydrate scales, bauxite scales, bauxite rejects, filter cloth, wood packaging, canteen waste, paper, plastics, limestone, sawdust, waste sandblasting materials, heater tubes, used tires, railroad ties etc.)

Solid Waste Management includes:

- The systematic control of the generation, collection, separation, storage, reuse, recycling, transportation, transfer, treatment, and disposal of solid waste; and
- The characterization & measurement of solid waste.

Hazardous Waste: As defined in the National Solid Waste Management Act, 2001 means, “waste because of its chemical or other property, may cause, promote or result, directly or indirectly, in:

i. Hazard or harm to human health or create a nuisance;
ii. Hazard to the natural living condition of plants and animals;
iii. Pollution of land, water, the atmosphere or the environment;
iv. Fire or explosion;

v. Excessive sound or noise;
vi. The appearance and multiplication of harmful animals or plants;
vii. The encouragement of pathogens;
viii. Disturbance of public order and safety and
ix. Such other waste as the Minister may, by order, declare to be hazardous;"

(This includes, caustic contaminated wastes e.g., tailings, acidic wastes such as spent cleaning acid wastes, PCB contaminated soils, asbestos etc)

Waste Minimization: Measures or techniques that reduce the amount of wastes generated during industrial production processes; this term is also applied to recycling and other efforts to reduce the amount of waste going into the waste stream.

Wood Packaging: Wood products such as pallets, crates, and barrels.

Hot Draining: Draining oil filter at or near engine operating temperature. Note that this can be done by removing the oil filter directly from the engine and draining immediately.

13.16.4 Responsibilities

The Maintenance Director shall ensure that:

- Signs are erected at the main waste storage and disposal sites.
- The management of the waste contractor (s) is overseen and a performance evaluation is provided for the Purchasing Department.
- Resources are provided for effective and efficient waste management.
- This procedure is adhered to.

Descaling Superintendent shall:

- Oversee the management of the Waste Contractor and ensure that waste is collected as set out in the contract;
- Ensure that designated waste storage and disposal areas are used as described in this procedure and attain good housekeeping standard.
- Ensure that non-hazardous wastes are transported to the Municipal Landfills as per agreement with the National Solid Waste Management Authority (NSWMA).
- Ensure that all other wastes to be recycled are sent off to the respective recycling company. (Alpart currently stores plastic bottles, used batteries and fluorescent bulbs for recycling off site.)
- Records are kept of waste removal/disposal and made available to the Environmental Engineer.
- Ensure that payments are made on time to the Solid Waste Management Authority for the use of the Myersville Landfill.

The Descaling Superintendent has the authority to reject comingled waste or any other types of waste deemed inappropriate for deposit in the Temporary Disposal site.

Fixed Plant Manager (Point C) shall ensure that:

- Designated waste storage and disposal areas are used as described in this procedure and attain good housekeeping standard.
- Non-hazardous wastes are transported to the Municipal Landfills as per government agreement.
- All other wastes to be recycled are sent off to the respective recycling company. (Alpart currently stores plastic bottles, used batteries and fluorescent bulbs for recycling off site.)
- Payments are made on time to the Solid Waste Management Authority for the use of the Martin's Hill Landfill.

The Grounds & Building Supervisor (Mines) shall:

- Oversee the management of the waste contractor and ensure that waste is collected as set out in contract;
- Records are kept of waste removal/disposal and made available to the Environmental Engineer.

Operations Team Leader (Port Kaiser) shall:

- Oversee the management of the waste contractor and ensure that waste is collected as set out in contract;
- Ensure that designated temporary waste storage area is used as described in this procedure and attain good housekeeping standard.
- Ensure that non-hazardous wastes are transported to the Municipal Landfills as per government agreement.
- Liaise with the Descaling Superintendent to coordinate the removal of all recyclable wastes. (Alpart currently stores plastic bottles, used batteries and fluorescent bulbs for recycling off site.)
- Ensure that records are kept of waste removal/disposal and made available to the Environmental Engineer.

The Commercial Director/designate shall ensure that:

- All Solid Waste Contractors are holders of a current licence as per requirement in the National Solid Waste Management Act, 2001, Part IV, section 23, as soon as the system is implemented by the Government of Jamaica.
- An Evaluation is done on the performance of the waste contractor once per year.
- Contractors hired with respect to waste management & disposal, are aware of, and trained on this procedure.
- Contracts are in place for all 3rd party waste contractors.

The Safety, Environment & Quality Director shall:

- Ensure that this procedure is adhered to.
- Liaise with the relevant government agencies on new requirements and waste management options.
- Liaise with Partners representatives on Corporate Requirements.

The Environment Superintendent shall ensure that:

- The Waste Management Procedure and practices at Alpart are in line with government regulations and other Alpart/Corporate requirements where applicable.
- This procedure is revised at least once every 2 years.

The Environment Engineer shall:

- Monitor/audit waste management practices/procedures at Alpart
- Prepare and submit the requisite reports to external agencies.
- Work with the Training Department to ensure that the entire workforce is familiar with this procedure.
- Keep/maintain a waste log.

The Safety Superintendents shall ensure that:

- All medical waste is stored and disposed of as per Safety Policy (i.e. sharps sent to incinerator at Hargreaves).
- A log of waste sent to Hargreaves is kept and a copy submitted to the Environmental Engineer.

Area Managers/Directors shall ensure that:

- Appropriately labeled receptacles are located in the area
- Waste generated in his/her area is sorted/segregated, stored and disposed of in the correct location (comingled waste or hazardous waste will not be accepted at the temporary waste storage sites)
- The Descaling Superintendent is notified prior to the transport of waste the temporary disposal site.
- Contractors and employees operating in the area are aware of this procedure and adhere to it.

13.16.5 Procedure

All Employees:

- Place waste in designated receptacles e.g.:
    - Wood /wood packaging in dempster labeled “Wood”;
    - Metal in receptacles labeled “Metal Only”
    - Plastic bottles in bins labeled “Plastic Bottles Only”

    - All other non-metallic waste e.g., paper, cloth, cardboard etc in bins labelled "Non—Metallic Waste"
    - Fluorescent Bulbs in containers labeled "Fluorescent Bulbs Only"
- All other industrial wastes such as scales, filter cloth, bauxite rejects, rubber tubing etc shall be stored in Dumpsters in the areas designated by the operating area for pick-up and disposal.
- All oil filters must be hot drained for 24 hours, crushed and then taken to the Domestic Waste Storage site for final disposal at the municipal landfill. The oil drained will be disposed of as per Disposal of Used Lubricant (Waste Oil) Handling Procedure
- Fluorescent Bulbs must be placed in plastic bags before placing in containers.
- At no time shall waste be stored or disposed of in any location outside of the designated areas. Storage of waste along the shoreline is not permitted and is deemed a breach of the Beach Control Act.
- Scrap Metal shall be stored at the Domestic Waste Storage Site in the section designated for Scrap metal storage.
- Lead Acid Batteries shall be stored at the Battery Storage Facility located at the Mobile Shop. (See Used Lead Acid Batteries Handling and Disposal Procedure: ENV- P- 014).

The Solid Waste Contractor(s) shall ensure that:

- Waste is collected and transported to its designated storage or disposal site in accordance with this procedure and contractual agreement.
- Ensure that all storage and disposal sites attain good housekeeping standard.

