Prepared on behalf of:

UC Rusal Alumina Jamaica Limited (Windalco)
Ewarton Works
St. Catherine
Jamaica, W.I.

Environmental Impact Assessment

for

Proposed Bauxite Mining Operations

in the

Special Exclusive Prospecting License 524 (SEPL 524) Area

located in

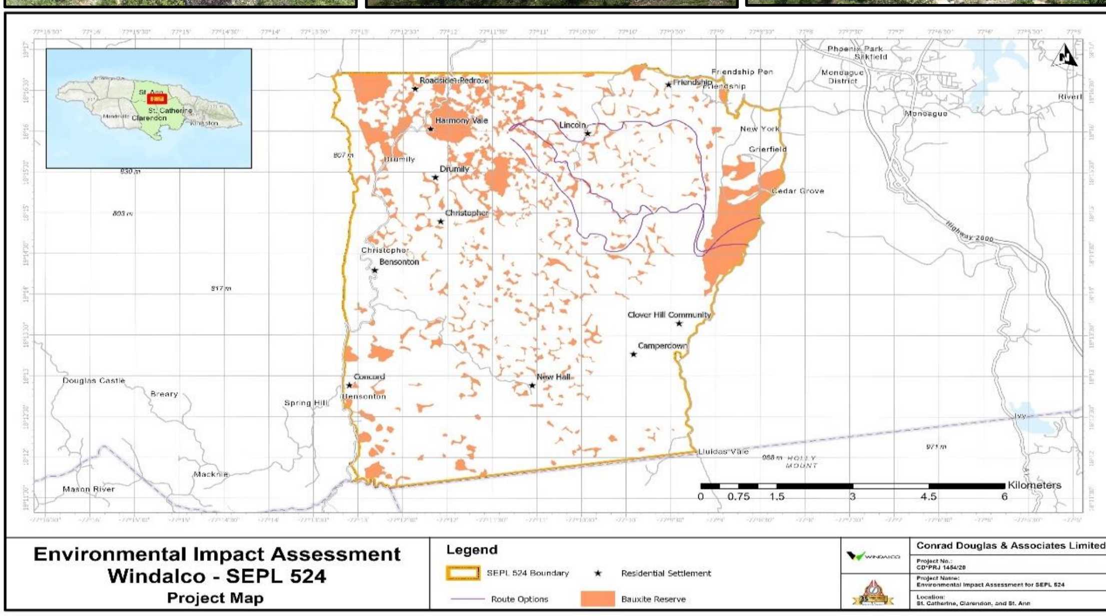
St. Ann, Jamaica

by

UC Rusal Alumina Jamaica Limited (Windalco)

Draft Final

May 21, 2021



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AWS	Automatic Weather Station
ADR	Age Dependency Ratio
amsl	above mean sea level
AQ	Air Quality
AQMS	Air Quality Monitoring Stations
BCH	Biosafety Clearing House
BOD	Biochemical Oxygen Demand
CD&A	Conrad Douglas & Associates Limited
CDC	Centers for Disease Control and Prevention
CITES	Convention for the International Trade in Endangered Species
cm	Centimeter
dBA	Decibels (A-weighted decibels)
DBH	Diameter at Breast Height
DMT	Dry Metric Tonnes
DO	Dissolved Oxygen
ED	Enumeration Districts
EHS	Environmental Health and Safety
EHU	Environmental Health Unit
EIA	Environmental Impact Assessment
EMMP	Environmental Monitoring and Management Programme
F	Fahrenheit
FAO	Food and Agriculture Organization
FD	Forestry Department
ft	Feet
GDP	Gross Domestic Product
GIS	Geographical Information System
GoJ	Government of Jamaica
gpm	Gallons per Minute
GPS	Global Positioning System
ha	Hectares
Hr	Hour
IGPM	Imperial Gallons per Minute
IMF	International Monetary Fund
in	Inches
IUCN	International Union for Conservation of Nature
JAAQS	Jamaica Ambient Air Quality Standards
JBI	Jamaica Bauxite Institute
JBML	Jamaica Bauxite Mining Limited
JCO	Jamaica Caves Organization
JNHT	Jamaica National Heritage Trust

JNNS	Jamaica National Noise Standard
JPS	Jamaica Public Service
JPSCo	Jamaica Public Service Company
JSLC	Jamaica Survey of Living Conditions
kg/m	Kilogram per meter
Km	Kilometer
ktpa	Kilo ton per annum
LAT	Latitude
LMO	Living Modified Organism
LONG	Longitude
m	Meter
m^3/d	Cubic meters per day
mbgl	Meters below ground level
mg/L	Milligram per litre
MGD	Mines and Geology Division
mm	Millimeter
NBSAPs	National Biodiversity Strategies and Action Plans
NDCs	Nationally Determined Contributions
NEPA	National Environment and Planning Agency
NFAP	National Forest Action Programme
NFMCP	National Forest Management and Conservation Plan
NGOs	Non- Governmental Organizations
NH	Natural Hazard
NIC	National Irrigation Commission
NIR	Net International Reserves
NJBP II	Noranda Jamaica Bauxite Partners II
NO_2	Nitrogen Dioxide
NPK	Nitrogen, Phosphorus, Potassium
NRCA	National Resources Conservation Authority
NSWMA	National Solid Waste Management Authority
NWC	National Water Commission
^oC	Degrees Celsius
ODPEM	Office of Disaster, Preparedness and Emergency Management
OSC	Oil Spill Contingency
PASMP	Protected Areas System Master Plan
pH	Potential of Hydrogen
PIOJ	Planning Institute of Jamaica
PM_{10}	Particulate Matter of size 10 microns or less
PPE	Personal Protective Equipment
RADA	Rural Agricultural Development Authority
RH	Relative Humidity
ROM	Run of Mine
SDC	Social Development Commission
SDC	Social Development Commission
SEPL	Special Exclusive Prospecting Licence Area

SeW	Sewage Waste
SMFP	Strategic Forest Management Plan
SML	Special Mining Lease
SO_2	Sulphur Dioxide
SPAW	Special Protected Areas and Wildlife
STATIN	Statistical Institute of Jamaica
SW	Solid Waste
TOR	Terms of Reference
TSP	Total Suspended Particulates
TSS	Total Suspended Solid
UNCED	United Nations Conference for Environmental and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VR	Vegetative Resources
WHO	World Health Organization
Windalco	UC Rusal Alumina Jamaica Limited
WRC	Windsor Research Center
WMUs	Watershed Management Units
WPT	Waypoint
WQ	Water Quality
WR	Wildlife Resources
WRA	Water Resources Authority
µg	Microgram
$\mu g/m^3$	micrograms per cubic meter air

1.0. Executive Summary

1.1. Background

UC Rusal Alumina Jamaica Limited (Windalco) has made an application to the National Environment & Planning Agency (NEPA) in keeping with the requirements of the Natural Resources Conservation Authority (NRCA) Act of 1991, the regulations of 1996 and the amendments of 2015. An Environmental Permit application was submitted to the National Environment and Planning Agency (NEPA) and subsequently NEPA requested that Windalco carry out an Environmental Impact Assessment (EIA) on Special Exclusive Prospecting Licence 524 (SEPL 524) located in the parish of St. Ann (See Figure 1-1 below). The purpose of the proposed project is to obtain the requisite permits from the National Environment and Planning Agency for land clearance within the SEPL, construction of haul roads as well as for the mining of bauxite to convert the entire SEPL 524 into a Special Mining Lease (SML), similar to that which now exists as SML 162, for the winning of bauxite as required by law. The geospatial boundaries of the SEPL and the SML will be similar.

It is proposed to conduct bauxite mining in SEPL 524 for a period of about twenty-five (25) years. The area of SEPL 524 is shown in Figure 1-1 below. This represents a total area of 6,839.90 hectares. Of this SEPL 524 area 496.7 hectares is proposed for bauxite mining. The area to be impacted by mining activities and associated infrastructure, represents 8.2% of the land area containing orebodies. The 8.2% also includes the haul roads that must be constructed in order to gain access to and transport the bauxite ore.

The mining activities proposed for the 8.2% of the total area of SEPL 524, represents a temporary change in land use from predominantly pasture and subsistence agriculture. There is also some human settlements, which contain residential structures in the areas proposed for bauxite mining. After bauxite mining takes place the exhausted bauxite mines or pits will be rehabilitated and dedicated to various uses such as a suitable vegetation cover, pre-mining, housing, agriculture, greenhouses and water storage as determined in the rehabilitation process under the Regulations of the Mining Act by the Commissioner of Mines. At no time during the 25 years lifetime of the project will all 496.7hectares be actively mined concurrently. As far as practicable and agreed with the Municipality, most of the haul roads will become community roads. In these cases haul roads will become community roads, providing improved access to the communities dispersed over the SEPL. Selected haul roads will be removed and the land restored, as close as possible, to its original condition. Windalco will be guided by the requirements of the Mining Act and its regulations.

Windalco has engaged the services of the multi-disciplinary environmental management consultancy firm, Conrad Douglas & Associates Limited (CD&A) to carry out an EIA and engage in the permitting process.

This Draft Final EIA is presented in three (3) Volumes, as follows:

- ✓ Volume I: Environmental Impact Assessment
- ✓ Volume II: Heritage Survey
- ✓ Volume III: Air Dispersion Model Report

The final EIA will contain a third volume, *viz*: The Mandatory Public Consultation Meeting Report.

On 18 February 2020 NEPA granted an environmental permit for prospecting and exploration for bauxite at SEPL 524.

SEPL 524 is located along the southern boundary of the parish of St. Ann and is in proximity to important resources such as:

- Surface water
- Ground water
- Biodiversity
- Forest reserves
- Historical heritage resources
- Human settlements and
- Agricultural activities.

Windalco has been involved in the management of these important renewable and non-renewable resources as a pioneer in Jamaica's bauxite-alumina industry since 1948. Windalco recognizes the importance of these renewable and non-renewable resources and their integral relationship in sustaining Windalco's viability and sustainability, directly and indirectly and the need for their protection. Windalco's Corporate Social Responsibility policies take these into account as well as the regulatory framework in which they must comply.

There are bauxite deposits in SEPL 524, which are valuable mineral resources required for providing feedstock for sustaining Windalco's alumina production. Windalco's export earnings from the sale of alumina forms a part of the world's vertically integrated aluminum industry. This is a major contribution to maintaining Windalco's operations and a critically important contribution to Jamaica's economy at the macro and micro economic levels overall. Importantly, it earns foreign exchange, which contributes substantially to gross domestic product (GDP) growth, employment and the development and operations of several social and economic services.

Prior to the COVID-19 pandemic, Jamaica had achieved nineteen (19) consecutive quarters of positive GDP growth. "*The economy declined by 0.1% for the 3rd quarter of 2019, when compared to the previous quarter. This is as a result of 0.4% decline in the goods producing industries.*"[1] This decline in the growth rate is directly linked to the closure of JISCO-ALPART bauxite processing plant.

The Planning Institute of Jamaica (PIOJ) Economic and Social Survey for 2018 stated that: "*Export earnings were boosted by the exports of alumina, bauxite and mineral fuels, which together accounted for 77.0 per cent of the value of exports.*"

Consequent on the sustained exogenous impact of the COVID-19 pandemic, which has caused lockdowns in several economies across the world, Jamaica's economy has declined 18.4 per cent in the second quarter of 2020 when compared to the similar quarter of 2019[2]. It is projected that annualized the economy will experience a contraction of 10-12% for 2020. A

[1] STATIN News Release, Quarterly Gross Domestic Products (GDP) 3rd quarter 2019, Kingston, December 30, 2019

[2] News Release, Quarterly Gross Domestic Product (GDP), Second Quarter 2020, STATIN

similar projection is estimated for 2021. It is estimated that the economy will not return to pre-COVID-19 positive growth for another 5 years.

The Jamaican economy has declined sharply into unprecedented levels of negative growth and projections are that it is likely to decline further. Natural hazards such as hurricanes, floods, earthquakes, and other pandemics or epidemics could compound or exacerbate the problem of negative GDP growth. The present COVID-19 pandemic has severely impacted on the Jamaican economy with cruise shipping practically at a standstill and with a sharp major in visitors arrivals. The Centers for Disease Control and Prevention (CDC) issued a caution internationally that cruise shipping should be avoided. The impact of the COVID-19 pandemic has caused closures or significant reduction in occupancy in Jamaica’s tourism industry.

At this juncture, maintaining or increasing production in the bauxite-alumina sector has become even more important, than in normal times. This is required for improving macro-economic performance and stability, and to continue to support development at the micro-economic and community level. There is no other sector of the Jamaican economy which can be identified at this time in the immediate and short term, to provide the necessary level of export income to support the economy.

In essence, the objective of this scientific investigation carried out in conducting this EIA is to inform a major decision concerning the critical balance, which exists between the management of a finite non-renewable mineral resource of major economic importance (bauxite) and potential impacts on important renewable resources. Both the finite non-renewable and renewable resources are important in supporting and sustaining the local and regional bio-physical and socio-economic future of Jamaica. The decision on the issuance of environmental permits is also to be guided by the regulatory framework.

1.2. Terms of Reference

NEPA has provided an agreed detailed draft Terms of Reference (TOR) for conducting the EIA. The main headings covered by the TOR are provided below:

- ✓ Executive Summary
- ✓ Introduction
- ✓ Legislation & Regulatory Consideration
- ✓ Project Description
- ✓ Description of the Environment
- ✓ Public Participation
- ✓ Impact Identification & Assessment and Analysis of Potential Impacts
- ✓ Impact Mitigation
- ✓ Residual Impacts
- ✓ Analysis of Alternatives
- ✓ Outline Environmental Monitoring & Management

The detailed TOR is to be found at Appendix I of this draft EIA Report.

1.3. General Approach & Methodology

Research and consultations for this EIA commenced in June 2020 and continued up to November 2020. The general approach and methodology involved a combination of literature reviews, consultations, remote sensing and scientific field investigations, inclusive of ground truthing using state-of-the-art approaches and methodologies. This covered all aspects of the agreed draft TOR for the EIA (see Appendix I).

1.4. Main Findings

1.4.1. Project Description

The project is located in SEPL 524 in the parish of St. Ann (See Figure 1-1 below) and is aimed at providing bauxite feedstock for Windalco's alumina production plant located at Ewarton, St. Catherine.

The preponderantly gibbsitic bauxite reserves in the adjacent SML 162 is currently being mined by Windalco. However, at the present rate of alumina production, the forecast is that this will be exhausted in 2021, thereby requiring the mining of SEPL 524 to commence to provide feedstock for the Ewarton Works Plant.

Windalco will continue to use standard international best practices in compliance with its internal corporate social responsibility policies and Jamaica's regulatory framework.

1.4.2. Legislation and Regulatory Consideration

The relevant regulatory framework has been exhaustively and critically reviewed. This is reported on in detail in section 3.0 of this EIA report. It covers international treaties, protocols and conventions to which Jamaica is signatory, as well as, all relevant Jamaican laws and standards concerning bauxite mining and environmental management. The environmental management study and EIA report focuses on the mineral, bio-physical, socio-cultural, economic and archaeological heritage resources within the SEPL 524 area. The mining of bauxite, which is a non-renewable resource, will only commence in SEPL 524 upon issuance of regulatory approvals and permits.

Although this EIA study takes into account sub-regional, regional and national matters of relevance, the specific environmental setting and baseline is essentially confined to the SEPL 524 area.

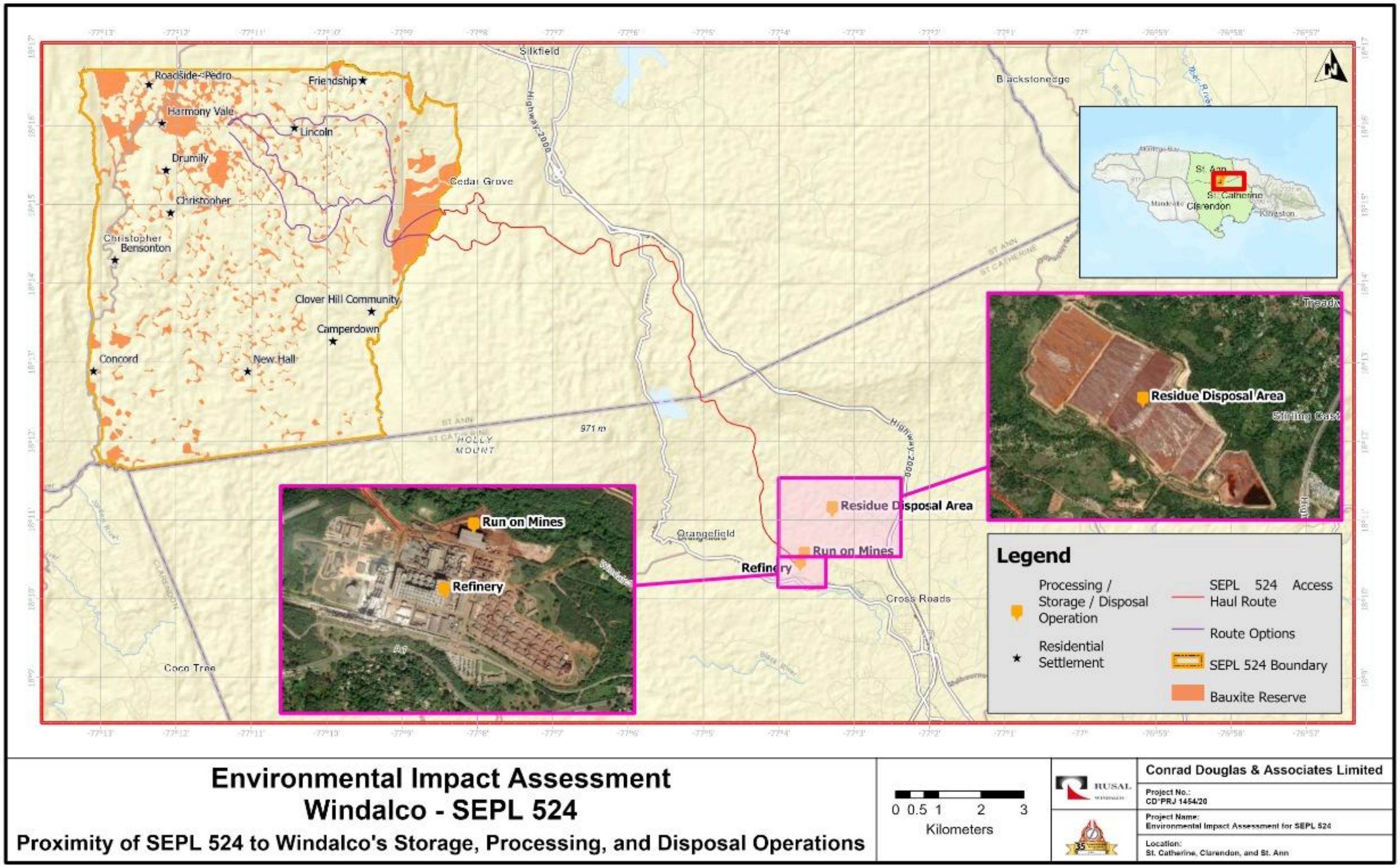


Figure 1-1: Project Location Map

1.4.3. Description of the Environment

The bio-physical, socio-economic and cultural environment has been exhaustively studied in keeping with the requirements of the agreed draft TOR. The SEPL 524 area is not pristine and has been subjected to various anthropogenic stresses, both historically and ongoing. These stresses include establishment of plantations in the early 1700s, hunting, human settlements, access roads for both plantations and settlements as well as agricultural practices.

1.4.4. Geology and Geomorphology

SEPL 524, located within the Dry Harbour Mountain Hydrologic Basin, White River Sub-basin, has the St. Ann-St. Catherine Parish Boundary as its southern boundary and is underlain by limestone members of the White Limestone Group. Bauxite deposits across the island occur atop the White Limestone Members as blanket deposits with interfingering into fissures, fractures and solution hollows in the limestone.

There are eleven (11) caves listed by the Water Resources Authority (WRA) as being within the SEPL 524 area.

The height range of these hillocks and depressions ranges from 382 to 735 meters above mean sea level (amsl).

1.4.5. Hydrology

Groundwater forms the major source of water resources in SEPL 524. There is no major surface water features within the boundary of the area. The high permeability of the limestone members that outcrop in the SEPL, enhanced by the results of the tectonic activity (faults and fractures) and karstification (solution effects, sinkholes) allows for the rapid infiltration of rainfall the main source of recharge to the limestone aquifers.

There are two short streams mapped along the western boundary and halfway up the SEPL. These streams may be spring risings and sinks associated with the limestone in the Bensonton area.

The WRA studies indicates that groundwater flow is to the north and to the northeast through the SEPL 524 area. However, work done by D'Aguilar and Fernandez in 1991-1993 in the Dry Harbour Mountain Hydrologic Basin-White River Sub-basin indicated that groundwater flow was to the north and northwest through the SEPL 524. Groundwater flow was traced using sodium as the main tracer element from the Mount Rosser Red Mud lake to the Rio Hoe Riverhead east of Moneague.

There are also a number of man-made ponds and hillside catchments, which provides water for agriculture and residential use.

1.4.6. Biological Environment

The biological environment (renewable resources) contains important floral and faunal resources which constitute high levels of biodiversity. In general, the area is characterized by a series of forested hillocks and depressions that have secondary growth, which results from human activity within these depressions.

The dominant tree species varied based on each location, with plant species showing more consistency in the lowland/ore body areas and much of the variation in species occurred within the hillock.

Lowland/ore bodies were generally characterized by pasture lands, or shrubs where pasture activities were not maintained. Tree species in lowland areas were common fruit trees planted for agricultural purposes. Woody tree species were more commonly observed along the slopes of the hillocks.

The transition zone between hillocks and grassland is well established on all the areas studied. Further, those areas that have been impacted by anthropogenic stresses show the characteristics of the transition zone at higher elevations on the hillocks.

Forty-one (41) species of trees were identified within SEPL 524 of which one (1) was categorized as vulnerable based on the International Union for Conservation of Nature (IUCN) list.

Seven (7) species of bromeliad, three (3) species of aroids, four (4) species of orchids, eleven (11) species of ferns, twenty-three (23) species of herbs, twenty-one (21) species of vines, twenty-two (22) species of shrubs and five (3) species of grasses were identified in SEPL 524.

Forty-seven (47) species of birds were observed during the study of which one (1) is considered near threatened and one (1) vulnerable based on IUCN list. All the birds observed were on the periphery of the grassland or within the highly vegetated hillocks. 49% are insectivorous, 20% herbivorous, 18% omnivorous, 9% frugivorous and 4% granivorous.

Seven (7) species of anole and five (5) species of amphibians were observed during the study. Two (2) of the amphibians identified are considered endangered based on the IUCN list. Nine (9) species of gastropods were observed and identified, while four (4) species were observed but not identified in SEPL 524. Eight (8) species of bats were identified within SEPL 524.

1.4.7. Socio-Economic Environment

Comprehensive socio-economic and land use surveys were undertaken in SEPL 524 and surrounding areas. The socio-economic survey was undertaken using a pre-tested, pre-coded questionnaire, which was approved by NEPA prior to administration.

According to the 2011 census report (STATIN, 2012), the population of the study area is approximately 11,121 persons. The area is confined to the south-eastern end of the parish of St. Ann and northern portions of St. Catherine and Clarendon. St. Ann dominate the population within the study area, with a total of 9,341 individuals while the areas in St. Catherine and Clarendon totaling 1780 persons, accounts for only 16% of the population for the project impact area. The age-sex structure of the population reflects the transitional nature currently being experienced in Jamaica, consisting of a large but declining youthful population, a dominant working population and a growing ageing population. Males significantly outnumber females in the communities within the study area with a ratio of approximately 115.3 males for every 100 females, outnumbering females in every age cohort with the exception of the 25 -29 age group.

There is a total of approximately 6,432 dwelling units and 6,711 households in the study area. Generally, there has been an increase in the number of dwelling units and the number of households, while the average household size is getting smaller. The majority of the units are occupied by owners followed by those who rent. Leasing and squatting appear to be least popular tenure in the area. There is also the prevalence of people living alone, with single-person households being the most common type of household by size, contributing to a decline in the average household size.

There are no hospitals or fire stations in the study area. The nearest hospitals are located in St. Ann's Bay and Linstead, with the latter being location of the nearest fire station along with Ocho Rios. Health care is provided in the study area by Type I public health centres in McNie and Gibraltar, while Type II facilities exist in Moneague and Bensonton Ewarton and Moneague highlight the locations with Police Stations within the study, but there is also one in Claremont just outside project area.

Educational institutions in the study area provide a wide range of services from infant/all-age level to the tertiary. The Moneague Community College is the only tertiary institutions in the area, and while the peripheral areas contain several high schools, the study area is dominated by all age schools.

Although access to electricity has increased over the previous census by 6%, the use of electricity in the project area is significantly below national and parish levels, at approximately 82% of the households. The use of kerosene as a source of lighting in the area is conversely higher than the national average.

Unlike the standards established nationally and at the parish level, where the majority households receive water from the National Water Commission (NWC), the majority of the household in the project area receive water from private sources. Households with water piped into dwelling or the yard is not very common in the communities in the project area, accounting for less than 13% of the households in the area. The availability of waste disposal facilities in the project area is satisfactory. Only 1.6% of the households reported having no access.

1.4.8. Historical & Archaeological Heritage

The historical heritage of SEPL 524 has been investigated in detail by the Jamaica National Heritage Trust (JNHT). The Heritage Survey as a companion document to this Draft EIA Report as Volume II: Heritage Survey. The main objective of the Heritage Survey was to ascertain the presence of significant archaeological assets, describe and appraise their worth in the context of the proposed development (SEPL 524). The heritage survey identified:

"A total of 306 heritage site were captured in the field survey. They represent remnants of our diverse ancestral heritage including the Amerindians (Taino), Europeans and Africans, Apart from historical cut stone water tanks, surficial archaeological assets are sparse in the depressions. The overwhelming majority of significant historical architecture, archaeological sites, caves, and modern communities throughout SEPL 524 are found on hillocks and limestone ridges."

For a summary of the Heritage Survey Report, please see the section titled Non-Technical Summary in the Heritage Survey Report (AIA pages i- xcix).

1.4.9. Public Participation

The Voluntary Stakeholder Consultations, which CD&A normally carries out in keeping with international best approaches and practices, were severely constrained as a result of the rapidly spreading COVID-19 pandemic in Jamaica. In this regard, it was critically important to comply with the requirements of the Disaster Risk Management (Enforcement Measures) Order, 2020. For this reason an alternative methodology for Voluntary Public Consultation meetings were employed using telephone calls, zoom meetings, and limited face-to-face meetings with key stakeholders within the SEPL 524 and sphere of influence.

In this case the meetings were limited to online meetings with the main Government of Jamaica stakeholders the Forestry Department (FD) and the Water Resource Authority (WRA). These authorities expressed the importance of ensuring that potential impacts on forestry and water resources are avoided within SEPL 524.

The main concerns that were raised with the political directorate, community stakeholders and institutions were as follows: Social Intervention, Farming, Water Resources, Relocation and Security of Land Tenure, Changes in Land Use, Dust Nuisance and Mining. Recommendations were also made by the stakeholders on how some issues maybe addressed.

1.4.10. Impact Identification and Assessment and Analysis of Potential Impacts

The potential impacts on the physical, biological, social-economic and heritage resources were extensively identified and investigated. The critical potential impacts identified in the study are mainly the predicted changes in the topography and land use resulting from the proposed bauxite mining operations. There will be a temporary reversible loss of habitat associated with the construction of these haul roads, as well as, changes in the landscape aesthetics. Under very dry conditions there will be the potential for the formation of fugitive dust from re-entrainment of road dust during transportation of the mined bauxite.

There is also a low potential for the loss of biodiversity and destruction of heritage sites within SEPL 524.

1.4.11. Impact Mitigation

Mitigation measures on the following are proposed in Section 8.0 of this EIA: Aesthetics, Geological and Geotechnical, Water Quality, Surface Water Hydrology and Groundwater, Air Quality, Climate Change, Noise, Terrestrial Wildlife Resources, Terrestrial Vegetative Resources, Employment & Worker Health & Safety, Dislocation and Compensation, Heritage Sites and Traffic.

Potential negative impacts can be avoided or mitigated. These are illustrated in the impact mitigation tables and matrices in sections 7.0 and 8.0. In addition, all activities are transient. Temporary mining activities will be carried out at various locations within SEPL 524. The general progression is from East to West. This depends on the quality and quantity of the bauxite. Details of five-year mining plans will be submitted to the regulators at least 1 year before relocation to the new area. All required mitigation for environmental protection will therefore be effectively planned as the mining progresses to the satisfaction of the regulatory agencies.

The mitigation to be employed by Windalco will include but not be limited to: Haul roads will be properly maintained; Special emphasis will be placed on dust suppression especially during dry periods to reduce fugitive dust formation and dispersion during bauxite transportation; Natural drainage will be maintained as far as practicable; Portable chemical toilets will be installed at the ore bodies; Silencers or mufflers on construction equipment will be properly fitted and maintained; The footprints of the operations will be strictly maintained to that which is unavoidable; Protected, rare, threatened or endangered species of plants identified will be removed and relocated to areas that will not be affected by the operations or at Windalco's greenhouses; Windalco's Environmental Health and Safety policies and procedures will be implemented; In the event that settlements will be impacted, Windalco will employ its relocation and/or compensation plans; In the event that there is an archaeological find, Windalco is obliged to act in keeping with the JNHT's Act. Intersections will be actively monitored and signs installed, where necessary.

The vast majority of the hillocks within SEPL 524 will not be impacted from mining activities. Most haul road construction will be confined to the transition zones. Only 8.2%, or less (i.e. 496.7 hectares), of the land area within SEPL 524 will be impacted over the estimated 25-years life of the project.

Most of these potential negative impacts are not high in intensity, magnitude and duration and are reversible, with the exception of the changes in topography.

With respect to any identified sinkholes, Windalco will be guided by best practices, precedence and the directives of the relevant regulatory agency in establishing appropriate setbacks.

1.4.12. Analysis of Alternatives

Four (4) alternatives were analysed during the preparation of the EIA. These include: (1) No Action Alternative, (2) The Proposed Mining Activity, (3) Location and (4) Technology. The proposed mining activity is the preferred option of the alternatives assessed.

1.4.13. Environmental Monitoring and Management

State-of-the-art environmental monitoring, evaluation and management methods will be used by Windalco prior to and during the entire mining operations. The objective is to ensure that compliance is maintained within the regulatory framework and its own internal policies and standards. The internal environmental management resources of Windalco will be augmented with the services of external consultants, and where appropriate in consultation with the Community Councils.

Creative conservation strategies will be employed using various universally accepted strategies for the protection of the area and restoration of habitats. Opportunities for water storage and agriculture will also be considered.

1.5. Conclusions

The mining of bauxite represents a temporary change in land use. The potential impacts identified can be effectively mitigated.

Pasture lands constitute most of the lands to be temporarily disturbed. It has been efficiently demonstrated for more than 60 years that rehabilitated bauxite lands is excellent for use as pastures in cattle rearing. In fact, this has formed the basis over several decades for supporting some of the largest dairy and beef cattle herds in Jamaica. Jamaica Is internationally recognized as having the largest and best herd of red poll cattle throughout the world.[3] In addition, Windalco presently has cattle and a tenant farming programme on mined out lands, as part of their commercial operations.[4]

[3] Private communications with The Honourable Dr. Karl Wellington, OJ internationally renowned Jamaican cattle breeder and geneticist. Several other sources within the Ministry of Agriculture, Bodles Agricultural Station and unpublished information.

[4] https://jis.gov.jm/ministry-treating-rehabilitation-of-mined-out-lands-with-urgency/

2.0. Introduction

2.1. Purpose of the Project

An application has been made to the Natural Resources Conservation Authority (NRCA) through National Environment and Planning Agency (NEPA) by UC Rusal Alumina Jamaica Limited (Windalco), the proponent, for environmental permits which will be subsequently associated therewith for the establishment of mining operations and its associated activities in SEPL 524.

Windalco has been mining in its current location, now demarcated SML 162, since 1957. The SML162 stretches from Mount Zion in the South to Forsa in the North. The alumina refinery which was built in 1959 is designed to use bauxite with a gibbsite content greater than 42.5% to run at its optimal level. The current bauxite reserves with gibbsite at this level, within the SML 162 are forecasted to be exhausted within three years by 2021.

The purpose of the proposed project is to obtain the requisite permits from the National Environment and Planning Agency for land clearance within the SEPL, construction of haul roads as well as for the mining of bauxite to convert the SEPL 524 into a Special Mining Lease (SML), similar to that which now exists as SML 162, for the winning of bauxite as required by law. The geospatial boundaries of the SEPL and the SML will be similar. The size of SEPL 524 is 6,839.90 hectares, stretching from Grier Park in the East to Edinburgh Castle in the North. Windalco in parallel to its mining activities, has been conducting exploration drilling within SEPL 524 as required by Jamaican law. The results of these exploration activities have proven that there are bauxite deposits of sufficient quantity and quality within SEPL 524 that can maintain the current refinery for many years. The SEPL 524 area proposed for bauxite mining is 496.7. The area to be mined, represents 8.2% of the land area containing orebodies. The 8.2% also includes the haul roads that must be constructed in order to gain access to and transport the bauxite ore.

An additional opportunity of this proposed project would be the extension of the mining activities within the current SML 162. This extension would be well beyond the forecasted one years, due to the blending of bauxites from the new mining lease with the remaining lower grade bauxites of SML 162 following the extraction of the higher gibbsite bearing bauxites found in SEPL 524.

2.2. Brief Description of the Project

With more than 63 years of bauxite mining occurring in Special Mining Lease (SML) 162, the quantity and quality of the remaining bauxite reserves is unable to support the efficient and long-term operations of Windalco's alumina refinery. As at January 2019, WINDALCO's estimated reserves in SML 162 was calculated at 11.1 million crude wet tons which equates to 5.5 years of mining. The bauxite quality of the remaining reserves is within SML 162 falls below 41% Gibbsite and above 3% Silica. Windalco's Ewarton refinery was designed to process bauxite with a minimum Gibbsite of 42.5% and low Silica of 1.5%. This has resulted in a decrease in productivity capabilities from 640 kilo ton per annum (ktpa) in 2005 to 600 ktpa in 2018 and an overall increase in production cash cost.

The conversion of the area which encompasses the Special Exclusive Prospecting Licence (SEPL) 524 to a mining lease and the construction of the requisite haul road will facilitate access to over 25 years supply of proven bauxite of suitable quality.

The proposed project will involve:

1. Land clearing for ore access and road construction (90 hectares to be cleared) over a period of 25 years (average approximately 3.6 hectares of land cleared per year)
2. The mining of bauxite from the ore bodies within the 472.7 hectares of cleared land over a period of 25 years (averaging 18.9 hectares of land cleared per year).
3. The transportation of bauxite to existing loading areas using haul roads to be constructed on 90 hectares of cleared lands over a period of 25 years.
4. The reclamation of the mined-out lands over a period of 25 years. Averaging approximately 20 hectares per year starting once the MGD approves areas for reclamation.

2.2.1. Land Clearing

Before mining commences the surface of the bauxite deposit is cleared of the existing vegetation (mainly grass in the depressions) using heavy equipment within the footprint of the orebody. Between 6-18 inches of top soil is removed by tractor-dozer and scraper-hauler and stored in proximity to the edge of the deposit. The stored top soil will be used in the rehabilitation operation on completion of mining. Areas for access roads are also cleared using the same equipment and methodology.

2.2.2. Mining and Transportation of Bauxite

Once access to an orebody is established, excavators are transported to the orebody where they are used to mine the bauxite in benches of 15 feet. The excavated bauxite is then loaded into 25 ton capacity dump trucks and delivered to Windalco's ROM for temporary storage. The total operating capacity for hauled bauxite is estimated to be 1.8M cwt/year. Each loaded mining truck is weighed at the ROM truck scale prior to offloading so that the total tonnage mined from the orebody per day, can be determined.

2.2.3. Reclamation of Mined-out Lands

After mining, the mined area is reshaped and contoured to form gentle slopes. This involves the grading of fringe areas using bulldozers to create smooth rolling slopes (bowls). Where adequate material cannot be generated from the perimeter of the pit to achieve the necessary slopes and configuration, material is burrowed and trucked to the pit. A mix of rock rejects and bauxite is sometimes used as fill material. The final reshaped area will be greater than the area of the original pit; this excess area is referred to as the '*swell area*'.

After the mined pit is reshaped, the stockpiled soil, which was kept in storage, is spread over the reshaped surface to a minimum depth of 8 inches evenly over the entire area. Once re-soiling has been completed the larger stones left on the surface are manually removed and the land ploughed. Poultry manure is spread manually and grass is planted in some areas

Reclamation is done mainly with bulldozers, while spreading topsoil is by scrapers.

Routine restoration of the reclaimed land is handled by the Agriculture department and is achieved almost entirely by planting the reclaimed area with crops, fruits trees, pangola grass (*Digitaria decumbens*) or guinea grass (*Panicum maximum*). Occasionally, Caribbean pines (*Pinus caribaea*) or in some instances the area is shaped for relocation housing development. Once grass cover is deemed adequate, a request for approval is forwarded to the Ministry of Mining who then sends its officers to examine and certify the orebody as being satisfactorily restored.

2.3. Project Background

Bauxite, the ore from which alumina is extracted, has been mined in Jamaica since as early as 1952. Bauxite is converted to alumina by the Bayer Process and the alumina is then exported overseas where it is further refined to aluminum metal. In Jamaica, Windalco operates an alumina refinery in Ewarton, St. Catherine. Authority to access the bauxite to be supplied to the refinery comes from the Government of Jamaica through the Mines and Geology Division (MGD) in the form of a Special Mining Lease. A prospecting licence (Special Exclusive Prospecting Licence SEPL 524) is also granted to the company to facilitate the exploration and identification of additional bauxite reserves. The bauxite supplied to the Ewarton refinery, is mined from within the boundaries of our Special Mining Lease (SML) 162. Bauxite mining in SML 162 has been almost continuous from 1959. The efficiencies of the alumina refinery operations are heavily dependent on the quality and the quantity of the bauxite with which it is supplied.

2.4. Brief Description of Bauxite

Bauxite is the commercially viable ore for aluminum production. There are other aluminum bearing ores occurring throughout the world. However, these are not considered economically viable or competitive when compared with bauxite. These include for example shale, nepheline syenite, alunite and clay minerals such as kaolinite and halloysite. Jamaican bauxite has an average particle size of 0.5 micron in diameter. It has a surface area which ranges from 35 square meters/gram to 80 square meters/gram.

The moisture content of naturally occurring bauxite ranges from about 20% to 25%. Bauxite, when wet, is a non-Newtonian fluid. As a result of these physical properties and rheological characteristics wet bauxite does not readily flow, unless subjected to great force. Depending on the % moisture, it behaves like a Bingham plastic or a thixotropic gel. It is sticky and difficult to handle when wet as it bridges across the components of mining equipment. It is often classified as a clay mineral. For these reasons, bauxite mining is not carried out during heavy rainfall. The chemical and mineralogical composition of bauxite is shown in Table 2-1 below:

Table 2-1: Chemical and Mineralogical Composition of Bauxite

Chemical		Mineralogical
Al_2O_3: 40-65 percent	Gibbsite Nordstrandite Boehmite Diaspore	$Al_2O_3.3H_2O$ $Al_2O_3.H_2O$
SiO_2: 0.5 – 10 percent	Kaolinite Quartz	$Al_4(OH)_8.Si_4O_{10}$ SiO_2
Fe_2O_3: 3 - 30 percent	Hematite Goethite	Fe_2O_3 $Fe_2O_3.H_2O$
TiO_2: 0.5 - 8 percent	Anatase Rutile	TiO_2
H_2O (hydration: 10 - 34 percent)	In gibbsite, norstrandaite, boehmite, diaspore Kaolinite and goethite.	
Trace elements: Organic Matter	As, Ca, Cr, Ga, Hg, Mg, Mn, Ni, P, V, etc.	

Jamaica's rich bauxite resources, which are found throughout the island as surface deposits hosted or underlaid by karstic limestone, are mainly concentrated in the central, or mid-island parishes. These aluminum bearing metallic minerals resources were discovered by Sir Alfred DaCosta in the late 1940's because of their natural infertility. Reportedly, Sir Alfred's curiosity was piqued when bananas did not flourish on his farmlands. For that reason, he commissioned a soil investigation which was carried out by the then Government Chemist, Mr. Reginald Innes. The Government Chemist found that the soil had a very high concentration of the light metal aluminum. He sent samples to England for confirmatory analysis. Aluminum was critically important for the construction of airplanes especially at that time, during and after World War.

The English confirmed the Government Chemist’s findings and in submitting their report essentially stated that, you may not be able to produce bananas on these lands at this time however you will be able to produce airplanes instead. This marked the birth of Jamaica’s bauxite industry as it ushered in a period of intensive exploration activities followed by rapid growth. This led to the following:

1. The first shipment of bauxite was made from the Reynold’s Port in Ocho Rios in 1952. This was eloquently recorded on the front page of the Gleaner of the day with the caption, “*Red gold going for the first time*”.[5]


The Daily Gleaner
LARGEST CIRCULATION
ESTABLISHED 1834
Price: TWOPENCE-HALFPENNY
KINGSTON, JAMAICA, WEDNESDAY, MAY 28, 1952.
TWELVE PAGE
'RED GOLD' GOING FOR FIRST TIME
Bauxite ore loading starts at Ocho Rios

Figure 2-1: 1st Export of Bauxite - 1952

[5] Daily Gleaner, *Red gold going for the first time,* 28 May 1952

2. A 200 tonne per year alumina pilot plant was established by Alcan at Kirkvine Works Manchester.

These two major activities marked the beginning of the commercial activities of the Jamaica bauxite and alumina industry.

From that time onwards, the bauxite-alumina industry grew to become Jamaica's most important economic sector. It was the largest foreign exchange earner and the number one contributor to GDP growth. Jamaica became the world's number 1 producer of bauxite up to 1974.

2.5. Land Description

The SEPL 524 area comprises private and government holdings. Windalco holds a percentage of the total land areas and the remainder is either held by the Commissioner of Lands or privately held. The subject lands identified as SEPL 524 comprises several hundred parcels of land. The spatial distribution of land ownership in SEPL 524 is illustrated in Figure 2-2 below. There are mechanisms in place to manage land acquisition before mining commences within the regulatory framework discussed in chapter 3.0 of this EIA Report.

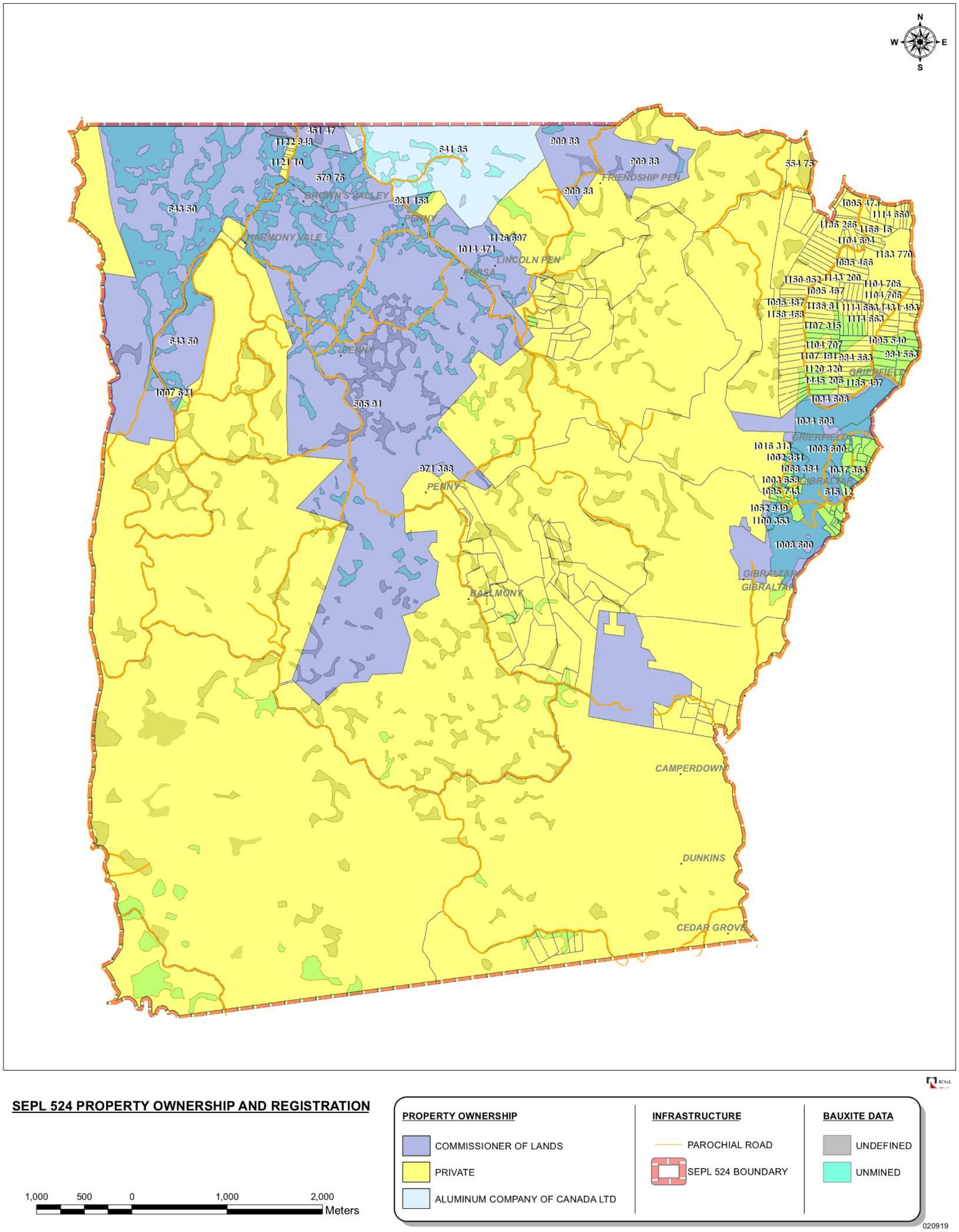


Figure 2-2: SEPL 524 Property Ownership and Registration

2.6. Profile of the Project Proponent

The project will be executed over the lifetime of lease with all activities outlined above occurring to varying levels within each year of operation.