Waste Storage & Disposal Sites – Refinery

The following areas have been designated as waste storage or disposal sites:

1. Industrial Disposal Site (Mud Lake Area) – for the disposal of waste such as red-mud and alumina scale, filter-cloth, ash, absorbent, etc and any other materials approved by the Safety, Environment & Quality Department.
2. Residue Disposal Area (RDA) – for the disposal of mud tailings.
3. Domestic Waste Storage Site (South of the RDA/Mud Lake Booster Pumps) – for the temporary storage of non-hazardous waste such as paper, wood, cloth etc. Used tires shall be temporarily stored in this area.
4. Metal Scrap Storage (West of the RDA/Mud Lake Booster Pumps) – for temporary storage of metal waste. This waste may be sold to a third party. Metal scrap generated at Port Kaiser shall be placed in a labeled dempster and transported to the Plant.
5. Scrap/Waste Sale – Scrap/waste will only be sold to a registered company dealing in scrap purchases as a part of its business activities. No scrap/waste shall be sold to any other entity or person. The purchaser must declare in writing to the Company the final use/disposal of the materials bought.

6. The Shift/Infrastructure Superintendent will notify the Commercial Director whenever there is a need to remove/sell waste/scrap materials.
7. Plastic Bottle Storage (south of Diesel generator) – for the temporary storage of PET and other recyclable bottles prior to collection by an approved recycler.
8. Medical Waste – Will be disposed of by the as per Safety Policy.
9. Steel Drums – Steel drums when empty will be collected and taken to the designated area (north of the Carpenter Shop) for preparation for disposal. Preparation will include draining, washing and crushing.
10. Plastic Drums – Will be returned to the supplier.

Waste Storage & Disposal – Mines

Solid Waste – This shall be collected in dumpsters located around the Point C facility. Solid waste is to be disposed of at the Martin's Hill Landfill.

Waste Storage & Disposal – Port Kaiser

Solid Waste – This shall be collected in dumpsters located around the Port facility for final disposal at the Myersville Landfill.

13.16.6 Colour Codes and Standard for Waste Receptacles

- Yellow Receptacles – Metal waste
- Green Receptacles – Non-Metallic waste e.g. Paper, cloth
- Orange Receptacles – Recyclable plastic
- Brown – Wood
- Black – Electronic Waste

All receptacles must be labeled.

13.16.7 Auditing

The requirements of this procedure shall be audited annually by the Environmental Engineer. Audit findings/recommendations shall be communicated in writing to affected departments and general management.

13.16.8 Review

The Environment and Maintenance Departments shall review this procedure every 2 years and revise if necessary. The Safety, Environment & Quality Department shall maintain and issue revisions of this procedure.

13.16.9 Reference Documents

- The National Solid Waste Management Act 2001
- PCB Management Procedure (ENV- P- 017)
- Disposal of Used Lubricant (Waste Oil) Procedure
- Used Lead Acid Batteries Handling and Disposal Procedure (ENV- P- 014)

13.17 GUIDELINES FOR WATER SAMPLE COLLECTION AND PRESERVATION

ALUMINA PARTNERS OF JAMAICA

STANDARD PROCEDURES FOR ENVIRONMENTAL CONTROL

((SPEC)

File No.

Date Orig. Issue

LOCATION **Quality & Environment Department**

Revision No.

Control Task

Protocol for the collection and preparation of Well Water Samples for laboratory analysis.

Responsible for Control

Junior Environmental Engineer

Environmental Standard

DRAFT AMBIENT WATER QUALITY STANDARDS ARE ATTACHED AS *APPENDIX A.*

Reason for Control

1. To ensure proper sample collection to avoid contamination;
2. To minmise holding time and to provide proper communication with laboratory as to sample identification, test required, test method etc.
3. To ensure proper Chain of Custody .

Measurement **N/A**

Tools/Equipment **as listed below**

1. Air Compressor
2. Portable Generator
3. Sample bottles
4. Igloo with ice
5. Sterile glass bottles (samples for Total & Faecal Coliform analysis)

Frequency:

Monthly

By- Junior Environmental Engineer

Routine Reporting of Data
Form/Form No.

Monthly Performance Report
Quarterly Government Report

By- Junior Environmental Engineer

Critical Procedures

General :

1. Ensure that sample bottles are cleaned either with water or acid washed and appropriately labeled prior to use.
2. Rinse sample bottle 3 times with the sample before filling the bottle.
3. For samples to be tested for Heavy Metals add about 3 drops of Concentrated Nitric Acid to the collected sample.
4. For samples to undergo biological analyses, collect sample to about 3/4 of the bottle. **Do not fill the bottle to overflowing.** Store on ice immediately after collection and dispatch to external laboratory within 6 hours of collection.
5. ***Tests requiring same sample preparation may be combined in the same bottle as long as the total volume required is met.***
6. Complete Chain of Custody Form and submit to Laboratory for signature along with sample. Retain signed document for records for no less than 2 yrs.(Appendix C)

Collection of Monitor Well Samples (North of Plant): Start Generator and empty 3 volumes of the well casing before collecting sample. (Well Descriptions attached as Appendix B.)

Collection of Monitor Well Samples (South of Plant): Start generator and lower pump reel to required depth. Start Air Compressor and empty 3 volumes of the pump tubing before collecting sample.

Collection of Production Well Samples: Open sample point and allow water to run for 1 minute before collecting sample.

NB See Page 2 for Guidelines for Sample Collection and Preservation.

Corrective Actions

If collection was not carried out as described in "Critical Procedures" discard the sample and collect new sample.

Audits

To be audited twice per year by Environmental Group Leader or nominee.

Developed by: **Approved by:**

Originator **Owner**

Approved by:

Quality & Environment Manager **Environment Group Leader**

pg 1 of 8

ALUMINA PARTNERS OF JAMAICA

STANDARD PROCEDURES FOR ENVIRONMENTAL CONTROL

(SPEC)

File No.

Date Orig. Issue

Revision No.

Responsible for Control

Junior Environmental Engineer

Critical Procedures Continued.

Guidelines for Sample Collection and Preservation

Parameter	Guidelines
Ammonia/Ammonium	1. Collect samples in clean glass or plastic bottles. 2. If Chlorine is present, add 1 drop of 0.1N Sodium thiosulphate for each 0.3mg/L Chlorine present. 3. Preserve the sample by reducing the pH to 2 or less with Sulphuric Acid (at least 2mL). Store at 4^{o}C or less. Preserved samples may be stored up to 28 days. Warm samples to room temperature, neutralize with Sodium Hydroxide before analysis. 4. Minimum sample volume: 150mL.
Barium	1. Collect samples in acid cleaned glass or plastic bottles. 2. Adjust the pH to 2 or less with Nitric Acid (about 2mL/Litre) for spectrophotometric analysis. 3. Preserved samples can be stored up to 6 months at room temperature. Adjust pH to 5 with 5.0N Sodium Hydroxide before analysis. 4. Minimum sample volume: 150mL.
Beryllium	1. Collect samples in acid cleaned glass or plastic bottles. 2. Minimum sample volume: 30mL
Boron	1. Collect samples in polyethylene bottles or Alkali-resistant Boron-Free glass. 2. Minimum sample volume: 150mL
Calcium	1. Collect samples in plastic or glass bottles that have been washed with detergent and rinsed with tap water, 1:1 Nitric Acid solution and deionized water. 2. To preserve the sample, use a glass serological pipette and pipette filter to add 1.5mL of Nitric Acid per litre or quart of sample. Check sample to ensure pH is 2 or less. Store at least 6 months at room temperature. 3. Before running the test, adjust pH to 7 by adding Potassium Hydroxide standard solution and mix thoroughly. 4. Minimum sample volume: 300mL
Chloride	1. Collect samples in clean plastic or glass bottles. 2. Minimum sample volume: 150mL.
Colour	1. Collect samples in clean plastic or glass bottles. If prompt analysis is impossible, fill bottles completely and cap tightly. 2. Avoid excessive agitation and prolonged contact with air. Samples can be stored for 48hrs by cooling to 4^{o}C. 3. Warm to room temperature before running the test. 4. Minimum sample volume: 400mL.
Detergent	1. Collect samples in clean glass or plastic bottles. 2. Cool to 4^{o}C for up to 24hour storage. Warm to room temperature before testing. 3. Minimum sample volume: 2 Litres.
Iron	1. Collect sample in acid-washed glass or plastic bottles. 2. Adjust the pH to 2 or less with Nitric Acid (about 2mL/Litres). Preserved samples can be stored up to 6 months at room temperature. Adjust pH to between 3 & 4 with 5.0N Sodium Hydroxide standard solution. **Do not exceed pH 5 as Iron may precipitate.** 3. Minimum sample volume: 300mL.
Manganese	1. Collect samples in clean plastic or glass bottles. 2. Adjust the pH to 2 or less with Nitric Acid (about 2mL/Litres). Preserved samples can be stored up to 6 months at room temperature. Adjust pH to between 3 & 4 with 5.0N Sodium Hydroxide standard solution. 3. Minimum sample volume: 100mL.
Nitrate	1. Collect samples in plastic or glass bottles. 2. Store at 4^{o}C or lower if sample is to be analysed within 24 to 48 hours. Warm to room temperature before running the test. For storage period of up to 14 days, adjust to pH 2 or less with Sulphuric acid (about 2mL per Liter). Refrigeration is still required. 3. Minimum sample volume: 150 mL.

ALUMINA PARTNERS OF JAMAICA

STANDARD PROCEDURES FOR ENVIRONMENTAL CONTROL (SPEC)

File No.

Date Orig. Issue

Revision No.

Responsible for Control

Junior Environmental Engineer

Critical Procedures Continued.

Guidelines for Sample Collection and Preservation

Parameter	**Guidelines**
Nitrate	1. Collect samples in clean glass or plastic bottles. 2. Store at 4°C or lower if the sample is to be analyzed within 24 to 48 hours. Warm the sample to room temperature before testing. For storage of up to 14 days, adjust the pH to 2 or less with Sulphuric Acid (at least 2mL). Store at 4°C or less. Refrigeration is still required. 3. Minimum sample volume: 150mL.
Oil & Grease	1. Collect samples in wide mouth glass bottles. 2. Add 6mL 1:1 Hydrochloric Acid solution per Liter or quart of sample. Ensure pH is 2 or less. Preserved samples can be stored for 28 days. 3. Minimum sample volume: 3 Liters
Magnesium	1. Collect samples in clean glass or plastic bottles. 2. Minimum sample volume: 300mL.
pH	1. Collect samples in clean glass or plastic bottles. 2. Fill completely and cap tight. Cool to 4°C and determine pH within 6 hours. If samples cannot be analyzed within 6 hours, report the actual holding time with results. 3. Minimum sample volume: 10mL.
Phenols	1. Collect samples in clean glass bottles. 2. The most reliable results are obtained when samples are analyzed within 4 hours after collection. When prompt analysis is impossible add Copper Sulphate and adjust pH to 4 or below with 10% Phosphoric Acid solution. Store at 4°C or lower and analyze within 24 hours. 3. Minimum sample volume: 2 Litres
Sodium	1. Collect samples in clean glass or plastic bottles. 2.Minimum sample volume: 300mL.
Phosphorus, Reactive	1. Collect samples in clean plastic or glass bottles that have been cleaned with Hydrochloric Acid solution and rinsed with deionized water. **Do not use commercial detergent containing phosphate for cleaning glassware used in the test.** 2. Sample pH should be neutral (6- 8) before the addition of reagents. Analyze samples immediately for best results. If prompt analysis is not possible, preserve samples by filtering immediately and storing at 4°C. Warm to room temperature before testing. 3. Minimum sample volume: 300mL
Sulphate	1. Collect samples in clean glass bottles. 2 Samples may be stored up to 28 days by cooling to 4°C or lower. Warm to room temperature before testing. 3. Minimum sample volume: 150mL.
Sulphide	1. Collect samples in clean glass bottles. 2. Completely fill and cap tightly. Avoid excessive agitation or exposure to air. Samples may be analyzed immediately upon collection and cannot be preserved or stored. 3. Minimum sample volume: 300mL.
Total Dissolved Solids	1. Collect samples in clean glass bottles. 2. Analyze as soon as possible after collection. Samples may be stored 7 days by cooling to 4°C. 3. Minimum sample volume: 1 Litre
Total Suspended Solids (Nonfilterable Residue)	1. Collect samples in clean glass bottles. 2. Analyze as soon as possible after collection. Samples may be stored 7 days by cooling to 4°C. 3. Minimum sample volume: 300mL.

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STANDARD PROCEDURES FOR ENVIRONMENTAL CONTROL

(SPEC)

File No.

Date Orig. Issue

Revision No.

Responsible for Control

Junior Environmental Engineer

Critical Procedures Continued.

Guidelines for Sample Collection and Preservation

Parameter	Guidelines
Total Organic Carbon	1. Collect samples in amber glass bottles with TFE-Lined cap. Wash bottles with acid, seal with aluminium foil and bake at 400°C for 1 hour. Wash TFE Septa with detergent and rinse repeatedly with organic-free water. Wrap in aluminium foil and bake at 100°C for 1 hour. 2. Preserve samples that cannot be examined promptly by holding at 4°C with minimal exposure to light and air. 3. Minimum sample volume: 300mL
Heavy Metals	1. Collect samples in plastic or glass bottles. 2. Minimum sample volume: 300mL.
BOD	1. Clean glass bottles with detergent. 2. Analyze samples within 6 hours of collection and in no case later than 24 hours. Store at 4°C and warm to 20°C before analysis. (Report length of time and temperature of storage with results.) 3. Use water seal during incubation. 4. Minimum sample volume: 1 Litre
COD	1. Collect samples in plastic or glass bottles. Use only bottles known to be free of organic contamination. 2. Homogenize samples containing solids to ensure representative samples. 3. Samples treated with Sulphuric Acid to pH of less than 2 (about 2mL per Litre) and refrigeration at 4°C can be stored up to 28 days. 4. Minimum sample volume: 300mL
Oxygen Demand	1 Prevent contamination of the sample with atmospheric air. Flush the sampling system with sample for at least 5 minutes. 2. Minimum sample volume 1 Litre.
Total & Faecal Coliform	1. Collect samples in sterilized plastic or glass bottles. 2 Transport and store at 4°C. The maximum time between collection and preparation for analysis of samples should be 8 hours. 3. For chlorinated samples ensure that sufficient dechlorianting agent is present in sample bottle. 4. Minimum sample volume: 150mL.