Name: UC Rusal Jamaica Limited (Windalco)
Contact Address: Ewarton, St. Catherine, Jamaica
E-mail: norton.cooper@rusal.com
Implementing organization: UC Rusal Jamaica Limited (Windalco)
Project Consultants: Conrad Douglas & Associates Limited

Windalco has confirmed that the project meets the approved Terms of Reference and environmental and planning standards applicable for the project.

Windalco has declared that there is no litigation pending against the proposed project and/or any direction or order passed by any court of law against the project.

2.7. Economic Profile

The bauxite mining, and processing dates back to 1948, when ALCAN commenced operations for bauxite mining operations at Kirkvine in Manchester. ALCAN developed the Ewarton works in 1959 and operated the two plant until they were sold to Glencore and subsequently to UC Rusal.

The Kirkvine plant is presently mothballed as a result of the 2008 world economic crises while the Ewarton plant is returned to operations in 2009 after a short closure due to the same crisis.

The worldwide recession began to affect Glencore in 2008. Global aluminum prices fell during 2008 – 2009 and negatively impacted the bauxite industry in Jamaica.

There are significant quantities of economical bauxite deposits in SEPL 524 area which are required for providing bauxite feedstock for the continued viability of the Ewarton works. The revenue from the extraction of this resource is a critically important contribution to Jamaica's economy overall and more specifically, GDP growth and employment.

GDP growth in Jamaica's economy, which is only recently emerging from a debt to GDP ratio in excess of 150%, and recently concluded a Standby Agreement with the International Monetary Fund (IMF) in November 2019, has shown steady, though small positive growth in recent times (see Figure 2-3 below). Jamaica's debt to GDP ratio is now delicately balanced at 96%.

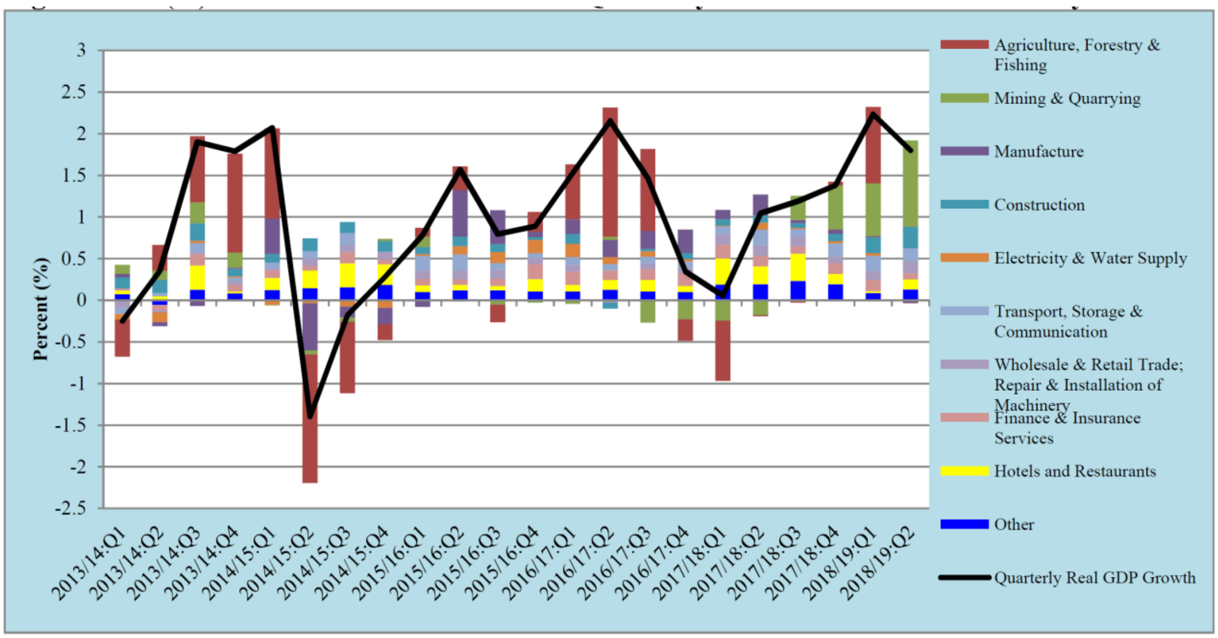
Source: STATIN

Figure 2-3: Quarterly year over year % change in Goods and Services components of real GDP (Original Source: STATIN)

The country recently achieved eighteen (18) consecutive quarters of positive GDP growth. Growth in the last quarter of 2018 was registered at 1.9%, of which, the mining and quarrying sector alone accounted for 40% of this growth. In addition, the Planning Institute of Jamaica (PIOJ) Economic and Social Survey for 2018 stated that: "*Export earnings were boosted by the exports of alumina, bauxite and mineral fuels, which together accounted for 77.0 per cent of the value of exports*". Growth in the second quarter of 2019 was registered at 0.3%, while a lower growth rate was recorded in the third quarter. "*The economy declined by 0.1% for the 3rd quarter of 2019, when compared to the previous quarter. This is as a result of 0.4%*

in the goods producing industries."[6]. This decline in the growth rate was directly linked to the recent closure of JISCO-ALPART bauxite processing plant. The global coronavirus pandemic has further diminished the economic growth of the Jamaican economy and the PIOJ is reporting 12 % decline in GDP over the last year. Figure 2-4 below shows that the mining & quarrying sector is a major contributor to economic growth.

The Jamaican economy is presently subject to exogenous and endogenous shocks. These include natural hazards such as hurricanes and a pandemic. The latter is the potential collapse of major economic sectors including bauxite and alumina production. Changes in the global economy also have the potential to cause shocks to Jamaica's economy. At the same time imports are still outperforming exports and there is a persistent trade deficit.



Source: STATIN

Figure 2-4: Contribution to Quarterly GDP Growth by Industry

The Government of Jamaica (GoJ) Fiscal Policy Paper 2019-2020 indicates that maintaining the mining sector, in general and bauxite mining in particular, is more important now than

[6] STATIN News Release, Quarterly Gross Domestic Products (GDP) 3rd quarter 2019, Kingston, December 30, 2019

ever before for sustaining macro-economic performance and stability in the country's economy, and to continue supporting micro-economic development at the community level[7].

There is no other sector of the Jamaican economy which can be readily identified in the immediate and short term to provide the necessary level of export income to support the economy and support the projected economic growth. This industry, coupled with the country's strategic gateway location and infrastructure, presents the ideal stable business climate for the English-speaking Caribbean. These characteristics have supported Jamaica's emergence as a regional hub for trade and an important destination for major transnational corporations.

During the consultations, it was highlighted that over fiscal years 2012-2013, 2013-2014, and 2014-2015 exports of bauxite and alumina contributed 83.60%, 84.45% and 85% of the value of Jamaica's traditional exports, respectively. The value of limestone exports during the same period ranged from 0.352% - 0.476% of the value of the country's non-traditional exports, which totaled US$719,628,000.00, US$606,086,000.00.00, and US$419,229,000.00, respectively.

"*The foreign exchange earned from the exportation of bauxite, limestone and their value-added products has been critical to helping the country pay for its imports, support the Net International Reserves (NIR) and protect the value of its currency. Significantly, the sector provides some of the highest paying jobs within the economy.*" (Source: Ministry of Mining & Transport, 2019).

2.8. Macro-economic

Bauxite mining has been a significant contributor to national export for the past seven decades. The mining sector has consistently contributed over 5% to GDP annually from the start-up of the bauxite industry[8]. Mining and quarrying contributed 10% of GDP in 1962 but

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[7] The Ministry of Finance & the Public Service, Fiscal Policy Paper 2019-20, 14 February 2019

[8] National Export Strategy, Mining & Minerals, 2009

has declined since then to approximately 5% presently. The production numbers for the country between 1952 and 2015 are shown in Figure 2-5 below. The highest production tonnage occurred in 1973 with a precipitous drop in production between 2007 and 2009. The production has not returned to pre-depression output.

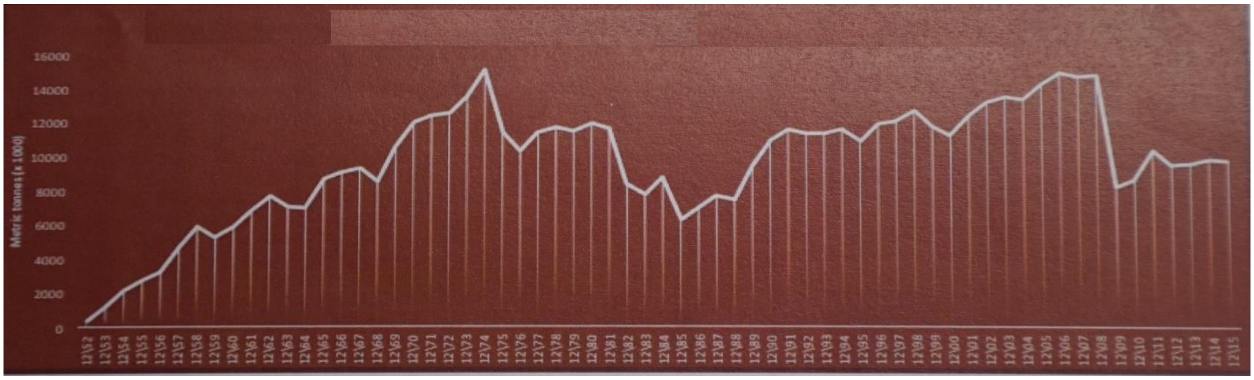

Figure 2-5: Bauxite Production for Jamaica 1952 to 2015[9]

There is a strong correlation between Jamaica's economic performance and bauxite mining. Historically, whenever there is serious decline in bauxite production, the International Monetary Fund becomes deeply involved in the country's economy. IMF interventions are recorded in 1963, 1968, the mid 1970's to the early 1990s and the 2010s and up to 2019 November, when the most recent Stand-by Agreement was concluded.

2.9. Micro-economics

The local economy will benefit from the mining operation within SEPL 524 and its environs. Jobs will be created, and local goods and services will be required by Windalco and its employees. Living standards of local communities (and Jamaica, in general) will improve through increased employment and earning.

Windalco's ongoing corporate social initiatives have resulted in tremendous benefits to thousands of individuals who have achieved upward mobility.

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[9] Porter, A. R. D., Jamaican Bauxite, A Retrospective, iMagiNation Books, 2017

3.0. Legislation and Regulatory Consideration

3.1. Introduction

The legislation and regulatory framework of the proposed project includes mining laws, environmental laws and land management laws. This section provides an analysis of all the legislations and regulations that are applicable to the proposed mining operation within SEPL 524.

3.2. Applicable National Legislations, Standards and Policies

The following represents descriptions of applicable legislations with which activities of this proposed project must comply.

3.2.1. NRCA Act, 1991

The Natural Resources Conservation Authority Act (NRCA Act), 1991 is the overriding legislation governing environmental management in the country. It designates National Parks, Marine Parks, Protected Areas and regulates the control of pollution as well as the manner in which lands are to be used in protected areas.

The NRCA Act requires, among other things, that all new projects or expansion of existing projects, which fall within a prescribed description or category, must obtain a permit before commencement. In cases where there is a potential for significant adverse impact to the environment as a result of the implementation of the project the NRCA may subject the project to an Environmental Impact Assessment (EIA). The National Environment & Planning Agency (NEPA) exercises regulatory authority under the NRCA Act.

Specifically, the relevant section(s) under the Act which addresses the proposed project activities are:

s.10:(1) Subject to the provisions of this section, the Authority may by notice in writing require an applicant for a permit of the person responsible for undertaking in a prescribed area, any enterprise, construction or development of a prescribed description or category-

(a) to furnish the Authority such documents or information as the Authority thinks fit; or

(b) where it is of the opinion that activities of such enterprise, construction or development are having or are likely to have an adverse effect on the environment, to submit to the Authority in respect of the enterprise, construction or development, an EIA containing such information as may be prescribed, and the applicant or, as the case may be, the person

The guidelines for the EIA process require that fourteen (14) copies of the EIA Report must be submitted to the Authority for review. There is a preliminary review period of ten days to determine whether additional information is needed. After the initial review the process can take up to ninety days for approval. If on review and evaluation of the EIA the required criteria are met, a permit is granted.

3.2.1.1. <u>The Natural Resources Conservation Authority (Air Quality) Regulations, 2006</u>

These regulations were gazetted on July 12, 2006. The regulations speak to the quality of the air shed within which an industrial entity discharges emissions (gases and particulate matter). Discharge license requirements are outlined in Part I of this Act. Part prescribes stack emission targets, standards and guidelines.

The environmental impact from any air emissions (gases or particulate matter) will be influenced by the ambient meteorological conditions within the area, such as wind (speed and direction), and rain.

Table 3-1 below outlines the ambient air quality standards as issued by NEPA.

Table 3-1: Air Quality Standards for Jamaica (NEPA)

Pollutant	Averaging Time	Standard (maximum concentration in $\mu g/m^3$)
Total Suspended Particulates Matter (TSP)	Annual	60
	24-hour	150
PM_{10}	Annual	50
	24-hour	150
Lead	Calendar Quarter	2

Pollutant	Averaging Time	Standard (maximum concentration in µg/m³)
Sulphur Dioxide	Annual	80 primary, 60 secondary
	24-hour	365 primary, 280 secondary
	1-hour	700
Photochemical oxidants (ozone)	1-hour	235
Carbon monoxide	8-hour	10,000
	1-hour	40,000
Nitrogen Dioxide	Annual	100

3.2.1.2. <u>State of the Environment Report</u>

The proposed project is located in the Rio Bueno-White River Watershed Management Unit which has a classification of least degraded as reported in the 2013 State of the Environment Report which the NRCA is mandated to prepare. Rio Bueno White River Watershed Management Unit is classified as least degraded (See Figure 3-1 below).

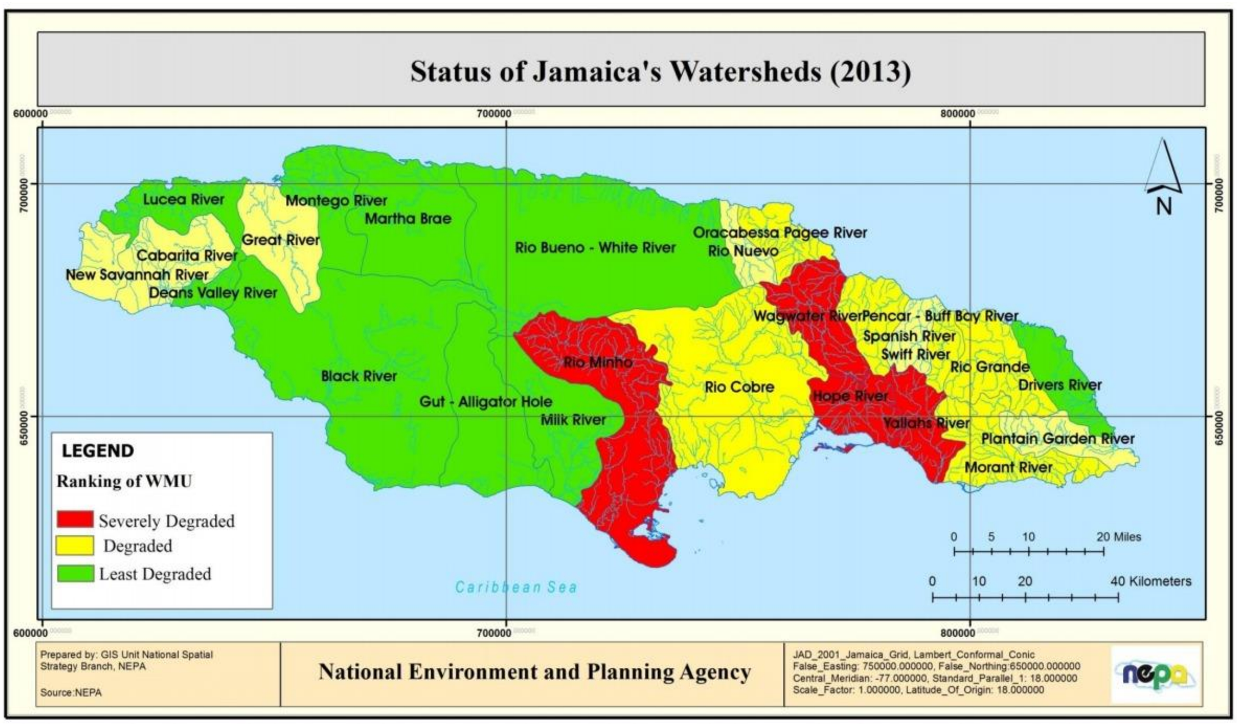


Figure 3-1: Status of Jamaica's Watersheds (Source: State of the Environment Report, 2013, NEPA)

3.2.1.3. The Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013

These regulations set out that persons who intend to operate a treatment plant for the discharge of trade effluent or sewage shall apply to the Authority for a licence.

They also state that a person whose business, industry, manufacturing or trade effluent or sewage effluent or both, as the case may be, from a treatment plant into the environment must apply to the Authority for a licence to discharge such effluent into the environment.

The regulations also set out the standards to be met in the Third Schedule.

It is noted that industrial sludge may only be released into the environment where the industrial sludge is used for agricultural purposes or the Authority has given written approval to the operator of the treatment plant for such release.

3.2.1.4. Noise Standards

Noise Standards for Jamaica have been recommended based on the World Health Organization (WHO) Standards. The guideline for daytime perimeter noise is 75 decibels and 70 decibels for night-time noise.

3.2.2. The Wild Life Protection Act, 1945

This Act involves the declaration of game sanctuaries and reserves, game wardens, control of fishing in rivers, protection of endemic and endangered animal species. The Act also provides for the protection of animals and makes it an offence to harm or kill a species which is protected. It stipulates that, having in one's possession —whole or any part of a protected animal living or dead is illegal.

This Act has to be considered for the proposed project. Ecological assessments will determine if rare or endangered species will be impacted.

The Act also makes provision for the declaration of an annual bird shooting season.

The Wild life Protection (Amendment of the second and third schedules) Regulations, 2016 is provided in Appendix IV.

3.2.3. The Forest Act, 1996

This Act provides for the management and conservation of declared Forest Reserves and Forest Management Areas on Crown Lands by the Forestry Department, as well as areas declared on privately-owned lands, if the (Minister) is satisfied that the use of the land should be controlled for the protection of the national interest.

3.2.4. Water Resources Act, 1995

Water Resources Act, 1995 regulates Jamaica's water resources. It establishes the Water Resources Authority a body corporate whose main duty is to allocate, conserve or otherwise manage Jamaica's water resources. It is also the responsibility of the Authority to submit to relevant Minister a National Water Resources Master Plan for Jamaica. This Act also governs the abstraction and use of water in Jamaica and persons who wish to abstract water must have a licence from the Authority to do so. Persons who wish to search for groundwater must first obtain permission from the Authority. Any person who proposes to construct any new boring, or to enlarge or otherwise alter any existing boring, for the purpose of searching for or extracting minerals or other substances under a relevant statute shall take such measures as may be required by the Authority for conserving underground water, being measures which, in the opinion of the Authority, will not interfere with the winning of minerals or other substances and shall submit to the Authority, at its request, such data or other information as the Authority may require in connection with such construction or enlargement, as the case may be. The information must be provided to the Authority with 30 days of the request must be made to the Authority within or such longer period as the Authority may allow. The relevant statutes include the Mining Act, the Petroleum Act or any other Act that may involve the winning of substances.

3.2.5. The Watersheds Protection Act, 1965

The Watersheds Protection Act, 1965 provides a framework for the management of watersheds in Jamaica. There are 26 watershed management units declared under the Act. Provision is made for the intervention of the Government in regulating uses of private land including the clearing of land and implementing appropriate agricultural practices. There are also provisions for intervention through assisted improvement agreements whereby improvement works can be carried out on land to protect watersheds. SEPL 524 falls within the Rio Bueno White River Watershed Management Unit and Rio Bueno Watershed.

3.2.6. The Clean Air Act, 1964

The Clean Air Act speaks to entities such as the Stockpiles, conveyors and ship loading, which are industrial operations. The proposed mining operations has the potential to discharge particulate matter to the atmosphere. This Act allows inspectors to inspect any premises, carry out tests and take samples of any substance that he/she considers necessary.

3.2.7. The Town and Country Planning Act, 1958

This Act governs the development and use of land. Under this law the Town and Country Planning Authority is the agency responsible for the review of any plans involving industrial development. The law allows for specific conditions to be stipulated and imposed on any approved plans. This planning decision is based upon several factors, these include;

- the location of the development
- the nature of the industrial process to be carried out
- the land use and zoning
- the effect of the proposal on amenities, traffic, etc.

This Act is applicable to the proposed activities. All necessary permits and licenses will be applied for.

3.2.8. Town and Country Planning (St Ann Parish) Confirmed Development Order, 2000

There are policies which are designed to prevent the ad hoc mining of minerals. They are as follows:

i. Physical development of a permanent of a capital-intensive nature will not be given permission on mineral bearing lands;
ii. Where communities have to be resettled because the land is needed for the purpose of mining then they should be located near to communities that already exist;
iii. Mining and quarrying plans should be submitted to the appropriate authorities before mining or quarrying commences;
iv. No permission will be granted for the conversion of good agricultural land to mud lakes unless there is no possible alternative;
v. All mined out lands are to be restored to a level satisfactory to the planning and be properly re-vegetated;
vi. Lands which are slated for development may be quarried on a priority basis and prepared for development to the satisfaction of the planning authority;
vii. Plant sites should be located as close as possible to mineral deposits.

3.2.9. Parish Councils Act, 1901 (Amended 2007)

This act provides that each Parish Council has the authority to cancel or alter the regulations with regard to the construction and restrictions as to the elevation, size and design of buildings built with the approval of the relevant Minister.

3.2.10. The Jamaica National Heritage Trust Act, 1985

The Act is administered by the Jamaica National Heritage Trust (JNHT), formerly the Jamaica National Trust. This Act provides for the protection of important areas, including the numerous monuments, forts, statues, buildings of historic and architectural importance in Jamaica.

3.2.11. The Public Health Act, 1975

This Act controls and monitors pollution from point sources. Any breaches of this Act would be sent through the Central Health Committee which takes action through the Ministry of Health & Wellness, Environmental Health Unit (EHU). The EHU has no direct legislative jurisdiction but works through the Public Health Act to monitor and control pollution from point sources. Action against any breaches of this Act would be administered by the Central Health Committee. The functions of the department include:

- The monitoring of wastewater quality, including regular water quality analysis, using water standards published by NEPA;
- Monitoring of occupational health as it relates to industrial hygiene of potentially hazardous working environments;
- Monitoring of air pollutants through its laboratory facilities.

In addition, there are various sections of this legislative instrument which governs and protects the health of the public. Relevant sections under the Public Health Act of 1985, are Sections 7.- (1) *A Local Board may from time to time, and shall if directed by the Minister to do so, make regulations relating to (0) nuisances and 14.- (1) The Minister may make regulations generally for carrying out the provisions and purposes of this Act, and in particular, subject to section 7, but without prejudice to the generality of the foregoing, may make regulations in relation to (d) air, soil and water pollution*.

3.2.12. Disaster Risk Management Act, 2015

This Act governs the handling of Disaster Risk Management in Jamaica. For the purposes of this Act it establishes an Office of Disaster Preparedness and Emergency Management whose principal objectives are to advance disaster preparedness and emergency management measures in the Island by facilitating and coordinating the development and implementation of integrated disaster management systems and institute measures as may become necessary for mitigating disasters. The functions of the Office include:

i) developing and implementing 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;

ii) encouraging and supporting disaster preparedness and mitigation measures in all parishes in collaboration with local authorities, community-based organizations and non-governmental organizations respectively;

iii) providing appropriate training programmes and consulting services related to all aspects of disaster preparedness, disaster mitigation, loss reduction, disaster assessment and disaster management;

iv) planning and implementing programmes to enhance public awareness and understanding of disaster related issues, emergency management, hazard mitigation and other similar matters;

v) identifying and analyzing hazards or emergency situations and conducting related operational research into their effects;

vi) ensuring that agencies and organizations with functions under the National Disaster Risk Management Plan are made aware of those functions and are provided with adequate information for the purpose of understanding and carrying out those functions;

vii) monitoring the capacity of such agencies and organizations to properly carry out those functions;

viii) coordinating the development and implementation of strategies and policies relating to disaster management (also at the national level);

ix) establishing, maintaining and managing mutual assistance and cooperation agreements and arrangements with organizations within and outside of Jamaica.

It is also a duty of the Office to advise the Minister on issues relating to disaster management including disaster mitigation, disaster preparedness, warning systems and emergency management.

The Act also provides for the creation of a National Disaster Risk Management Council.

3.2.13. Factories Act

The Factories Act regulates factories and makes conditions for their inspection. The major points under this act that may affect this project are:

- The safe means of approach or access to, and exit from, any factory, or machinery
- The fencing and covering of all dangerous places or machines;
- Life-saving and first aid appliances;
- Securing safety in connection with all operations carried on in a factory
- Securing safety in connection with the use of cranes, winches, pulley-blocks and of all engines, machinery, mechanical gear, and contrivances generally
- The periodic inspection, testing and classification, according to age, type or condition, of boilers
- The duties and responsibilities assignable to any person generally, and in particular to employers, owners, and managers in charge of factories, in connection with any one or more of such regulations;
- The proper ventilation of any factory, having regard to the nature of the process carried on therein;
- The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory

3.2.14. National Solid Waste Management Authority Act, 2001

The National Solid Waste Management Authority (NSWMA) under this Act has the responsibility to manage and regulate the solid waste sector. It includes requirements for licences for operators and owners of solid waste disposal facilities (in addition to permit requirements of NEPA).

3.2.15. The Road Traffic Act, 2016

This act involves the rules surrounding road usage in Jamaica. The act provides for the establishment of an Island Traffic Authority whose duty is to regulate and control traffic on roads. The act also provides for the classification of motor vehicles permitted to use the roads as well as the restriction on driving motor vehicles. The act also provides for the application for a motor vehicle licence as well as conditions of a driver's licence. The act also provides for the rules of the road and sets out the road code.

3.2.16. The Main Road Act

This Act provides the stipulations for the management of the nation's main road network and also the penalties for breaches of the Act.

The Act gives the Minister with responsibility for the Main Road network, the power to declare other roads as Main Road and also remove Main roads from the existing schedule. The Minister has the power to direct a "Director" to manage the main road network. The Director is the Chief Technical Director.

The Act requires that any person planning to install a fence along the main road must give notice to the Director and get the Director's consent for the activity.

The Director has the power to convey abandoned roads to owners of taken lands for the construction of new roads. The Director, with the approval of the Minister, has the power to grant permission to construct or lay down works across, above or under any main road.

The Director has the power to grant permission to the owner of lands adjacent to the main road to erect and maintain a gate across the main road.

Offenses against the Act include, encroachment onto the main road, cutting trees that fall onto the main road, taking material from the main road or quarry unlawfully, hindering road users and willfully damaging main road or associated infrastructure.

3.2.17. Parochial Roads Act

This act involves the jurisdiction of Parish Councils over parochial roads. It sets out under section 4 that each Parish Council shall have the exclusive care, management, control and superintendence of all highways, and of all public roads, thoroughfares, streets, lanes, aqueducts, and bridges for which it is appointed, except such roads as are otherwise governed and regulated under laws of the Island, specially relating thereto, and except the roads under the superintendence of the Chief Technical Director. The act also stipulates that each Parish Council shall appoint a Superintendent of Parochial Roads and sets out his duties. The act also sets out that each Parish Council at any meeting held after the first day of October in each year and before the first meeting in January, allot a sum not exceeding four-fifths of the whole amount applicable within the year for parochial road purposes within such parish, for repairs and maintenance of parochial roads and bridges within such districts respectively. The act also sets out the powers of Parish Councils to contract as to repairs of roads. The act also involves the Parish Council serving notice on landowners where there are to be alterations or new roads.

3.2.18. The Mining Act, 1947

The purpose of this legislation is to regulate mining in Jamaica. Any person who mines other than in accordance with this legislation is guilty of unlawful mining. It does not have any application to oil. A Commissioner of Mines is enacted to overview all mining activity. The Minister may delegate all his powers without losing the right to enact them. Minerals extracted are liable to pay royalties to the government of Jamaica. The Minister may close and then reopen any area of land other than an area on which a mining lease has previously been granted. If false or misleading information is given when making an application for rights to mine the Minister or commissioner may revoke such rights.

Land owners may seek compensation for any disturbance to their surface rights as a result of mining activities. It is only lawful to prospect under license. All minerals obtained from prospecting are the property of the crown. Any holder of a prospecting license may prospect on relevant land. The Commissioner must be notified of any minerals found other than those for which they are licensed. A license cannot be transferred without the approval of the Minister. It is illegal to mine without a mining lease in accordance with the terms and conditions of a mining lease.

The Minister grants mining leases and may require an applicant for a mining lease to prove they have sufficient funds to properly develop the mining operations. The period of a mining lease should not exceed 25 years. Rights of a mining lease include but are not limited to, the right to enter lands subject to the lease, the exclusive right to mine, the right to stack or dump the products of mining and the right to construct machinery and workshops. The mining lease cannot be sold without the consent of the Minister.

Any property, such as extracted ore, machinery and equipment, that remains on the land after a mining lease has been terminated, shall become the property of the Crown, if it is not removed in a reasonable amount of time.

Any agent of the Commissioner may at all reasonable times enter to inspect land and examine the ventilation of mines. If an accident occurs in the mine, then the Commissioner shall set up an enquiry to determine the cause of the accident.

No person shall possess minerals unless they have the authority to do so under this act, i.e. a licensed mineral dealer. No person shall sell or buy minerals to any person other than a licensed mineral dealer or a person to whom a permit has been granted.

No person may export minerals or radioactive materials without a certificate from the commissioner. If any radioactive material is found it must be reported to the commissioner. No person may interfere with mining operations or any person exercising a right authorized under this act.

Under this legislation the bauxite reserves in Jamaica were issued under Special Leases to international companies. In 1970 there were 5 companies owning leases over the reserve areas. This distribution is shown in Figure 3-2 by the solid boundaries overlaid on the hashed areas. The legislation also gives the Minister the responsibility to revoke and withdraw Leases. The active leases in 2015 and 2020 are shown in Figure 3-3 and Figure 3-4, respectively.

The development of policies such as the National System for Protected Areas in Jamaica has initiated the process of protecting large sections of the country from certain categories of anthropogenic activities.

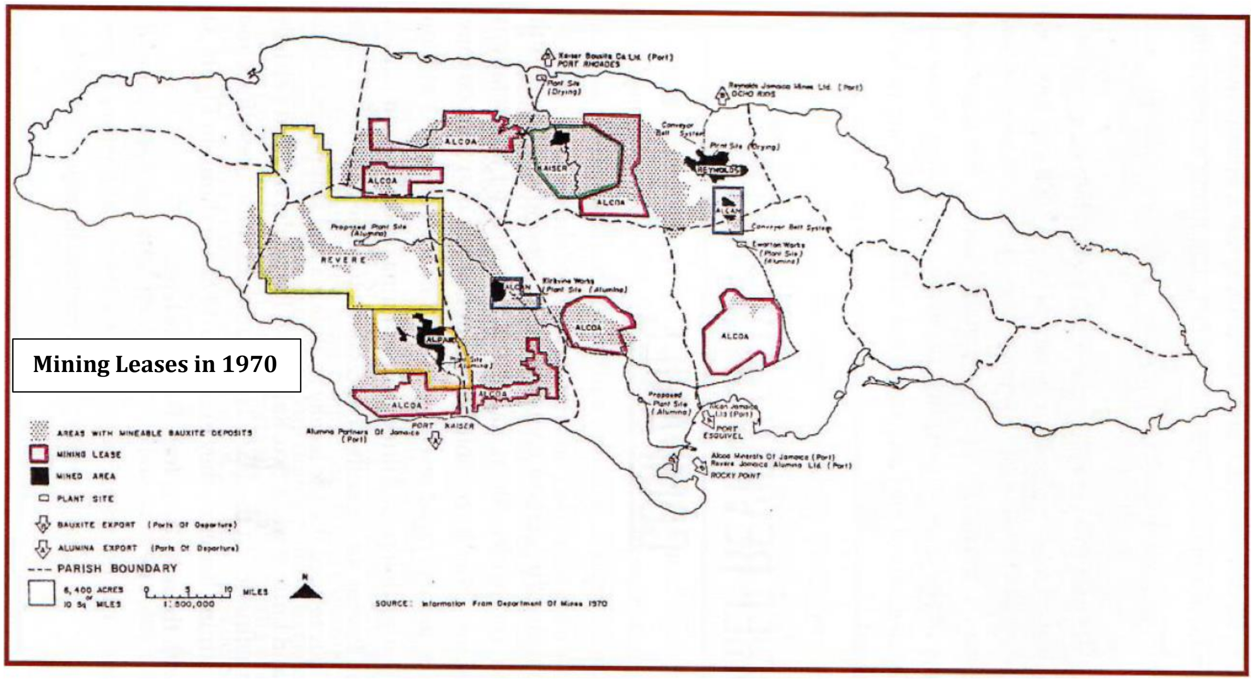


Figure 3-2: Mining Leases in 1970 ***(Source: Jamaican Bauxite: A Retrospective, ARD Porter, 2017)***

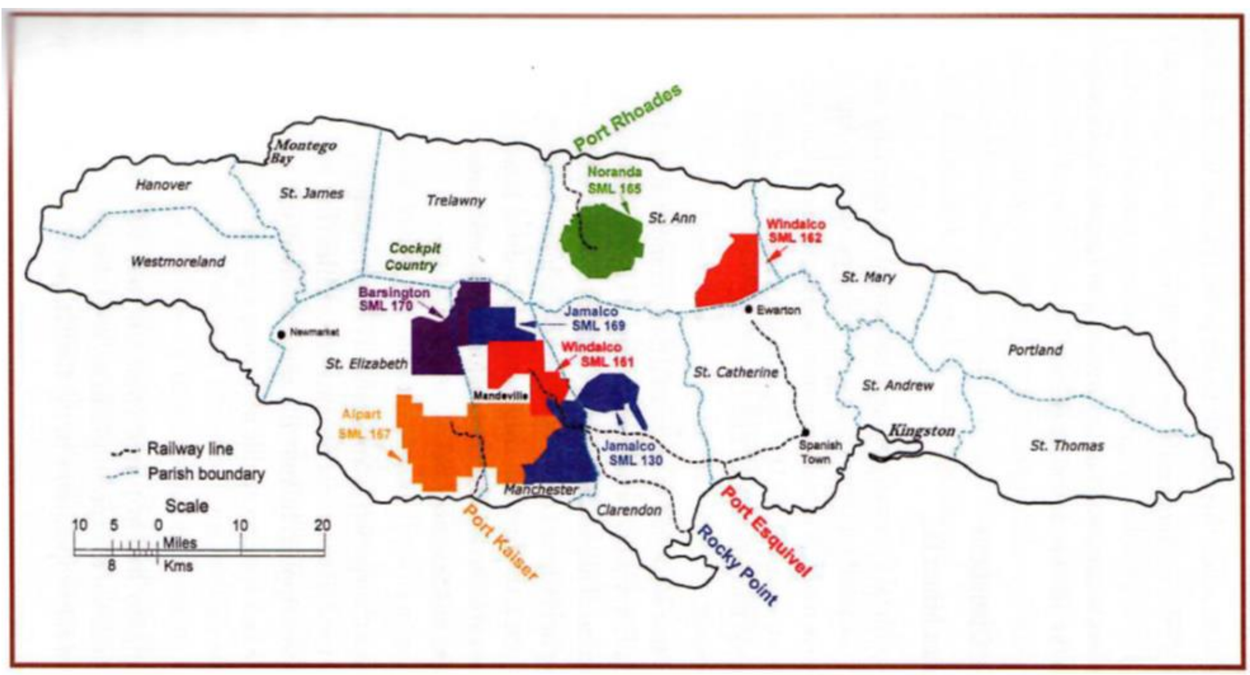


Figure 3-3: Mining Leases in 2015 ***(Source: Jamaican Bauxite: A Retrospective, ARD Porter, 2017)***

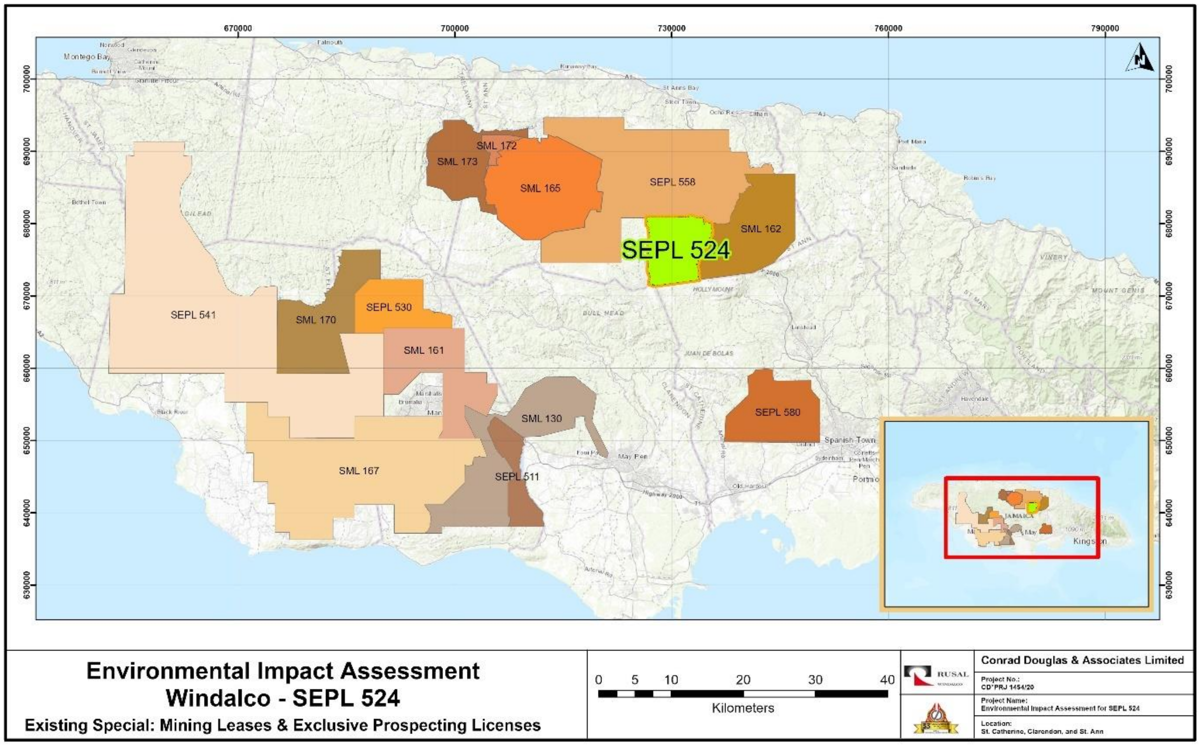


Figure 3-4: Mining Leases in 2020 (Source: Jamaican Bauxite Institute)

<u>The Mining Act</u>: - Section 11 requires the Company to give notice to an owner and an occupier of lands within the Mining Lease on which the Company intends to conduct prospecting or mining activities.

Section 12 requires the Company to pay, on demand of the ***<u>owner or occupier</u>*** of land within the Mining Lease, fair and reasonable compensation for the disturbance of his surface rights. This includes damage to any live or dead stock, crops, trees, buildings or works. Where compensation cannot be agreed, either party may refer to the Parish Court for a determination.

Section 35 (1) - In so far as it may be necessary for or in connection with its mining operations, a mining lessee shall have, on the lands included in the SML, the following rights:-

a) the right to enter upon the lands the subject of the lease, the exclusive right to prospect or mine on such lands and the right to remove and dispose of the mineral specified in the lease on payment of the prescribed royalty;

b) the right to make all necessary excavations thereon and to stack or dump any of the products of mining thereon;
c) the right to erect, construct and maintain houses and buildings for his use and for the use of his agents and servants;
d) the right to erect, construct and maintain such engines, machinery, buildings, workshops and other erections as may be necessary or convenient;
    - (f) deleted
e) the right to construct and maintain all such passageways as may be necessary;
f) the right, subject to the directions of the Conservator of Forests, which directions shall be obtained before the exercise of any right under this paragraph, to cut, take and use any tree.

Paragraph 10, of the SML repeats the rights set out at S35 of the Mining Act.

The Agency Agreement authorizes the Company, as agent for the Commissioner of Lands on its behalf to purchase, lease or acquire lands or surface rights over lands within the Mining Lease.

Historical practice:

Although there is no legislative requirement for the mining Company to purchase bauxite-bearing land, the historical practice has been to do so.

There were unresolved land tenure issues consequent on the fact that the 'owner/occupier' were not always in a position to convey titles for the lands acquired.

Compensation for Disturbance to Surface Rights - A new approach:

Windalco relies on S35 of the Mining Act to gain access to bauxite. This allows the company to pay compensation to land owners/occupiers contemporaneously with the mining of bauxite. Compensation is calculated at the fair market value of the land, as if it were being purchased. This methodology does not require the conveyance of land, eliminating legal capacity to pass title. By this methodology, the land is returned once it has been rehabilitated and deemed no longer necessary for the company's mining operations.

3.2.19. The Bauxite and Alumina Industries (Special Provisions) Act

This Act gives power to the appropriate Ministers, on behalf of the Government, to make or confirm agreements and arrangements, which contain undertakings between the Government and associated producers to enable the Government to participate in the operations of bauxite and alumina and related enterprises in Jamaica.

This Act also provides for the Minister to declare associate producers of bauxite and includes any bauxite producer the Government has an agreement with, under which the Government is associated directly or indirectly in the production of bauxite or alumina in Jamaica or related enterprises.

This Act also empowers the Minister to declare certain categories of persons to be associated producers of bauxite, namely, any bauxite producer with whom the Government has an agreement in force, under which the Government is associated in the production of bauxite in Jamaica or in other related enterprises. Other categories of persons include any person who is engaged in the winning in Jamaica of bauxite or alumina production of bauxite won in Jamaica or other related enterprises or in all those activities and enterprises.

This Act also provides for the right to mine for a bauxite producer who is also an associated producer and who lodges with the Commissioner of Mines a sum, or give security for the payment of any compensation which may be payable under section 12 of the Mining Act.

3.2.20. The Bauxite and Alumina Industries (Encouragement) Act

This Act provides that, where the Minister is satisfied that any person that is engaged in or is desirous of engaging in the winning in Jamaica of bauxite or the production of alumina so won, the Minister may by order declare such person to be a recognized bauxite producer or a recognized alumina producer. It must be noted that this is subject to conditions including, but not restricted to, conditions requiring payment by the producer to whom the order relates to the Government of Jamaica of any sum of money as the Minister may think expedient for securing that the total area and fertility and productivity of land available in Jamaica for agricultural and pastoral purposes is not to be diminished to any greater extent or for any longer period than can in the opinion of the Commissioner of Mines be economically be avoided.

3.2.21. The Mining Regulations

These regulations provide for the clear demarcation of mining licence boundaries once a licence has been granted. An application for a licence shall be made to the Minister through the Commissioner in triplicate, and in the form set out as Form 5 in f-5 of the First Schedule. There shall be forwarded with such application the appropriate fee as set out in the Second Schedule and a sketch plan in quadruplicate on a reasonable scale showing to the satisfaction of the Commissioner the following detail:

i. The main topographical features in and about the area applied for in such a manner as will enable the boundaries to be identified on the ground;
ii. The location beacon
iii. An approximate estimate square kilometers of the area.
iv. Such other information as will enable the area to be delineated on the general map of the district applied for is situated

A licence shall be in the form set out as a Form 6 in First Schedule and if granted subject to any conditions, such conditions will be endorsed on the licence.

Upon receipt of an application for a licence, the Commissioner must publish a notice setting out the main particulars of the application at the expense of the applicant once in the Gazette and once in a daily newspaper circulating in Jamaica and give notice of the particulars of such application to any person who to his knowledge has any interest.

Upon the grant of a mining licence, the holder shall if required by the Commissioner cause all the boundaries of his area to be permanently beaconed or demarcated in accordance with the written directions of the Commissioner and shall paint clearly on a plate securely bolted to every beacon on the side facing the area subject of such lease his name and the official number of such licence.

The holder of a mining licence shall during the period of such lease maintain his beacons in good condition and in proper position keep clearly the particulars of the lease and also very importantly keep cut and cleared of vegetation all or any of the boundaries specified by the Commissioner for a distance of not less than three metres from the beacons defining such boundaries.

3.2.22. The Bauxite (Production Levy) Act

This act provides for the establishment Capital Development Fund where all sums received as payment of production levy under the Act and all other income from the asses of the Fund shall be paid into the Fund. Any moneys and investments forming part of the Fund may from time to time be invested or realized, as the case may be in accordance with the directions of the Minister. The Minister may from time to time by order direct that such sum as shall be specified in the order shall be drawn from the Fund for such purposes and subject to such conditions as shall be so specified. It should be noted that every order made shall be subject to an affirmative resolution of the House of Representatives.

3.2.23. Minerals (Vesting) Act

The Minerals (Vesting) Act: - Section 3, provides that the Crown owns all minerals including bauxite. By operation of section 5(j) of the same act, the landowner is not entitled to payment nor royalty for the bauxite.

3.2.24. Building Act 2017

The Building Act seeks to establish a modern legislative framework that will serve to reduce the vulnerability of Jamaica's built environment and ensure public safety.

It also repealed the Kingston and St. Andrew and Parish Council Building Acts and will created and maintained standards for the construction and maintenance of physical structures.

The Act provides for the establishment of the National Building Code and identifies the Bureau of Standards Jamaica as the agency that will set the acceptable local and international standards for construction.

In addition, the legislation establishes that the municipal corporations are to be the local building authorities and will be responsible for inspecting, certifying and taking the actions necessary to approve new structures, change existing buildings or destroy dangerous structures.

It also streamlines the permit application system to eliminate unnecessary referrals and expedite responses; facilitate the introduction of special express services; and ensure the rights of persons with disabilities regarding accessibility, safety and user-friendliness.

3.2.25. The Endangered Species (Protection, Conservation and Regulation of Trade) Act 2000 (Amended 2015)

This act involves Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora. In 1997 Jamaica became a party to the Convention for the International Trade in Endangered Species of Wild Fauna and Flora (CITES). This act also involves the international and domestic trade in endangered species in and from Jamaica.

The proponent of the project has never and will continue to play its role in the management of environmental resources and will not trade in any protected or endangered plant or animal. This is not a part of its business.

3.3. National Policy

3.3.1. Jamaica's National Energy Policy (2009-2030)

This policy is designed to promote Jamaica's energy efficiency. The goals of the National Energy policy are as follows:

- Goal 1: Jamaicans use energy wisely and aggressively pursue opportunities for conservation end efficiency.

- Goal 2: Jamaica has a modernized and expanded energy infrastructure that enhances energy generation capacity and ensures that energy supplies are safely, reliably, and affordably transported to homes, communities and the productive sectors on a sustainable basis.
- Goal 3: Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint.
- Goal 4: Jamaica's energy supply is secure and sufficient to support long-term economic and social development and environmental sustainability.
- Goal 5: Jamaica has a well-defined and established governance, institutional, legal and regulatory framework for the energy sector that facilitates stakeholder involvement and engagement.
- Goal 6: Government ministries and agencies are a model/leader in energy conservation and environmental stewardship in Jamaica.
- Goal 7: Jamaica's industry structures embrace eco-efficiency for advancing international competitiveness and moves towards building a green economy.

Jamaica's National Energy policy is designed to develop a modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies.

3.3.2. Vision 2030

Vision 2030 is a national development plan for Jamaica which seeks to promote four National Goals as associated National outcomes for each goal, to be achieved by 2030, with the objective of developing Jamaica into a country with a lively and stable economy, and society and environment, and greater opportunities for the country's population

3.3.3. Policy for the National System of Protected Areas, 1997

The various types of protected areas in Jamaica should, individually and as part of a comprehensive system, contribute to achieving common environmental, economic, cultural and social goals. The system should be an essential tool for environmental protection, conserving essential resources for sustainable use, helping to expand and diversify economic development and contributing to public recreation and education. There are six general types of areas to encompass the diverse natural resources and landscapes and are comparable to those of the IUCN (International Union for Conservation of Nature) 4:

1. National Nature Reserve/ Wilderness Areas (Equivalent to IUCN Category I)
2. National Park, Marine Park (Equivalent to IUCN Category)
3. Natural Landmark/ National Monument (Equivalent to IUCN Category I)
4. Habitat/ Species Management Area (Equivalent to IUCN Category IV)
5. National Protected Landscape, or Seascape (Equivalent to IUCN Category V)
6. Managed Resource Protected Area (Equivalent to IUCN Category VI)

3.3.4. National Strategy and Action Plan on Biological Diversity in Jamaica 2016-2021

National Biodiversity Strategies and Action Plans (NBSAPs) are the principal instruments for implementing the Convention on Biological Diversity at the national level.

Jamaica has a diverse range of ecosystems and related habitats:

- Terrestrial -wetlands, mangrove forests and inland forests (highland, lowland)
- Marine/coastal- coral reefs, beaches, seagrass beds, coastal waters and fisheries
- Freshwater – coastal and inland wetlands, ponds, and rivers

In recognition that the value of ecosystem services are essential to human well-being, Jamaica has declared several marine and terrestrial protected areas and prepared the Protected Areas System Master Plan (PASMP), (2013 to 2017) to develop a comprehensive and representative system of protected areas. The ecosystems in these sites have or support extractive direct use values (e.g. forestry); non-extractive direct use values (tourism and recreation); indirect use values (control of soil erosion and coastal protection); and non-use values (biodiversity).

Species diversity refers to the number and variety of species found within the marine, terrestrial and freshwater ecosystems of Jamaica, such as coral reefs, dry and wet limestone forests and wetlands.

Almost 19% of the country is classified as having mixed land use (a combination of any of the forest broad classification with that of non-forest) and the remaining 41% of the mainland is classified as non-forest inclusive of bamboo (which in 1998 was considered as contributing to forest cover), crop plantations, quarries, water bodies, infrastructure etc. (State of the Environment Report, 2013).

Limestone aquifers provide the main source (84%) of Jamaica's freshwater resources, while the remaining 16 % is provided by surface water.

The island is divided into 26 Watershed Management Units (WMUs) containing over 100 streams and rivers. These WMUs are essentially composites of watersheds that fall within 10 hydrological basins (regions).

One national target is "*By 2021, at the latest, the rate of loss of natural habitats, including forests, is at least halved and where feasible, brought close to zero and degradation and fragmentation is significantly reduced*."

Further, "*Jamaica's forests are the main repositories of terrestrial biodiversity, especially of endemic fauna and flora.*"

The Convention on Biological Diversity creates the framework for Parties to implement national legislative, policy and administrative measures. Jamaica became a party to the Convention in 1995, and in 1999, officially established its National Clearing House Mechanism (CHM), which directly responds to Article 8.3 of the Convention, to promote and facilitate technical and scientific cooperation.

In 2012, Jamaica became a Party to the Cartagena Protocol on Biosafety, having been a signatory since 2001. Jamaica's Biosafety Clearing House (BCH) was established in accordance with Article 20 of this Protocol. The BCH serves to facilitate the exchange of scientific, technical, environmental and legal information on, and experience with, living modified organisms.

Jamaica is signatory to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity, 2010.

Successful implementation of national biodiversity strategy implementation of national biodiversity strategy and action plan, will require among other things the mobilization of resources. A strategy for mobilizing resources must include human, institutional and other non-monetary (or financial) forms of resources. Resource mobilization must therefore be considered beyond the limited lens of financial or capital support. This policy is critically important for the development of the project to be in line with the Guiding Principles of the NBSAP.

3.3.5. National Forest Management and Conservation Plan 2016-2026

The NFMCP forms part of the policy tools that guide the work of the Forestry Department and as such its vision statement is the same as presented in the Forest Policy for Jamaica 2017:

"By 2062, Jamaica's forests and its biodiversity are sufficiently restored and sustainably managed, so once again the island can adequately be described as "the land of wood and water", capable of meeting the social, economic and ecological needs of current and future generations."

The articulated goal by the Forestry Department of the NFMCP is as follows: *"Sustainably manage and utilize Jamaica's forest resources to enhance social and economic development and contribute to building the country's climate resilience."*

The NFMCP seeks to achieve this goal through four Strategic Forest Management and Conservation Objectives (SOs):

- SO1: Reverse forest degradation, deforestation and the loss of forest biodiversity, through conservation and sustainable forest management, as well as strengthening the legislative, policy and institutional framework of the sector.
- SO2: Enhance economic, social and environmental benefits of forests through the sustainable utilization of forest resources.
- SO3: Build the capacity within the Forestry Department, its partners and forest communities to manage, protect and conserve the forest resources.
- SO4: Increase public education and awareness to protect, conserve, restore and manage Jamaica's forests.

The NFMCP will be implemented in two phases. The first five years of implementation represent the first phase after which there will be a mid-term evaluation.

In 1990 with the support of the United Nations Development Programme (UNDP) the first

National Forest Action (NFAP) was developed. Since, the development of the first NFAP, the Forest Division underwent further evolution; and in 1996 with the passage of the Forest Act, the Forestry Department (FD) was created with an emphasis on reforestation, conservation, and greater community participation. By 2001 the FD guided by the 1996 legislation prepared the National Forest Management and Conservation Plan (NFMCP) 2001-2010. As the agency grew there was increasing focus on its institutional strengthening and by 2004 the Cabinet Office took a decision to transform the FD into an Executive Agency. This was accomplished on May 1, 2010.

The country's forests and forest resources contribute to food production, timber, provision of fuel wood and other forest resources, livelihoods, biodiversity and ecosystems services and there is no doubt about the contribution that well managed forests can make to climate change adaptation and mitigation.

3.3.5.1. The Forest Policy for Jamaica

The revised Forest policy for Jamaica, 2017 is aligned with national sustainable development goals of Vision 2030 Jamaica. It also builds on the Strategic Forest Management Plan (SMFP) 2010-2015, which was developed as a framework for increasing the Agency's capacity to manage state-owned forests by "*increasing the participation of the private sector, community-*

based organizations, and Non-Governmental Organizations (NGOs) in the sustainable management and conservation of Jamaica's forests".

3.3.5.2. Sustainable Development Goals and Forests

Forests cover 31 per cent of the world's land area and provide a very wide range of products and ecosystem services including water management and the prevention of soil erosion and landslides. Forests are also regarded as important habitats for biodiversity and the protection and conservation of forests in Jamaica are of significant importance in protecting the country's unique biodiversity. Additionally, forests deliver social, environmental, and economic benefits and are essential for building climate resilience as forests store more carbon than the atmosphere and have the potential to absorb about a tenth of the global carbon emissions projected for the first half of this century.

3.3.5.3. Guiding Principles

The long-term vision of the Forestry Department sees Jamaica once again as *"the land of wood and water"*. Forests and their biodiversity are restored and Jamaica is capable of meeting the social, economic and ecological needs of its people. Sustainable forest management and climate resilience are woven throughout the institutions and daily habits of Jamaicans.

The strategic forest management and conservation objectives will be achieved by implementing different actions over a period of times. Given the complex and cross-cutting nature of managing forests sustainably, involving many stakeholders and interested parties, the Forestry Department has articulated several guiding principles by which the Plan will be implemented to achieve the long-term goal. These are based on guiding principles detailed in the 2001 NFMCP, the input of stakeholders as well as the principles from the UN Forest Instrument.

Enhancing partnerships and encouraging authentic dialogue and participation among all stakeholders

Private landowners, forest communities, NGOs, and government agencies will be engaged in a united vision on the sustainable management of forests.

Combating climate change- The impact of climate change on forests and sustainable forest management and the contribution of forests to climate change adaption and mitigation will be recognized.

Implementing sustainable forest management- Due consideration will be given to emerging thinking on landscape restoration.

Innovating forest finance- Financing mechanisms for the management and conservation off the forest sector are to be diversified and methods are to be introduced to incentivize contributing activities.

Increasing public education and awareness- Abiding by its mantra, "*It is the responsibility of each able-bodied Jamaican to join in this national effort to recapture the fast disappearing beauty of our country…..*", the Forestry Department will undertake a vigorous and sustained effort to educate the various publics.

Enhancing the decision-making capability – Investments will be made in developing staff capability and in expanding and supporting forest research.

Ensuring alignment to Vision 2030 Jamaica – the National Development Plan. The NFMCP will be fully aligned to Jamaica's national planning efforts.

Embracing relevant National and Sectoral Policies- Pertinent policies and guidelines will be considered such as the Protected Areas System Master Plan (PASMP), the National Biological Diversity Strategic Action Plan (NBSAP) and others.

Meeting international obligations and commitments- The Forest Sector will support the country's commitment to various multilateral agreements.

3.4. International Policy

3.4.1. Agenda 21

In June 1992, Jamaica participated in the United Nations Conference for Environment and Development (UNCED) in Rio de Janeiro, Brazil. One of the main outputs of the conference was a plan of global action, titled Agenda 21, which is a —comprehensive blueprint for the global actions to affect the transition to sustainable development|| (Maurice Strong). Jamaica is a signatory to this Convention. Twenty-seven (27) environmental principles were outlined in the Agenda 21 document. Those most relevant to this project, which Jamaica is obligated to follow are outlined below:

- Principle 1: Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.
- Principle 2: States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies.
- Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.
- Principle 8: To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.
- Principle 10: Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes.
- Principle 15: In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

- Principle 16: National authorities should endeavour to promote the internationalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.
- Principle 17: Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

3.4.2. Convention on Biological Diversity (Rio de Janeiro, 1992)

Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live.

Jamaica signed to the convention on June 11, 1992 and ratified it on January 6, 1995. Under this treaty, Jamaica is ranked fifth among islands of the world in terms of endemic plants. The country also enjoys a high level of endemism for animal species, as these examples illustrate: 98.2% of the 514 indigenous species of land snails and 100% of the 22 indigenous species of amphibians are endemic to Jamaica. Nearly 30.1% of this mountainous country is covered with forests. Jamaica‘s highest point, the Blue Mountain Peak, reaches a maximum height of 2,256m. There are 10 hydrological basins containing over 100 streams and rivers, in addition to several subterranean waterways, ponds, springs, and blue holes. The country‘s rich marine species diversity include species of fish, sea anemones, black and stony corals, mollusks, turtles, whales, dolphin, and manatee.

The activities undertaken by Jamaica derive from seven goals, which are:

- to conserve Jamaica‘s biodiversity;

- to promote sustainable use of biological resources;
- to facilitate access to biological resources (to promote biotechnology and ensure benefit sharing);
- to ensure safe transfer, handling and use of Living Modified Organisms (LMOs);
- to enhance resource management capacity;
- to promote public awareness, education, and public empowerment; and
- to promote regional and international cooperation and collaboration

The action plan comprises specific projects that have been elaborated with regards to these goals. Those most relevant aspects of this convention to this project, which Jamaica is obligated to follow are outlined below:

- Article 6. General Measures for Conservation and Sustainable Use
- Article 7. Identification and Monitoring
- Article 8. In-situ Conservation
- Article 9. Ex-situ Conservation
- Article 10. Sustainable Use of Components of Biological Diversity
- Article 13. Public Education and Awareness
- Article 14. Impact Assessment and Minimizing Adverse Impacts

3.4.3. United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on May 9, 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it. The UNFCCC objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Jamaica ratified the Paris Agreement in 2017.

3.4.4. Montreal Protocol

The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production and consumption of a number of substances that are believed to be responsible for the depletion of the ozone layer. The treaty was opened for signature in September 1987 and entered into force on January 1, 1989. Initially, the protocol was signed by 27 countries when it opened in September 1987, and subsequently ratified by 100 countries. Jamaica ratified the treaty at the 1993 Vienna Convention. As of September 16, 2009, all countries in the United Nations have ratified the original Montreal Protocol.

3.4.5. Kyoto Protocol, 2005

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gas emissions, based on the fact that:

(a) Global warming exists;
(b) Human-made CO_2 emissions have caused it.

The Kyoto Protocol was adopted in Kyoto, Japan on December 11, 1997 and entered into force on February 16, 2005. There are currently 192 parties to the Protocol. Jamaica ratified the treaty on June 28, 1999.

3.4.6. Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region), 1983

The Convention for the Protection and Development of the Marine Environment in the wider Caribbean Region or Cartagena Convention is a regional legal agreement for the protection of the Caribbean Sea.

The Convention was adopted in Cartagena, Colombia on March 24, 1983 and entered into force on October 11, 1986.

The Convention is supported by three technical agreements or Protocols on Oil Spills, Specially Protected Areas and Wildlife and Land Based Sources of Marine Pollution:

1. *The Protocol Concerning Co-Operation on Combating Oil Spills in the Wider Caribbean Region* , which was adopted and entered into force at the same time as the Cartagena Convention;
2. *The Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region* was adopted in two stages, in January 1990 and the Protocol entered into force on June 18, 2000;
3. *The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region* was adopted on October 6, 1999 and entered into force on August 13, 2010.

3.4.7. Accord de Paris (The Paris Agreement)

3.4.7.1. Paris Agreement: essential elements

The Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

3.4.7.2. Nationally Determined Contributions

The Paris Agreement requires all Parties to put forward their best efforts through nationally determined contributions (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

In 2018, Parties will take stock of the collective efforts in relation to progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs.

There will also be a global stock-take every 5 years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

3.4.7.3. Status of Ratification

The Paris Agreement entered into force on 4 November 2016, thirty days after the date on which at least 55 Parties to the Convention accounting in total for at least an estimated 55 % of the total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession with the Depositary.

4.0. Project Description

Bauxite is the principal ore of aluminum and in Jamaica these bauxite deposits occur as pockets or blanket deposits on the karst surface of the Tertiary White Limestone Group. The Bayer Process for the alumina process for the extraction of alumina from bauxite, installed at the Ewarton refinery from 1956, converts or refines the bauxite to alumina. Prior to and con-current with that production process is the prospecting for, qualitatively identifying, quantifying, stripping, mining, transporting the mined bauxite followed by reclaiming and restoring the mined-out bauxite pits.

A map showing the boundaries of SEPL 524 for which an application has been made to the Natural Resources Conservation Authority (NRCA) in order to obtain an Environmental Permit is shown in Figure 4-1 below. The areas with potential exploitable bauxite reserves are highlighted in orange. These orange areas constitute about 8% of the surface area of SEPL 524. These areas will account for all potential activities within SEPL 524 during the project lifetime. The remaining 92% will remain untouched. SEPL 524 is adjacent to the existing mining area of SML 162 which has been in mining operations for the last 5 decades. All activities of SML 162 will be transferred to SEPL 524.

The first phase of any mining operation involves reconnaissance and exploration and once that phase proves successful, followed by mine planning, development and mining. These activities have already been completed for this project. The general description of the project is a modification of approximately 467 hectares of land within the 6,839.9 hectares of SEPL 524 area over a period of 25 years. The process of extracting the mineral over the twenty five years of the project is a continuous repetition of the activities described below as the bauxite is extracted from new orebodies over the lifetime of the project. The project is incorporating existing infrastructure including the existing Run of Mine (ROM), haul roads which will take extracted bauxite from SEPL 524 to the existing bauxite processing plant.

The main activity and the most visible is bauxite which has been mined in SEPL 524 being transported to be stored at Windalco's Run of Mine (ROM) Stockpile from which it is transported in keeping with planned blend sequence. Once mining within an orebody in

SEPL 524 has been completed, or as soon as may be practicable, the pit will be reshaped, graded and the 18” to 24” topsoil previously removed and stored will be replaced in order to restore it to a productive level of use in accordance with the regulations of the Mining Act.

The mining operations is described under the following headings and is illustrated in the process flow sheet shown in Figure 4-2 below:

- Exploration
- Planning & Development/Stripping
- Stripping
- Mining & Hauling
- Reclamation & Restoration
- Environmental Protection

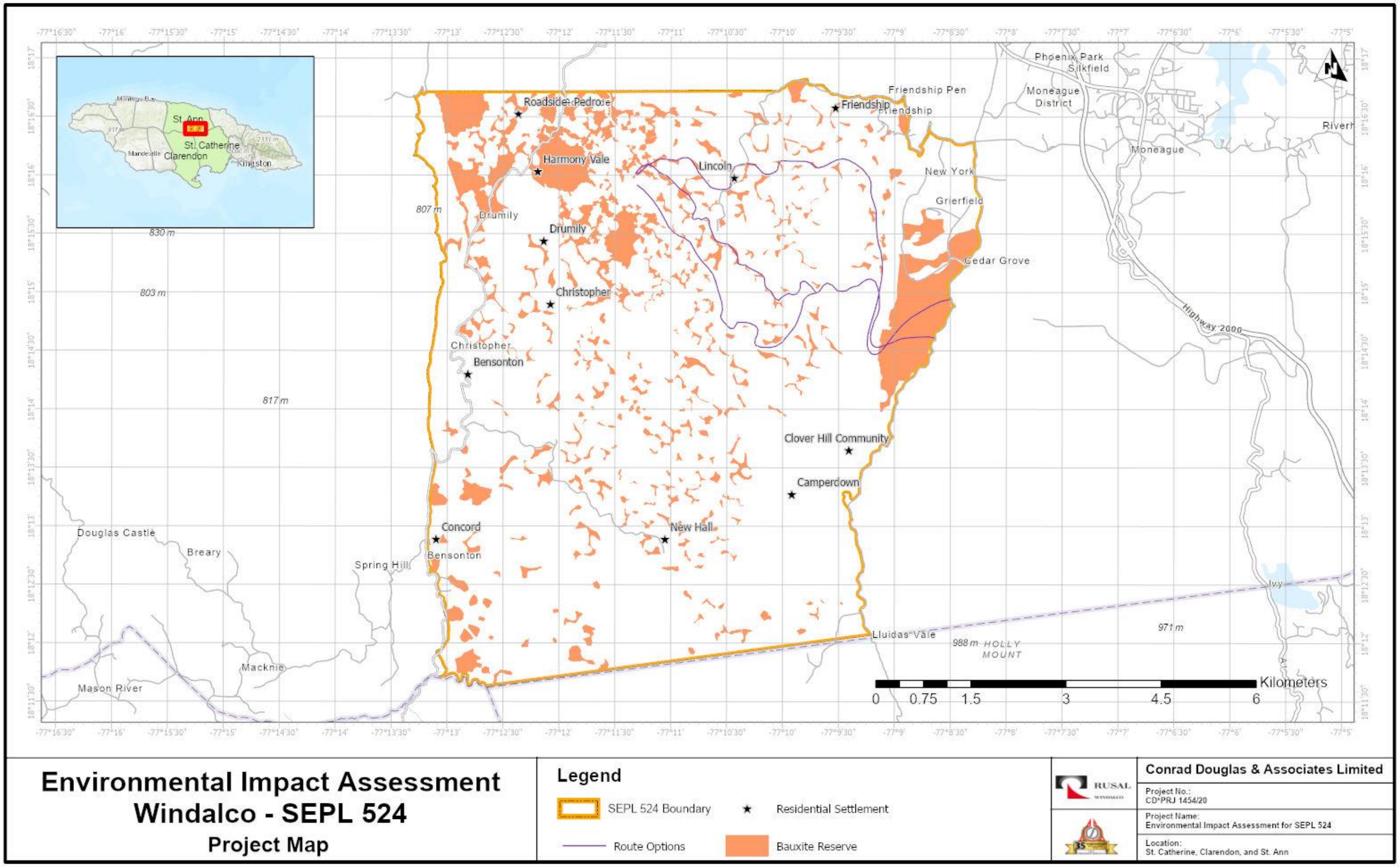


Figure 4-1: Project Map

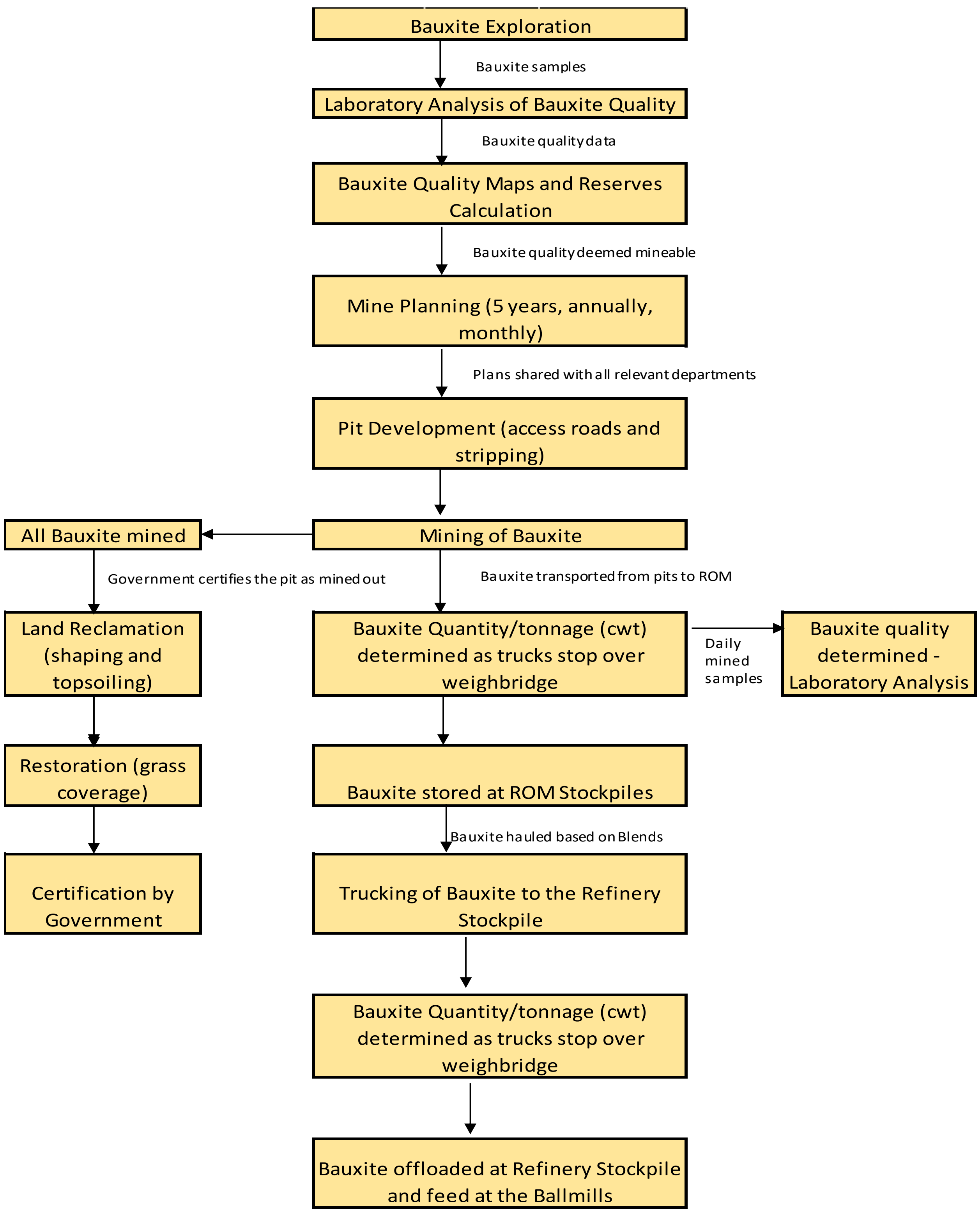


Figure 4-2: Process Flow Sheet for Windalco's Mining Operations

4.1. Exploration

The earliest stages of exploration are usually described as reconnaissance and involves the delineation of areas of geological interest and economic potential. Through the reconnaissance it is established where reasonable prospects exist for locating bauxite ore. Published topographic maps, aerial photographs and previous reports or other records are relied on for guidance at this stage.

Positive identification of bauxite through reconnaissance in a particular area forms the basis for the next step of exploration. The objective of exploration is to determine quantitatively and qualitatively the nature of the ore, followed by assessing and evaluating the whether it is economically feasible to mine it.

Prospecting or exploration for Ewarton Mines is facilitated through a Special Exclusive Prospecting License (SEPL) 524 issued by the Government of Jamaica. The geospatial boundary of which is illustrated in Figure 4-1 above.

Exploration aims to provide reliable information for decision on whether to acquire properties followed by proceeding to mine planning, mining and rehabilitation activities. Exploration also incorporates other activities such as mapping, drilling, chemical and physical tests and quantity calculations.

Topographic maps are usually used as base maps with the valleys demarcated from the hillocks. Bauxite deposits are usually located within the valleys. A grid is established within the demarcated area with spacing of 50 feet. This grid is used as the drilling layout. The variability of the Jamaican Bauxite discourages any widening of the drilling grid.

Drilling samples are recovered by rotary augers on a mechanized drill rig with samples taken every 15 feet depth interval. These samples are analyzed for their chemical and mineralogical composition. The analyses include the following parameters: Total Alumina, Gibbsite, Boehmite, Silica, Phosphorus, Zinc, Iron, Goethite, Titanium, Chromium, and Manganese. This information is called the chemical and mineralogical (gibbsite and boehmite) assay for the bauxite sample. The drilling data and chemical assay are then used for tonnage calculations and updating of the reserves database.

The exploration phase has been completed and this EIA is concerned with the following phases.

4.2. Planning and Development/Stripping

The drilling information and reserves database are used to generate yearly, monthly and daily mine plans which guide the operations of the mines. This enables Windalco to meet the quality and volume requirements of the refinery. The planning phase also facilitates the design and extension of the haul road networks.

Before mining commences the surface of the bauxite deposit is cleared of the existing vegetation (mainly grass in the depressions) using heavy equipment within the footprint of the orebody. Between 6-18 inches of top soil is removed by tractor-dozer and scraper-hauler and stored in proximity to the edge of the deposit. The stored top soil will be used in the rehabilitation operation on completion of mining. Areas for access roads are also cleared using the same equipment and methodology.

4.3. Mining and Hauling

The mining regulations define commercial bauxite as bauxite which contains at least 47% alumina (by the standard difference method) and not more than 4% silica on dry basis. The bauxite Windalco is able to mine is confined to the boundary limits of Special Mining Lease (SML) 162. The Special Mining Lease has a life of thirty years and authorized by the Minister of Mining. Mining will be conducted as per monthly and daily plans with as many as eleven (11) orebodies being mined per month and as many as four (4) on a daily basis. Owing to the variability of the bauxite, not only between orebodies, but within each orebody itself, mining is usually done on a block by block basis. Areas within the orebody containing the quality which has been planned, are staked out or blocked out (demarcated) in the field by the surveying team.

Table 4-1: Size of areas to be disturbed over the first three (3) years and five year increments thereafter.

Year	2022	2023	2024	TOTAL (2020-2024)	2025-2029	2030-2034	2035-2039	TOTAL
Disturbed Area (ha)	14.73	20.49	35.49	**70.71**	152.29	122.36	56.64	472.70

The maximum production capacity is 2.1M cwt/annum. The operations will be carried out on a single day shift, which operates from 7am to 6 pm, six days per week.

Mining will commence with orebody Penny 1, and move to the next orebodies within closest proximity which also have the equivalent volumes (See Figure 4-4 and Table 4-3 below).

Haul roads will be established to access the bauxite in the Penny 1 orebody. These haul roads will terminate at the ROM where dump trucks deposit the bauxite that has been extracted from the Penny 1. The size of the areas to be disturbed for road construction is shown in Table 4-3 below and Figure 4-3.

Table 4-2: Size of areas to be disturbed for road construction

Year	Length (m)	Road Construction (m^2)	Road Construction (hectares)
2023	4000	80000	8
2024	3000	60000	6
2025	2000	40000	4
2026	2000	40000	4
2027	2000	40000	4
Total (2023-2027)	**11000**	**220000**	**22**
2027-2032	10000	200000	20
2032-2037	12000	240000	24
2037-2042	12000	240000	24

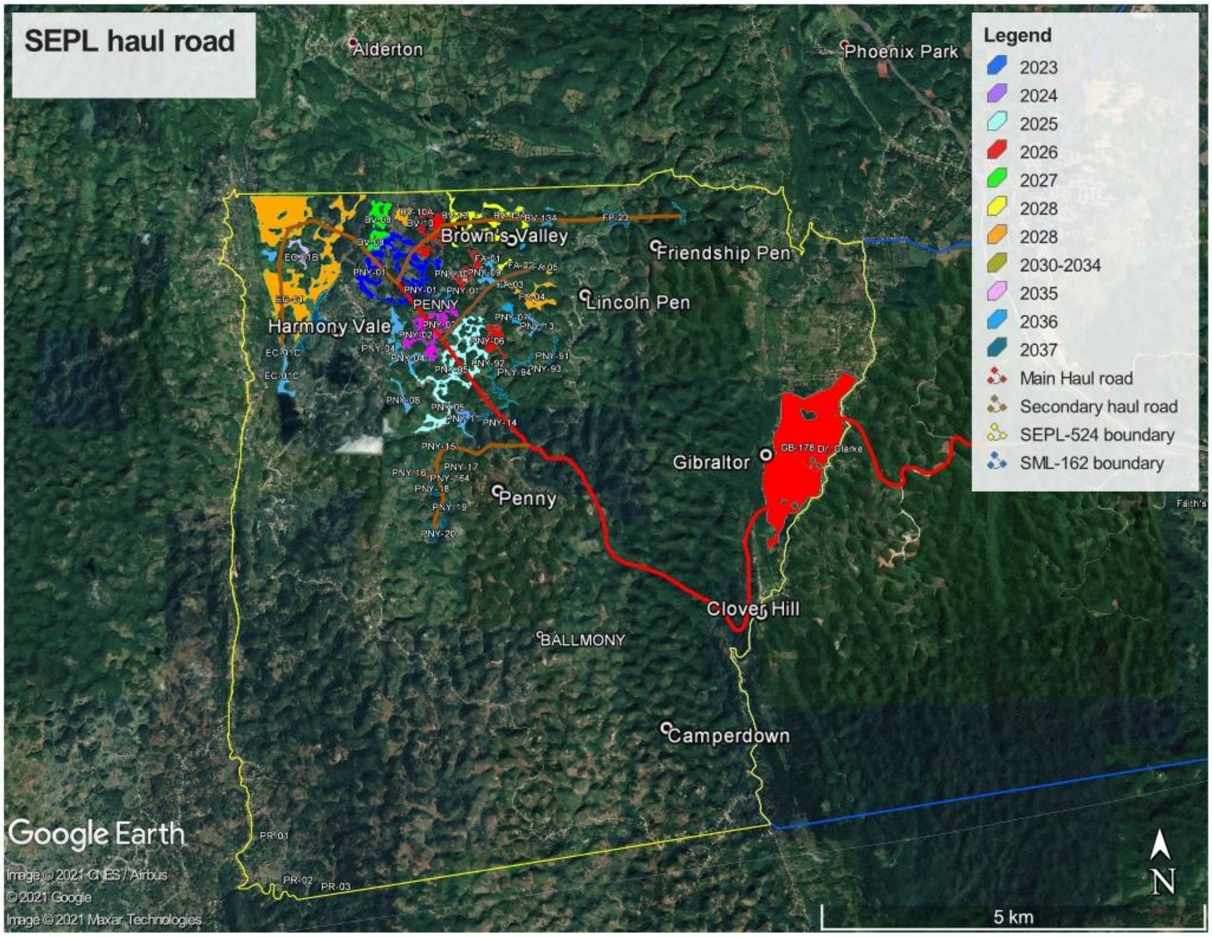


Figure 4-3: Haul Roads proposed for SEPL 525

To construct haul roads, the potential of using existing roads and pathways will be assessed. The overall aim is to develop safe reliable roads that provide the safest and shortest travel time and least potential for adverse environmental impact. The design of roads are based on engineering best practices and highway safety standards. Some of the main features are:

- These are a maximum of 11 m wide
- Maximum slopes of: Normal – 8%, Maximum – 10%
- Road surface material: Marl (>3 inch)
- General drainage features: Channel, chute and culvert drains with inlet and outlet features
- Total road length: 11 km

The specifications of haul road with limestone surfaces and two lane traffic is provided in Table 4-2 below.

Table 4-2: The Specifications of Haul Road with limestone surfaces and two lane traffic

Specification of Haul Road with limestone surfaces and two lane traffic		
A	**Maximum Speed (km/hr)**	60
B	**Length of roadway (km)**	11
C	**Width of roadway 2 lane traffic (m)**	9
D	**Width of road shoulder (m)**	
	In mountains	1
	In regular conditions	2
E	**Longitudinal Gradient %**	
	maximum	8
	in exceptional cases	10
F	**Mininum Radius of Vertical Curve (m)**	
	Convex	2500
	Concave	500
G	**Minimum radius of curve in plane (m)**	
	Recommended	300
	Design	200
	Minimum	100
H	**Road Surface Material**	Limestone

Once access to an orebody is established, excavators are transported to the orebody where they are used to mine the bauxite in benches of 15 feet. The excavated bauxite is then loaded into 25 ton capacity dump trucks and delivered to Windalco's ROM for temporary storage. The total operating capacity for hauled bauxite is estimated to be 1.8M cwt/year. Each loaded mining truck is weighed at the ROM truck scale prior to offloading so that the total tonnage mined from the orebody per day, can be determined.

The total stockpiled volume will be 150,000 cwt. The ROM stockpile is managed in such a manner that will allow trucks to safely dump the mined bauxite on well drained and leveled surfaces. Each truck from that orebody for the specific day offloads at a specific location. Each offloaded truck of bauxite is sampled to create a composite sample of the day's mining as this enables quality monitoring and future blending. After sampling, the bauxite is pushed into conical piles using a dozer. This is done in a way that allows separation between piles of bauxite mined on different days and from different orebodies.

Each stockpiled bauxite is identified and clearly labelled with the orebody name and the date on which it was mined. This identification is also attached to the sample which had been collected and sent to the Refinery Laboratory for quality determinations. What then exists for the ROM is a database of each pile, its associated identification, quality parameters and total tonnage. The variability which exists with the quality of the bauxite means that in order to meet the stringent grade requirements of the refinery, various stockpiles will have to be blended. For example, a stockpile of high boehmite bauxite will have to be combined with stockpile of low boehmite bauxite in order to get within the boehmite limit of the refinery. This blending regime forms the basis for Windalco's daily haulage plan for bauxite from the ROMs at Rio Hoe, Montgomery and Schwallenburgh to the refinery stockpile. Trucks are loaded from different stockpiles at the ROMs using either track mounted excavators or rubber wheeled loaders. These trucks are then weighted at the refinery scale and the bauxite offloaded in the blend sequence at the refinery stockpile. At this point a tractor is used to physically blend the different quality bauxites which is then stockpiled followed by the use of wheel loaders that feed the blended bauxite to the refinery's ball mills.

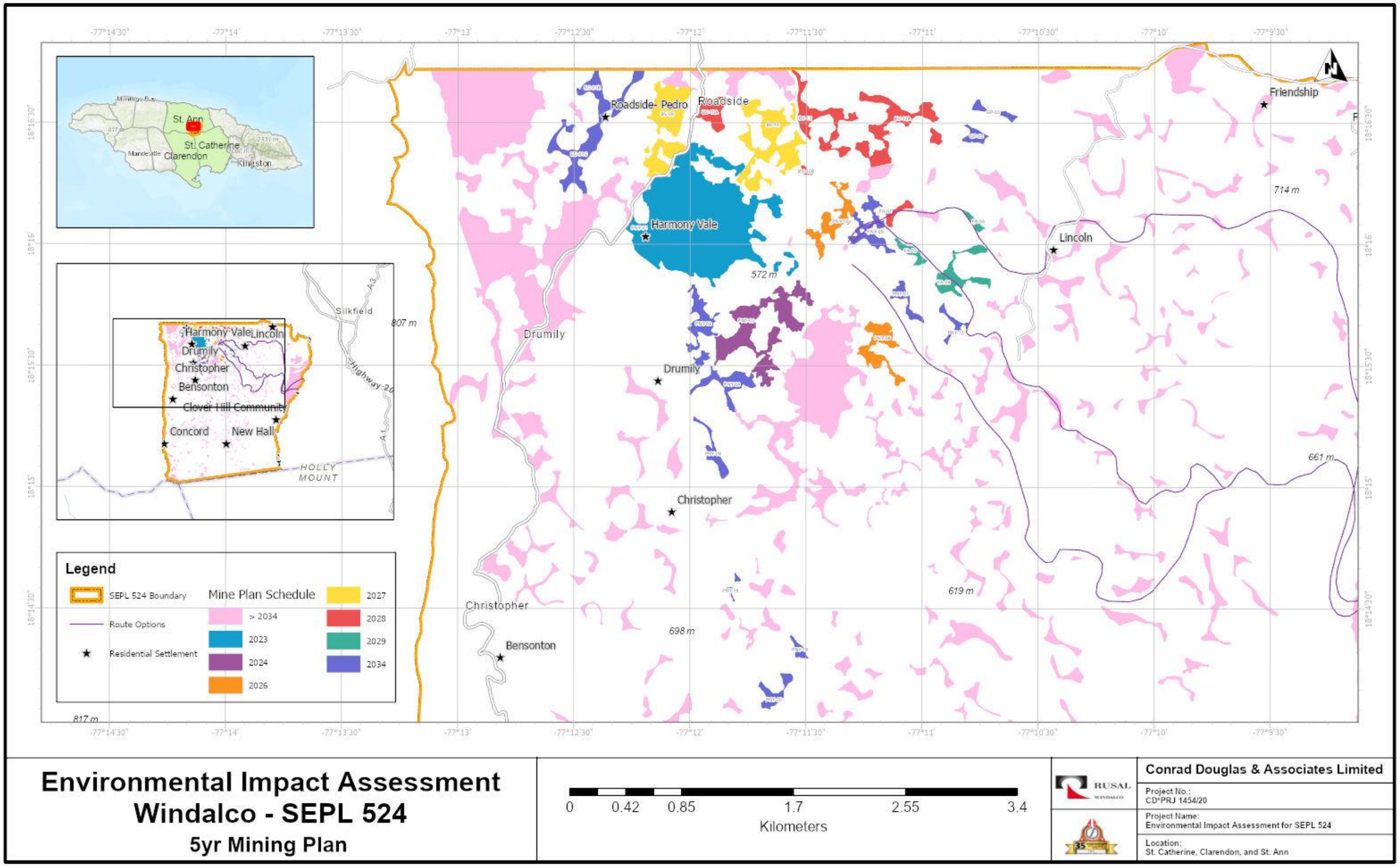


Figure 4-4: Size of areas to be disturbed (Orebodies) over the period 2023-2037 (Windalco to include haul roads to the orebodies)

Table 4-3: SEPL 524 Mining Plan (2022 – 2036)

Orebody	Total Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
PNY-01	368,200.00	147,280.00	36,820.00	184,100.00												
PNY-03	171,524.93		168,094.43	3,430.50												
PNY-05	277,535.99			167,354.20	110,181.79											
GB-178	1,009,115.61				100,911.56	100,911.56	100,911.56	100,911.56	100,911.56	100,911.56	100,911.56	100,911.56	100,911.56	90,820.40	10,091.16	
PNY-06	65,015.29				65,015.29											
PNY-10	53,050.33				53,050.33											
BV-10	143,753.90				21,563.08	122,190.81										
BV-08	129,556.47					73,847.19	55,709.28									
BV-13A	104,538.00						104,538.00									
BV-13	69,076.66						67,695.13	1,381.53								
BV-10A	39,146.97							39,146.97								
BV-10B	3,709.01							3,709.01								
FA-01	13,809.22							13,809.22								
FA-02	8,866.59							8,866.59								
FA-03	14,890.00							14,890.00								
FA-04	51,342.51							51,342.51								
FA-05	8,428.64							8,428.64								
EC-01	922,494.00							55,349.64	147,599.04	147,599.04	147,599.04	147,599.04	147,599.04	129,149.16		
EC-01B	36,964.88													9,610.87	27,354.01	
EC-01C	15,562.55														15,562.55	
EC-05	19,955.14														19,955.14	
GP-01	5,810.11														5,810.11	
GP-02	7,685.98														7,685.98	
GP-03	13,565.89														13,565.89	
PNY-02	45,491.65														45,491.65	
PNY-04	55,481.62														55,481.62	
PNY-07	23,297.62														23,297.62	
PNY-08	24,009.62														24,009.62	
PNY-09	39,471.57														39,471.57	
PNY-11	29,785.25														29,785.25	
PNY-13	16,986.82														6,454.99	10,531.83
PNY-14	9,058.41															9,058.41
PNY-15	8,434.00															8,434.00
PNY-16	4,686.37															4,686.37
PNY-17	7,331.59															7,331.59
PNY-18	192.50															192.50
PNY-19	10,091.84															10,091.84

Orebody	Total Area	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
PNY-20	26,457.27															26,457.27
PNY-88	3,648.40															3,648.40
PNY-89	7,614.55															7,614.55
PNY-90	3,556.03															3,556.03
PNY-91	17,337.54															17,337.54
PNY-93	5,720.21															5,720.21
PNY-94	7,211.18															7,211.18
PNY-164	14,933.28															14,933.28
FP-03	11,324.64															11,324.64
FP-23	22,944.83															22,944.83
HV-62	71,264.88															71,264.88
	Disturbed Area (ha)	**14.73**	**20.49**	**35.49**	**35.07**	**29.69**	**32.89**	**29.78**	**24.85**	**24.85**	**24.85**	**24.85**	**24.85**	**22.96**	**32.40**	**24.23**

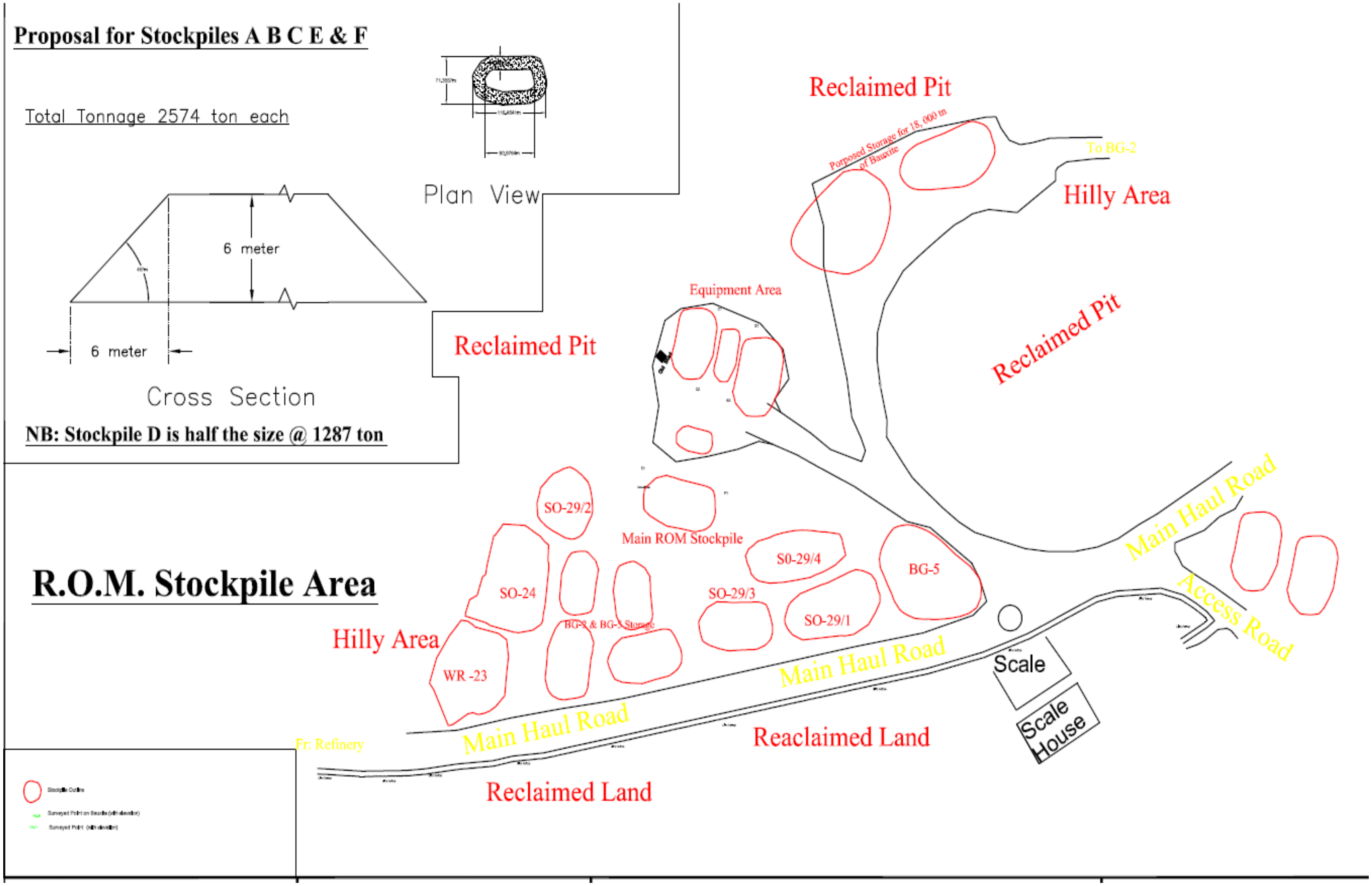


Figure 4-5: Typical Layout of R.O.M Stockpile Area

4.4. Reclamation and Restoration

On completion of mining an orebody the next steps involve:

- certification of the pits as being mined out by the GoJ
- reclamation and restoration of the mined-out pits

The terms reclamation and restoration are sometimes used interchangeably but there is greater clarity of expression when we assign different interpretations to these two terms.