APPENDIX A

DRAFT NATIONAL AMBIENT WATER QUALITY STANDARD

Parameter	Standard Range	Unit
Calcium	40 - 101	mg/L
Chloride	50 - 20	mg/L
Magnesium	3.6 - 27	mg/L
Nitrate	0.1 - 7.5	mg/L
Phosphate	0.01 - 0.8	mg/L
pH	7 - 8.4	
Potassium	0.74 - 5.0	mg/L
Silica	5 - 39	mg/L
Sodium	4.5 - 12	mg/L
Sulphate	3.0 - 10	mg/L
Hardness	127 - 381	mg/L (as $CaCO_3$)
Biological Oxygen Demand	0.77 - 1.7	mg/L
Conductivity	150 - 600	micromhos/cm
Total Dissolved Solids	120 - 300	mg/L

APPENDIX B
TABLE OF WELL DESCRIPTION

WELL DEPTH (ft)	Static Water Level (ft)	PUMP POSITION (ft)	PUMP RATE	PUMP TUBING	Pump Time (for 3 volumes)	COMMENTS
674	516	556	1565gpm	-	N/A	Flush for 1min then collect sample.
721	594.6	599	500gpm	-	N/A	"
616	499.75	537	950gpm	-	N/A	"
680	565.9	544	580gpm	-	N/A	"
700	477.5	524	1180gpm	-	N/A	"
400	251.5	-	1145gpm	-	N/A	"
400	228.76	-	830gpm	-	N/A	"
400	271.6	-	1040gpm	-	N/A	"
399.5	234.9	-	2020gpm	-	N/A	"
767	692.75	* 720	0.5 gpm	0.375	25 Min	
700	532.3	570	10 gpm @ 650 ft	1.25"	11 Min.	
700	609.57	630	10 gpm @ 650 ft	1.25"	12 Min.	
902	516	600	10 gpm @ 650 ft	1.25"	11 Min.	
725	573	672	10 gpm @ 650 ft	1.25"	13 Min.	
802	576.23	626	10 gpm @ 650 ft	1.25"	12 Min.	
700	428	511	10 gpm @ 650 ft	1.25"	10 Min.	
625	368.13	450	10 gpm @ 650 ft	1.25"	9 Min.	
550	312.98	384	10 gpm @ 650 ft	1.25"	7 Min.	
702	513	580	10 gpm @ 650 ft	1.25"	11 Min.	
850	632.57	* 700	0.5 gpm	0.375	24 Min	
860	668.4	* 720	0.5 gpm	0.375	25 Min	
800	591.45	* 650	0.5 gpm	0.375	22 Min	
950	718.43	* 700	0.5 gpm	0.375	24 Min	
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950	715.86	* 730	0.5 gpm	0.375	25 Min	
400	119.55	200	16 gpm @ 273 ft	1.25"	2 Min	
400	129.3	*180	1 gpm	0.375	3 Min	
305	170	227.5	10 gpm @ 650 ft	1.25"	4 Min.	
360	267.66	-	110gpm	-	-	
145	41	-	833gpm	-	-	
150	29.5	-	1083gpm	-	-	
18.75	15.4	-	-	-	-	
17.8	10.51	-	1340gpm	-	-	
65	14.57	-	-	-	-	
625	411	-	135gpm	-	-	Sample tank if pump is off.
353	297.45	-	700gpm	-	-	
200	-	-	1388gpm	-	-	
350	104	-	1250gpm	-	-	
350	106.5	-	1875gpm	-	-	
400	337.6	-	840gpm	-	-	

SAMPLE SUBMITTAL - CHAIN - OF - CUSTODY (SAMPLE FORM)

ALUMINA PARTNERS OF JAMAICA

QUALITY & ENVIRONMENT DEPARTMENT
Nain P.O., St. Elizabeth.

Sample Type Codes:			
Petroleum Product	PE	Water - Drinking	DW
Sludge	SL	Groundwater	GW
Soil	SO	Surface	SU
Waste - Liquid	LW	Wastewater	WW
- Solid	SW		

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Test Results to:
Company: ______________________
Contact: ______________________
Phone No. ______________________
Fax No. ______________________

Sampler ______________________
Sample Site/Project ______________________
____

SAMPLE INFORMATION							TESTS REQUIRED																				
SAMPLE TYPE (Use code above)	SAMPLE IDENTIFICATION (Keep brief and assign sample number if possible)	DATE Collected	TIME Collected	COMPOSITE	GRAB	NUMBER OF CONTAINER	pH	BOD	COD	TSS	TDS	Conductivity	Magnesium	Total Hardness	Ammonia	Chloride	Nitrite	Oil / Grease	Phosphate	Sulphate	Sulphide	Calcium	Iron	Sodium	Total Coliform	Faecal Coliform	COMMENTS (i.e. Priority Service, methods, detection limits, etc.)

Relinquished by (Signature)	Printed Name / Affiliation: Date: Time:		Received By (Signature)	Printed Name / Affiliation:	Date: Time:	
Relinquished by (Signature)	Printed Name / Affiliation: Date: Time:		Received By (Signature)	Printed Name / Affiliation	Date: Time:	

APPENDIX C –SAMPLE OF CHAIN OF CUSTODY FORM

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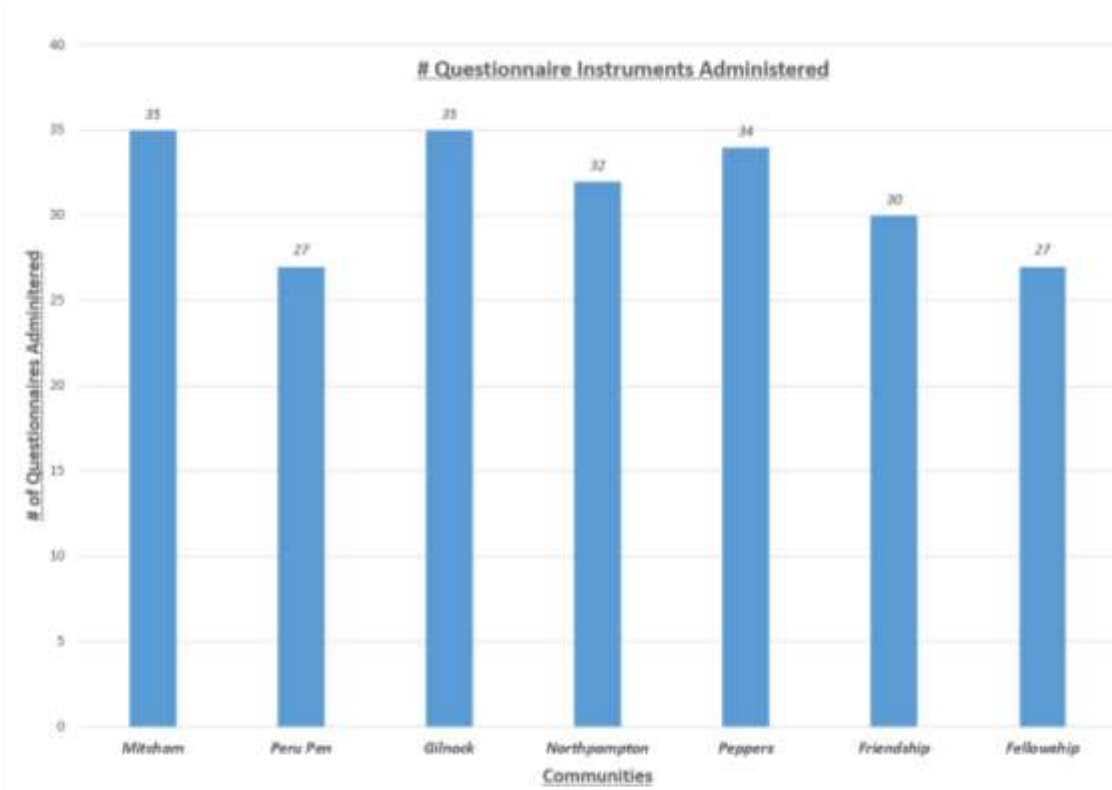
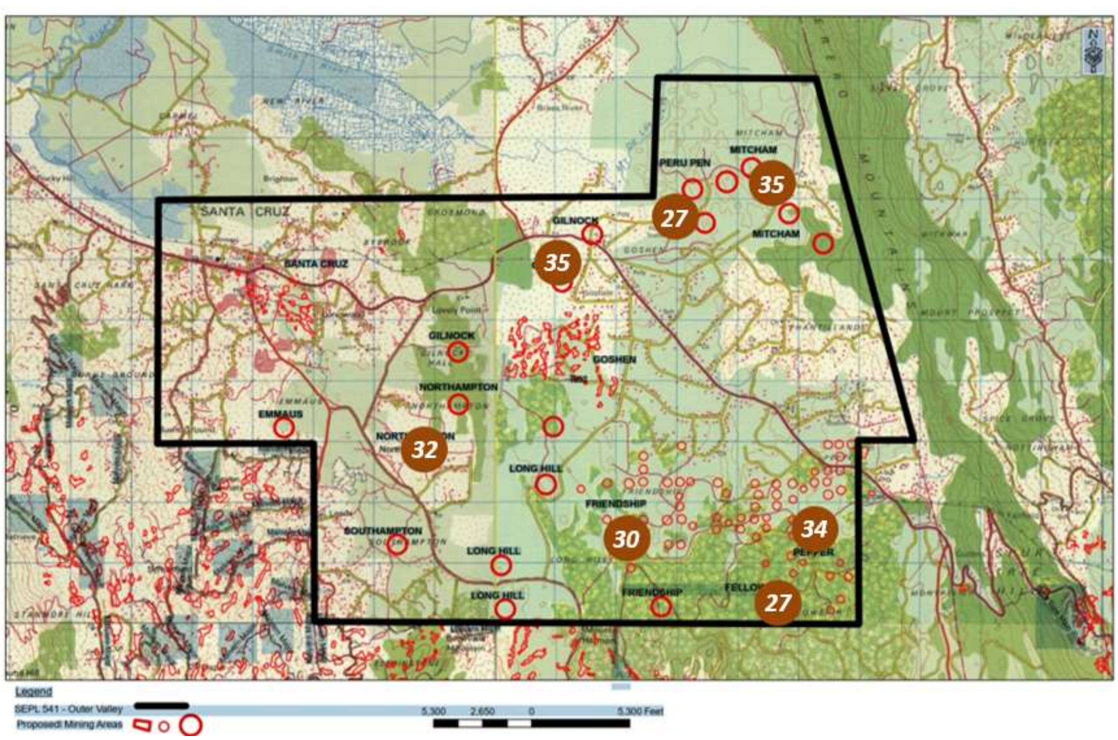
13.18 Socio-economic Survey Instrument Administered per Community