- **Reclamation** includes all activities necessary to reshape and re-soil a mined area and associated non-mined marginal lands.
- **Restoration** is defined to include all activities necessary to produce a crop on the land after it has been reclaimed.
- The processes involved in reclamation and restoration are collectively called **rehabilitation.**

The Mining Act stipulates that every acre of land mined shall be restored as nearly as practicable to the level of agricultural or pastoral productivity or utilization for afforestation which existed immediately prior to mining thereof.

The routine reclamation of bauxite mined lands is achieved by the following steps:

1. Before mining, surface soil is stripped and stockpiled as mentioned under development section.
2. After mining, the mined area is reshaped and contoured to form gentle slopes. This involves the grading of fringe areas using bulldozers to create smooth rolling slopes (bowls). Where adequate material cannot be generated from the perimeter of the pit to achieve the necessary slopes and configuration, material is burrowed and trucked to the pit. A mix of rock rejects and bauxite is sometimes used as fill material. The final reshaped area will be greater than the area of the original pit; this excess area is referred to as the '*swell area*'.

3. After the mined pit is reshaped, the stockpiled soil, which was kept in storage, is spread over the reshaped surface to a minimum depth of 8 inches evenly over the entire area. Once re-soiling has been completed the larger stones left on the surface are manually removed and the land ploughed. Poultry manure is spread manually and grass is planted in some areas
4. Reclamation is done mainly with bulldozers, while spreading topsoil is by scrapers.

Routine restoration of the reclaimed land is handled by the Agriculture department and is achieved almost entirely by planting the reclaimed area with crops, fruits trees, pangola grass (*Digitaria decumbens*) or guinea grass (*Panicum maximum*). Occasionally, Caribbean pines (*Pinus caribaea*) or in some instances the area is shaped for relocation housing development. Once grass cover is deemed adequate, a request for approval is forwarded to the Ministry of Mining who then sends its officers to examine and certify the orebody as being satisfactorily restored.

4.5. Personnel Requirements

The operations are controlled by a Mine Manager who has overall responsibility and is supported by a team of engineers, technicians, equipment operators and artisans.

Environmental quality is managed and monitored by an Environmental Department.

4.6. Vehicle Maintenance

Vehicle maintenance for existing mining areas are carried out outside of the SEPL 524 at Schwallenburgh. This will continue to be the maintenance area for the proposed operations in SEPL 524. The facilities established for the mining in SML 162 will continue to be utilised for the operation in SEPL 162.

4.7. Traffic Management

Windalco will implement its Traffic Management Plan for this proposed project. Windalco has been managing the movement of bauxite by haul roads for the last 5 decades. The expertise, experience and resources required for proper traffic management for safety of the public and employees is integrated into the organization.

A few of the important initiatives in the Traffic Management Plan are :

1. Signs are installed at critical nodes.
2. In addition, safety wardens are posted to direct traffic at major intersections with public roads.
3. The distance between each truck load is variable

4.8. Fuel Supply

The existing fuel supply mechanism at Schwallenburgh will be used to support operations in SEPL 524.

There are two fueling regimes. The majority is for fueling of trucks that transport bauxite and the fueling of service trucks that supply fuel to heavy equipment in the mining area.

In most instances, the fueling of bauxite transport trucks and the service trucks are done on hard surfaces at the established contractors stations. As necessary, the transfer of fuel from the service trucks to the heavy equipment occurs at designated locations within the mining area. Service trucks as well as heavy equipment will be equipped with spill kits and spill containment apparatus.

Fuel tanks will be maintained by Windalco or contractor. Oil changes from standby generators will be pumped into special bunded containers and returned to the refinery for disposal.

4.9. Utility Requirements

4.9.1. Electricity Demand

There is no requirement for electricity within the mining areas.

4.9.2. Water Demand

Water at Schwallenburgh Mines takes the form of:

- a catchment tank and
- abstraction from wells.

Water is required for:

- dust suppression,
- sanitation for portable toilets,
- hand washing stations, and
- potable water.

4.10. Solid Waste Management

There are no established waste disposal site within the SEPL 524. Tyres will be disposed of at the Haddon Waste Disposal Landfill Site.

4.11. Sewage Waste Management

During mining operations portable toilets will be placed in the field. These will be serviced by a certified operator who will remove them periodically and dispose of them at an approved site and replace them with conditioned portable toilets.

4.12. Fugitive Dust Management

Dust monitoring stations will be established in proximity to the mining areas. Dust suppression will be carried out using water for irrigation. The frequency of the wetting of surfaces will vary depending on weather conditions. A log of dust suppression measures will be maintained and made available for inspection by NEPA.

4.13. Plan for Drainage

4.13.1. Orebodies

The aim of the drainage system and its management is to ensure that all stormwater run-off is contained within the orebodies. As far as practicable, the natural drainage regime will be incorporated. The first action is to create a channel that transports stormwater run-off towards the design sump.

4.13.2. Haul Roads and Communities

Haul roads are designed to channel stormwater run-off into orebodies into the design sumps. Thereby reducing the length of time that the stormwater remains on the haul roads. This also ensures that no significant quantity of run-off will exit a mining area.

In general, rain run-off water will be controlled to avoid flooding of roadways or communities. The general area will typically drain to sinkholes/natural depressions. This regime will be undisturbed by the mining process. Since all run-off will be contained within an orebody, the drainage of an orebody will not affect a road or community drainage. Therefore sinkholes/depressions will not be affected by what occurs in an orebody.

4.13.3. Design Criteria

4.13.3.1. Storm Water Management System

The design criteria governing the storm water management system is such that storm water from the surrounding terrain and surface run off from the project area must limit post-development peak flows for a 100 year storm return event from exceeding the pre-development peak flows. Where this cannot be achieved downstream infrastructure must be protected against damage and erosion resulting from excess flows.

There are no significant structures immediately downstream that could be affected by the installation of the haul road and as such no mitigation measures are considered.

4.13.3.2. Culvert Sizing

The design criteria used for culvert sizing is twofold as it considers minor and major structures.

Minor structures shall be designed to convey 1:10 year storm events without surcharging and to convey 1:100 year storm events with the headwater not exceeding 1.0m above the top of the culvert.

Major structures shall be designed to convey 1:100 year storm events with a 1.0m freeboard.

4.14. Security Plan

Security will be done by Windalco's Resource Protection Department. The following are critical components:

- Industrial Health Centres are located at Schwallenburgh Mining Offices and Ewarton Plant.
- Two (2) ambulances one (1) fire truck are the available emergency equipment.
- No security fencing will be established for the mining areas. Access routes will be along constructed mining roads.
- Routes to the Ewarton Works alumina plant will be along existing haulage roads or alternatively using public roads via Claremont, Moneague, Faiths Pen, Mount Rosser and Ewarton.

4.15. Safety, Health and Environmental Protection

The Mining Act details specific safety and health regulations which govern the operations of the Mines. Such regulations are extensive and covers the protection of personnel, operation of equipment and the preservation of the environment. The stance of the Mines includes but is not limited to the following:

a. Operate the mines in such a way that the surrounding community and the environment are protected from fugitive dust and noise pollution.
b. Set operating parameters to control or eliminate dust generation.
c. Installation of monitoring environmental equipment to ensure that emissions are in accordance to internal and regulatory standards.

4.16. Environmental Monitoring

Environmental monitoring is an integral part of Windalco's operations. At a minimum, a log will be maintained of the following:

- dust suppression measures
- air quality measurements
- noise abatement measures
- noise measurements
- sensitive species of plant relocated and reintroduced

- water quality data
- spill events
- complaints

5.0. Description of the Environment

5.1. Physical Environment

5.1.1. Geology

SEPL 524, located within the Dry Harbour Mountain Hydrologic Basin, White River Sub-basin, has the St. Ann-St. Catherine Parish Boundary as its southern boundary and is underlain by limestone members of the White Limestone Group. Bauxite deposits across the island occur atop the White Limestone Members as a blanket deposit with interfingering into fissures, fractures and solution hollows in the limestone.

The following members of the White Limestone Group outcrops within the boundary of SEPL254. In chronological order they are-

- Troy-Claremont Limestone Formation
- Somerset Limestone Formation; and
- Walderston-Browns Town Limestone Formation.

SEPL 524 is primarily underlain by the Troy-Claremont and the Walderston-Browns Town Limestone Formations. The Troy-Claremont Limestone outcrops to the south and southeast of the area while the Walderston-Browns Town Limestone Formation outcrops to the north and western sections of the area. Figure 5-1 below.

Outside the boundary of the SEPL 524 within a 5-kilometer radius zone of influence the geology and the rock formations are more diverse in the southwest corner which extends into the Rio Minho Hydrologic Basin (Clarendon). These rocks that outcrop in this southwest corner of the zone of influence form a part of the Central Inlier that extends east-west across the center of the island. An inlier is an outcrop of older rocks surrounded by younger rocks. The rock formations that outcrop in this corner of thezone of influence include

- Albert Town Member-Chapelton Formation
- Guys Hill Member-Chapelton Formation
- Settin Member
- Summerfield Formation

- Slippery Rock Formation
- Bullhead Formation
- Arthurs Seat Formation

These rocks are all older in age than the members of the White Limestone Group and are of a different origin and depositional environment. No bauxite deposits are associated with these rock formations.

5.1.1.1. <u>Faulting</u>

The area within and outside the SEPL 524 is highly fractured and faulted an indication of the past tectonic activity and influence of water (solution effects). The fractures and faults trend in various directions particularly North-West, North West-South East, North East-South West and East-West. This faulting has increased the permeability of the limestone members and the infiltration rate of recharge. The members of the White Limestone Group have all undergone karstification with increased permeability and other characteristics of karst limestone terrain.

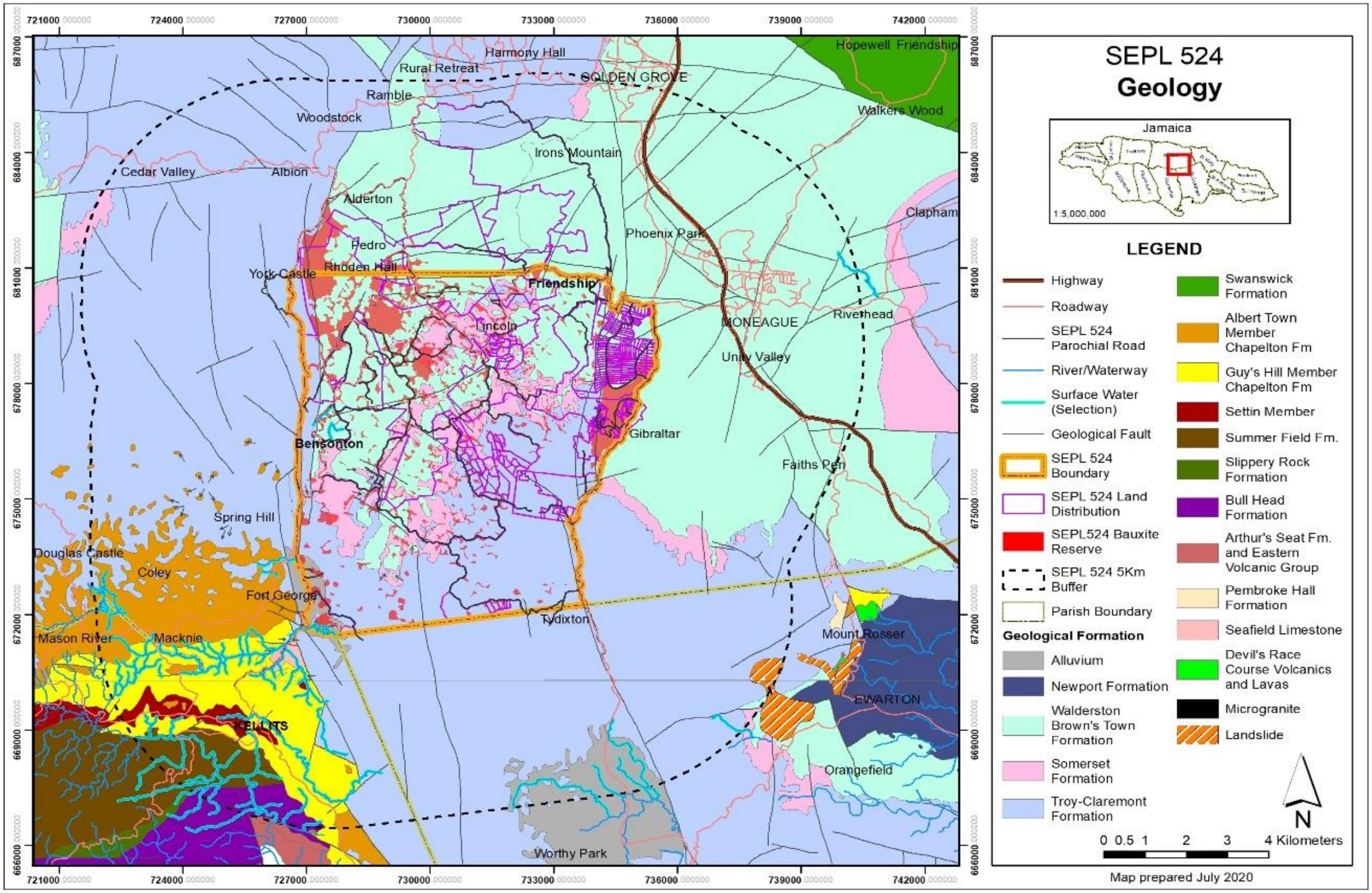


Figure 5-1: Geology of SEPL524 and 5km radius zone of influence

5.1.1.2. Caves

There are several caves located within the area of SEPL 524 as shown on Figure 5-2 below. The greater number of caves are located outside the proposed mining area and within the 5km radius zone of influence. There are eleven (11) caves listed by the Water Resources Authority (WRA) as being within the SEPL 524 area.

Caves may be pathways to the groundwater table and within the mining area there should be identification of these caves and action taken to prevent any surface runoff entering the caves and possibly getting to the groundwater table.

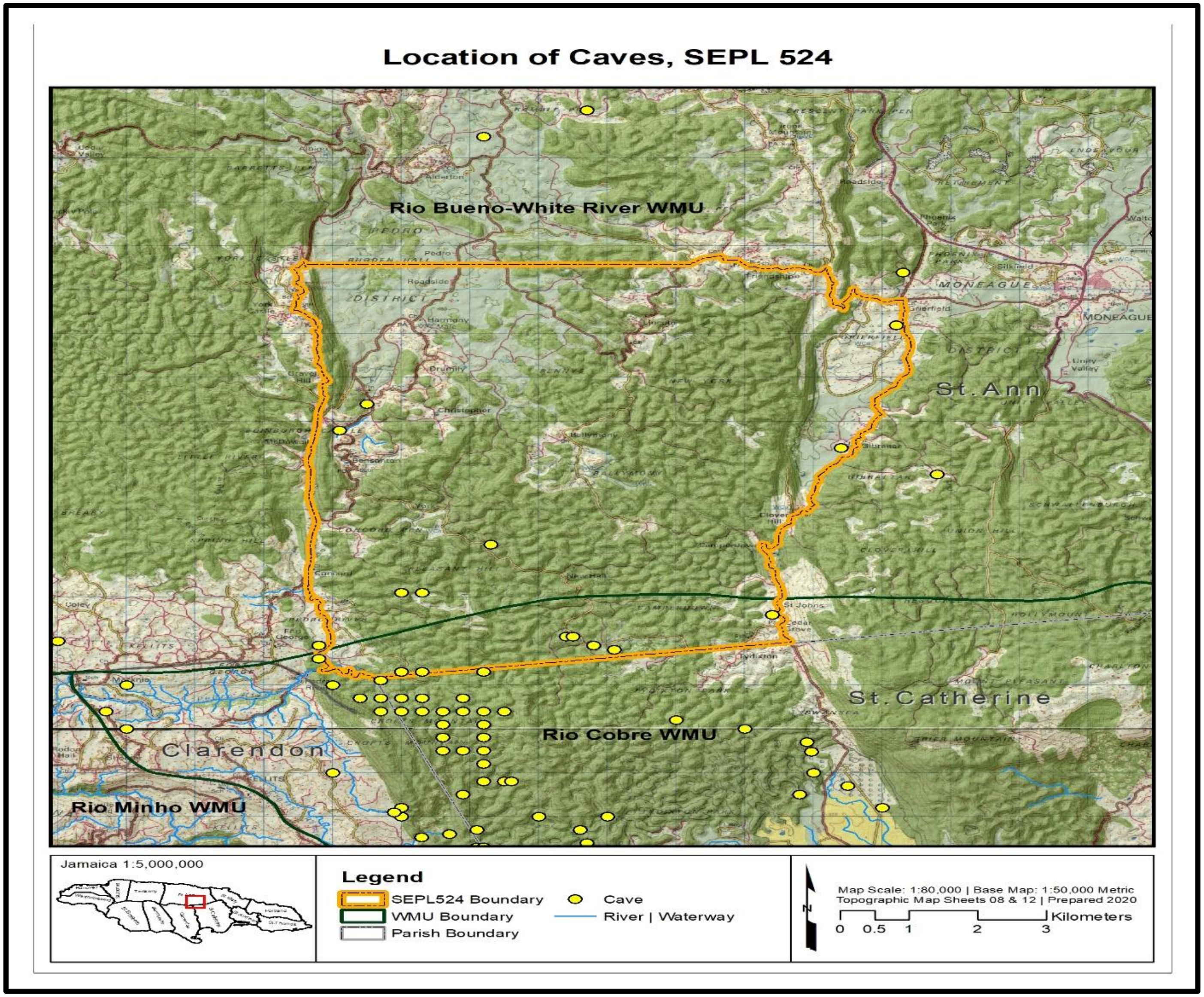


Figure 5-2: Caves located within the Area of SEPL 524 and the 5km radius zone of influence

5.1.2. Geomorphology

The formation of sinkholes, caves and other solution features are typical of limestone which have undergone karstification. The evolution of features within the SEPL 524 area is no different than that of the immediate surrounding limestone terrain.

Multiple theories have been proposed on the formation of bauxite deposits within limestone formations. For example, by Hill, 1898 and Sawkins, 1866, as reported by Robinson, Edward (n.d.). The consensus from these studies is that limestone has undergone erosion and dissolution through weathering overtime, leaving the bauxite residuum within the inverted cones.

Table 5-1 represents potential sinkholes that have been identified based on depressions obtained from geospatial information provided by the WRA. Figure 5-3 below shows a potential sinkhole that was identified in SEPL 524 in the southern section of the SEPL area. Known caves identified by the WRA caves database in SEPL 524 and within the adjoining SML 162 are shown in Table 5-1 and Figure 5-3. The potential sinkholes seen in SEPL 524 are massive openings in the ground, which form cliffs at the edges. The opening in the sinkholes identified in Figure 5-3 below are over 20 meters across.

Figure 5-3: Sinkhole identified in SEPL 524

Table 5-1: Known caves identified within the boundaries of SEPL 524

Name	Parish	Area of Proximity	Source
Alice's Field Hole	St Ann	Pedro River	WRA
Berry's Sinkhole	St. Ann	New Hall Area	WRA
Gibraltar Sink	St Ann	Gibraltar Area	WRA
Grierfield Cave	St. Ann	Grierfield Area	WRA
Hutchinson's Hole	St Ann	Edinburgh Castle Area	WRA
Ken Connell Hole	St Ann	Edinburgh Castle Area	WRA
Mount Noll Hole	St Ann	Concord Area	WRA
New Hall Hole 2	St Ann	New Hall Area	WRA
New Hall Hole 3	St Ann	New Hall Area	WRA
New Hall Hole 4	St Ann	New Hall Area	WRA
Pedro Cave	St Ann	Pedro River	WRA
Penitentiary 3	St Ann	Concord Area	WRA
Shop Sink	St. Ann	Pedro River	WRA
St. John's Sink	St. Ann	St. Johns	WRA

It is important to note that the caves are protected by the heavy vegetation (See Figure 5-4) of the hillocks in which they are formed. The vegetation and the caves' elevations on the hillocks form natural barriers that make the caves, in general, extremely difficult to access or disturb.

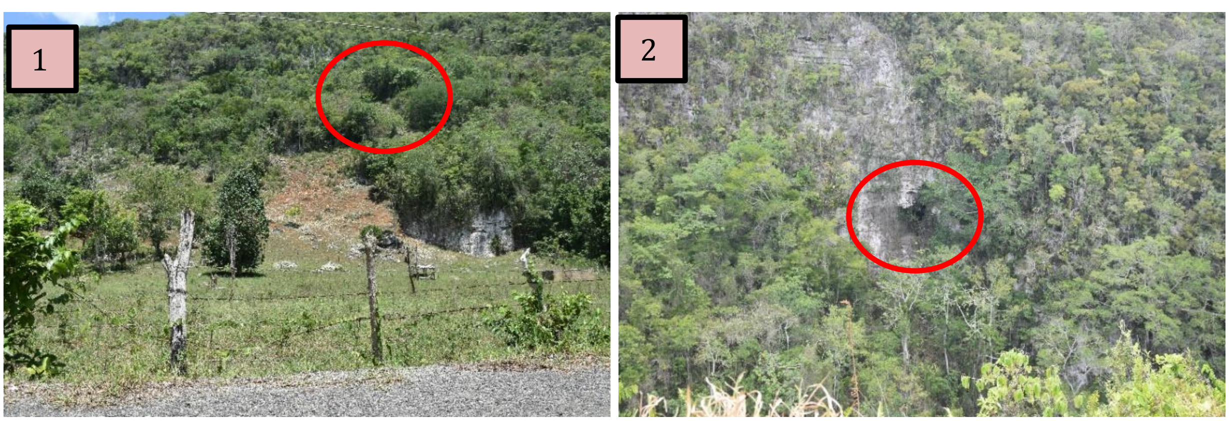


Figure 5-4: Location of Grierfield Cave | 1: Showing location within hillocks and 2: Showing a cave in the cliff face.

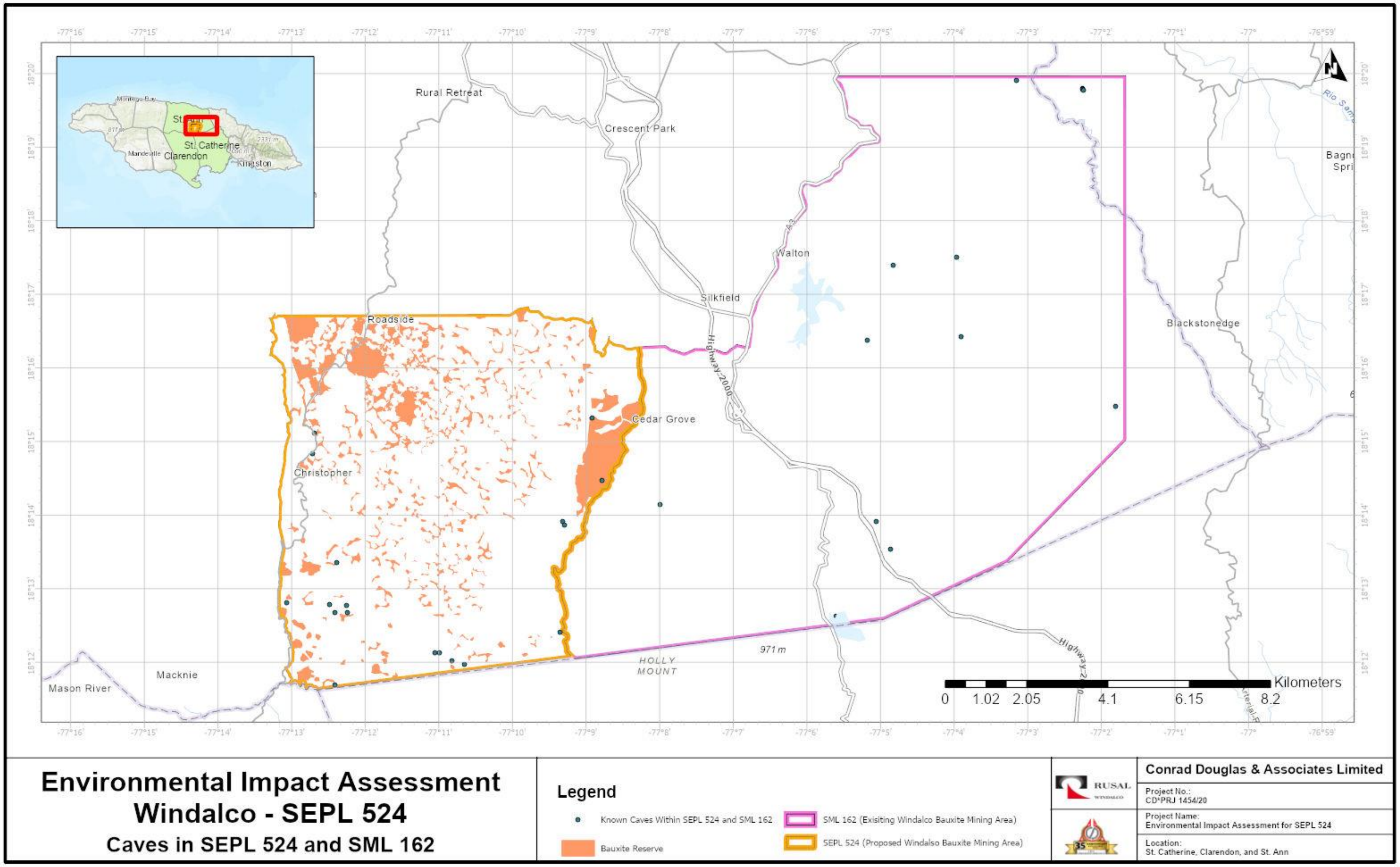
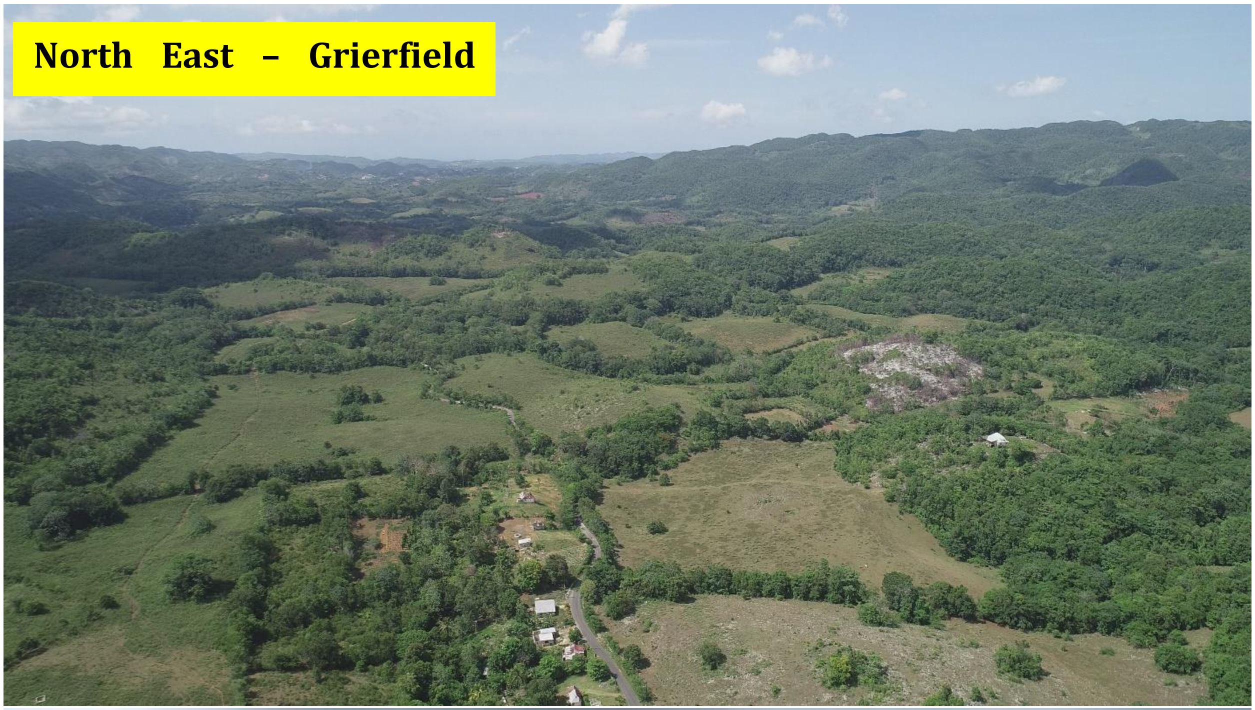


Figure 5-5: Known Caves Located in SEPL 524 and within the Adjacent of SML 162

5.1.3. Topography

The topographical features of the SEPL 524 area comprises gentle rolling knolls, hillocks and valleys and are generally characteristic of limestone that has undergone karstification. Approximately 85% of the surface coverage of the island of Jamaica consists of limestone.

This type of karstic topography is common in Jamaica. The first and most extensive studies were carried out on Cockpit Formations in Lluidas Vale, St. Catherine, where there are classic examples. The classic cockpit formations are shown in the images of the general topography of the area shown in the collage below. The 1:50,000 topography map of the area is shown in Figure 5-7. The height range of these hillocks and depressions ranges from 382 to 735 meters above mean sea level (amsl).

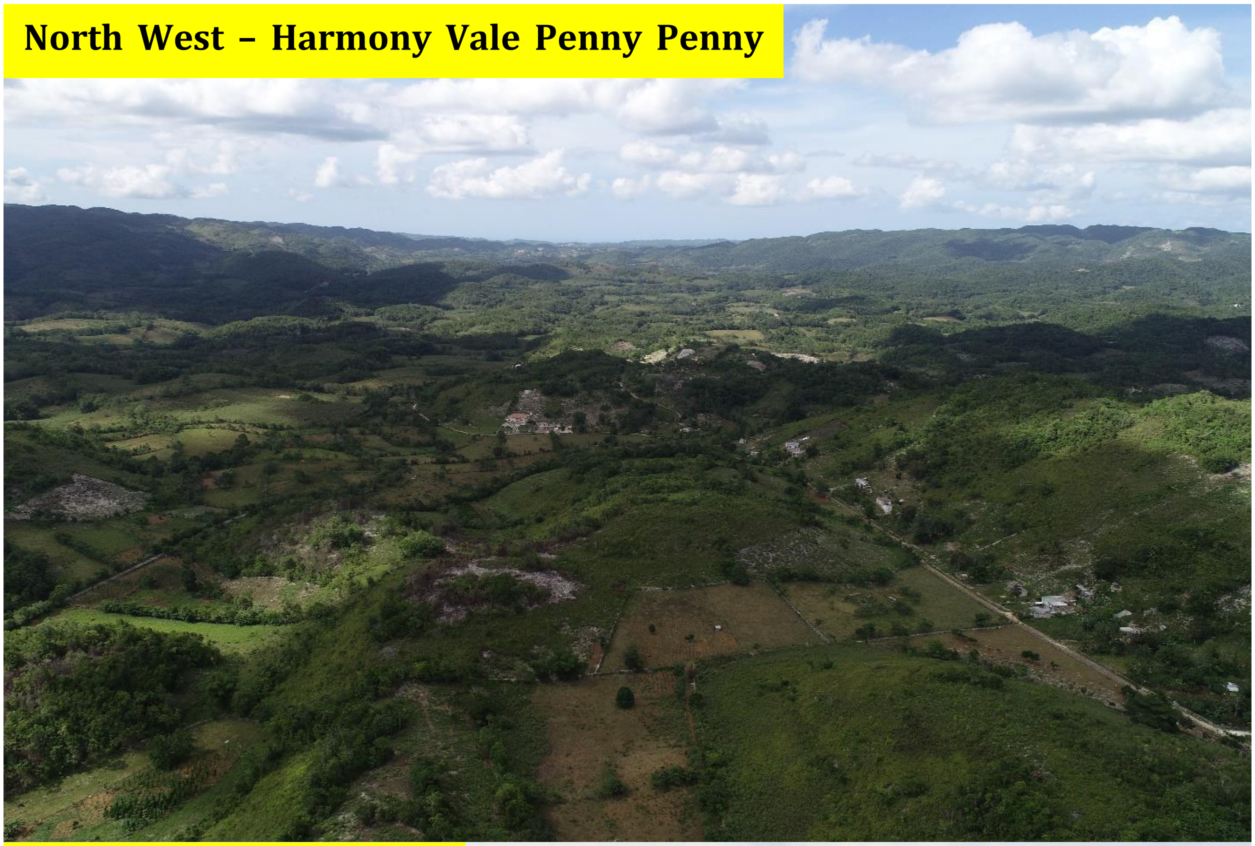

North East – Grierfield


South East - Camperdon Tydixon Area

South Tydixon

South West – Crossroads/ Fort George

North West – Harmony Vale Penny Penny



Central – Ballimony Area

Figure 5-6: Aerial photographs showing the typical topography of the SEPL 524

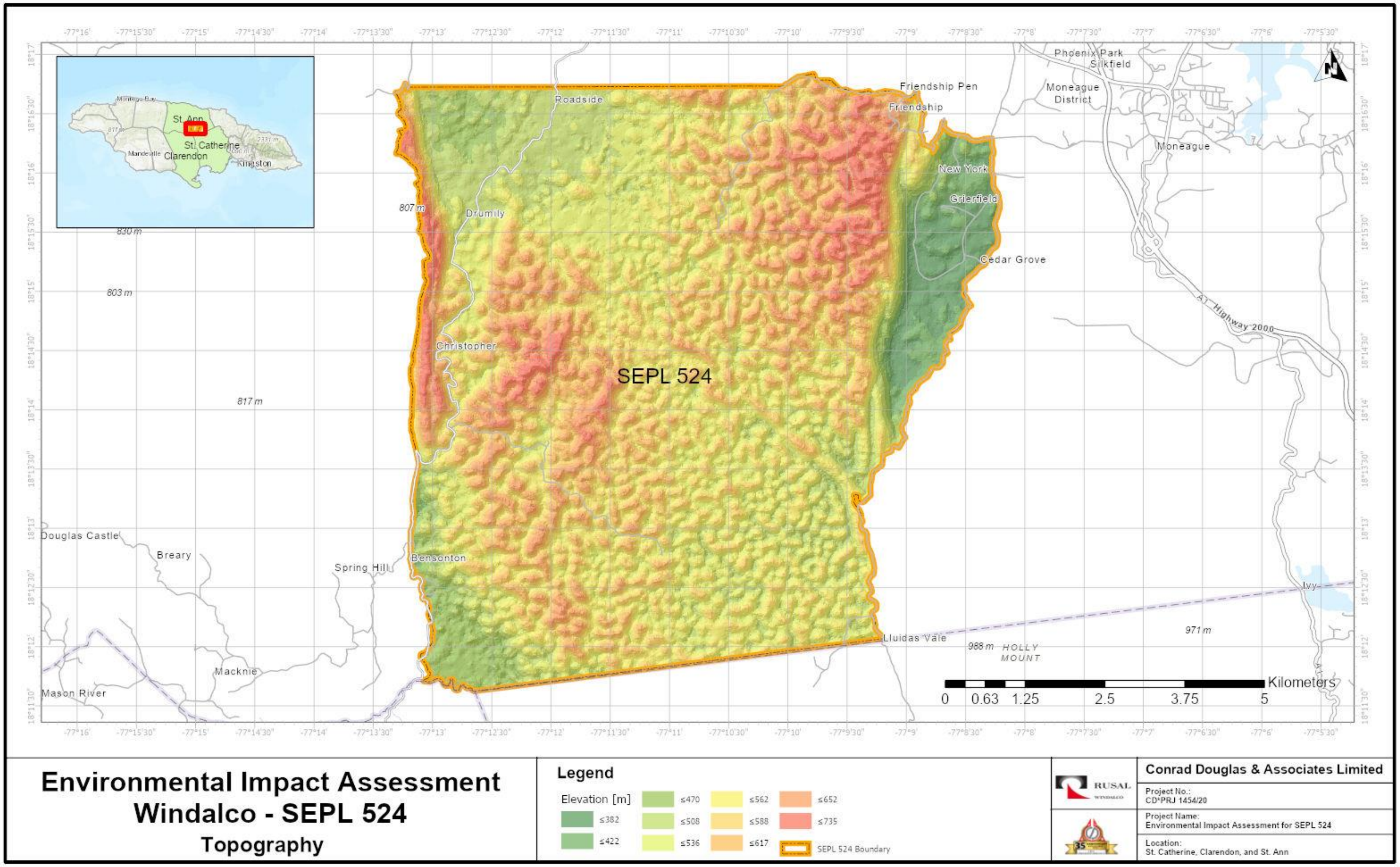


Figure 5-7: Topography for the SEPL 524

5.1.4. Soils

The soils in the area of the SEPL 524 can be classified as upland plateau soils. SEPL 524 is contained on the fringes of the Dry Harbour Mountains of the east central region of the island.

The specific soil textures and their distribution in SEPL 524 are shown in Figure 5-8 below. The soils are derived from the erosion and weathering of the limestone which is the main formation of the geology underlying the area. This type of soil makes up approximately 64% of the soils found on the island[10].

The soils in the area are predominantly, well drained, moderately deep to deep, highly weathered red to dark red clayey soils (*terra rossa*)[10]:

The soils types and texture encountered in the SEPL 524 area are shown in Figure 5-9 below. The Bonnygate soil type is the predominant soil type in the SEPL 524 area. This soil type is described as being a thin mantle covering hard white limestone. This soil type dominates the limestone hills of the SEPL 524 area.

[10] Government of Jamaica Ministry of Agriculture, Natural Resources Conservation Division, Jamaica Country Environmental Profile, September 1987.

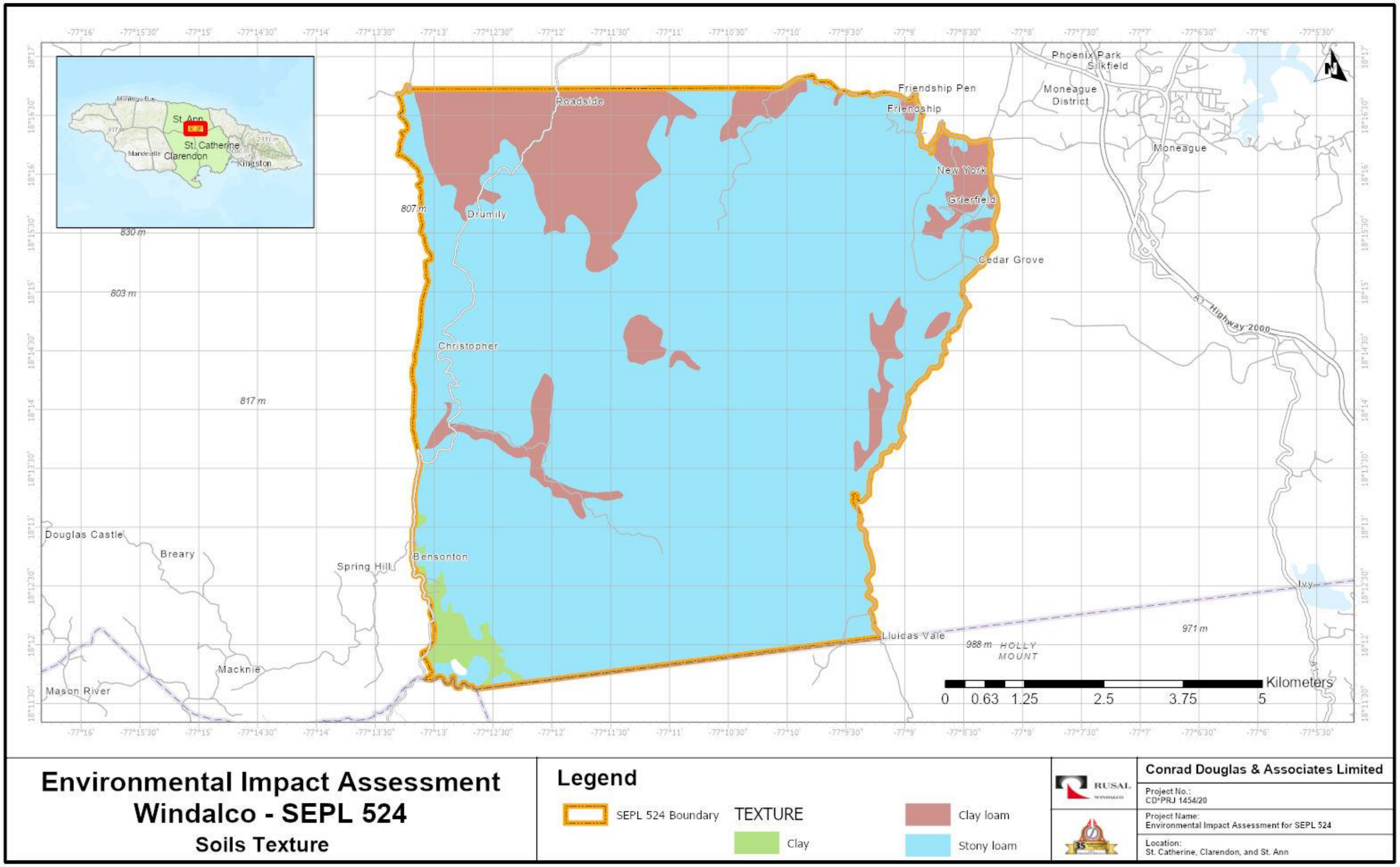


Figure 5-8: Soils Texture Map for the SEPL 524 Area (Source data: *Agricultural Land Management Division, MICAF*)

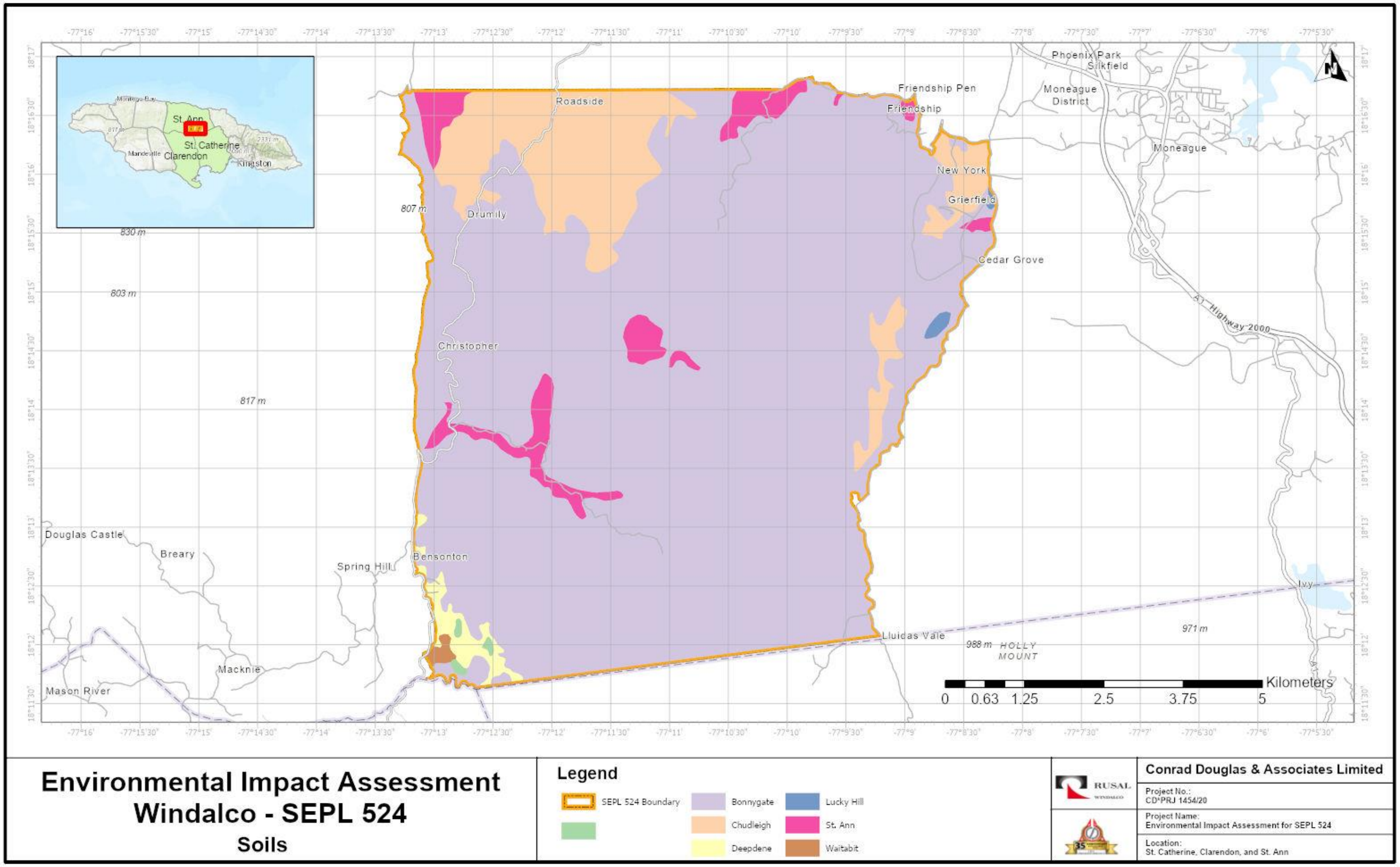


Figure 5-9: Soils Map for the SEPL 524 Area (Source data: *Agricultural Land Management Division, MICAF*)

5.1.5. Hydrology

5.1.5.1. Hydrostratigraphy

The limestone members that outcrop within the SEPL area are all classified as aquifers i.e. they yield water readily to wells and springs. The main water resources type of aquifers is groundwater.

The rocks that outcrop in the southwest corner of the 5km radius zone of influence and are volcanic in origin and form part of the Central Inlier are classified as aquicludes and the main water resources type is surface water. The aquiclude formations are all located within the 5km radius zone of influence. See Figure 5-10 below.

The main water resources type of the SEPL 524 is groundwater as there is no major surface water system within the boundary of the area. The high permeability of the limestone members that outcrop in the SEPL, enhanced by the results of the tectonic activity (faults and fractures) and karstification (solution effects, sinkholes) allows for the rapid infiltration of rainfall the main source of recharge to the limestone aquifers.

There are two short streams mapped along the western boundary and halfway up the SEPL. These streams may be spring risings and sinks associated with the limestone in the Bensonton area. The streams do not seem to be perennial and may have a high variability in flow as Bensonton and environs are always short of a domestic water supply as there are no nearby resources to be tapped.

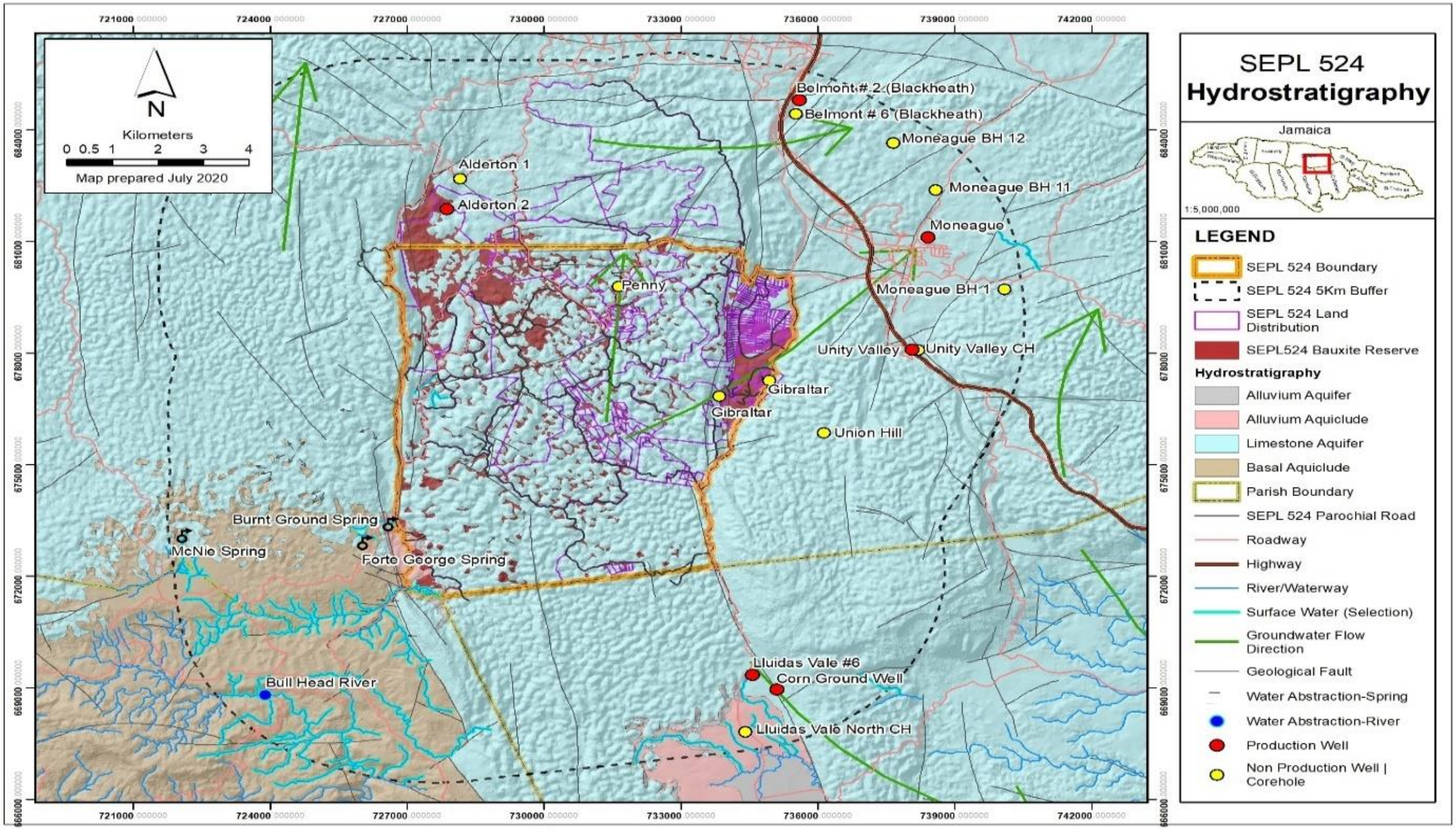


Figure 5-10: Hydrostratigraphy of SEPL 524 and 5km radius zone of influence

5.1.5.2. Groundwater Development

There are no wells drilled within the boundary of SEPL 524. There are three (3) small diameter test bores done by Alcan Jamaica Ltd in 1973. These are at Penny south of Claremont, and two at Gibraltar along the eastern boundary of the SEPL 524.

The Penny borehole was drilled in May 1973 and the depth was 112.78m (370 feet) and encountered groundwater at 75.74m (248.5 feet). The diameter of the borehole was 7.62 cm (3 inches). The lithology of the Penny borehole showed alternately bedded hard and soft limestone, cavernous in several horizons, indicating high permeability from solution effects.

There is no record for one of the boreholes at Gibraltar. The one Gibraltar borehole with any data on the Water Resources Database shows a depth of 35.36m (116 feet) and no water encountered. This borehole was also 7.62 cm (3 inches) in diameter. The boreholes were drilled to obtain information on groundwater level, bauxite thickness and geology.

Table 5-2: Summary of Production Well Construction Data Within the 5km Radius Zone of Influence of SEPL 524

Name of Well	Drill Hole		Casing Assembly					Water Level		Yield Test			Lithology				Elev. (m. amsl)	Notes
	Dia. (cm)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Drawdown (m)	Type	From (m)	To (m)	Thickness (m)		
Belmont 1	No									Details				On	Well	Record	ND	Ind Use
Belmont 2 (Blackheath)	No									Details				On	Well	record	ND	Ind Use
Belmont 6 (Blackheath)	50.8	122	Plain Perf	40.6 40.6	0.7 94.5	94.5 122	95.2 27.5	85.6		2725	84.4	1.22	White Limestone	0	122	122	ND	Ind Use
Moneague Camp #1	61 50.8 40.6 30.5	38 65.8 85.6 91.4	Plain	61	0.60	23.5	24.1	33.8	292.9	1581	39.0	5.2	White Limestone	0	91.4	91.4	326.7	NWC PS
Moneague Camp #2	40.64	91.4	Plain Perf	40.6 40.6	0.6 39.6	39.6 91.4	92.0	43.3	283.4	3813	49.58	6.43	Chalk Limestone (WBT)	0 22.9	22.9 91.4	22.9 68.5	326.7	NWC PS
Unity Valley Well	40.6 33.0	28.0 83.8	Plain Perf	30.5 30.5	0 41.5	41.5 83.8	41.5 42.3	41.5	299.8	2098	41.5	25.2	Bauxite Limestone	0 4.3	4.3 83.8	4.3 79.5	341.3	Dom Supply
Alderton #1	No									Details				On	Well	Record	ND	Abd
Alderton #2	40.6	163.1	Plain Perf	30.5 30.5	0 118.9	118.9 163.1	118.9 44.8	114.3		No	Test	Done	Soil/Marl Limestone	0 44.2	44.2 163.0	44.2 118.8	ND	Agri Use

Table 5-3: Summary of Monitoring Well Construction Data Within the 5km Radius Zone of Influence of SEPL 524

Name of Well	Drill Hole		Casing Assembly					Water Level		Yield Test			Lithology				Elev. (m. amsl)	Notes
	Dia. (cm)	Depth (m)	Type	Dia. (cm)	From (m)	To (m)	Length (m)	bgl (m)	amsl (m)	Discharge (m^3/d)	Water Level (mbgl)	Drawdown (m)	Type	From (m)	To (m)	Thickness (m)		
Unity Valley Corehole	10.2	80.8	PVC Plain and Perf	6.4	0	88.8	88.8	50.3		No	Test	Done	Limestone	0	80.8	80.8		Unity Valley Corehole
Moneague MW 1 Watson Hill	10.2	155.3	Plain Perf Plain Perf Plain	5.1 5.1 5.1 5.1 5.1	0 85.3 88.3 149.3 152.3	85.3 88.3 149.3 152.3 155.3	85.3 3.0 61 3.0 3.0	31.4	301.5	No	Test	Done	Soft Limestone Somerset Claremont	0 61 154.5	61 154.5 155.3	61 93.5 0.8	332.9	Moneague MW 1 Watson Hill
Moneague MW 11 Endeavour	10.2	213.4	Plain Screen	5.1 5.1	0 207.3	207.3 213.4	207.3 6.1	60	270.1	No	Test	Done	Claremont Limestone	0	213.4	213.4	330.1	Moneague MW 11 Endeavour
Moneague MW 12	10.2	304.8	Plain Screen	5.1 5.1	0 274.3	274.3 304.8	274.3 30.5	94.4	314.6	No	Test	Done	Limestone	0	304.8	304.8	409.0	Moneague MW 12
Union Hill	9.84	215.2	Galvanize Plain Perf	3.81 3.81	0 207.6	207.6 215.2	207.6 7.6	103.0	-	No	Test	Data	Limestone	0	215.2	215.2		Alcan Ja Ltd.

There are several small diameter boreholes and a number of production wells drilled within the boundary of the 5km radius zone of influence around the SEPL 524 area. The boreholes and wells are located within the southern and northeastern area of the zone of influence. The borings in the south are located in the Rio Cobre Hydrologic Basin-Upper Rio Cobre Sub-basin.

The borings listed in Table 5-2 and Table 5-3 above are owned by the following and were drilled for the reasons stated in Table 5-4 below.

Table 5-4: List of Wells-Production and Monitoring and Owners with Use/Purpose Within the 5km Radius zone of influence Around SEPL 524.

Name of Well Borehole	Name of Owner	Use/Purpose	Comments
Production Wells			
Belmont 1	Reynolds/JBM	Industrial	No longer in service
Belmont 2 (Blackheath)	Reynolds/JBM	Industrial	No longer in service
Belmont 6 (Blackheath)	Reynolds/JBM	Industrial	
Moneague 1	NWC	Public Supply	
Moneague 2	NWC	Public Supply	
Unity Valley	Alcan/Windalco	Domestic to land settlement at Faiths Pen	
Alderton 1	Alcan/Windalco	Agricultural	No longer in service
Alderton 2	Alcan/Windalco	Agricultural	
Lluidas Vale 6	NWC	Public Supply	
Corn Ground	Worthy Park	Industrial/Domestic	
Monitoring Wells			
Unity Valley Corehole	Alcan/Windalco	Groundwater Monitoring	Monitored for water levels and water quality
Moneague Monitor Well 1-Watson Hill	Alcan/Windalco	Groundwater Monitoring	Monitored for water levels and water quality
Moneague Monitor Well 11-Endeavour	Alcan/Windalco	Groundwater Monitoring	Monitored for water levels and water quality

Name of Well Borehole	Name of Owner	Use/Purpose	Comments
Moneague Monitor Well 12	Alcan/Windalco	Groundwater Monitoring	Monitored for water levels and water quality
Union Hill	Alcan/Windalco	Geology and Groundwater Monitoring	
Lluidas Vale North Corehole	NWC/WRA	Groundwater Monitoring	

5.1.5.3. Groundwater Flow Direction

Groundwater flow is to the north and to the northeast through the SEPL 524 area as given by the WRA. However, work done by D'Aguilar and Fernandez in 1991-1993 in the Dry Harbour Mountain Hydrologic Basin-White River Sub-basin indicated that groundwater flow was to the north and northwest through the SEPL 524. Groundwater flow was traced using sodium as the main tracer element from the Mt Rosser Red Mud lake to the Rio Hoe Riverhead east of Moneague. Groundwater flow from Rio Hoe Riverhead goes northeast and northwest with a groundwater ridge dividing the flow. Groundwater flowing northeast goes to the White River and groundwater flowing northwest goes to Hinds Town and environs. See Figure 5-11 below. The two wells at Alderton owned by Alcan/Windalco are in the direct groundwater flow path from the SEPL 524. These wells were drilled for agricultural purposes and only one is now in operation (see Table 5-4 above).

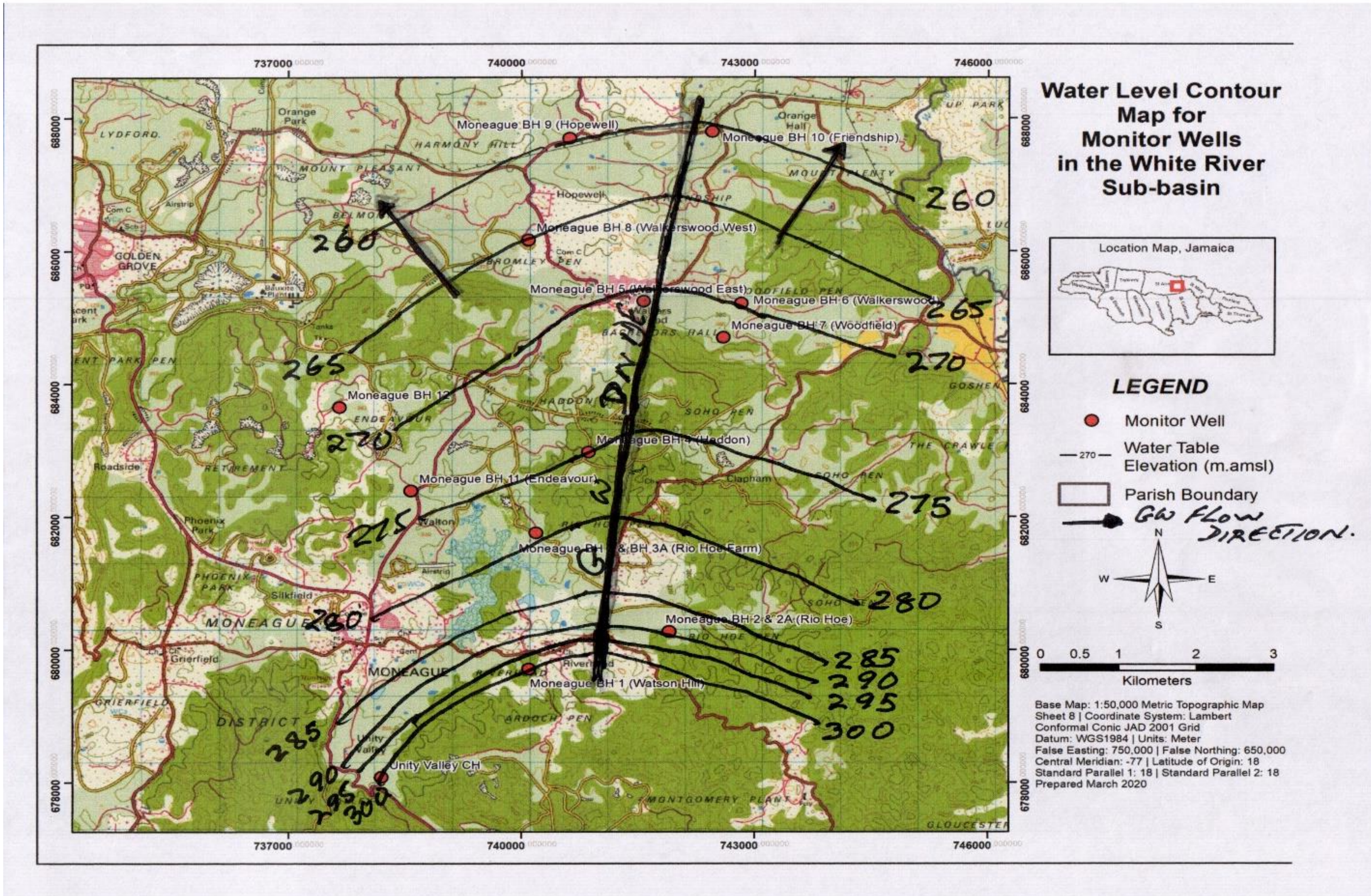


Figure 5-11: Groundwater Level Contours in White River Sub-basin Showing Groundwater Divide that Controls Flow Direction. Note MW 11 and 12 are Located Within the 265 and 275 Metres Above Sea Level Contours. (SEPL 524 is to the west of the groundwater divide)

5.1.5.4. <u>Drainage</u>

As stated above there are no major surface water systems located within the boundary of SEPL 524. There are two short streams located along the western boundary halfway up the SEPL in the vicinity of Bensonton that seem to rise and sink within the SEPL 524 area. The streams while possibly being perennial, exhibit very low flow characteristics during dry periods. When flow is sufficient the source is used to meet the water demand of Bensonton and environs. These streams are not monitored by the WRA.

The surface water systems are denser on the aquiclude formations of the eastern section of the Central Inlier located in the southwest corner of the 5km radius zone of influence. These streams include the Pedro River, the Jordan River, Crofts River, Bullhead River and Pindars River. The Pedro River flows from west to east all within the Dry Harbour Mountain Basin - White River Sub-basin and sink into the limestone via two sinkholes within the area of the SEPL 524. See Figure 5-12 below. The Pedro River flows underground and reappears as a rise at Swansea in northern Lluidas Vale in the Rio Cobre Hydrologic Basin.

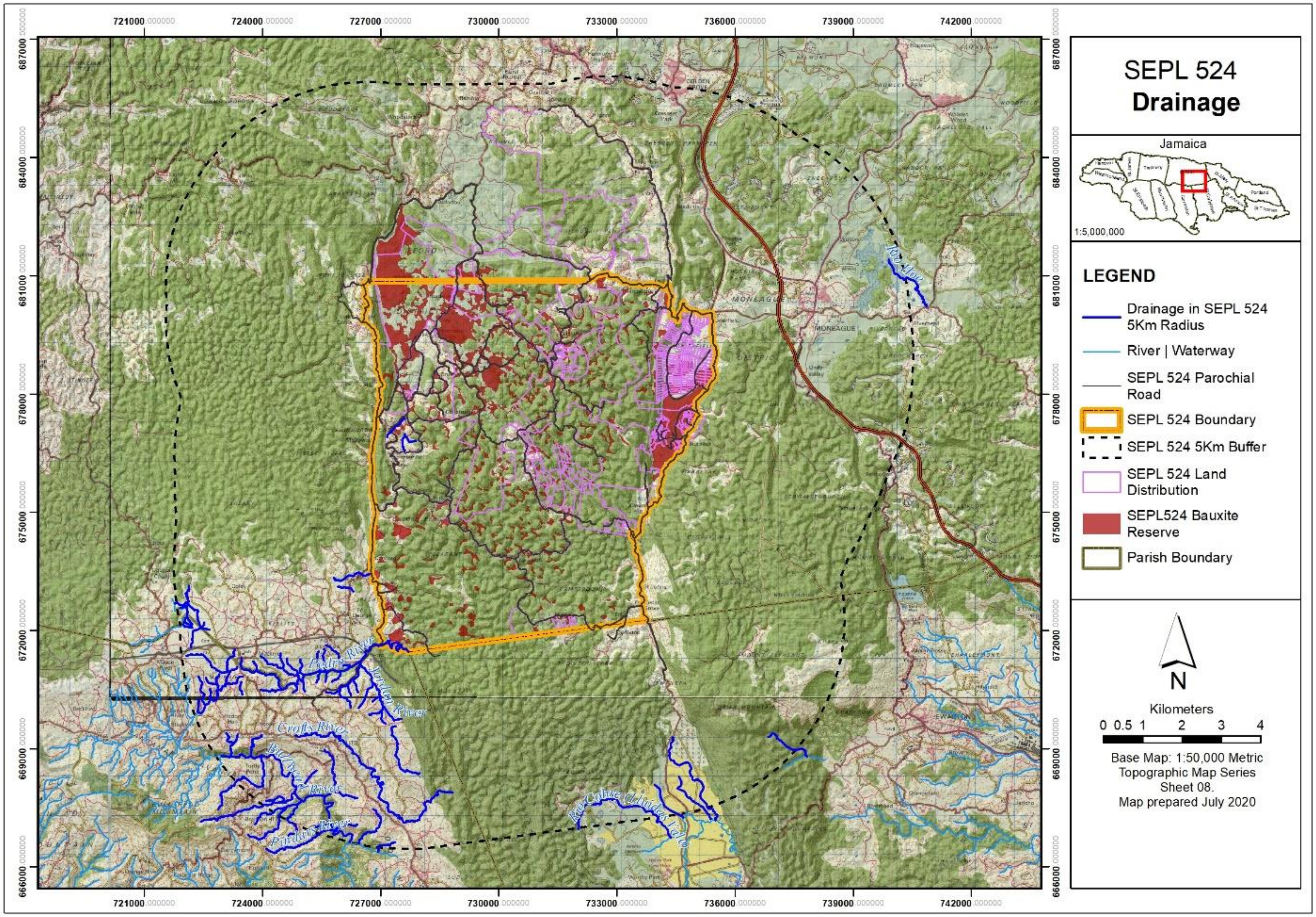


Figure 5-12: Drainage of the SEPL 524 and 5km Zone of Influence Areas.

Anecdotal evidence of material from the Public Works office in Pedro River during flooding being found at Swansea Cave in Lluidas Vale and high flows in the Rio Cobre at Lluidas Vale despite there being no rain at Lluidas Vale but flooding at Pedro River and Concord. The inability of the two sinkholes at Pedro River to intake the flows during the heavy rain season has led to flooding at Pedro River and Concord. The WRA has over the years monitored flood levels at Pedro River and had installed a flood warning system to inform residents of the closure of the road and to prevent loss of property and life. The WRA monitors flow on the Pedro River at Kellits.

The Pindars River flows to the southwest joining the Rio Minho in the Upper Rio Minho Hydrologic Basin (Upper Clarendon-above Chapelton). The Pindars River has been assessed for various water supply projects (domestic, agricultural and hydropower) with the construction of a possible dam across the river. However, because of declining river flows and increased sedimentation of the river (which is a major sand mining site) this project has not been implemented. The WRA monitors the Pindars River at 3 gauging stations at Arthurs Seat, near Arthurs seat and near Rock River. Streamflow data exist for the periods shown in Table 5-5 below.

Table 5-5: Pindars River Period of Stream Flow Data (Source: WRA Database)

Name of River	Name of Station	Period of Daily Stream Flow Data	Comments
Pindars River	At Arthurs Seat	1967-2017	
Pindars River	Near Arthurs Seat	1954-2016	
Pindars River	Near Rock River	1967-2020 March	Decline in streamflow since 2012

Bullhead Spring (Head of Bullhead River) and Bullhead River all flow south within the Rio Minho Hydrologic Basin. The National Water Commission (NWC) diverts water from the river and uses it to meet the demand for public water supply. The WRA monitors the flow in the Bullhead River above and below the NWC's intake. Data is available for the period 2014 to 2020. The flow is very low <0.000m^3/sec.

There are a number of streams south of the 5km radius zone of influence within the Lluidas Vale area of the Rio Cobre Hydrologic Basin-Upper Rio Cobre Sub-basin. These are the head waters of the Rio Cobre River such as Murmuring Brook and a number of springs diverted by Worthy Park Sugar Company for industrial uses. These are all located down gradient of the SEPL 524 area.

5.1.6. Meteorology

Jamaica is surrounded by the Caribbean Sea and is located in the Tropics at approximately latitude 18ºN and longitude 77ºW. Among the most important climatic influences are the Northeast Trade Winds, the range of mountains which runs east-southeast to west-southwest along the centre of the island, the warm waters of the Caribbean Sea, and weather systems such as upper- and low-level low-pressure centres, troughs and cold fronts.

The cold fronts, usually weak after migrating from the North American continent, are evident from mid-October to mid-April. The Tropical Weather Systems, namely Tropical Waves, Tropical Depressions, Tropical Storms and Hurricanes occur from April to December. The official hurricane season is from June to November.

Meteorological data for the SEPL 524 area was provided for the following close collection points by the Meteorological Service of Jamaica:

- Moneague (Unity Valley) Automatic Weather Station (AWS)
- Mason River AWS

The locations of the weather collection points are shown in Figure 5-13 below.

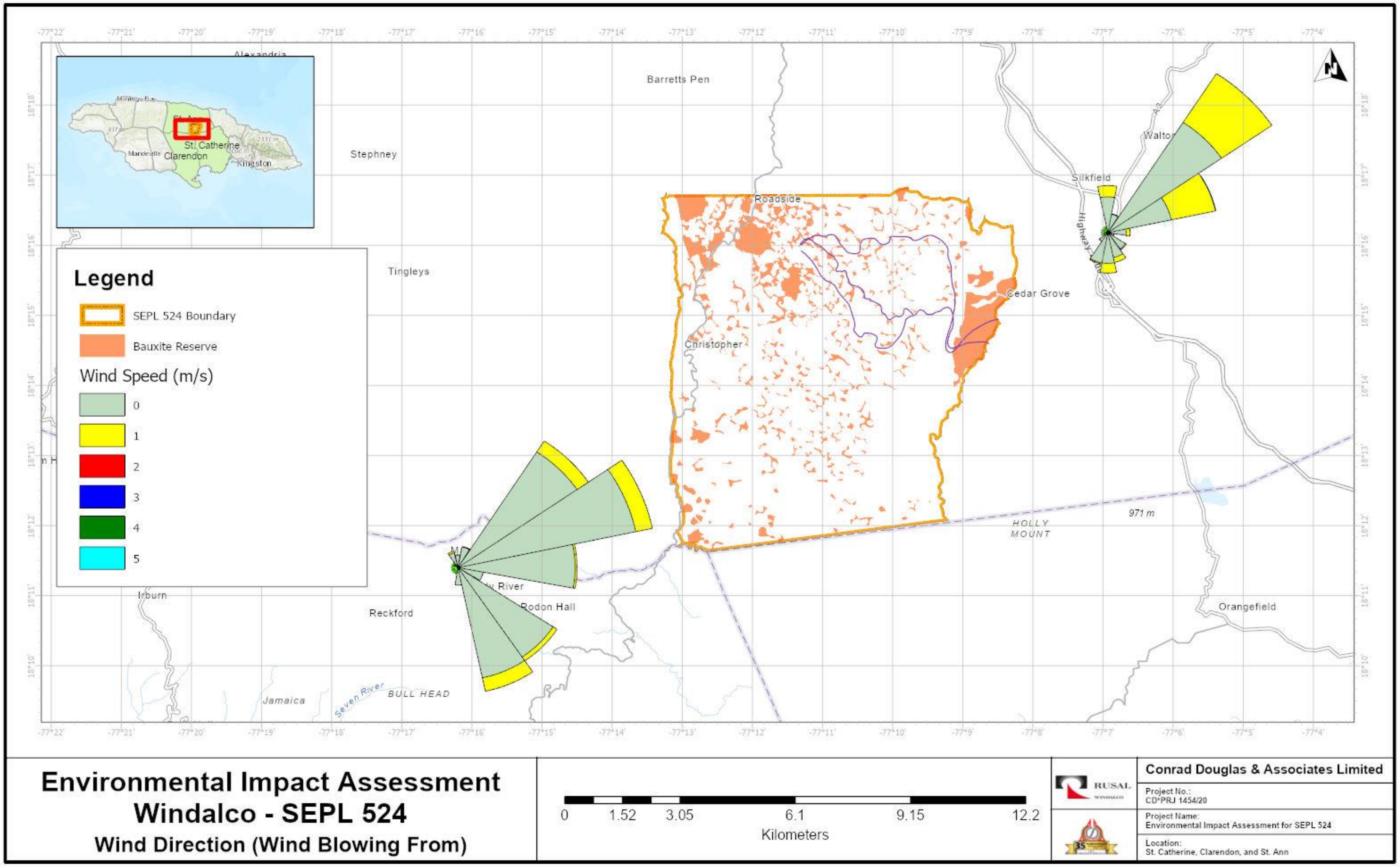


Figure 5-13: Locations of Weather Stations (Source: *Meteorological Services of Jamaica*)

5.1.6.1. Rainfall

In the past, Jamaica has had a cyclic bimodal rainfall pattern linked to its geographic location in the Caribbean, its topography and the effects caused by seasonal variations in atmospheric circulation patterns (Water Resources Authority, 2015). The latter is driven by the heating effects of solar radiation. The rainy season roughly spans April–November with peaks in May–June and September-November and a mid-summer drought that occurs in July-August (See Figure 5-14 below). There is also a dry period between December to April, with February being the driest month.

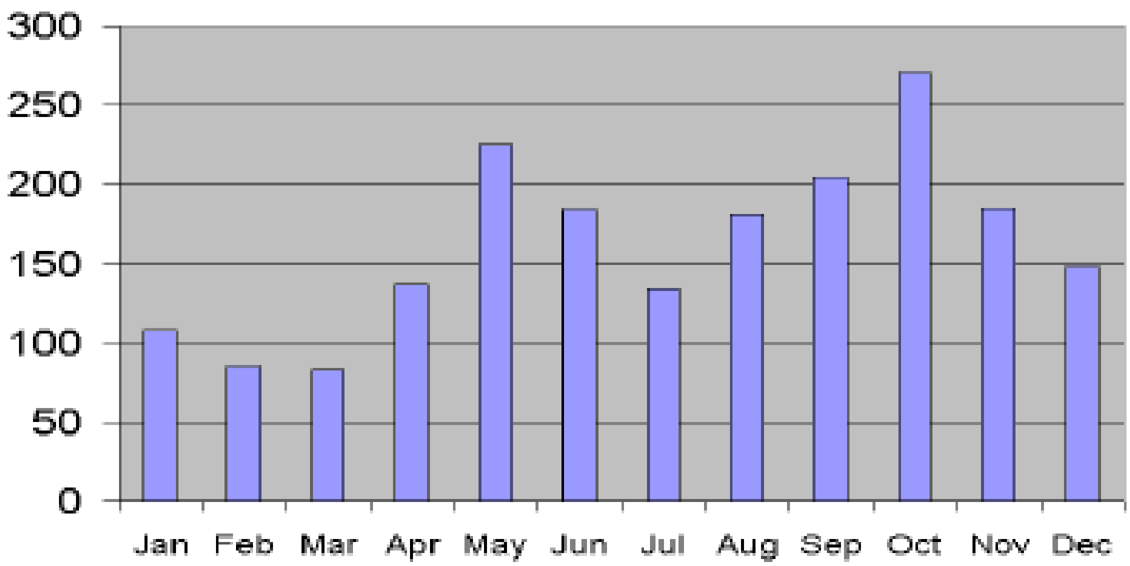


Figure 5-14: Rainfall in mm for Jamaica. Averaging period is 1951-1980 Source: National Meteorological Service of Jamaica and (Climate Studies Group, Mona, 2016)

Jamaica's 30-year rainfall average for the period 1951-1980 is shown in Figure 5-15 below. As shown, the highest rainfall occurs in the north-eastern part of Jamaica with rainfall of up to 5000 mm or more (Climate Studies Group, Mona, 2016). Conversely, the lowest rainfall is observed on the southern coast, with the plains of the south-coast significantly driest (just more than 1000 mm annually). This correlates with the fact that the Blue & John Crow Mountain Range is found in the north-eastern part of the island, which is the highest elevation in the country. In general, the moisture laden north-east trade winds, firstly impacts the north-eastern part of the island and as they rise to higher elevations, condensation and precipitation occurs (See Figure 5-15). In combination with sea breezes this result in the high levels of precipitation recorded (Climate Studies Group, Mona, 2016).

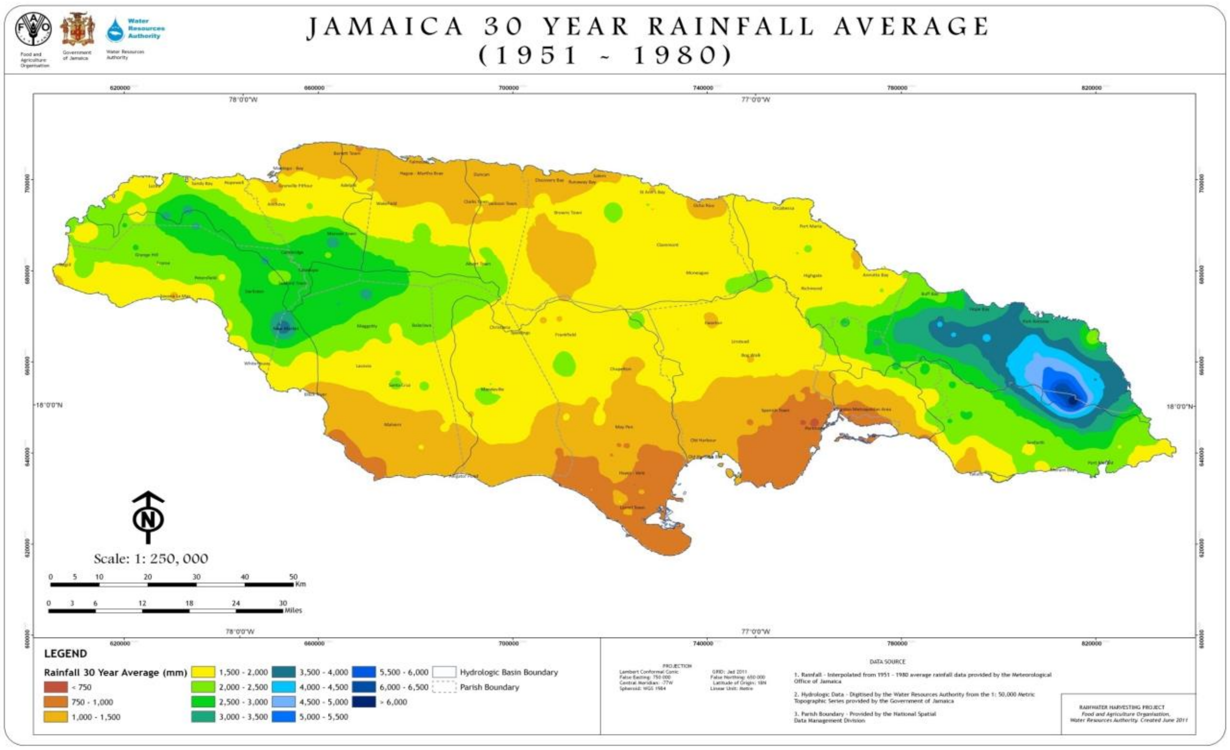


Figure 5-15: Jamaica 30 Year Rainfall Average (1951-1980) (Water Resources Authority, 2015)

Of the weather parameters, rainfall is the most variable. Island wide, during the period 1951 to 1980, annual rainfall ranged from a maximum of 2593 mm (102.09 in) in 1963 to a minimum of 1324 mm (52.13 in) in 1976, with an average of 1940 mm (76.38 in) annually. The hundred-year (1881-1990) mean annual rainfall is 1895 mm (74.61 in). Historically, the wettest year on record was 1933 with an annual rainfall of 2690 mm (116.54 in) whilst the driest year was 1920 with an annual rainfall of 1299 mm (51.14 in). Figure 5-16 and Figure 5-17 show the mean long-term mean rainfall for the parishes of St. Ann and Clarendon, respectively for 1971-2000.

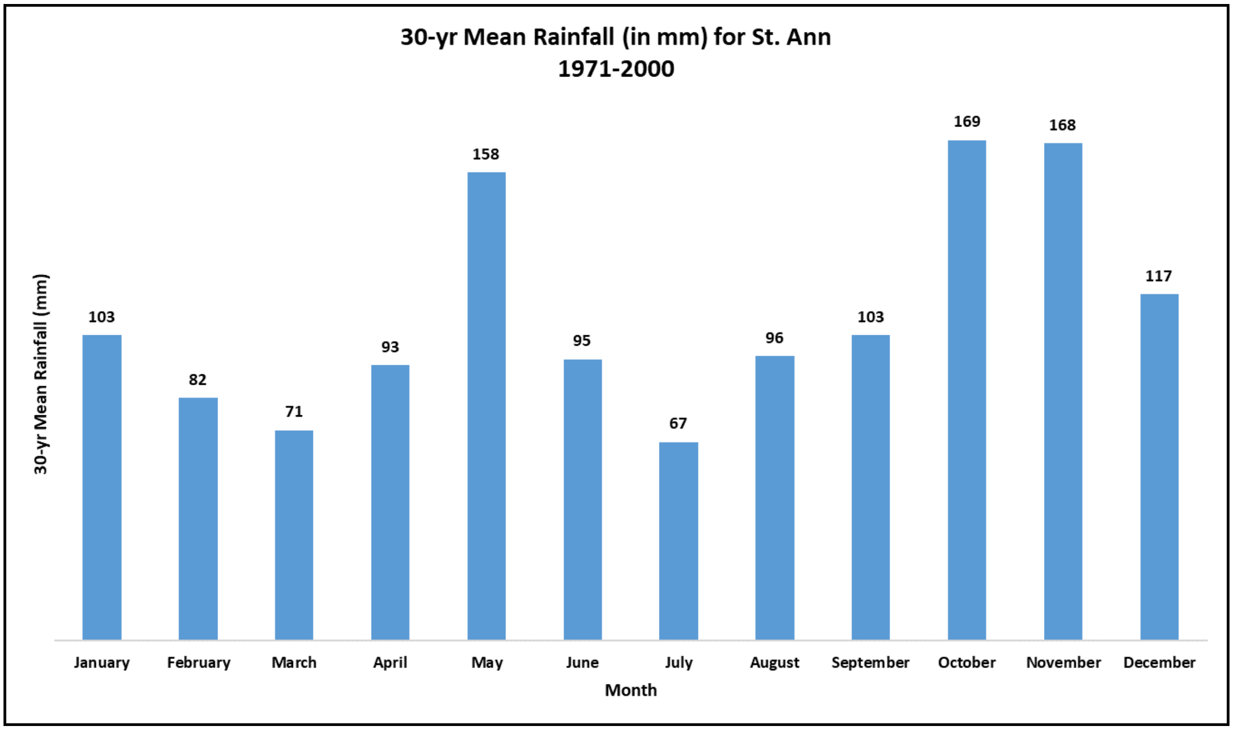


Figure 5-16: St. Ann Long-Term Mean Rainfall (mm) 1971-2000 (Source: Jamaica Meteorological Service, Climatological Data)

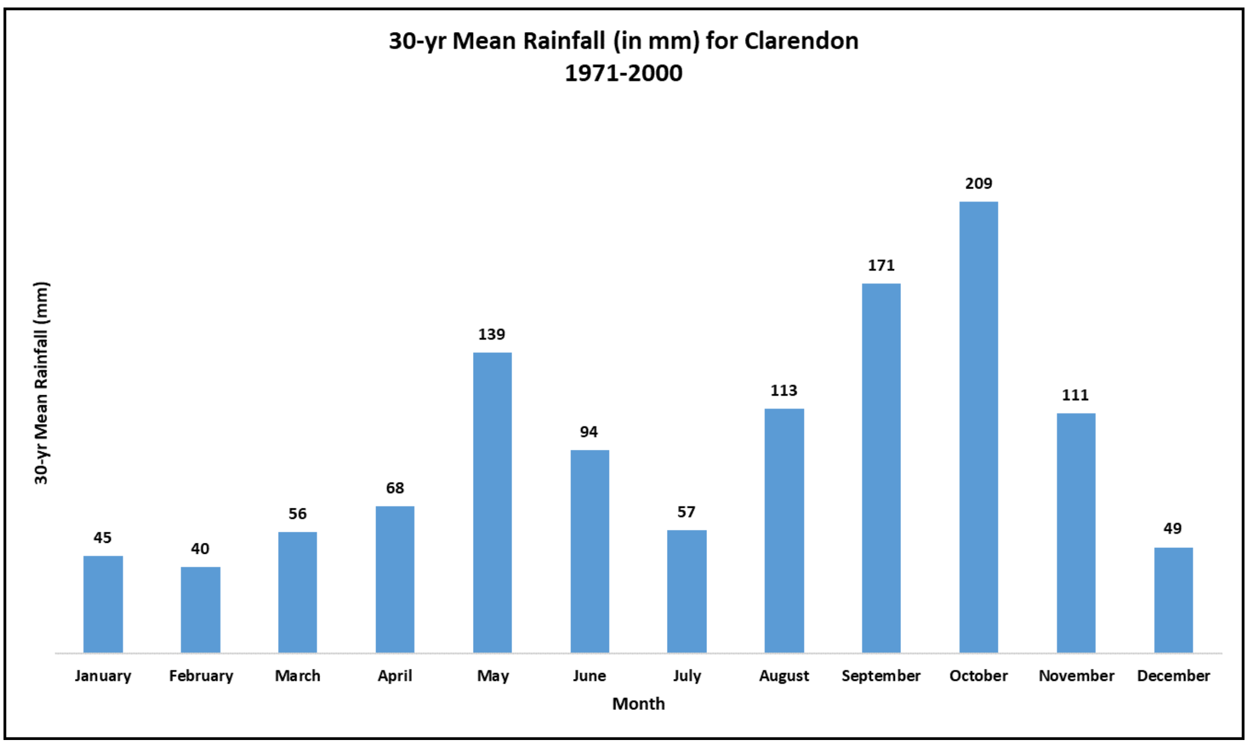


Figure 5-17: Clarendon Long-Term Mean Rainfall (mm) 1971-2000 (Source: Jamaica Meteorological Service, Climatological Data)

The parishes of St. Ann and Clarendon receives an annual average of 1323.67mm and 1,153mm of rainfall per year mainly during the month of May and the period of September to November. The driest period occurs in the months of March and July, with less than 72 mm per month as seen in Figure 5-16 for St. Ann. The driest periods for Clarendon occur in the months of December to February with less than 50 mm per month (See Figure 5-17).