Number of survey instruments administered per community



Communities within SELP 541 where questionnaires were administered

13.19 Glossary of Technical Terms

Terms	Definitions
ADC	Agricultural Development Corporation
Al_2O_3	Aluminum Oxide
AQ	Air Quality
AIA	Archaeological Impact Assessment
BFRs	Brominated Flame Retardants
BOD	Biochemical Oxygen Demand
CBO	Community Based Organization
CDEMA	Caribbean Disaster Emergency Management Agency
CFC	chlorofluorocarbons
DAFOR	D = Dominant; A = Abundant, F = Frequent, O = Occasional, R = Rare
dBA	Decibels (A-weighted decibels)
DBH	Diameter at Breast Height
DMT	Dry Metric Tonnes
DO	Dissolved Oxygen
EHU	Environmental Health Unit
EIA	Environmental Impact Assessment
EPL	EnviroPlanners Limited
ft	Feet
GIS	Geographical Information System
GoJ	Government of Jamaica
gpm	Gallons per Minutes
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
ha	Hectares
hr	Hour
JBI	Jamaica Bauxite Institute
JBML	Jamaica Bauxite Mining Limited
JISCO	Jiuquan Iron and Steel Company
JNHT	Jamaica National Heritage Trust
JNNS	Jamaica National Noise Standard
km	Kilometer
Lat.	Latitude
Long.	Longitude
mg/l	Milligram per litre
m	Meter
migd	Million Imperial Gallons per day
mm	Millimeter
M^3	Cubic meters

MGD	Mines and Geology Division
NEPA	National Environment & Planning Agency
NGO	Non-Governmental Organization
NHT	National Housing Trust
NHC	National Hurricane Center
NIC	National Irrigation Commission
NOAA	National Oceanic and Atmospheric Administration
NRCA	Natural Resources Conservation Authority
N.P.K	Nitrogen Phosphorus Potassium
NSWMA	National Solid Waste Management Authority
NWC	National Water Commission
ODPEM	Office of Disaster, Preparedness and Emergency Management
PPE	Personal Protective Equipment
PPH	Persons per Household
POPs	Persistent Organic Pollutants
PM10	Particulate Matter with diameter of 10 micrometers or less
ppm	Parts Per Million
SML	Special Mining Lease
SEPL	Special Mining Lease
SEMC	St. Elizabeth Municipal Corporation
SDC	Social Development Commission
STATIN	Statistical Institute of Jamaica
TOR	Terms of Reference
TDS	Total Dissolved Solid
WRA	Water Resources Authority
ug/m^3	Microgram per cubic meter
Uk	Unknown
UTECH	University of Technology
UWI	University of the West Indies

13.20 EIA TERMS OF REFERENCE

TERMS OF REFERENCE
For An
ENVIRONMENTAL IMPACT ASSESSMENT

For The

Proposed Mining and Quarrying

At

Nain, St. Elizabeth (SEPL 541)

By

JISCO ALPART Jamaica Limited

Date: 18 August 2020

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Foreword

The purpose of this document is to establish the Terms of Reference (TOR) for the EIA. The Terms of Reference (ToRs) outlines the aspects of an Environmental Impact Assessment which when thoroughly addressed, will provide a comprehensive evaluation of the proposed site, in terms of predicted environmental impacts, required mitigation strategies and potentially viable alternatives to the proposed development/project.

Please be advised that consultations should also be had with the Mines and Geology Division (MGD) with respect to the requirements for a Mining Licence. These requirements include, but are not limited to, a Business Development Plan and Sensitivity Report.

The EIA report must be produced in accordance with the approved TOR.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EIA study.

The National Environment and Planning Agency and the Natural Resources Conservation Authority reserves the right to reproduce, transfer and disclose any and all contents contained in the submitted environmental impact assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Impact Assessment are as follows:

1. Executive Summary

Provide a brief statement on the content of the EIA report. The executive summary should provide a comprehensive overview and objectives for the project proposal, natural resources, justification for the project etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions in the report.

2. Introduction

Provide the context of the project and the EIA, the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study.

The study area shall include at least the area within 1km radius of the boundaries of the proposed site.

3. Legislation and Regulatory Consideration

Outline the pertinent regulations, standards, government policies and legislation governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the Natural Resources Conservation Authority Act; the Mining Act; the Public Health Act; the Town and Country Planning Act; Building Act, Codes and

Standards; and any Regulations promulgated under any of the previously mentioned Acts; Development Orders and Plans and all appropriate international convention/protocol/treaty where applicable.