However, whether during the dry or rainy season, other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

Figure 5-18 and Figure 5-18 below show the total annual rainfall for Moneague, St. Ann and Mason River, Clarendon the closest available rainfall monitoring sites in the area.

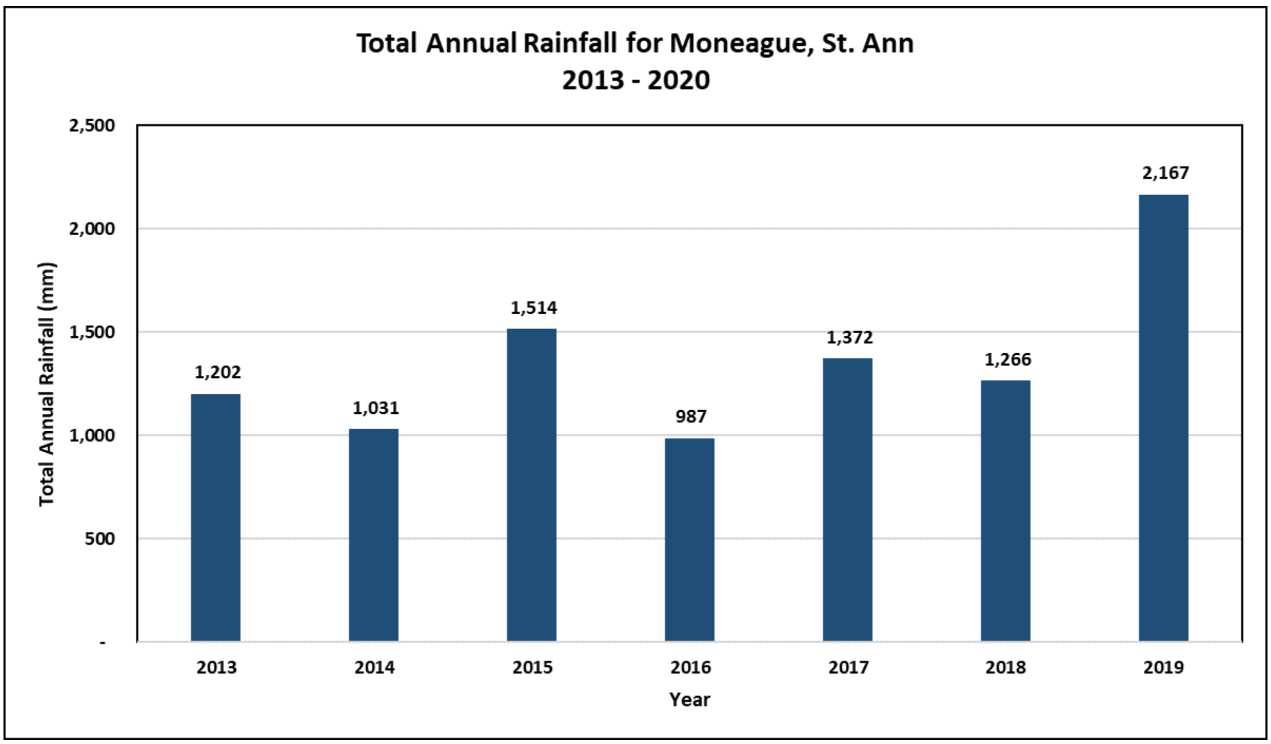


Figure 5-18: Total Annual Rainfall for Moneague, St. Ann for the Period 2013 – 2020 (Source: Meteorological Service of Jamaica)

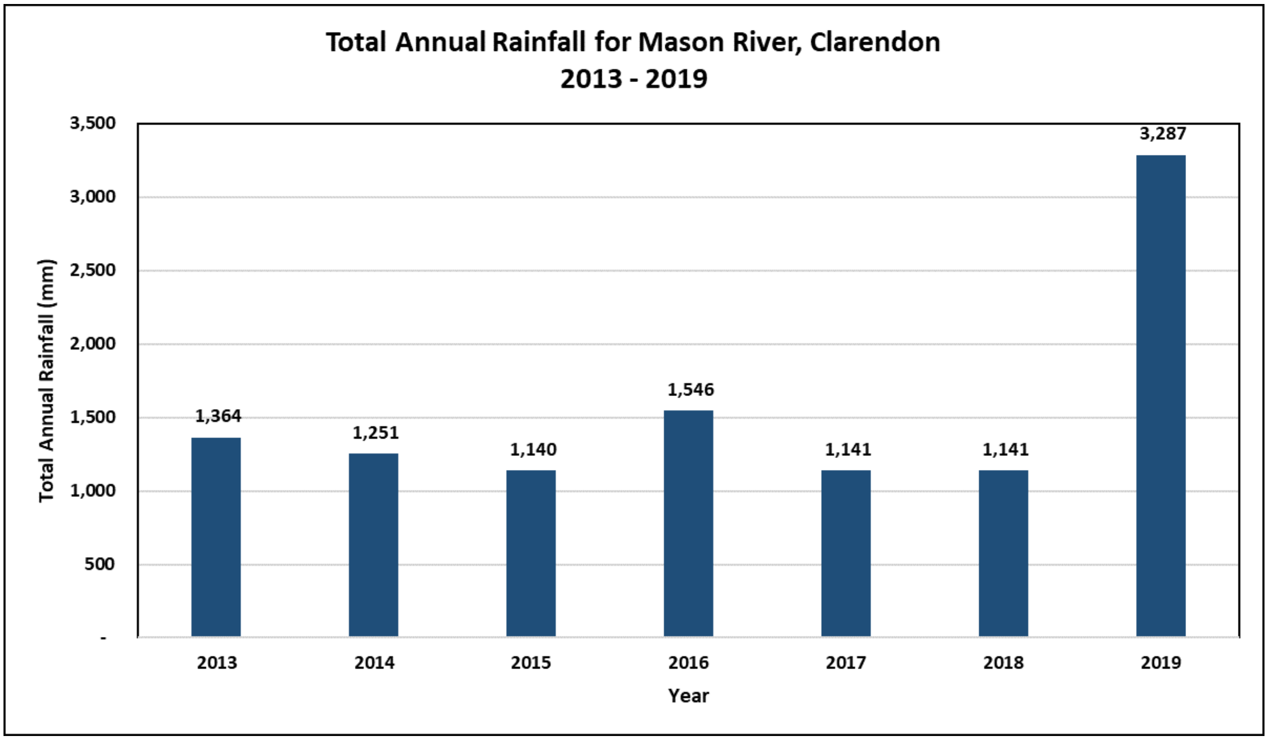


Figure 5-19: Total Annual Rainfall for Mason River, Clarendon for the Period 2013 – 2019 (Source: Meteorological Service of Jamaica)

5.1.6.2. Wind

The daily wind pattern is dominated by the Northeast Trades. During the day, on the North Coast, the sea breeze combines with the Trades to give an east-north-easterly wind at an average speed of 15 knots (17 miles per hour). In the period December to March, however, the Trades are lowest and the local wind regime is a combination of trades, sea breeze, and a northerly or north-westerly component associated with cold fronts and high-pressure areas from the United States.

By night, the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, on the North Coast, night-time winds generally have a southerly component with a mean speed of 5 knots (6 miles per hour). By day, from June to July, mean onshore winds often reach a maximum of up to 23 knots (26 miles per hour) along the North Coast during mid-afternoon.

5.1.6.2.1. Wind Pattern and Direction

Wind roses were also created from data supplied from the Meteorological Services of Jamaica. These were overlaid on a map of the area. The general wind direction and speed from the Moneague and Mason River weather stations are shown in Figure 5-20 and frequency distribution tables provided in Figure 5-21 to Figure 5-22 below. The data shows that majority of the wind directions measured were blowing towards the south-west. This suggests that dust generated will generally blow in these directions.

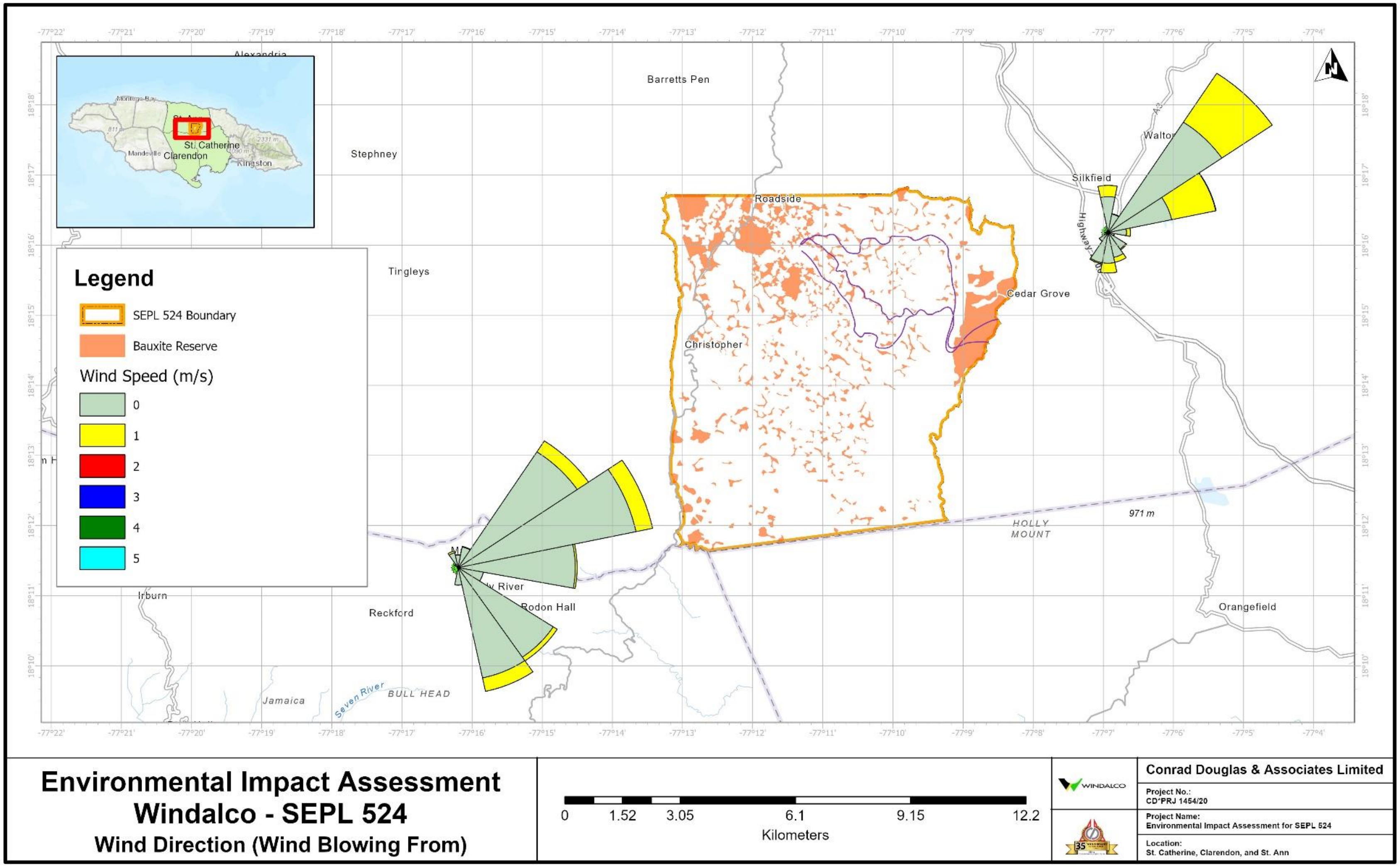


Figure 5-20: Wind Rose for Moneague and Mason River Weather Stations overlaid on Google Map

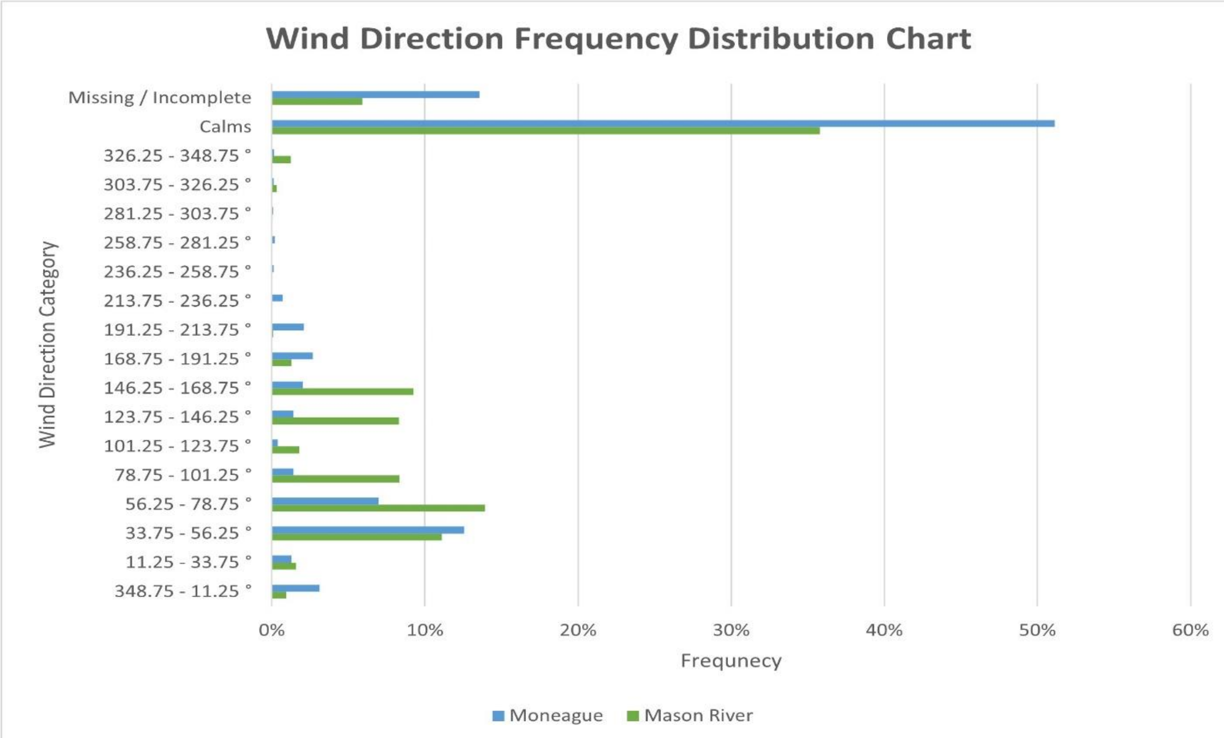


Figure 5-21: Wind Direction Frequency Distribution Chart

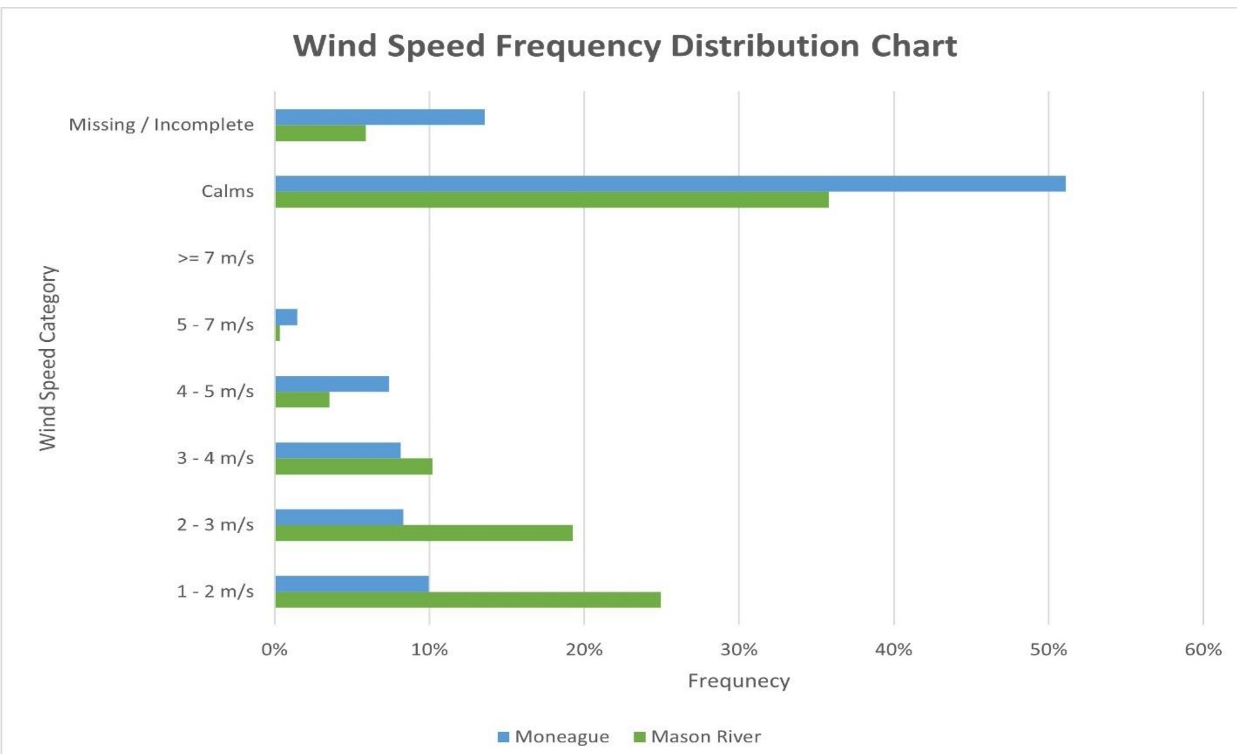


Figure 5-22: Wind Speed Frequency Distribution Chart

5.1.6.3. Temperature and Relative Humidity

Apart from rapid fluctuations associated with afternoon showers and/or the passage of frontal systems, the island's temperatures remain fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

The warmest months are June to August and the coolest December to February. Night-time values range from 18.9 ºC to 25.6 ºC (66 to 78.1 ºF) in coastal areas with inland temperatures cooler.

At elevations above 610 metres (2,000 feet), minimum temperature of the order of 10 ºC (50 ºF) have been reported occasionally when active cold fronts reach the island.

Variations of sunshine from month to month in any area are usually small, approximately one hour. Differences, however, are much greater between coastal and inland stations. Maximum day-length occurs in June when 13.2 hours of sunshine are possible, and the minimum day-length occurs in December when 11.0 hours of sunshine are possible. However, the mean sunshine in mountainous areas is less than 6 hours per day, while in coastal areas it is near 8 hours per day. The shorter duration in the hilly areas is caused mainly by the persistence of clouds.

Relative humidity is a term used to describe the amount of water vapour that exists in a gaseous mixture of air and water, expressed as a percentage of the maximum amount of water vapour that could be present if the vapour were at its saturation conditions. Afternoon showers are the major cause of most daily variations in relative humidity. Highest values recorded during the cooler morning hours near dawn, followed by a decrease until the early afternoon when temperatures are highest.

The average monthly temperature and percentage relative humidity (%RH) experienced at Mason River, Clarendon and Moneague, St. Ann are given in Figure 5-23 and Figure 5-24 below.

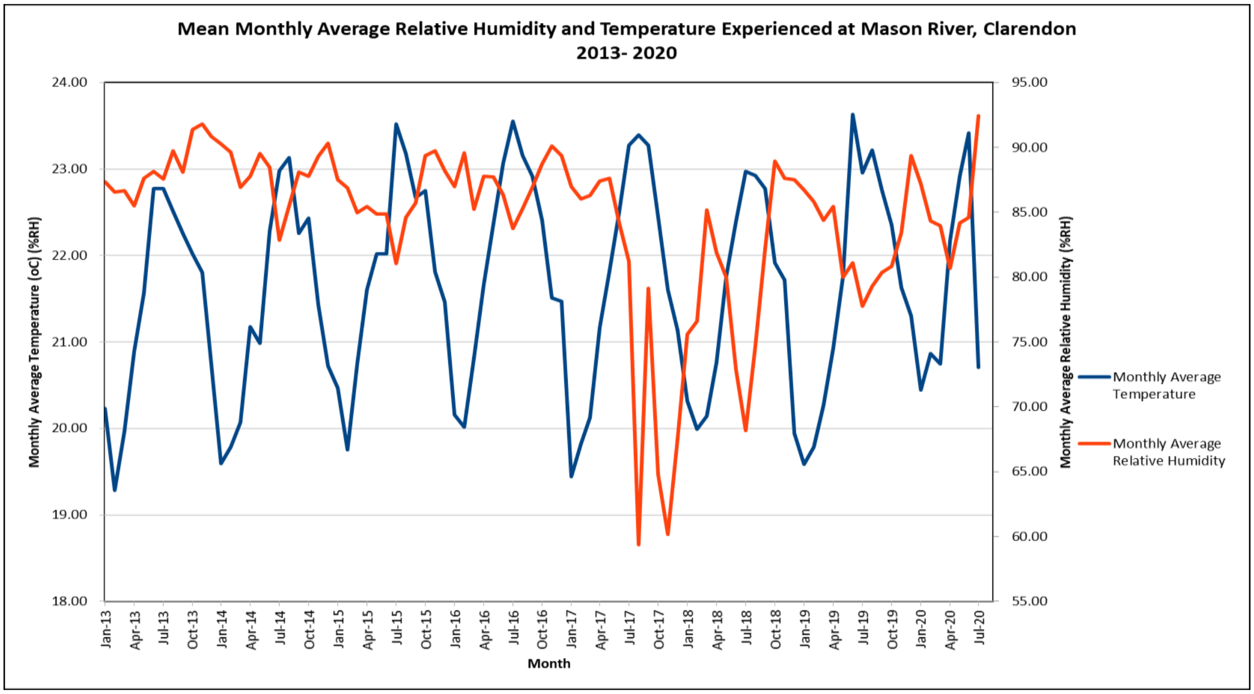


Figure 5-23: Mean Monthly Average Temperature and Relative Humidity Experienced at Mason River, Clarendon 2013- 2017

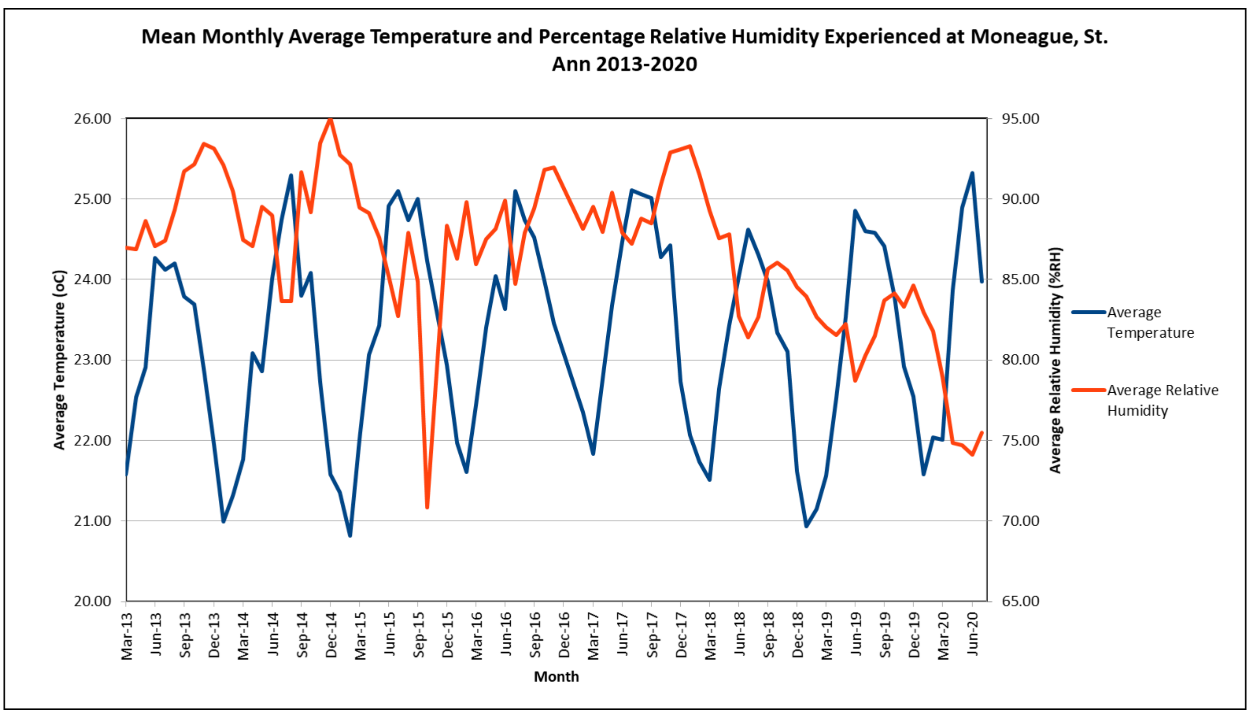


Figure 5-24: Mean Monthly Average Temperature and Relative Humidity Experienced at Moneague, St. Ann for the period 2013 - 2020

Spot relative humidity readings were taken at locations within the SEPL 524. The results are shown in Table 5-6 below.

Table 5-6: Results of Spot Temperature and Relative Humidity Measurements taken within the SEPL 524

Location	GPS	Date	Time	Weather	Half hour Averaged Temperature (°C)		Half Hour Averaged Relative Humidity (RH%)	
Tydixon	N 18°12.1244 W 77°10.2851	July 3, 2020	-	Sunny	33.5		59.5	
Community Center Drumily	18°15.2419 77° 12.6689	July 3, 2020	3:10 pm	Sunny	31.9		60.5	
Greirfield	N 18.26663 W 77.14534	July 17, 2020	10:30 am	Sunny	-		-	
Jeffereyville Agriculture School	N 18.24138 W 77.14447	July 20, 2020	11:12 am	Rainy	28.75		70.9	
Ballimony	N 18.24905 W 77.17596	July 20, 2020	1:17 pm	Sunny/ clear skies	Open Area	Hillock	Open Area	Hillock
					32.65	34.7	48.3	46.8

5.1.7. Air Quality Assessment

A baseline assessment of ambient pollutant concentration was carried out in the SEPL 524 area. The objective was to determine the baseline for particulate matter fractions as PM_{10} and total suspended solid. The fraction of particulate matter with aerodynamic diameter below 10 micrometers is called PM_{10} while the fraction called total suspended particle (TSP) contains all particles with aerodynamic diameter up to 65 micrometers.

Based on the Natural Resources Conservation Authority Ambient Air Quality Guidelines Document and the requirements of the agreed TOR sampling was done for the following types of stations:

1. Population exposure
2. Background stations

The existing major sources of pollutants in SEPL 524 include vehicular traffic, garbage burning, bush fires (natural and land clearing activities). The low traffic flow in the SEPL suggests that mobile sources of pollutant are not significantly impacting air quality. The low population of the area also indicate that waste incineration will not be significant.

Sites were therefore chosen to capture pollutant concentration where significant amount of people spend long periods of their days such as in residential communities and major shops and intersections where people visit based on transportation and pick up and drop off areas. The areas of the SEPL removed from towns and residential areas were also sampled to assess the background concentrations within the SEPL.

5.1.7.1. Approach and Methodology

CD&A implemented an air quality monitoring plan to assess the status of air quality within the proposed project area which included the assessment of existing air quality for areas adjacent to SEPL 524 as well as actual samples collected within the SEPL during the development of the EIA (See Figure 5-26 below).

The use of secondary data is important to discern the trends in air quality in areas in proximity to the SEPL of similar topography, development patterns and source of pollution as the length of the study does not facilitate an exhaustive air quality monitoring regime. Secondary data from Windalco for SML 162 were assessed for complimenting the data collected during this study. The use of hi-vol samplers are routinely done to measure both PM_{10} and TSP concentration in mainly population centers within SEPL 162 (See Figure 5-27 below). This is owing to the unavailability of the necessary utilities to operate the samplers in remote background areas. These samplers are stationed in a manner to assess population exposure for compliance analysis.

Based on the activities to be undertaken in the area there will be no significant source to produce NO_x and SO_x, as such no measurement for gases was taken. This is similar to that of the existing SML 162 for which the air quality framework approved by the authority only requires the monitoring of PM_{10} and TSP.

The Windalco database has ten (10) years of data between 2010 and 2020. The database comprises concentration measurements for PM_{10} at two (2) sites and TSP at five (5) sites. The data obtained for the ten (10) year period is presented in the Results and Discussions section. The results were assessed in relation to the air quality standards set by the regulatory agency.

The actual measurement exercise for this study employed active methods for pollutant concentration measurements. Active sampling was done for the particulate matter concentration measurements.

Twenty-four-hour sampling using minivol samplers for PM_{10} and TSP. Figure 5-25 shows the PM monitors exposed on the roof of a building in Jefferyville in the SEPL 524. These PM concentrations measurements can therefore be compared directly with the existing air quality standards as they are based on the same sampling time frame.

Table 5-7. Monitoring Site Locations

Site Name	Landuse in at Sample Site	Latitude	Longitude
APMS 1	Residence – Greirfield – Population Exposure	N 18.26663	W 77.14534
APMS 2	Agricultural School – Population Exposure	N 18.24138	W 77.14447
APMS-3	CrossRoads -Residential/Commercial – Population Exposure	N 18.230759°	W 77.214528°
APMS-4	Fort George – Residential – Population Exposure	N 18.207345°	W 77.218094°
APMS-5	Balimony- Agricultural/ Residential - Background	N 18.254057°	W 77.176800°

Figure 5-25: PM_{10} and TSP monitor exposed at Sampling Site 1 in SEPL 524

5.1.7.2. Quality Control

Quality control for the particulate matter sampling exercise included the following:

- ✓ Filters conditioned pre and post sampling and weighted on the same balance
- ✓ Samplers calibrated as recommended by the manufacturer (See Appendix V)
- ✓ Samplers exposed at least 10 m from the closest obstruction

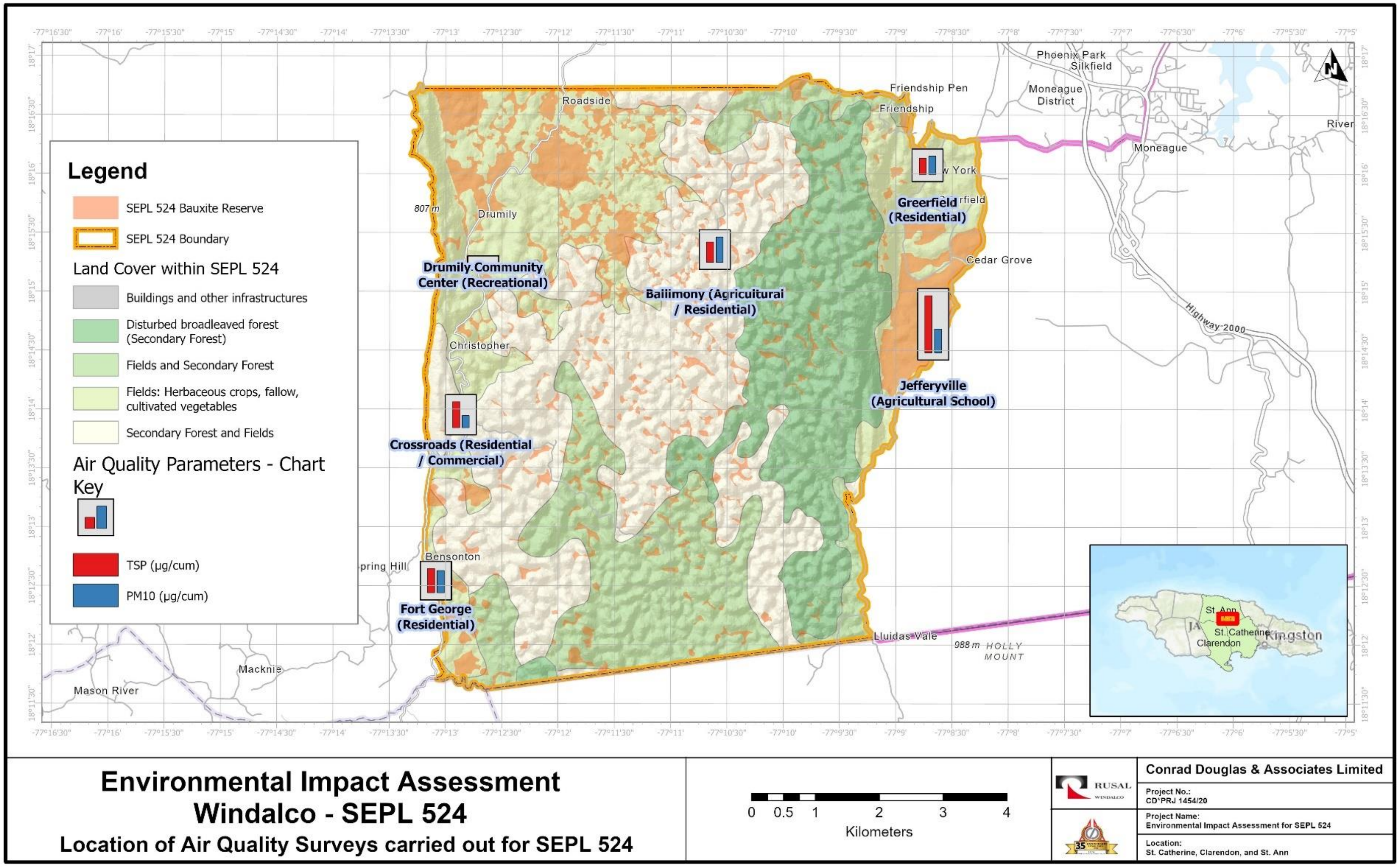


Figure 5-26: Location of Air Quality Monitoring (AQM) Surveys carried out for SEPL 524

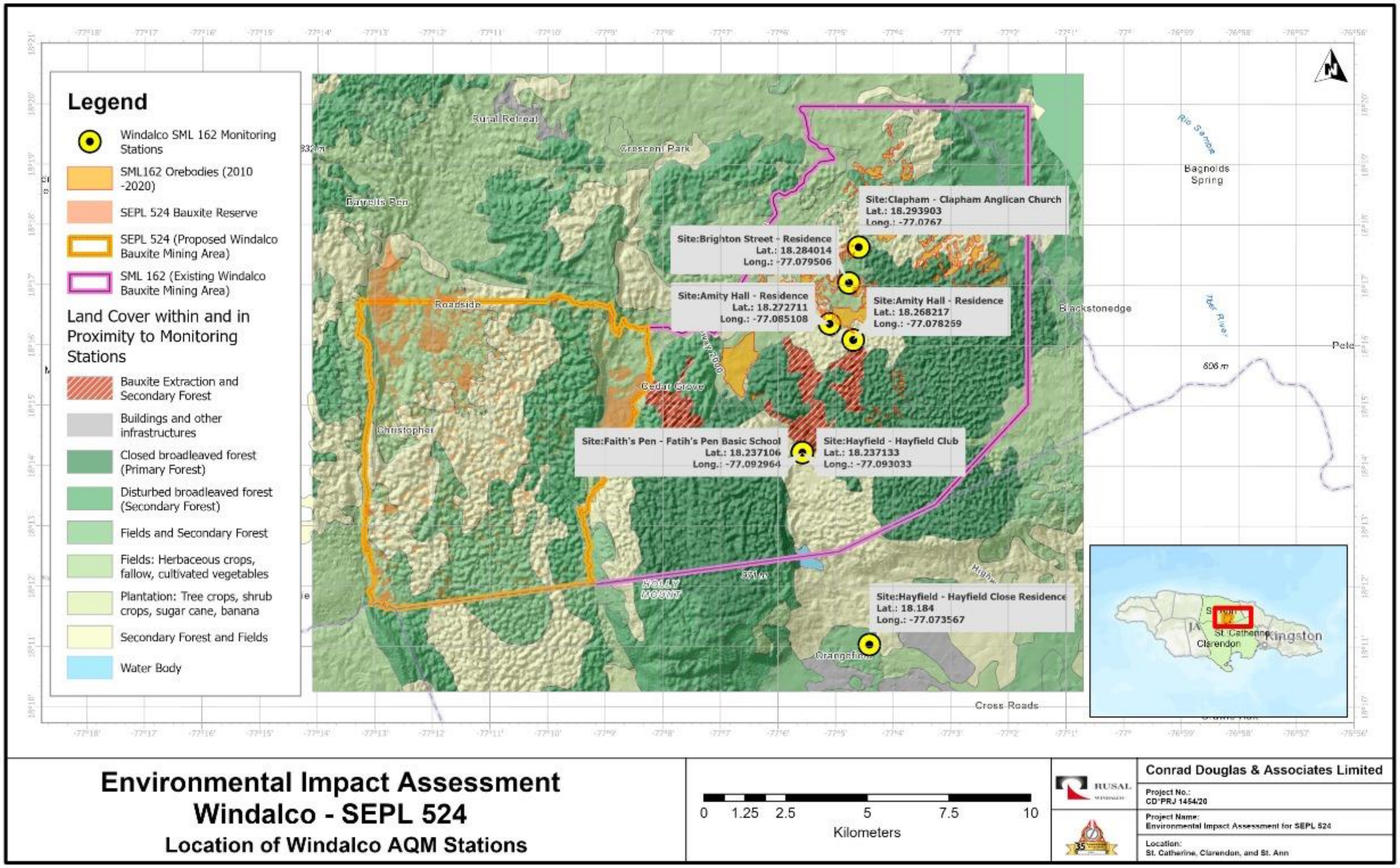


Figure 5-27: Location of Windalco AQM Stations

The dates of sampling are provided in Table 5-8 below.

Table 5-8: Date and Time of Sampling for TSP and PM_{10}

Site Name	Landuse in at Sample Site	Date of Sampling for TSP	Date of Sampling for PM_{10}	Time of sampling (TSP and PM_{10})
APMS 1	Residence – Greirfield	19-July-2020	17-July-2020	00:00
APMS 2	Agricultural School	17-July-2020	17-July-2020	00:00
APMS-3	CrossRoads - Residential/Commercial	23-July-2020	23-July-2020	00:00
APMS-4	Fort George - Residential	23-July-2020	23-July-2020	00:00
APMS-5	Balimony- Agricultural/ Residential	19-July-2020	29-July-2020	00:00

5.1.7.3. Results and Discussions

The results of the sampling of PM_{10} and TSP by Windalco in SML 162 are presented on a yearly basis in Figure 5-28 to Figure 5-40. Each graph present the data obtained from each monitoring site over the period 2010 – 2020.

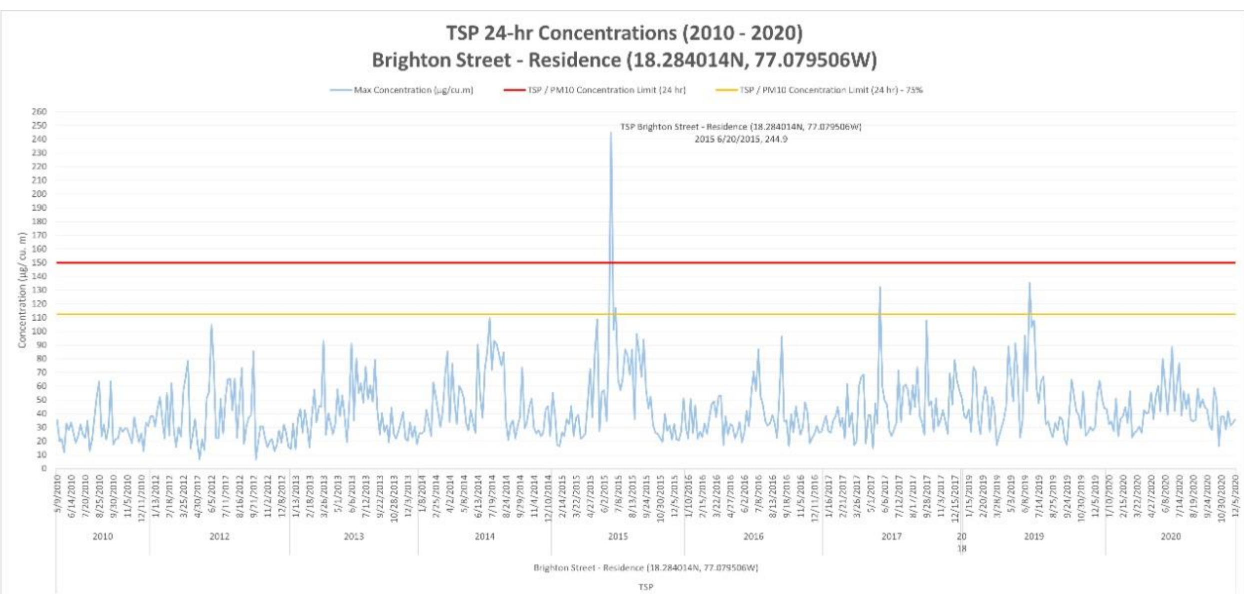


Figure 5-28: TSP 24-hr measurements at Brighton Street Residence in SML 162 for 2010 – 2020

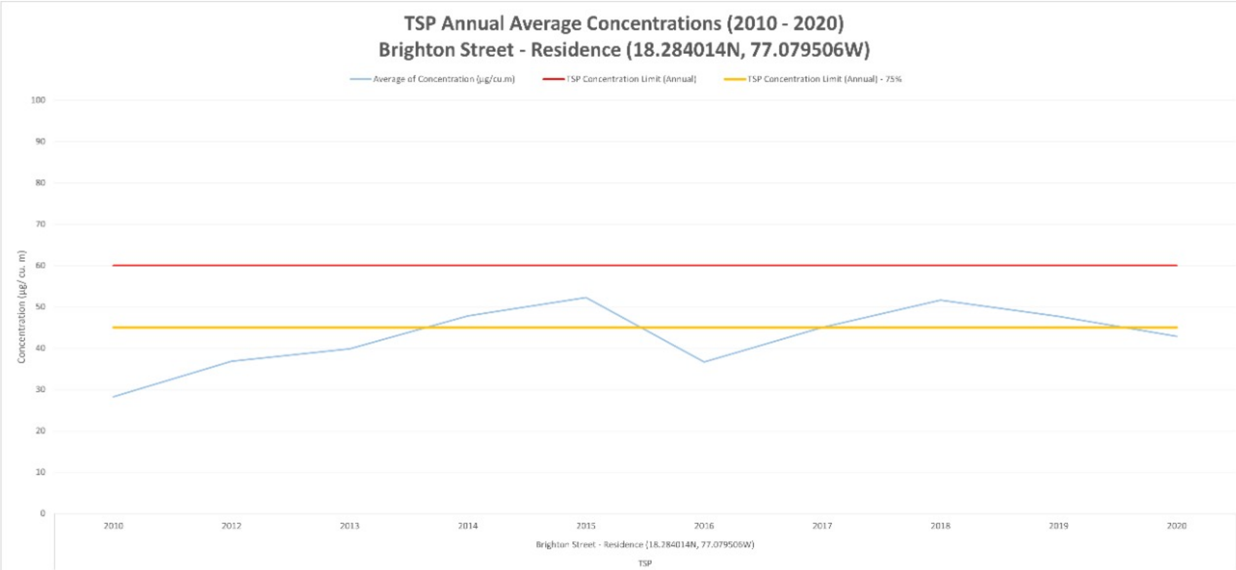


Figure 5-29: TSP Annual Average Concentrations at Brighton Street Residence in SML 162 for 2010 – 2020

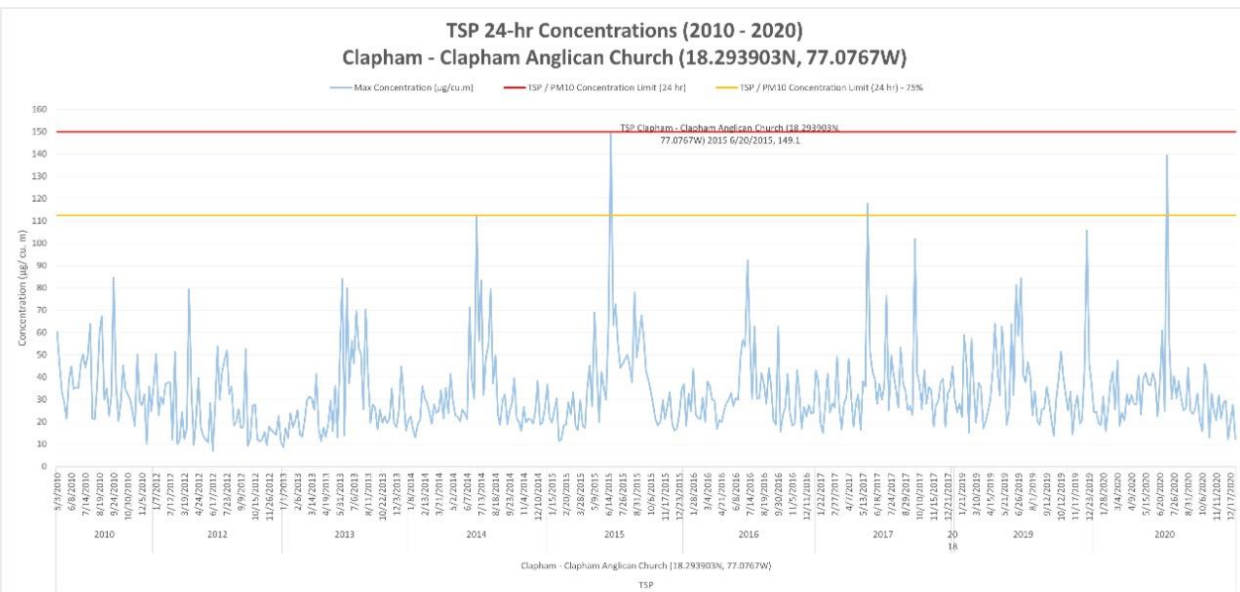


Figure 5-30. TSP 24-hr Measurements at Clapham Anglican Church in SML 162 for the period 2010 -2020

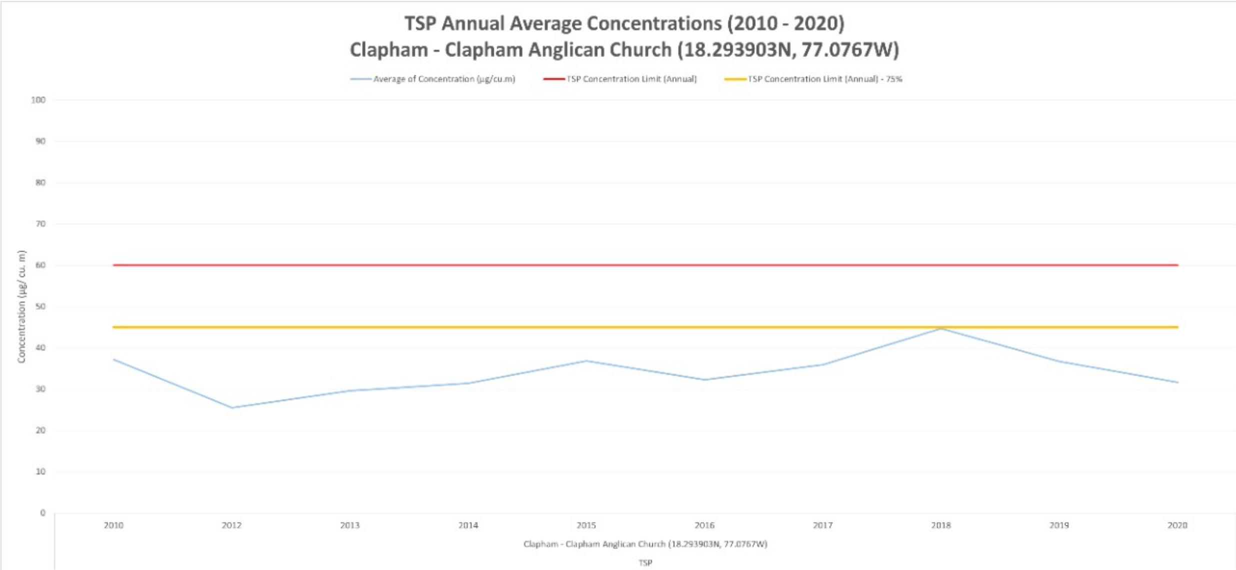


Figure 5-31: TSP Annual Average Concentrations at Clapham Anglican Church in SML 162 for the period 2010 -2020

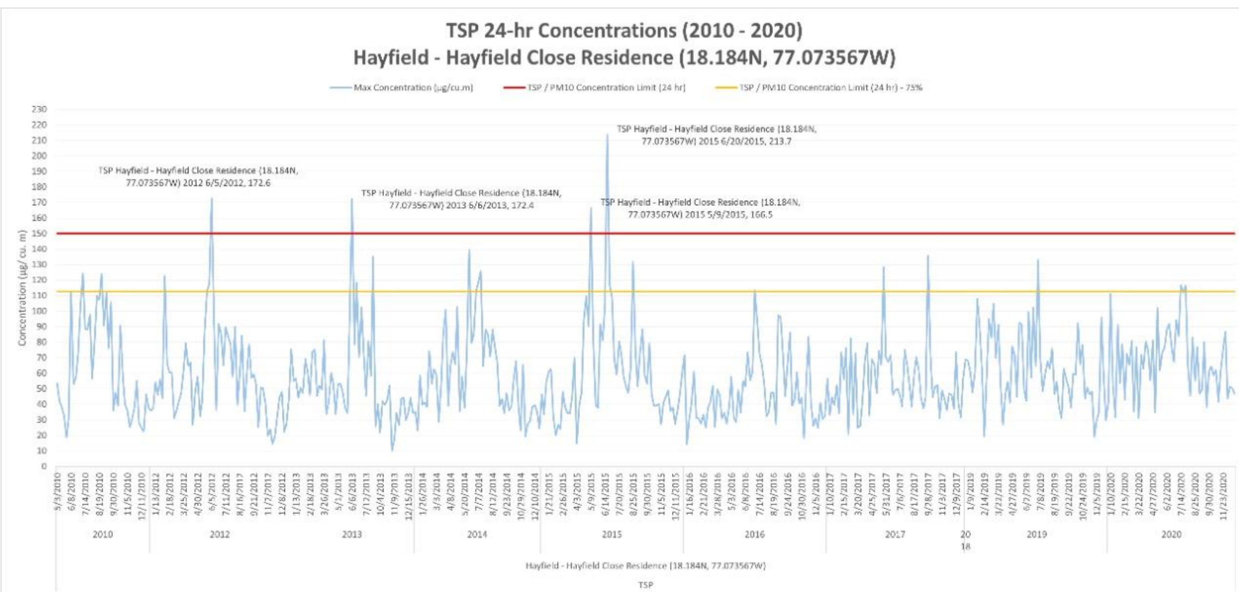


Figure 5-32: TSP 24-hr Concentrations at Hayfield Close in SML 162 for the period 2010 – 2020

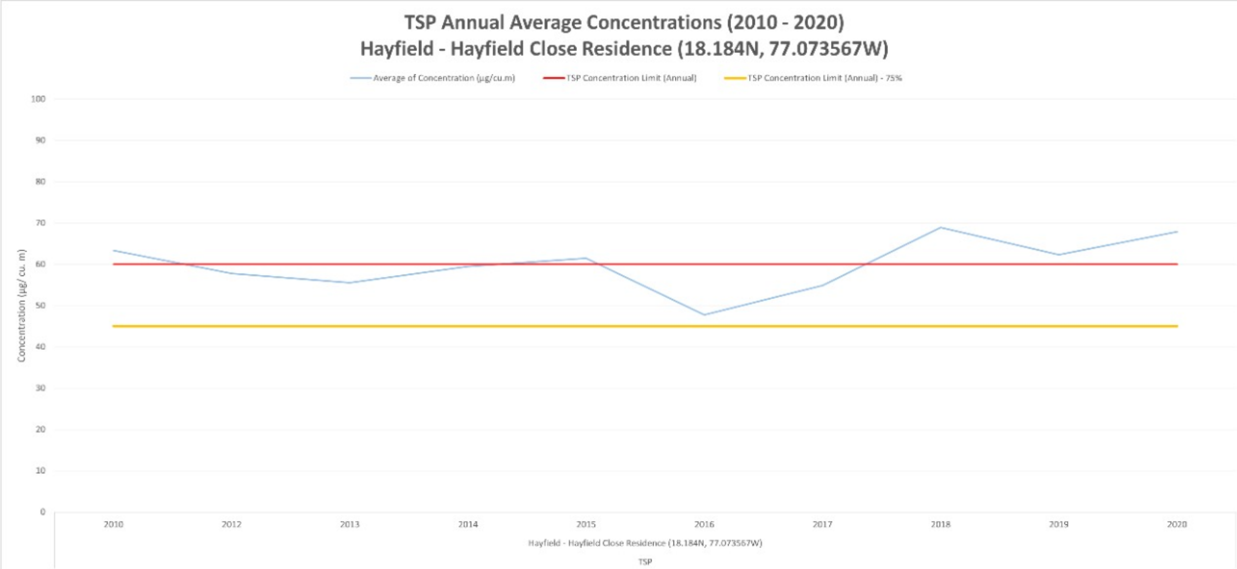


Figure 5-33: TSP Annual Average Concentrations at Hayfield Close in SML 162 for the period 2010 – 2020

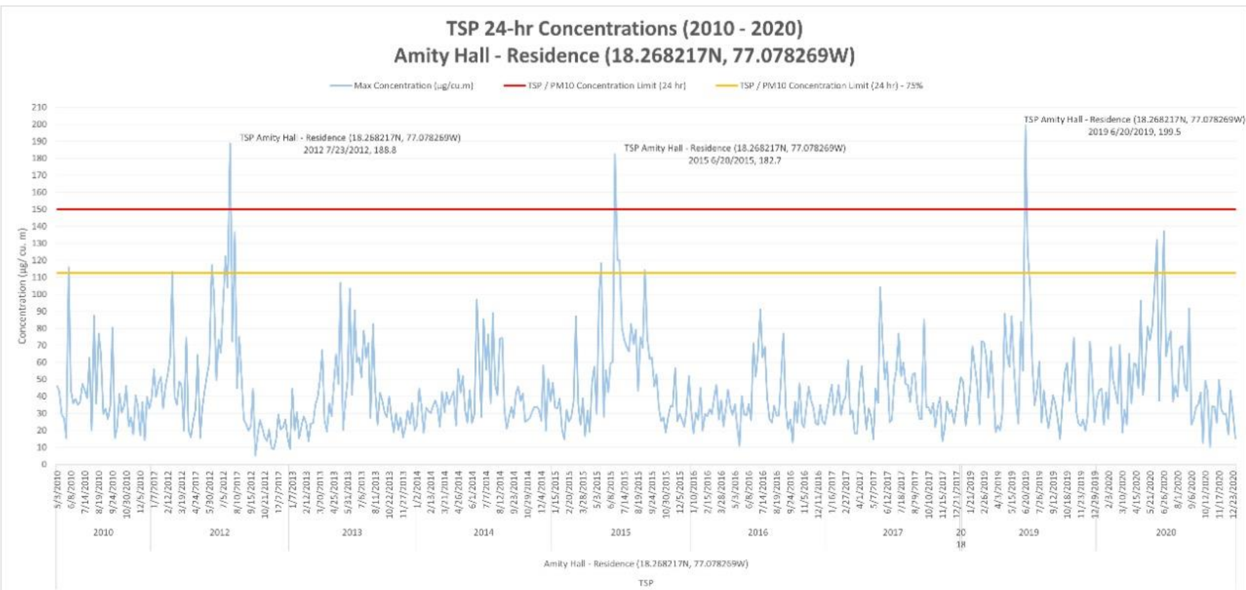


Figure 5-34: TSP 24-hr Concentrations at Amity Hall in SML 162 for the period 2010 – 2020

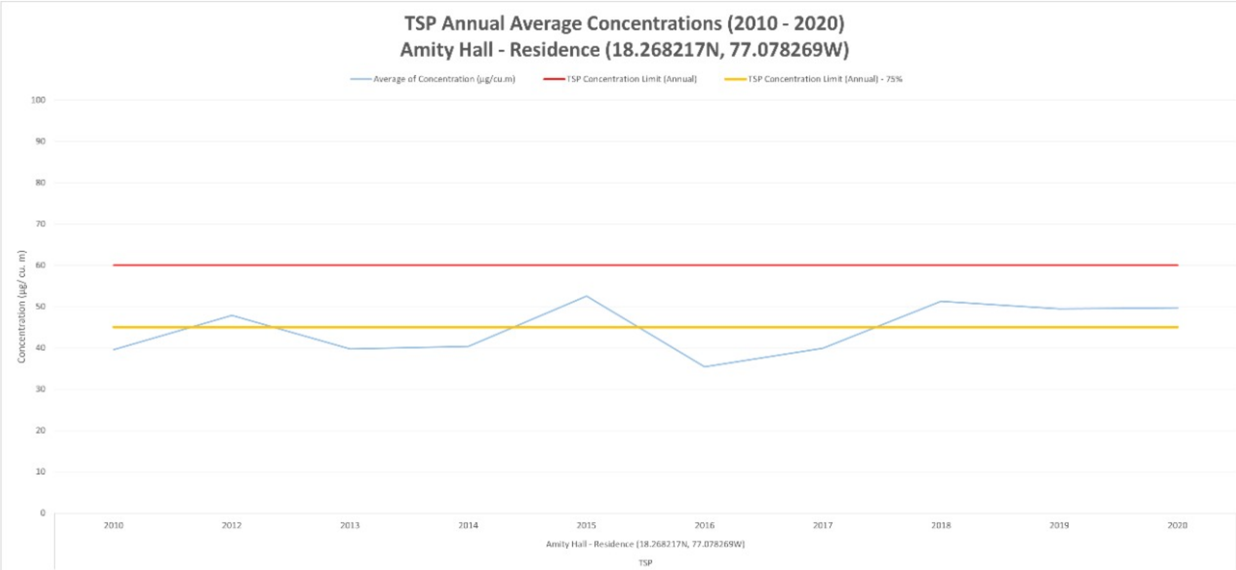


Figure 5-35: TSP Annual Average Concentrations at Amity Hall in SML 162 for the period 2010 – 2020

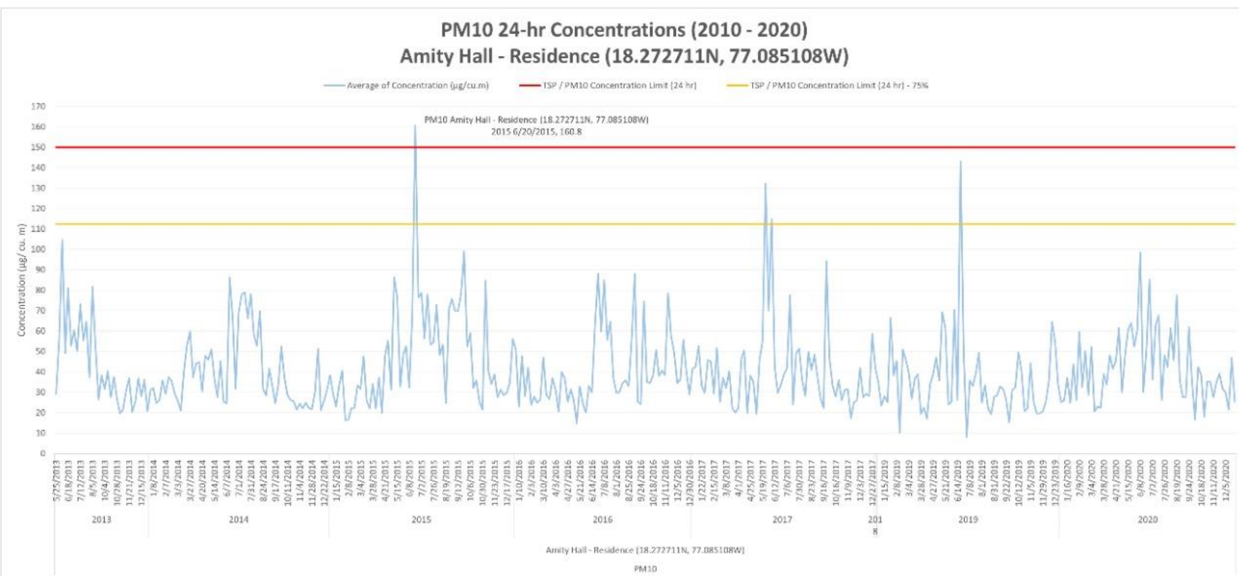


Figure 5-36: PM_{10} 24-hr Concentrations at Amity Hall in SML 162 for the period 2010 – 2020

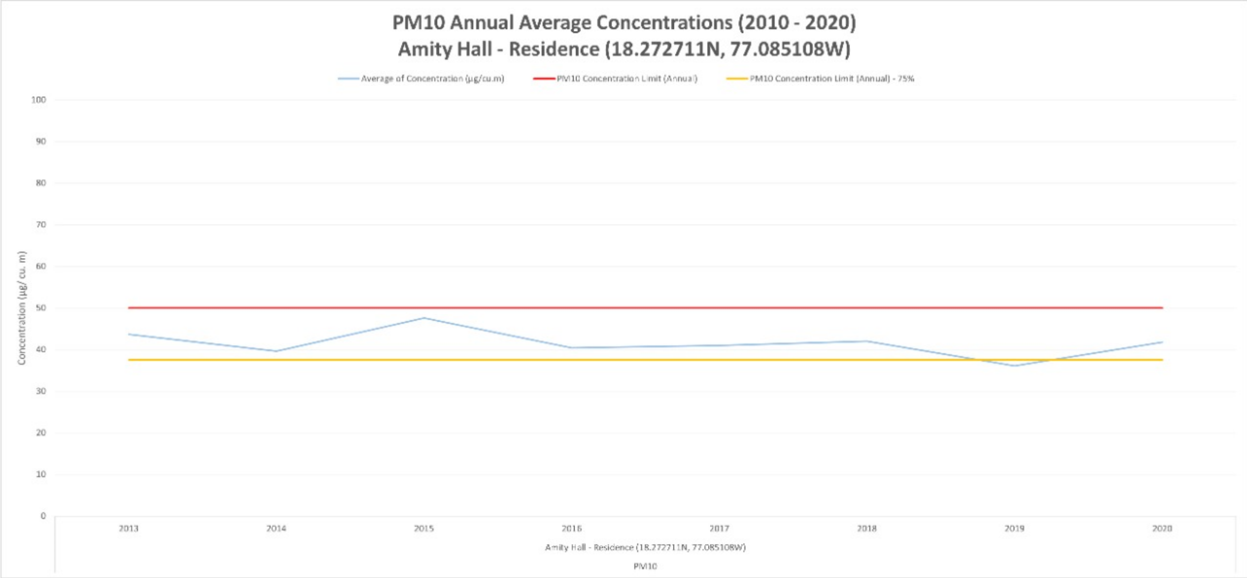


Figure 5-37: PM$_{10}$ Annual Average Concentrations at Amity Hall in SML 162 for the period 2010 – 2020

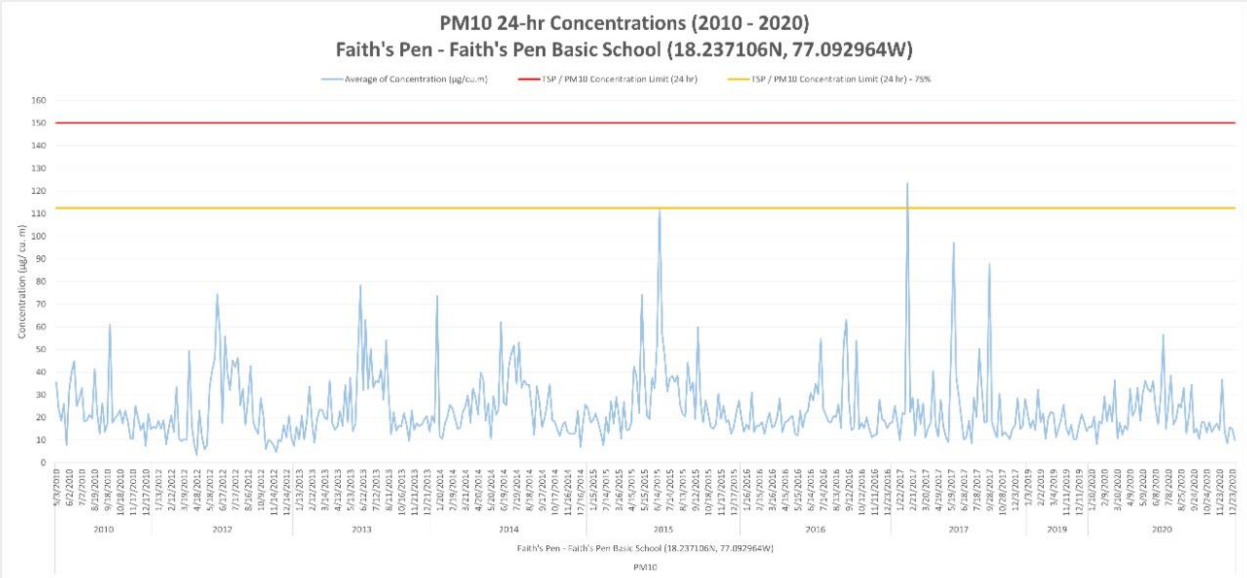


Figure 5-38: PM$_{10}$ 24-hr Concentrations at Faith's Pen in SML162 for the period 2010 – 2020

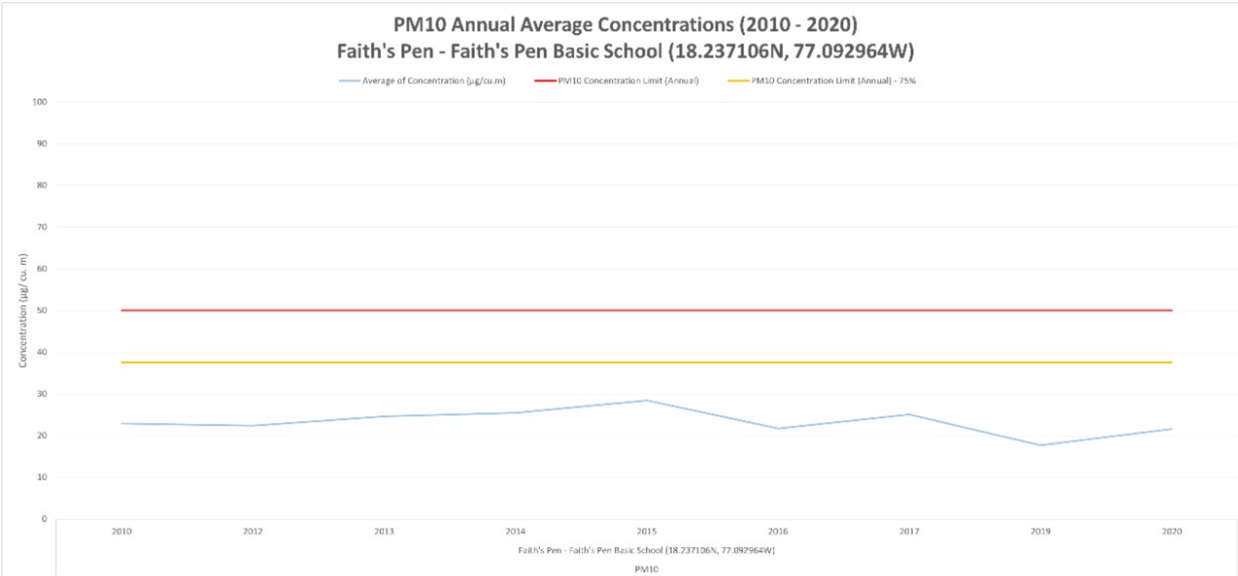


Figure 5-39: PM$_{10}$ Annual Average at Faith's Pen in SML162 for the period 2010 – 2020

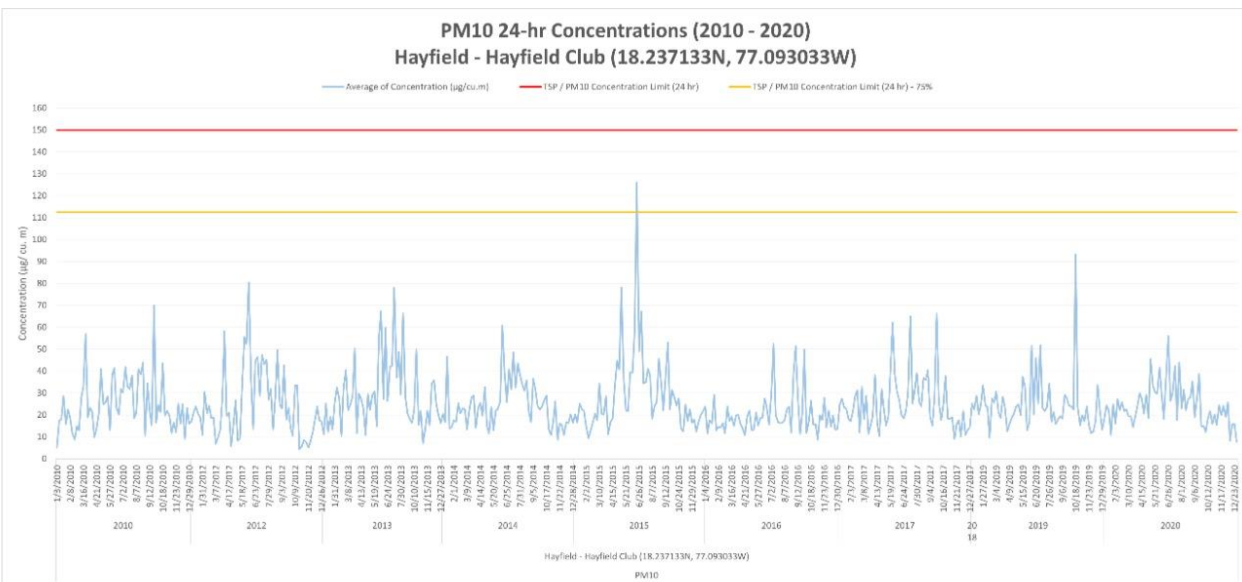


Figure 5-40: PM$_{10}$ 24-hr Concentrations at Hayfield Sports Club in SML 162 for the period 2010 – 2020

The general trend in the data at each site is a peak in the summer months which coincides to the incidences of Sub-Saharan dust movement across the region. The peak measurements at each site can be correlated to the incidence of Sub-Saharan dust in most instances. Burning within the communities surrounding the monitoring sites has also occurred and resulted in elevated particulate concentrations. The impact of mining activities on PM_{10} concentration and TSP concentrations are not discernible as there is no sustained increase in concentration in any fraction when new areas are mined in proximity to the monitoring sites. For instance, the 2010 annual average at Amity Hall is not significantly different from the 2015 or 2014 average when mining was occurring less than 300 m from the monitoring station.

The data shows that generally particulate concentration are well within the standards set for health protection in SML 162. There is a high level of compliance with the standards for health protection and breaches are observed due to activities not associated with mining. These include fires and the movement of Saharan Dust across the region. The SML 162 is of good air quality outside of these episodes. These measurements are obtained during active mining as well as in areas where there is no mining.

The results of the sampling exercises conducted during this study are presented in Table 5-9 below. The 24-hour measurement is presented for particulate matter. The results of the sampling exercise indicate that the air quality within the SEPL 524 during the sample exercise was good as the measurements were within the standard set for health protection. The concentrations of PM_{10} and TSP measured in the SEPL are within the daily standard set of PM_{10} and TSP. There was no significant Sahara Dust feature across the region during the sampling period hence no exceedance of the standards were anticipated.

Table 5-9: Averaged Result for Particulate Matter

Site Name	Land Use at site	PM_{10} (ug/m^3)	TSP (µg/m^3)
		150	150
AQMS 1	Residence – Greirfield	20.85	18.53
AQMS 2	Agricultural School	27.22	65.39
AQMS-3	CrossRoads -Residential/Commercial	13.90	29.75
AQMS-4	Fort George - Residential	25.48	27.80
AQMS-5	Balimony- Agricultural/ Residential	28.96	23.16

The comparison between Jamaica Ambient Air Quality Standard (JAAQS) and the values obtained in this baseline assessment of air quality are presented in Figure 5-41 and Figure

5-42 below. These compare the 24-hour standards for PM with those obtained in the measurements associated with this study.

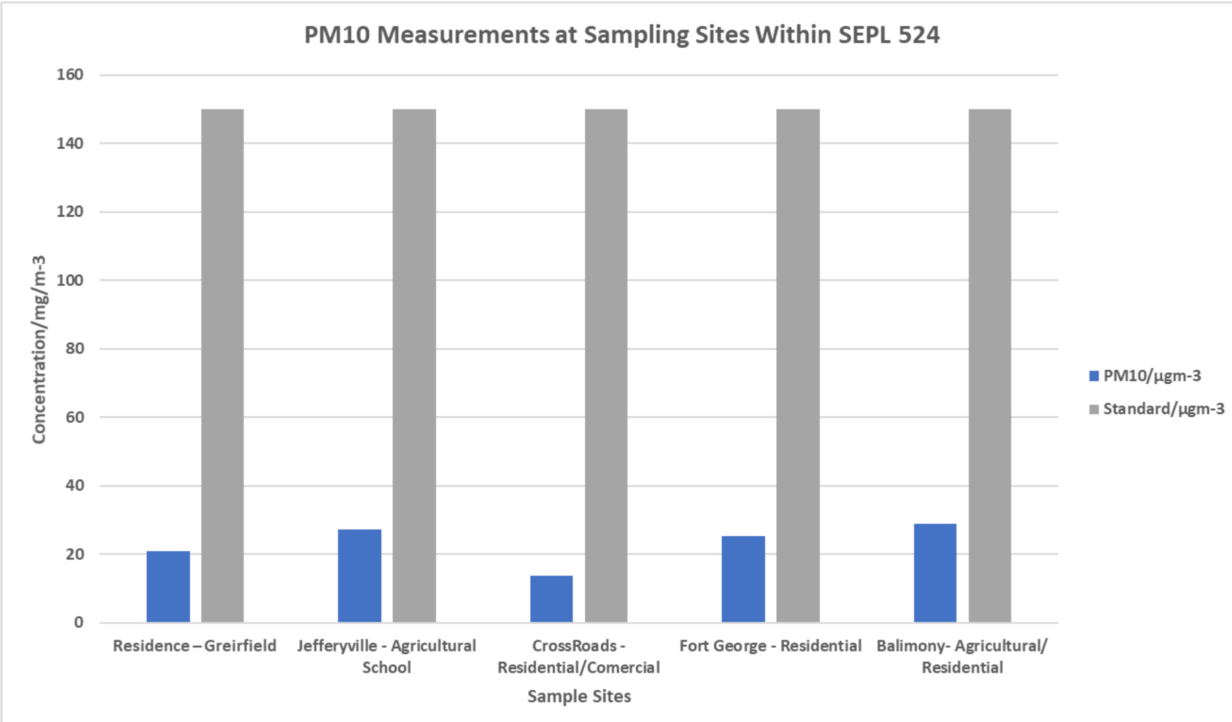


Figure 5-41: 24-hour PM_{10} measurements from Active Monitor Compared with JAAQS

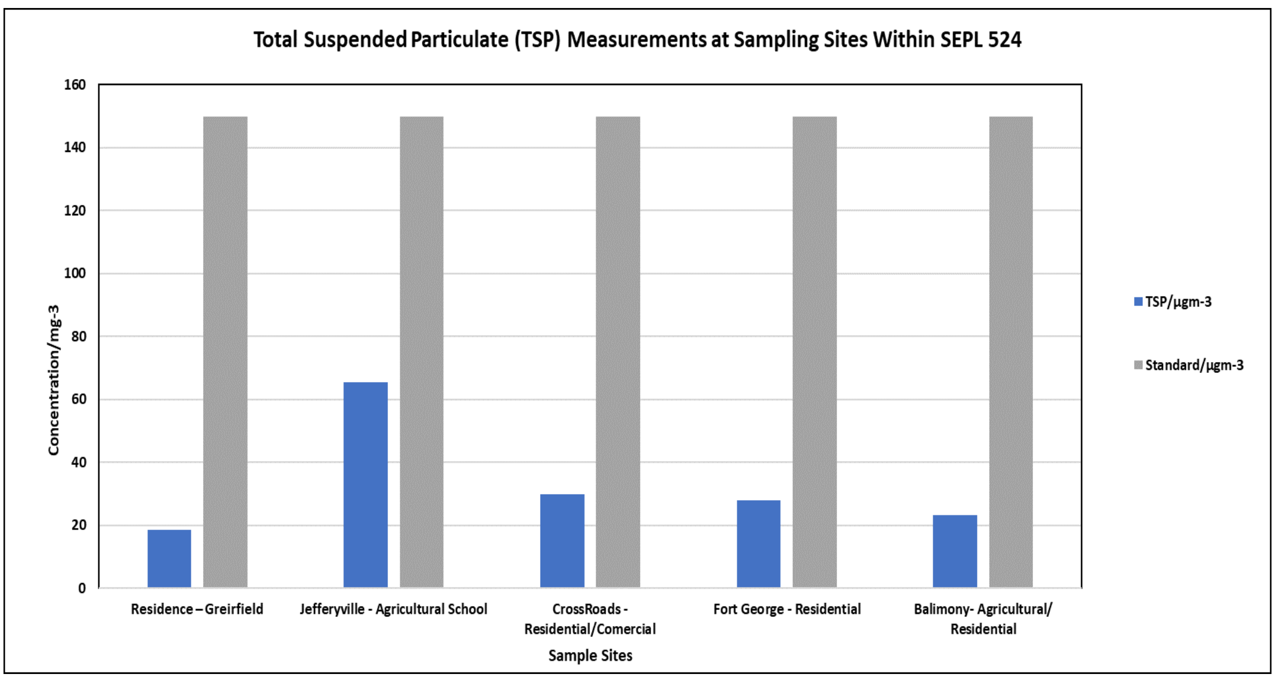


Figure 5-42: 24-hour TSP measurements from Active Monitor Compared with JAAQS

The data collected showed that the standards are not breached for any of the PM sampled in the baseline assessment.

The activities associated with the proposed project are not expected to generate excessive pollutants at sensitive receptors since the project is distributed over a large area of lands and the generated dust (mainly TSP) will fall out of the air stream before leaving the property boundary of the orebodies being mined.

Trucks will transport the bauxite to the loading area however the pollutant generated from the combustion of fossil fuel to power engines will be insignificant. The main pollutant will be dust generated from the movement of the trucks along haul roads. This will be localized to areas close to the roadways. It is obvious from the data in SML 162 that these elevated TSP concentrations are not detected at any significant distances from the mining orebodies or the haul roads.

Windalco will establish dust monitoring stations in proximity to the mining areas. Dust suppression will be carried out using water for irrigation along haul roads and within mining areas. The frequency of the wetting of surfaces will vary depending on weather conditions. A log of dust suppression measures will be maintained and made available for inspection by NEPA.

5.1.8. Water Quality

Water quality sampling (Figure 5-43 below) was conducted over the period of July 17 to July 29, 2020 and sent to a reputable, certified laboratory for analysis. The locations that samples were collected from are as follows:

- Pedro River, (N 18.195308 , W 77.218033)
- Little River, (N 18.241027, W 77.231282)

5.1.8.1. Parameters

Water quality parameters evaluated were nitrates, phosphates, total dissolved solids, total suspended solids, oil/grease, total coliform, faecal coliform and biochemical oxygen demand.

Table 5-10 below shows the results of the water sampling compared to the Jamaica National Ambient water quality standard (Freshwater) and the Jamaica National Trade Effluent Standard.

Table 5-10: Water Quality Results and comparison against standards

Parameter	Test Method	Detection limit	Pedro river	Little River	Jamaica Ambient Water Quality Standard (Freshwater)	Jamaica National Trade effluent Standard
Nitrate, mg/L	COL EPA 352.1	0.5 mg/L	<0.5	<0.5	0.1- 7.5	10 mg/L
Phosphate, mg/L	COL	0.05 mg/L	0.10	<0.05	0.01 - 0.8	5.0 mg/L
Total Dissolved solids, mg/L	GRAV	1.0 mg/L	255	177	120.0-300	1000mg/L
Total Suspended Solids, mg/L	GRAV	1.0 mg/L	20	24.5		<150 mg/l
Oil and Grease. Mg/L	GRAV SMEWW 5520B	1 mg/L	<1	<1		10 mg/l
Total Coliform	SMEW Method 9221-B		1600	540		< 500 MPN/ 100ml

Parameter	Test Method	Detection limit	Pedro river	Little River	Jamaica Ambient Water Quality Standard (Freshwater)	Jamaica National Trade effluent Standard
MPN/100 mL						
Faecal Coliform MPN/100 mL	SMEW Method 9221-E.1		110	350		<100 MPN/ 100ml
Biochemical Oxygen Demand mg/L	HACH Method 8043		1.09	0.95	0.8- 1.7	<30 mg/L

5.1.8.2. Analysis of water quality results for Pedro River and Little River

5.1.8.2.1. Pedro River

The parameters were within all the standards except for the following results:

- **Phosphate**- The result of 0.10mg/L exceeded the Jamaica Ambient Water Quality Standard (Freshwater) of 0.01 - 0.8 mg/L.
- **Total Coliform-** The result of 1600 MPN/100 mL exceeded the Jamaica National Trade effluent Standard of < 500 MPN/ 100ml
- **Faecal Coliform-** the result of 110 MPN/100 mL exceeded the Jamaica National Trade effluent Standard of <100 MPN/ 100mL.

5.1.8.2.2. Little River

The parameters were within all the standards except for the following results:

- **Total Coliform-** The result of 540 MPN/100 mL exceeded the Jamaica National Trade effluent Standard of < 500 MPN/ 100ml
- **Faecal Coliform-** the result of 350 MPN/100 mL exceeded the Jamaica National Trade effluent Standard of <100 MPN/ 100mL.

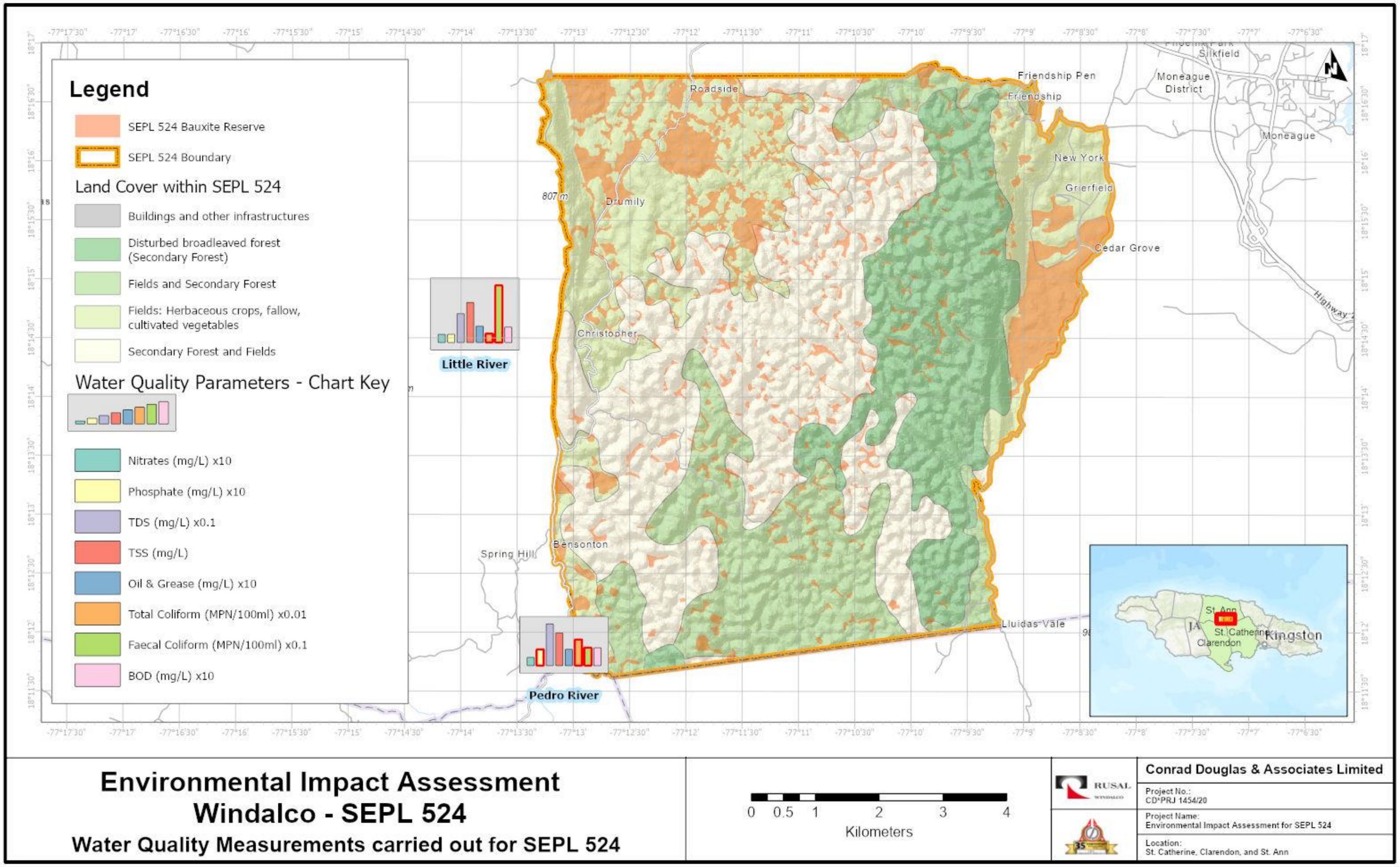


Figure 5-43: Water Quality Sampling Sites

5.1.9. Noise Assessment

Continuous spot measurements for noise levels were conducted over minimum and maximum measurement periods of 13 and 30 minutes respectively. An EXTECH ANSI and IEC 651 Type 2 compliant noise meter was used to measure the equivalent continuous sound pressure level at six (6) areas within the boundary of SEPL 524 as shown in the map below. The noise meter was set to carry-out fast response measurements with an A-weighted frequency weighting to simulate the noise levels that would typically be perceived by the human ear.

The average LAeq measurement recorded over each of the measurement periods are shown in the map below.