4. Project Description

The description should detail the elements of the development/project, highlighting the activities which will be involved in all the major aspects of the development/project. Therefore activities which will be involved in the construction, operation, decommissioning and rehabilitation phases should be addressed. These may include but are not limited to the following:

- ***Pre-operation*:** exploration drilling and trenching; location of stockpiles, general access to site and access to extraction/dig sites, plant and accommodation/administrative office during initial development phase, duration, timing and working hours of the initial phase, comprehensive drainage assessment and design, method of sewage treatment and disposal, traffic impact assessment, road construction plan and methods to be employed, source(s) of potable water, electricity, solid waste disposal for site operations.
- ***Operation:*** actual quarry site, quarrying rate, quarrying method, processing methods, plant, machinery and auxiliary facilities e.g. fuel storage, generators etc., duration and phasing, nature and quantity of material to be extracted, expected final depth of quarry area, methods for stabilization of quarry faces, storage area(s) (quarry material, spoils, overburden/topsoil), frequency of blasting and predicted vibration levels, dust generation and control (air quality), noise generation and control, drainage control, fuel and other chemical storage, power supply, transportation (internal and external), safety (worker), fencing and security and storage and disposal of excess topsoil, waste disposal (rock, boulders and unmarketable products).
- ***Decommissioning:*** long term pollution potential and control (water), removal of administrative buildings, plant and machinery, monitoring and management and land use options after closure.
- ***Rehabilitation:*** methods for long term quarry face stabilization, methods and strategies for site rehabilitation, re-vegetation plan, list of species to be used in proposed rehabilitation, top soil cover to be used, monitoring and management for rehabilitated areas, including potential use of the rehabilitated area.

In light of the above, a comprehensive and detailed description of the proposed development/project should be provided. This section will provide information on the proposed project and should include but not be limited to:

- History and background of the project,
- A location map at a scale of 1:12,500 (or an appropriate scale)
- The total area of the site to be considered. It should clearly demarcate the exact location of the proposed development/project and should clearly identify the areas which will be used for quarrying, those which will be used for mineral processing (crushing plant) and those which will be used for the storage and stockpiling of material.
- A site layout plan showing the various components and design elements of the proposed development.
- The spatial allotments for the various design elements of the project.

- Details which properly and accurately identify the location of all ore bodies (active and inactive) within SMLs 541 and 167 as referenced in technical report submitted in support of application. All ore bodies to be impacted must be accurately listed and identified.
- Buffers and areas to be preserved in their natural state should be clearly identified. This shall include buffers to mitigate impacts to springs and wells (both monitoring and production wells) located in proximity to ore bodies.
- Clearly indicate what is the intended use for the final quarried material (i.e. local market distribution and sale versus export and transportation to said destination), including destination.
- Expected project components, i.e. pre-operation, operation, decommissioning and rehabilitation **(see above for details)**.
- Schematic plans, diagrams and drawings.
- A detailed restoration plan highlighting grading and proposed changes in topography, as well as including proposed landscaping.
- Details of proposed access(es) to the site to be used for pre-construction, construction and operational phases
- Details on infrastructure development including design plans for all components of the development including the proposed wastewater/sewage treatment system and disposal of treated effluent must be clearly outlined.
- A comprehensive drainage assessment. This assessment should take into consideration existing natural drainage channels, proposed man-made drainage/water features or any proposed changes in topography. Potential issues of increased surface runoff and sediment loading must also be addressed. Special emphasis should also be placed on the storm water run-off, drainage patterns, characteristics of the aquifer, including the level and status of the groundwater.
- Plan for the providing utilities, including but not limited to details relating to the source of potable water, electricity generation, roads and other services should be clearly stated.
- A Waste Management Plan which clearly outlines expected quantities of construction waste during the construction phase, general waste arising from material consumption of the workforce, as well as, all expected waste during the operational phase should be completed. Details should also be provided for any central disposal area(s) being considered to serve the proposed development
- Details of equipment and machinery to be involved, how these will be mobilized and areas to be used for storage of machinery and material should be clearly indicated.
- Details of workforce, including proposals for mobilization and accommodation should be indicated.
- All phases of the project should be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.
- The study area should be clearly delineated and referenced. Taking into account the types of resources located in the area and the magnitude of the associated impacts, the study area should be large enough to include all valued resources that might be significantly affected by the project.

If there is potential room for growth or expansion with respect to the area, output or further processing then this should be discussed. Associated or ancillary activities/ developments should also be discussed. These may include machinery maintenance, haulage enterprises and the final repository of material.

It should be noted that the description should involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate and include information on location, general layout and size, as well as pre-construction, construction, operation, decommissioning and rehabilitation plans. For projects to be done on a phased basis, all phases must be clearly defined and the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included.

5. Description of the Environment

This section involves the generation of baseline data which is used to describe the study area as follows:

i) physical environment
ii) biological environment
iii) socio-economic and cultural environment

The methodologies employed to obtain baseline and other data should be clearly detailed in the EIA. The methodologies should be conducted for both the wet and dry seasons where applicable. This information will form the basis upon which impacts of the project will be assessed.

The following aspects should be described in this section:

5.1 Physical Environment

i. a detailed description of the existing
   a) **geology** – rock type and formation, faults, slope stability issues
   b) **geomorphology** – identified geomorphological features e.g. caves, caverns, soil type
   c) **hydrology** – special emphasis should be placed on drainage patterns.
ii. Air quality in the area of influence including air emissions (e.g. PM10, NOx, SOx) from stationary or mobile sources, climatic conditions inclusive of wind speed and direction, precipitation, relative humidity and ambient temperatures. (A review of the Natural Resources Conservation Authority Air Quality Regulations and the implications of the regulations on the proposed project should be conducted and ascertained).
iii. **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of quarrying and crushing activities. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, biochemical oxygen demand, suspended solids, dissolved solids and turbidity.
iv. Noise levels of undeveloped site and the ambient noise in the area of influence.
v. Sources of pollution existing and extent of contamination.

5.2 Ecological Services

- A statement of whether or not any percentage of the ecological services currently being offered by the site will remain or be recovered subsequent to quarrying.

5.3 Natural Hazards

Vulnerability assessment of the development in relation to the following must be undertaken:-

- Hurricanes, Earthquakes
- Natural hazard vulnerability assessment should take in account climate change projections.

5.4 Biological Environment

Present a detailed description of the flora and fauna of the area, with special emphasis on rare, endemic, protected or endangered species. In this section the emphasis is on a description of habitats, flora and fauna surveys inclusive of a species list; commentary on the ecological health, function and value in the project area, threats and conservation significance.

This should include:

- A detailed qualitative and quantitative assessment of terrestrial habitats in and around the proposed project sites and the areas of impact. This must also include flora and fauna surveys and should include species lists.
- Special emphasis should be placed on rare, endemic, protected or endangered species. Migratory species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment.
- Species dependence, niche specificity, community structure, population dynamics, species richness and evenness (a measure of diversity) ought to be evaluated.

The field data collected should include, but not be limited to:

- Vegetation profile
- Species lists must be provided for each community
- A habitat map of the area

5.5 Heritage

- An assessment of artifacts, archaeological, geological and paleontological features for the site.

5.6 Socio-economic Environment

Demography, regional setting, location assessment and current and potential land-use patterns (of neighbouring properties); description of existing infrastructure such as transportation, electricity, water and telecommunications, and public health safety; cultural peculiarities, aspirations and attitudes should be explored; and other material assets of the area should also be examined. A socio-economic survey to determine public perception of the project should also be complete and this should include but not be limited to potential impacts on social, aesthetic and historical/ cultural values.

The historical importance of the area should also be examined including identification of culturally significant features e.g. archaeological finds. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development will be conducted and the use/benefit/value of the existing site will be explored/explained. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires.

Describe traditional land use and advise of any prescriptive rights including public access rights. Additionally, where urban areas are included in the scope of the proposed project, these must be clearly mapped and identified within the EIA.

6. Public Participation

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The instrument used to collect the information must be included in the appendix. It may be useful and necessary to hold stakeholder meetings to inform the public of the proposed development and the possible impacts. This will also gauge the feeling/response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meetings should be held in accordance with the Guidelines for Conducting Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once the EIA is completed and submitted for consideration. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document. should be clearly outlined to the public.

7. Impact Identification and Assessment/ Analysis of Potential Impacts

A detailed analysis of the project components should be done in order to: identify the major potential environmental and public health impacts of the project; distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect and impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts.

Cumulative impacts should also be evaluated taking into account previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental and public health issues should be noted and their relative importance to the design of the project and the intended activities indicated. The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate and minor and presented in separate matrices for all the phases of the project (i.e. preconstruction, construction, operational and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts. All impacts should be listed, ranked and assessed.

The impacts to be assessed will include but not be limited to the following:

7.1 Physical

In general, for this proposed development, the physical impacts may include the effect on soil and geology (site clearance, storm water runoff, loss of topsoil, potential erosion, change in drainage patterns, flooding risks (as it pertains to the site and the surrounding environs/communities), air, particularly in the context of the potential impact that the proposed development may have on communities (generation of dust from processing, drilling, transportation, material storage and handling, fly rock from surface workings); water (possible contamination of surface and subsurface resources from improper waste disposal, storm water runoff); the landscape (loss of character of the area, impact of excavation); material assets (effects of vibration on surface structures as it pertains to the site and the surrounding environs/communities, damage to roads during transportation). The physical impacts should explore, but not be limited to the following:

- Impacts of construction activities such as site clearance, earthworks and spoil disposal.
- Impacts of accidental oil and chemical spills
- Impacts on Air Quality
- Impacts on Water Quality (pollution of potable, coastal, surface and ground waters). The EIA should also comprehensively assess the relationship between increased bauxite production as a consequence of expanded mining areas and the impact this will have on the existing mud lakes and on-going ground water quality related issues including the South Lake and surge basin.
- Impacts/demands/requirements of the following must be quantified
  - Water Supply
  - Drainage
  - Sewage Treatment and Disposal - Empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the Natural Resources Conservation Authority's Sewage Effluent Standards;
  - Wastewater Disposal
  - Trade Effluent Discharges and the Treatment and Disposal of same - Empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the Natural Resources Conservation Authority's Trade Effluent Standards;
  - Solid Waste Disposal
  - Electrical Power (fossil fuels, wind, sun, wave and tidal)
  - Communications and other utility requirements
  - Transport Systems and supporting infrastructure required
- Operation and maintenance – waste disposal, site drainage, sewage treatment and disposal solution, and air quality;
- Impacts on visual aesthetics and landscape
- Noise
- Dust
- Vibration
- Change in drainage pattern

- Carrying capacity of the proposed site

7.2 Natural Hazard
Impact of natural hazards including but not limited to hurricanes, earthquakes, landslides and flooding potential.

7.3 Biological
Direct and indirect impact and associated risks on ecology of the terrestrial and marine habitats, where relevant. Emphasis should be placed on any rare, endemic, protected or endangered species found. This should include habitat loss and fragmentation, loss of species, niches and natural features due to construction and operation. The impact of noise, dust and vibration on floral and faunal species should be explored.

7.4 Heritage
Loss of and damage to artifacts, archaeological, geological and paleontological features

7.5 Human/Social/Cultural
Effects on the socio-economic status such as changes to public access and recreational use; impacts on existing and potential economic activities; contribution of the development to the national economy and development of surrounding communities should be examined. Socio-economic and cultural impacts to include land use/resource effects, health and safety of the potential workers as well as the residents of the surrounding environs should be described. Public perception as it relates to loss of property value, loss of aesthetic enjoyment among other things should be explored.

7.6 Public Health Issues of Concern
The impact of the proposed development particularly in the context of the potential impacts on human health, that is, air quality, noise pollution, water quality e.g. possible respiratory effects) should be examined, in terms of what is the identified impact and proposed mitigation.

7.7 Risk Assessment
Analyze the risks to the safety of the workers and persons within the sphere of influence related to the projected impacts identified during the studies. This should include: 1) Identifying the hazards 2) Assessing the potential consequences 3) Assessing the probability of the consequences and 4) Characterizing the risk and uncertainty.

8. Impact Mitigation
The mitigation measures should endeavour to avoid, reduce and remedy the potential negative effects while at the same time enhancing the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. This should include recommendations for the enhancement of beneficial impacts and quantify and assign financial and economic values to mitigating methods. Green technology should be examined. A statement is to be made on strategies that will be used to conserve energy and water in relation to this development.

Appropriate mitigation measures must be proposed to ensure protection of all surface and ground water features. Examples of areas which must be protected include the Pepper Well Field, the Santa Cruz Well Field and the springs in the eastern and northern quadrants of SEPL 541.

9. Residual Impacts

Identify any residual negative impacts that potentially have no solution for mitigation, for example, change in aesthetics, habitat loss, etc.

10. Analysis of Alternatives

Alternatives to the proposed development/project including the no-action alternative should be examined. These should be assessed according to the physical, ecological and socio-economic parameters of the site. This examination of alternatives should incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives should also address specific aspects of the project such as methods proposed in the execution of the project (works) that have been identified as being causes of major impacts.

A rationale for the selection of any project alternative should be provided.

11. Environmental Monitoring and Management

An environmental monitoring and management plan should be developed which will detail the requirements for construction, operational and decommissioning/closure phases of the project. This should include, but not be limited to training for staff, as well as include recommendations to ensure the implementation of mitigation measures and long term minimization of negative impacts

A draft environmental monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development.

At the minimum the monitoring programme should include:

- Introduction outlining the need for a monitoring programme
- The activity(ies) being monitored and the parameters for monitoring and reference standards.
- The area(s) being monitored (should incorporate a control site), the methodology and frequency of monitoring recommended.
- The name and qualifications of the person(s) proposed to undertake the monitoring programme
- Frequency of reporting to NEPA
- A sample of the report that is to be submitted

The Monitoring report should also include, at minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

12. List of References

13. Appendices

The appendices should include but not be limited to the following documents:

13.1 Reference documents
13.2 Photographs/ maps
13.3 Data Tables
13.4 Glossary of Technical Terms used
13.5 Terms of Reference
13.6 Composition of the consulting team, team that undertook the study/assessment, including name, qualification and roles of team members
13.7 Notes of Public Consultation sessions
13.8 Instruments used in community surveys

14. ACTIVITIES

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which include:

14.1 Documentation Review

All documentation pertaining to the development will need to be reviewed. These should include, but not limited to, the project profile, site plan, drainage plan, vegetation clearance plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

14.2 Analysis of Alternatives

Alternatives to the site location, project design and operation conditions will be analyzed including the "no-action" alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives. This would clarify, for instance, whether the site could be used for other purposes as well as whether there are any particular aspects of the development that can be sited differently, operated differently, etc.

14.3 Impact Assessment

The consultant should carry out a detailed impact assessment of the project components (preconstruction, construction, operational and decommissioning/closure stages) in order to identify the potential impacts (positive, negative and cumulative impacts) that will be associated with the project. The significance and magnitude (major, moderate and minor) of the impacts identified will also be evaluated through the use of a weighted matrix.

The impacts to be assessed will include but not limited to the following:

- Effects of project design and engineering;
- Effects on visual aesthetics and landscape;

- Effect of noise and vibration;
- Effects of operation activities such as site clearance and geological formation, earthworks, hurricanes, access routes, transportation networks and spoil disposal;
- Effects of operation and maintenance activities such as waste disposal, traffic management, site drainage, sediment, sewage, public access and air quality; and
- Effects on ecology including effect on terrestrial and other habitats
- Emphasis should be placed on any rare, endangered, and endemic species found
- Effects on socio-economic status such as changes to public access, recreational use, existing and potential agricultural activities, contribution of development to national economy and development of surrounding communities.

All findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as, references. GIS references should be provided where applicable. One hard copy and an electronic copy must be submitted to NEPA for review after which ten (10) hard copies and an electronic copy of the report should be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, the study team and their individual qualifications, photographs, and other relevant information. All of the foregoing should be properly sourced and credited.

13.21 EIA Study Team

NAME	QUALIFICATION
Timon Waugh (PhD)	Environmental/Quality/Occupation Health & Safety Management
Balfour Denniston (PE, PMP)	Chemical Engineer
Basil Fernandez (C,D., BSc)	Geology & Hydrology
Eric Garraway (PhD)	Terrestrial & Conservation Biologist and Team Leader
Catherine Murphy (PhD)	Entomologist and Malacologist
Damion Whyte (MPhil. PhD Student)	Vertebrate Biologist
Abimbola Haughton (BSc, MSc. Pending)	Terrestrial Biologist and Data Analyst
Jevaughn Henry (BSc)	GIS Specialist and Data Analyst
Ivor Conolley (PhD)	Archaeologist Specialist in Jamaican pre-European Archaeology
Angelique Mullings (Ba)	Archaeologist
Constance Tyson-Young (BSc)	Environmental Engineer & Safety Management Professional
Earl Bailey (PhD)	Urban Planner and Land Resource Management

13.22 Instrument Used in Community Survey

Socio-Demographic Survey

To Inform EIA for Proposed Mining and Quarrying in the Outer Valley Section of SEPL 541, St. Elizabeth
by
JISCO ALPART Jamaica Limited

1. **Age, Gender**
   - ☐ Male (age______________________________)
   - ☐ Female (age______________________________)
   - ☐ Rather not say

2. **Employment Status**
   - ☐ Employed
   - ☐ Unemployed
   - ☐ Self-employed
   - ☐ Temporary employment______________________________
   - ☐ Other:______________________________

3. **Skills and occupation**
   - ☐ Yes______________________________
   - ☐ No______________________________
   - ☐ Not sure:______________________________

4. **Highest educational level/certification**
   - ☐ Tertiary
   - ☐ Secondary
   - ☐ Vocational
   - ☐ Other:______________________________

5. **How many in family**
   - ☐ 0 to 4______________________________
   - ☐ 5 to 8:______________________________
   - ☐ More than 8:______________________________

6. **Gender and age composition of family**
   - ☐ Male (ages______________________________
   - ☐ Female (ages______________________________

7. **Property (land and house) tenure status**
   - ☐ Own
   - ☐ Rent

- ☐ Lease
- ☐ Family
- ☐ Other:____

8. Mode of property acquisition
- ☐ Purchase (no mortgage)
- ☐ Purchase (mortgage)
- ☐ Inheritance____________________________________
- ☐ Gift____
- ☐ Other____

9. Number of rooms in house
- ☐ Less than 2
- ☐ 2 to 4
- ☐ 5 to 7
- ☐ Over 7

10. Material of outer-wall of house
- ☐ 100% concrete
- ☐ Concrete and timber
- ☐ Timber only
- ☐ Other

11. Type of roofing
- ☐ Zinc and Concrete Slab
- ☐ Zinc only
- ☐ Concrete slab only
- ☐ Other:____

12. Number of buildings on land
- ☐ 1 (dwelling unit only)
- ☐ 2 (dwelling unit and commercial/shop)
- ☐ 3 (state:______________________________________
- ☐ Over 4 (State:___________________________________

13. Approximate size of land
- ☐ Under ¼ acres
- ☐ ¼ to ½ acres
- ☐ ½ to 1 acre
- ☐ Over 1 acre

14. Dominant use of land
- ☐ Residential only
- ☐ Residential and Agricultural

- ☐ Agricultural only
- ☐ Other:________________________________

15. Tenure history in Community (Native – In-migrant, Visitor – Passing through)

- ☐ Native (born and bred)
- ☐ Migrant (condition:________________________________
- ☐ Visitor
- ☐ Other: ________________________________

16. Source of Water

- ☐ NWC
- ☐ Private well
- ☐ Rain water harvesting
- ☐ River
- ☐ Other________________________________

17. Source of Electricity/Light/Energy

- ☐ JPS
- ☐ JPS and Solar
- ☐ Solar only
- ☐ Other:________________________________

18. Internet and or Telecommunication Services

- ☐ Flow
- ☐ DigiCel
- ☐ Other provider:________________________________

19. Own land/property elsewhere in parish or elsewhere in Jamaica

- ☐ Yes:
- ☐ No
- ☐ Rather not say

20. Own land/property elsewhere in the community

- ☐ Yes (size and use________________________________
- ☐ No
- ☐ Rather now say

21. Major concern with your dwelling unit (house)

- ☐ Leaking roof
- ☐ Pests (rodents, insects, Rat Bat etc.)
- ☐ No inside toilet
- ☐ Faulty structure (cracks, broken windows and general aging)
- ☐ Other________________________________

22. Mode of Transportation
- ☐ Private (Type:____
- ☐ Public/Taxi____
- ☐ Other____

23. Tombs/grave on land
- ☐ Yes:
- ☐ No
- ☐ Rather now say

24. Water wells on land
- ☐ Yes:
- ☐ No
- ☐ Rather now say

25. Member of any Community Group etc.
- ☐ Yes: Name____
- ☐ No
- ☐ Rather now say

26. Physical vulnerability (flooding, landslide etc.) of the property?
- ☐ Yes:____
- ☐ No
- ☐ Not sure

27. Health status (presence of any underlying or active health issues)
- ☐ Yes:____
- ☐ No
- ☐ Not sure
- ☐ Rather not say

28. Major discomforts in community
- ☐ Unemployment
- ☐ Lack of services and infrastructure__________________________
- ☐ Crime and bad behaviour________________________________
- ☐ Lack of political representation
- ☐ Other.____

29. Method of solid waste disposal
- ☐ NSWMA (collection)
- ☐ Burn
- ☐ Other____

30. Method of sewage disposal

- ☐ Soak away (pit)
- ☐ Septic Tank
- ☐ Other____

Attitude and Perception Inventory

With regards to bauxite mining and other related operations;

#	Item	Agree	Disagree	Uncertain
1	Affect air quality making people sick			
2	Affect water quality			
3	Beneficial to community			
4	Beneficial to country			
5	Better infrastructure (roads, water, electricity)			
6	Company has good community relations			
7	Destruction/damage to house structure			
8	Disregard for graves/tombs			
9	Dust nuisance			
10	Ease of access to company when necessary			
11	Employment opportunities			
12	Farm and Business Resettlement			
13	Good compensations for damage caused			
14	Ill-health			
15	Increase migration to community			
16	Leave community/land unattractive/ugly			
17	Loss of agricultural and pasture lands			
18	Loss of recreational spaces in community			
19	Makes land infertile			
20	Ongoing community consultation			
21	Open pit Mining			
22	Mining increase flooding in community			

23	Provide services and infrastructure to community			
24	Rapid response to community concerns			
25	Reclaimed lands good for farming			
26	Reduce Land Value			
27	Reduction in local business			
28	Relocation/resettlement (house and family)			
29	Restore lands (farming) and infrastructure (roads)			
30	Support community businesses and functions			

…………………………………………………End of Questionnaire…………………………………………………