The one-minute averages over each measurement period were assessed against the Jamaica National Noise Standard (JNNS) limit of 55 dBA. These are illustrated in the graphs below. The following should be noted:

- Only two (2) areas showed episodic exceedances of the standard limit of 55 dBA. The increased noise levels were caused by team activities (drone flights) during the sampling period.
- All averages over the period were within the standard limit of 55 dBA

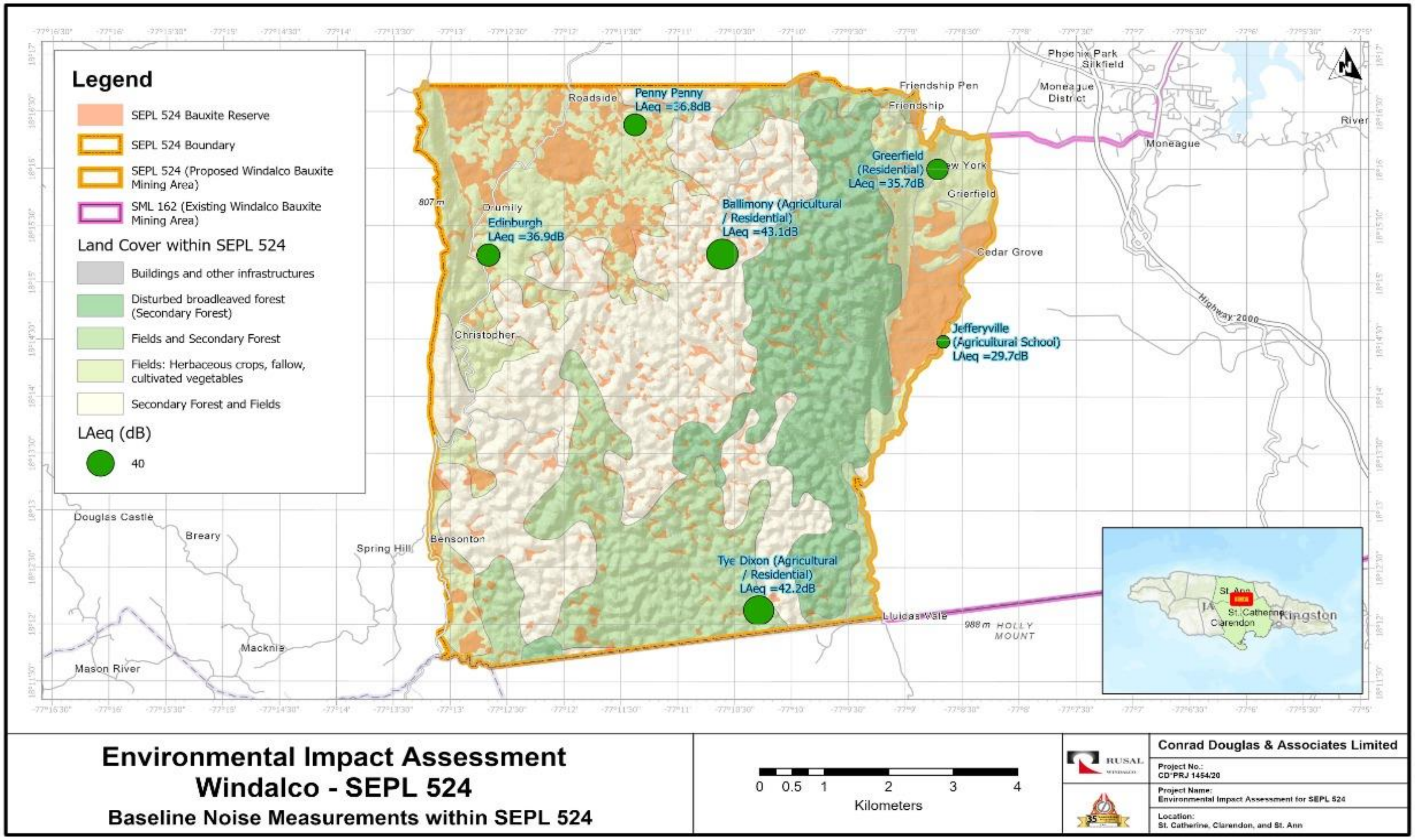


Figure 5-44: Location of Baseline Noise Measurements and their Average One-minute Noise Level Recorded over their Respective Measurement Periods.

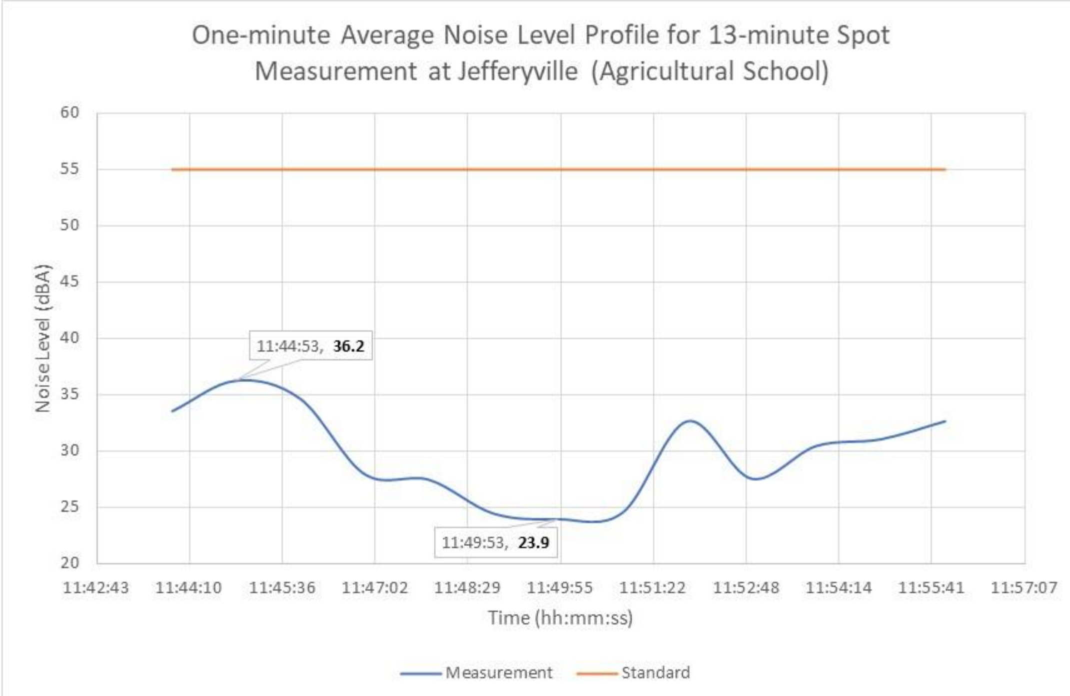


Figure 5-45:One-minute Average Noise Level Profile for 13 minute Spot Measurement at Jefferyville (Agricultural School)

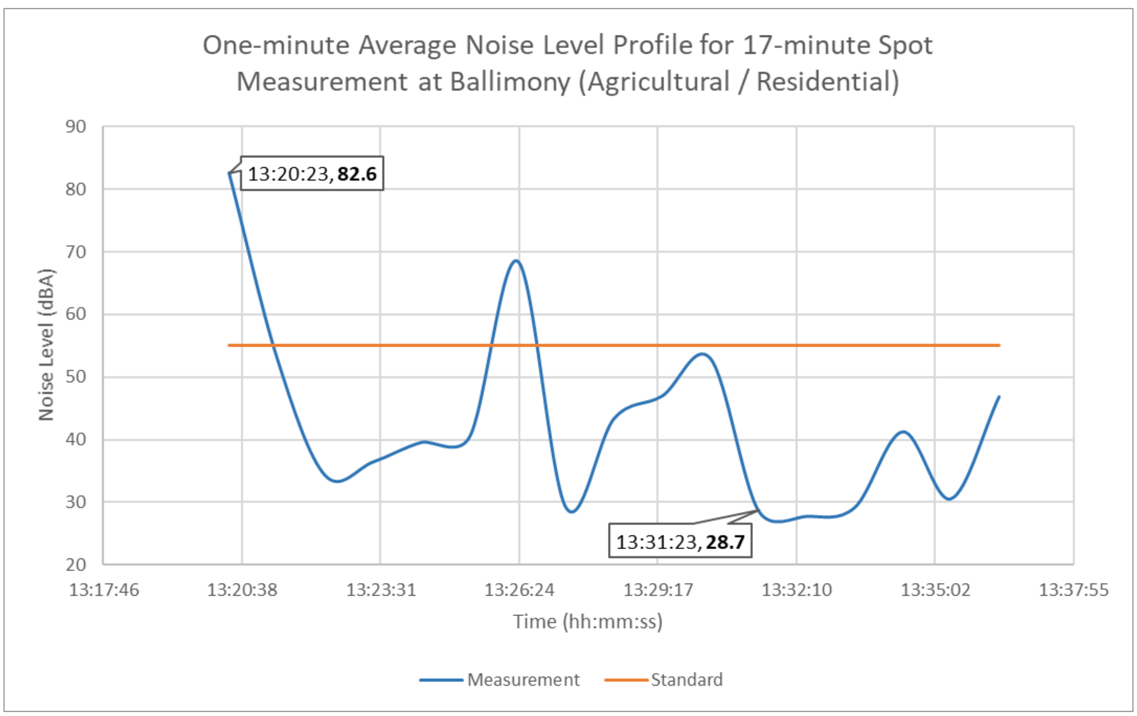


Figure 5-46:One-minute Average Noise Level Profile for 17-minute Spot Measurement at Ballimony (Agricultural / Residential)

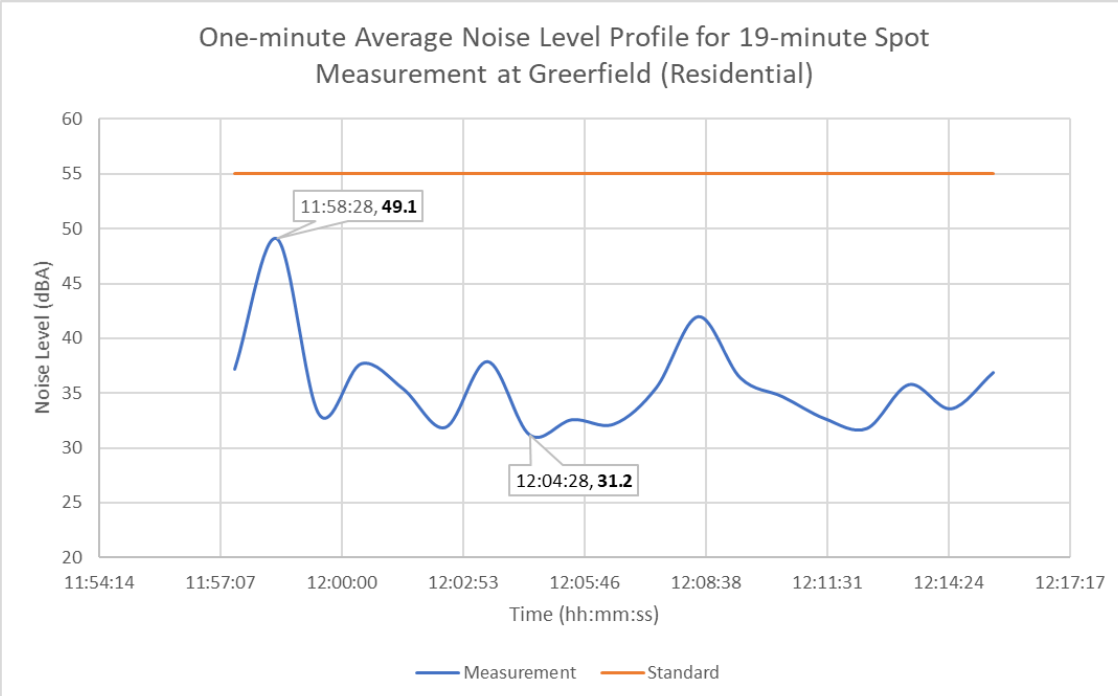


Figure 5-47:One-minute Average Noise Level Profile for 19- minute Spot Measurement at Greerfield (Residential)

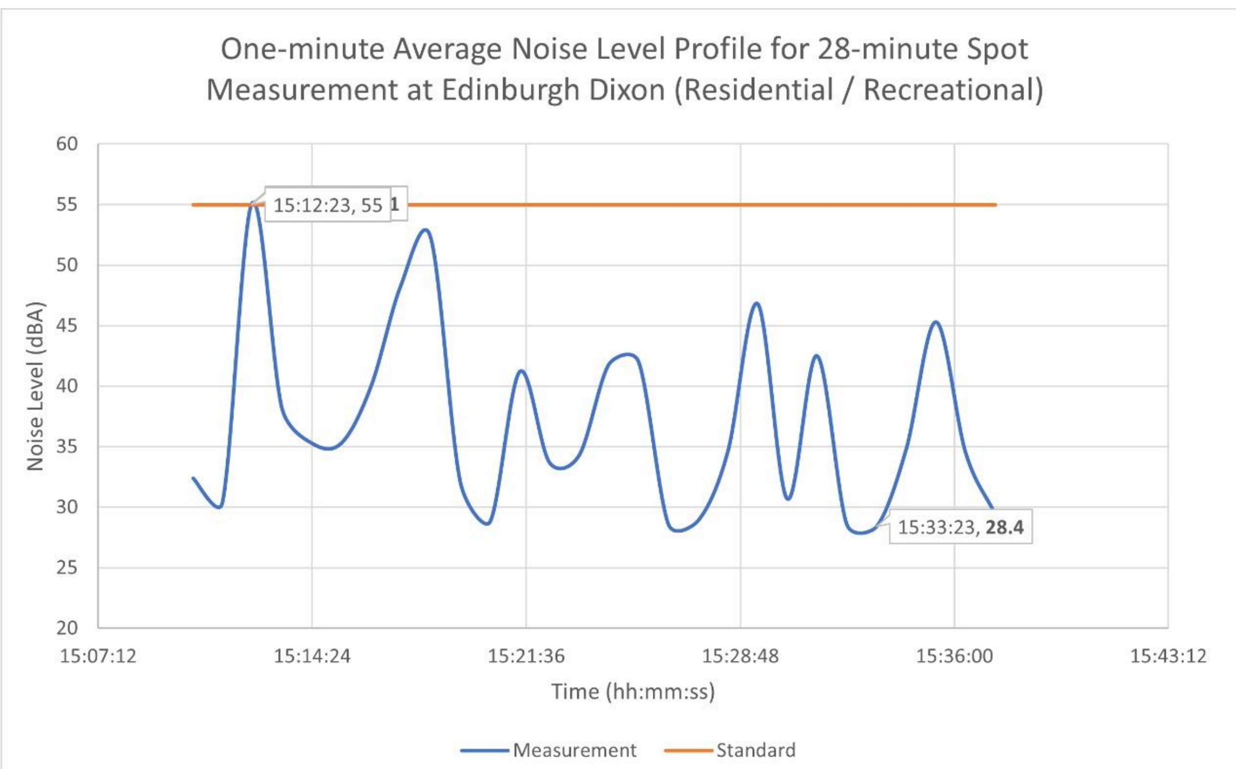


Figure 5-48: One-minute Average Noise Level Profile for 28- minute Spot Measurement at Edinburgh Dixon (Residential/Recreational)

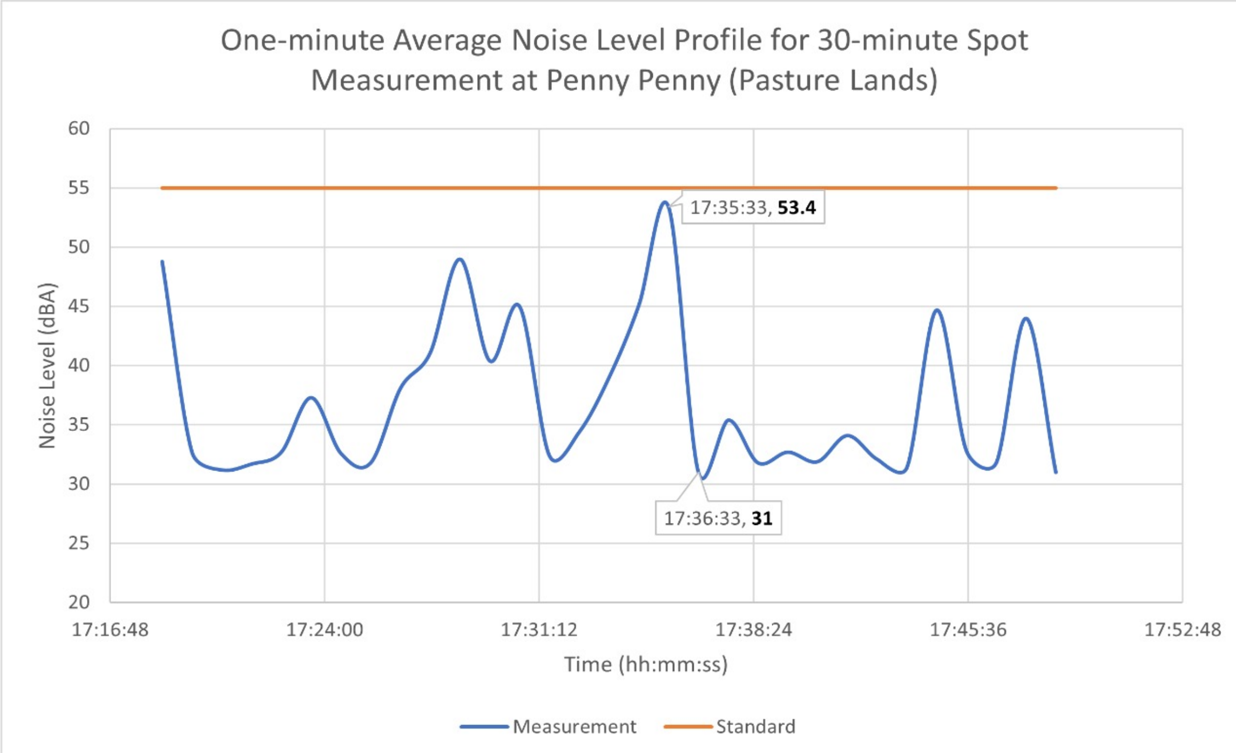


Figure 5-49: One-minute Average Noise Level Profile for 30- minute Spot Measurement at Penny Penny (Pasture Lands)

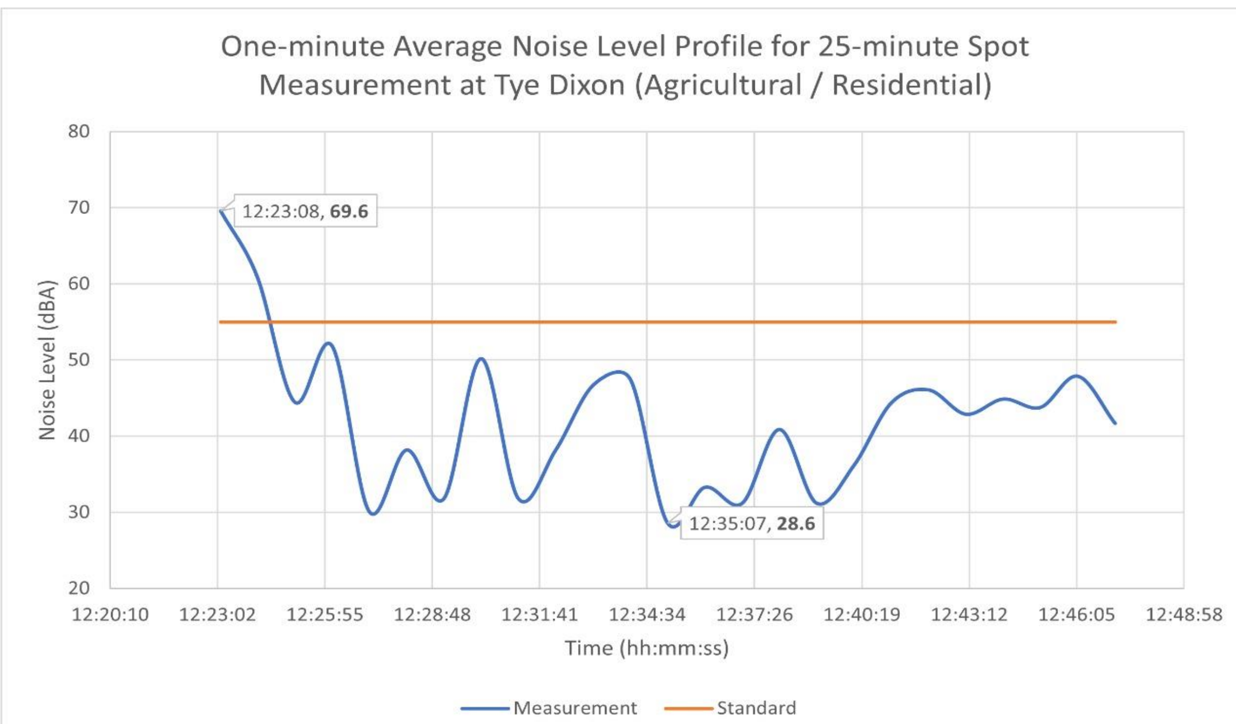


Figure 5-50: One-minute Average Noise Level Profile for 25- minute Spot Measurement at Tye Dixon (Agricultural/Residential)

5.1.10. Sources of Pollution Existing and Extent of Contamination

5.1.10.1. Introductions

The SEPL 524 is sparsely populated with no significant industrial activity occurring in the area. The major activity is farming. This includes small plots as well as large cattle ranging areas.

Figure 5-51: Aerial view of the SEPL 524 from the middle of the SEPL

The development of communities within the area is along the major road that traverses the SEPL. Farm roads are abundant in SEPL 524 which are used for many purposes including produce distribution, access to remote residential areas and farms hiking. Figure 5-52 shows the typical development pattern within SEPL 524.

Figure 5-52: Aerial View of a populated section of the SEPL. Main road on the left with all developments along the main road.

The activities within SEPL 524 has potential for pollution of the various elements of the environment. This section provides information of the potential pollution sources and their distribution throughout the SEPL 524.

Figure 5-53. Aerial View of the SEPL 524 from the Middle of the SEPL

5.1.10.2. Approach and Methodology

CD&A implemented a programme of site visits (to view the various areas of the SEPL 524. Photography was critical in developing a cadre of descriptors for the different potential pollutant sources within the SEPL 524.

5.1.10.3. Findings

Potential Environmental Pollutant Sources Presently in the SEPL are as follows:

1. Air pollutants Sources
    a. Road Traffic
    b. Forest fires
    c. Domestic fires – garbage incineration and food preparation fires

   d. African Dust
   e. Movement of Cattle in dry spells
   f. Accidental Fires – homes, vehicles, etc
2. Soil Pollution
   a. Fuel leaks from Vehicles
   b. Repair shops in communities along the main roads
   c. Broken down vehicles as they traverse the roads in the SEPL
   d. Wastewater from cook shops and commercial activities within the SEPL
   e. Sewage from pit toilets
   f. There is no established sewage management system in the SEPL.
   g. Solid waste disposal
   h. Batteries from vehicles and other parts
   i. Household garbage
   j. Commercial garbage
3. Water Pollution
   a. Fuel Leaks from Vehicles
   b. Sewage from pit toilets
   c. Solid waste disposal

5.1.10.4. Distribution of Sources of Pollution

There are a myriad of existing pollution sources within the SEPL. They are distributed all throughout the SEPL where humans have settled and carry out daily activities. The major areas of concerns are described below.

An active quarry was observed on the western boundary of the SEPL and heavy equipment was observed on the site. These activities could result in oil spills within the quarries and on the roads as heavy-duty vehicles transport quarried material throughout the SEPL. Figure 5-54 shows the equipment onsite and the quarried areas in the background.

Figure 5-54: Heavy Equipment at Quarry site on the western edge of the SEPL

The communities to the south west of SEPL 524 are prone to flooding and leptospirosis outbreaks have occurred in the area. Figure 5-55 shows a sign in the community warning of this possibility. This could result from sewage contamination of water as a result of flood pit latrines or improper disposal of sewage.

Figure 5-55: Existing Sign in Fort George Area indication potential for bacterial contamination of water

Farming and cattle rearing are major activities within the SEPL. These have the potential for contamination of land and water by the use of fertilizers and improper disposal of waste from both plant and animal rearing. This is widespread throughout SEPL 524 as most of the orebodies are now under some form of cultivation or animal rearing. Figure 5-56: shows active animal rearing in a populated area of SEPL 524. Cattle and horse rearing are common throughout SEPL 524.

Throughout SEPL 524 there are dwellings without proper sewage management facilities. In some communities the odor of raw sewage was evident. These include communities with derelict and old houses that do not have functioning waste management systems. These areas we suspect are already contaminated with human waste.

Figure 5-56: Cattle and Chicken Rearing at a homestead in Grierfield in the North eastern section of SEPL 524

Figure 5-57: A - Derelict occupied house in the south of the SEPL 524 | B - Unplanned development in close proximity

The proliferation of residential burial grounds is very evident within SEPL 524. All areas that have settlements have lots of graves within family plots and also community plots. These are within close proximity to the ribbon development along the main road. These can be sources of water and soil contamination if graves are not properly sealed. Figure 5-58: shows one of many such plots in the southern part of SEPL 524.

Figure 5-58: Family or Community burial plot in Southern section of the SEPL 524

The developments along the road usually comprise small commercial 9food shops, cookshops, farm store) churches, homes and schools. Figure 5-59: shows on such community in the eastern edge of SEPL 524. this area has churches, schools, community center, postal agency etc. These all generate waste and has the potential to pollute the lands and water sources in their vicinities. This type of development pattern is replicated throughout the SEPL and thus there is significant potential for environmental pollution throughout the SEPL.

Figure 5-59: Aerial View of the Gibraltar to Jefferyville community

5.2. Ecosystems services

There are many benefits that humans acquire from the natural environment. The natural environment of the SEPL 524 has been modified by human activities over the years by activities which have exploited these benefits in many of the areas of SEPL 524. There are possibly no areas in the SEPL that have not been impacted by human activities.

The services being provided presently by the natural environment within the SEPL 524 are described in the following sub-sections.

5.2.1. Provisioning services

SEPL 524 presently provides food, water, clean air, minerals and habitats for both plants and animals. These benefit the human population that live within SEPL 524 and also the island as a whole. SEPL 524 provides significant amounts of food from farming of crops and rearing of animals. The surface water in proximity to the SEPL makes its way into both the Rio Cobre and the Rio Minho watersheds. Surface water flows from SEPL 524 percolates into the aquifer, which feeds other catchments to the north of SEPL 524. The water within the SEPL 524 therefore become important to the region and provides life sustaining clean water for areas as far away as Kingston.

The food produced by farming and animal rearing in the SEPL 524 provides sustenance for both the local communities as well as the region and nation. Cattle rearing is a major activity in SEPL 524. Cattle rearing requires large swaths of land as a result the open valley in the north west region of the SEPL is predominantly used for cattle rearing. SEPL 524 spans sections of two (2) agricultural extension areas defined by Rural Agricultural Development Authority (RADA), these are the Claremont Extension and the Moneague extension. SEPL 524 occupies approximately 20% of the land area in Claremont Extension Area and approximately 8% of the land area of the Moneague Extension Area.

The limestone in SEPL 524 is being exploited in some areas to provide construction material for both local and regional construction.

The trees within SEPL 524 are used for fuel wood and furniture making and also for construction of dwelling structures. Trees are also harvested for yam sticks to support the production of yams. The fruits from the trees also form a major portion of the food produced within SEPL 524.

5.2.2. Regulating services

SEPL 524 with the extensive forest cover and various geological features cleans the air and water for the benefit of humans. The forest capture carbon dioxide which helps to regulate the concentration in the atmosphere. The vegetative cover on hillocks and the nature of the substrate of the hillocks regulate the erosion of soils and the infiltration of water into the aquifers. The decomposition of litter also helps to regulate percolation of water to the limestone aquifer and runoff from the hillocks into the existing depressions. The geology helps to regulate the outflow of water into nearby rivers to control potential flooding in adjacent areas.

5.2.3. Cultural services

Cultural services provided by the SEPL include:

1. Recreational – people visit the area to visit caves and hike the hills
2. Religious – people visit the area for church, baptisms, etc
3. Educational – schools exploit the resources for teaching. There is an agricultural school in SEPL 524.

5.2.4. Supporting services

These services comprise the provision of support for the food supply and purification of water. The area acts as a large catchment that feeds stormwater into the aquifers. The limestone bedrock effectively filters the stormwater as it percolates to the groundwater.

Significant flooding occurs in some sections of the SEPL presently. This is important for aquifer recharge and nutrient recycling as materials are eroded from the elevated areas of the SEPL to the pits/depressions.

These flooded depressions are a source of nutrient and water for pioneering species which support the food chain for insects including pollinators which are critical for the production of food.

The hillocks within SEPL 524 provide significant habitat for both plant and animals.

The habitats within SEPL 524 support the predators that prey on insects that can be vectors of disease and helps to protect the populations that may be exposed to these vector carrying insects.

The SEPL is also habitat to the pollinators of food and fruits which supports the food supply for the human population.

All these services are distributed over the SEPL and the vast majority of the SEPL will not be impacted by actual mining. Only 15% of the land mass will be impacted. It is important to note that the vast majority of the hillocks within SEPL 524 will not be impacted from mining activities. Most haul road construction will be confined to existing paths and roadways and existing disturbed areas. Only 8.2%, or less (i.e. 496.7 hectares), of the land area within SEPL 524 will be impacted over the estimated 25-years life of the project. The two (2) agricultural extension areas delineated by RADA comprises approximately 50,000 hectares, of this, a maximum of 496.7 could potentially be impacted by mining over a 25 year period. All impacted areas will all be restored and likely return to farming within 5 years of mining. Windalco has always made its lands available to farms and will continue to do so into the future. The restoration of mined out lands to cattle rearing is routine. Examples of these restorative re-use are plenty in Manchester where a striving cattle industry existed for many years.

The services provided by SEPL 524 presently will not be significantly impacted by the mining activity over time. Food production areas will be restored after mining. The regulating services will return when mining is halted and the areas are rehabilitated. The entire 496.7 hectares will not be impacted at one time therefore long before the last depression/bauxite bearing pit is impacted the first ones to be impacted will have been rehabilitated. It is estimated no more than 100 hectares will be impacted concurrently.

There should be no significant reduction in the services provided by the general area over the lifetime of the project. The mining activity may improve access to area making recreational, hiking and other cultural and educational resources more accessible to a wider cross-section of the population of the community and nation.

5.3. Natural Hazards

5.3.1. Hurricanes

Hurricanes are a part of the natural cycles in Jamaica and with the influences of climate change both the frequency and intensity of storms have increased. However, the effects of other anthropogenic stresses such as deforestation make species more vulnerable to the destruction of remaining habitats. Climatologists have suggested that global warming will increase the frequency and intensity of hurricanes in the Caribbean and this could increase their importance as a threat to the survival of certain species in the study area.

5.3.2. Drought

The study area is vulnerable to drought because of the rapid drainage associated with the limestone substrate. However, it is likely that most of the indigenous species in the area have adapted to the weather pattern.

5.3.3. Fire

There are fire climax communities in nature. It is likely that under conditions that conduce to fires, spontaneous combustion can occur. Anecdotal information suggests that there is an increase in fires as a result of the increase in anthropogenic influence within some communities and these are associated with the clearing of land for agricultural purposes.

5.3.4. Flood and Landslides

The lower lands are vulnerable to flooding when heavy rainfall causes natural drainage through sinkholes to be blocked. The Pedro River / Fort George District area is particularly vulnerable and water gauges have been installed. In October 2019, the Office of Disaster Preparedness and Emergency Management recorded flood heights of up to 19 feet which required evacuation by the Jamaica Defense Force as well as the Municipal Corporation.

There has also been an increase in the incidences of landslides as the steep rocky hills are denuded of vegetation as a result of deforestation.

Figure 5-60 shows recorded flood and landslide events in the SEPL 524 area.

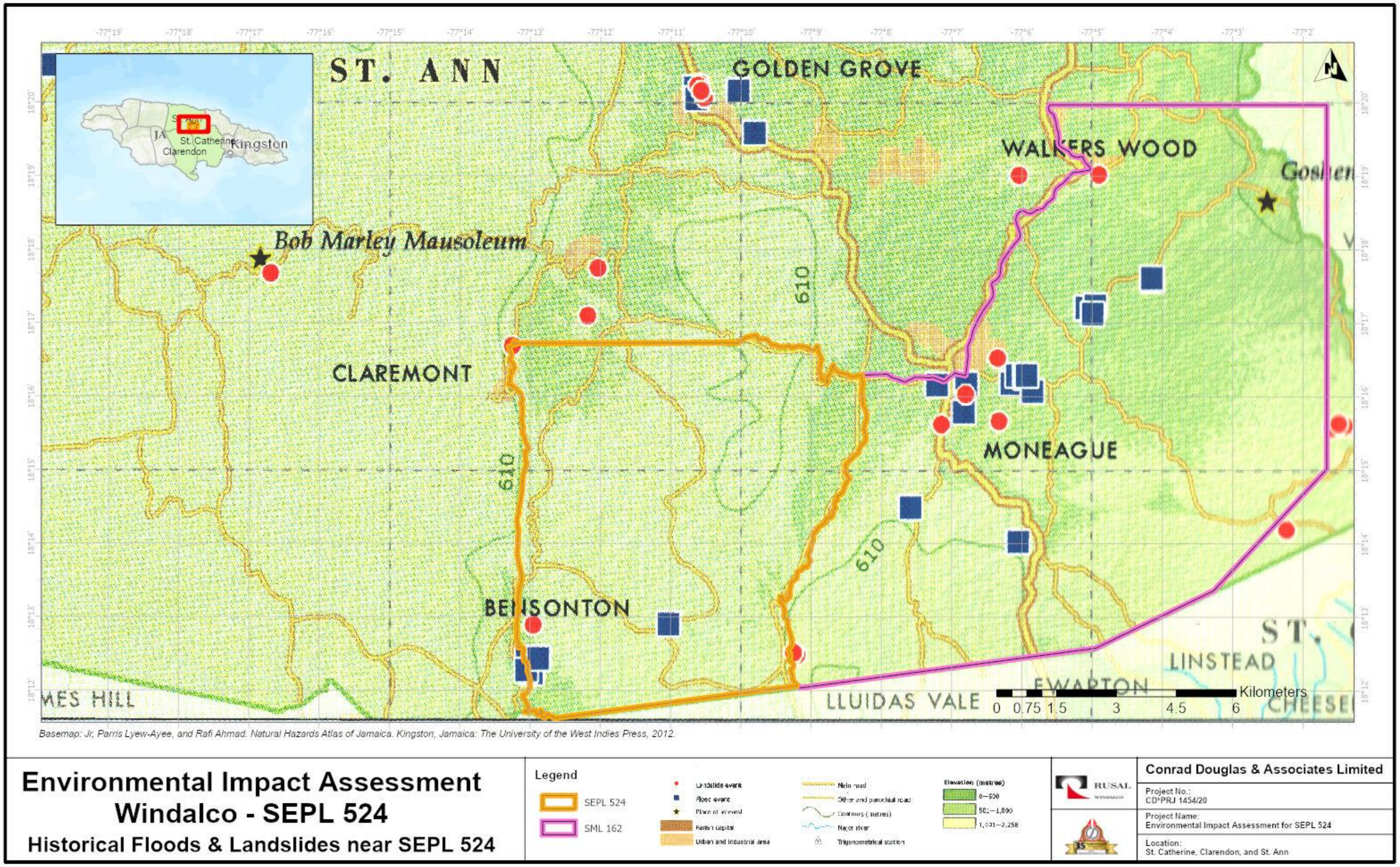


Figure 5-60: Map showing recorded Flood and Landslide Events

5.3.5. Earthquakes

Earthquakes are hazards on any of the major fault lines that traverse the SEPL 524 but are more a threat to the built environment than to the natural environment. The historical earthquake events in the SEPL 524 area are shown in Figure 5-61.

5.3.5.1. Seismic Analysis

The UWI Earthquake Unit reports that Jamaica experiences on average about 200 earthquakes per year. A majority of these are minor, having magnitudes less than 4.0. The most seismically active areas are the Blue Mountain block in eastern Jamaica and the Montpelier-Newmarket belt in western Jamaica.

SEPL 524 does not lie within these active areas and therefore is considered a low risk area for seismic activity. The activity proposed in the area is not vulnerable to seismic activity.

The Earthquake Unit reports that the June 12, 2005 earthquake that impacted Central Jamaica which was felt strongest at Aenon Town and Top Alston in Clarendon; Silent Hill, Manchester; Wait-a-bit and Lemon Walk, Trelawny resulted in moderate to heavy structural damage on most vulnerable structures; some people had to be dug out of collapsed dwelling; minor injuries from falling objects.

There have been reported landslides in the SEPL 524. Landslides have, however, been reported in the areas on the fringe of the SEPL 524 where towns and communities have developed. The lack of reports does not mean landslides do not occur.

5.3.6. Uncontrolled Exploitation

Uncontrolled exploitation of natural resources within the study area and other areas within the sphere of influence continue to escalate. One such activity is evidenced by increasing frequency of cleared hillocks predominantly for agricultural purposes.

The exploitation of the forest cover within the SEPL for yam sticks and other plant derived resources such as coal production will undermine the services provided by SEPL 524 in the long term if not managed sustainably.

The exploitation of sewage filtration services within the communities within the SEPL 524 is uncontrolled. The mining of bauxite could have the impact of increasing the population within these communities overtime which potentially could increase the wastewater generated in the SEPL, in general, without a concerted management strategy this could result in adverse water quality impacts in the long term.

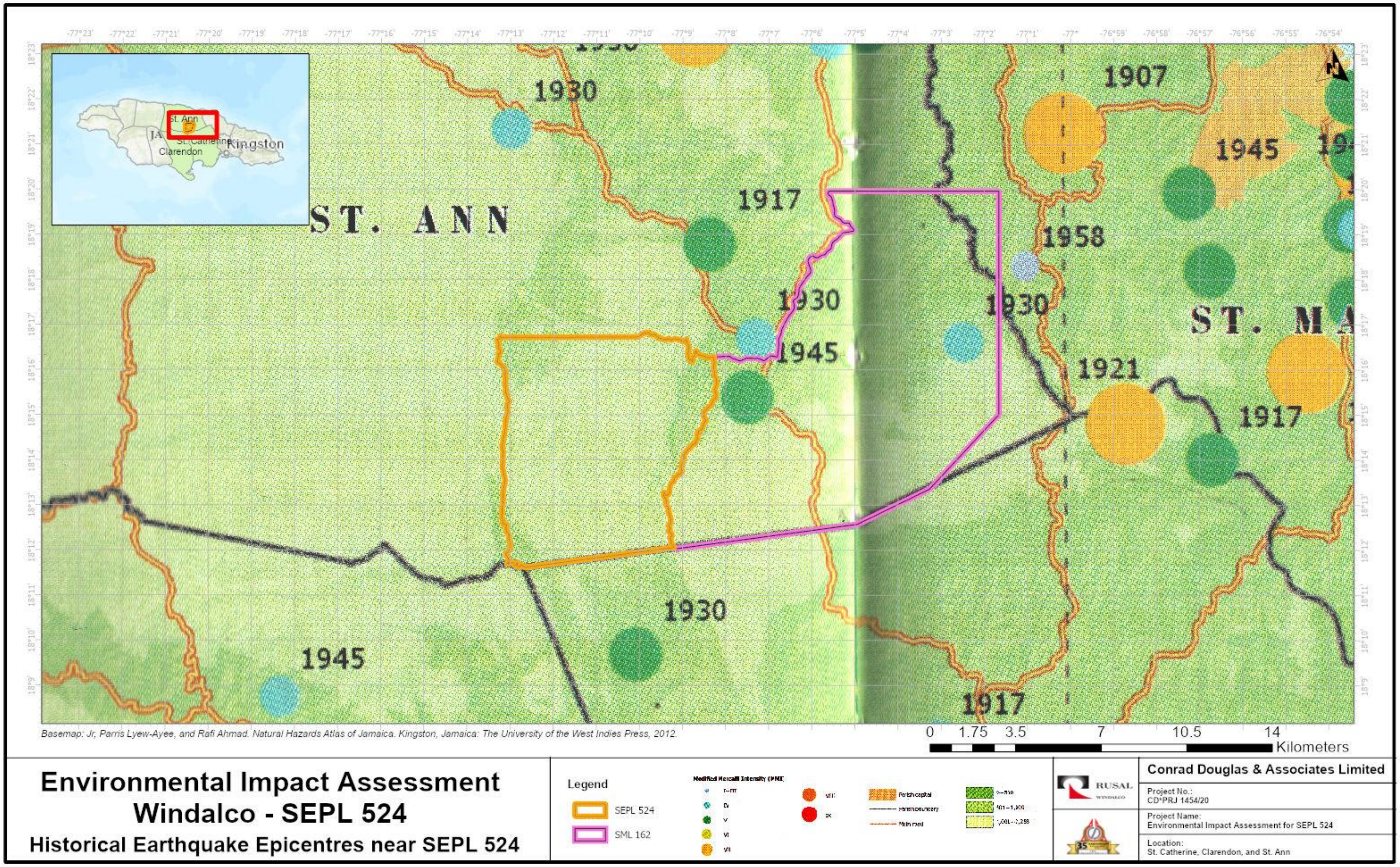


Figure 5-61: Historical Earthquake events in the SEPL 524 area

5.4. Biological Environment

5.4.1. Introduction

The biological assessment of the SEPL 524 area was conducted in accordance with the agreed Terms of Reference (ToR) established for the study. The overall objectives of this study were to:

1. Conduct and prepare a characterization of the flora in the entire SEPL 524 area using:
    - remote sensing techniques,
    - literature-based data sources and
    - ground truthing.
2. Conduct and prepare a description of the fauna in the SEPL 524 area.
3. Support descriptions identified from literature-based data sources and
4. Identify and evaluate potential impacts and recommend mitigation measures for proposed mining in SEPL 524.

The agreed Terms of Reference for the EIA requires that a study of the ecological resources within SEPL 524 be conducted to:

1. Describe the habitats in SEPL 524
2. Determine the distribution of habitats and species within SEPL 524, including habitat mapping
3. Provide commentary on the: ecological health, function and value in the project area, threats and conservation significance.

In order to gather the required information for the analysis of the Biological Environment Baseline and the Ecological Services provided by the area, a series of field visits were conducted within SEPL 524 and its environs over the period July to September 2020. This included:

SEPL 524 is characterized by a series of:

1. forested hillocks and

2. depressions that have secondary growth, which results from human activity, within these depressions.
3. Open valleys in the north east and north west regions

These hillock and depression formations are replicated throughout the majority of SEPL 524.

5.4.2. Approach & Methodology

CD&A used state of the art instruments and methodologies for data collection. Best practice requires that at least 20% of the area be analysed by ground-truthing. The literature indicates that the vegetation in the area is generally homogenous[11].

Google Earth images of the study locations within the SEPL 524 were referenced to the JAD2001 coordinate system using a Geographical Information System software[12]. The locations selected were chosen either:

A. On the basis of being close to a proposed ore body.

B. On the basis of being able to find access points (whether roadways, tracks or trails) that would facilitate ground access to or near to areas identified in point A above or

C. On the basis of there being a feature of significance at the site (for example a cave or a pond) that was identified by a resident from the area.

For each location to be examined, an area of approximately 1,200m x 800m (see Figure 5-62) was incorporated around the proposed study location(s), for which floral and land use characterization were done in order to:

1. Firstly, for the characterization of the site into various vegetation assemblages

[11] Insert reference that indicate homogenity

[12] www.mapmaker.com

2. Secondly, for the determination of estimates of floral assemblage spatial coverage on the site.

3. Thirdly for the determination of the most convenient areas of access to the locations to facilitate ground truthing.

The dimensions cited above were chosen on the ability to photo-interpret details from the largest area that could be reliably interpreted on Google Earth by a trained Photogrammetrist.

Figure 5-62: Position of Transect Location (Transect 10 at position N 18.27294, W 77.15382) within a 1,200m x 800m Sub Study Area of the SEPL 524

Observations made by the study team on the ground, whether at specifically chosen study areas or on paths traversed to get to the study areas, were used by the Photogrammetrist to generate a floral cover map of the area containing the detailed study locations (see Figure 5-63).

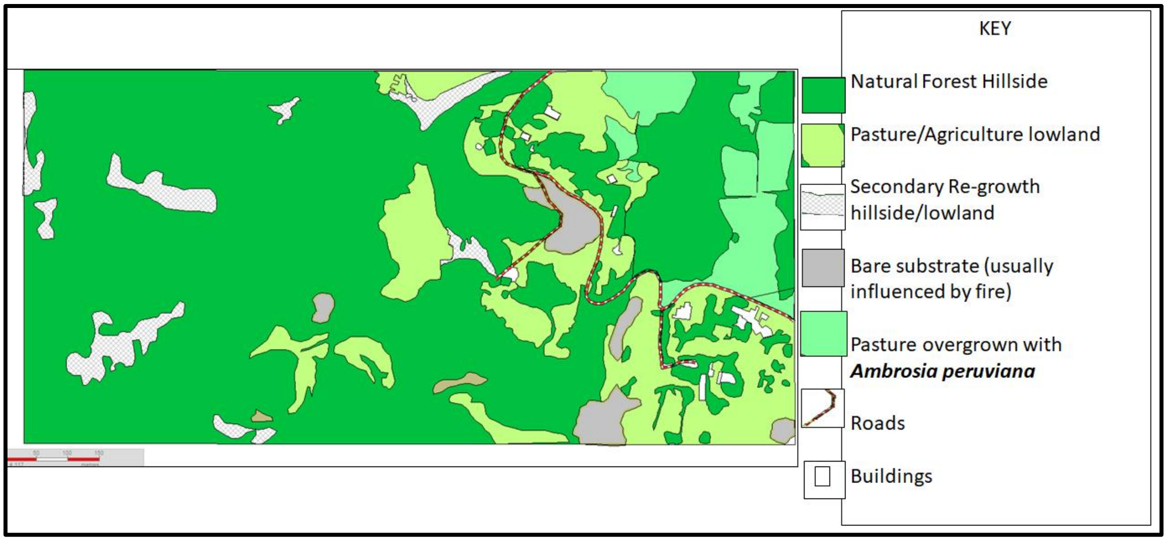


Figure 5-63: Example of Floral and Land Use Cover Map of 1200m x 800m Area Surrounding Transect 10.

The locations of the twenty six (26) 30m transects carried out as part of this EIA study (within SEPL 524 and adjoining SML 162) are shown in Figure 5-64 below.

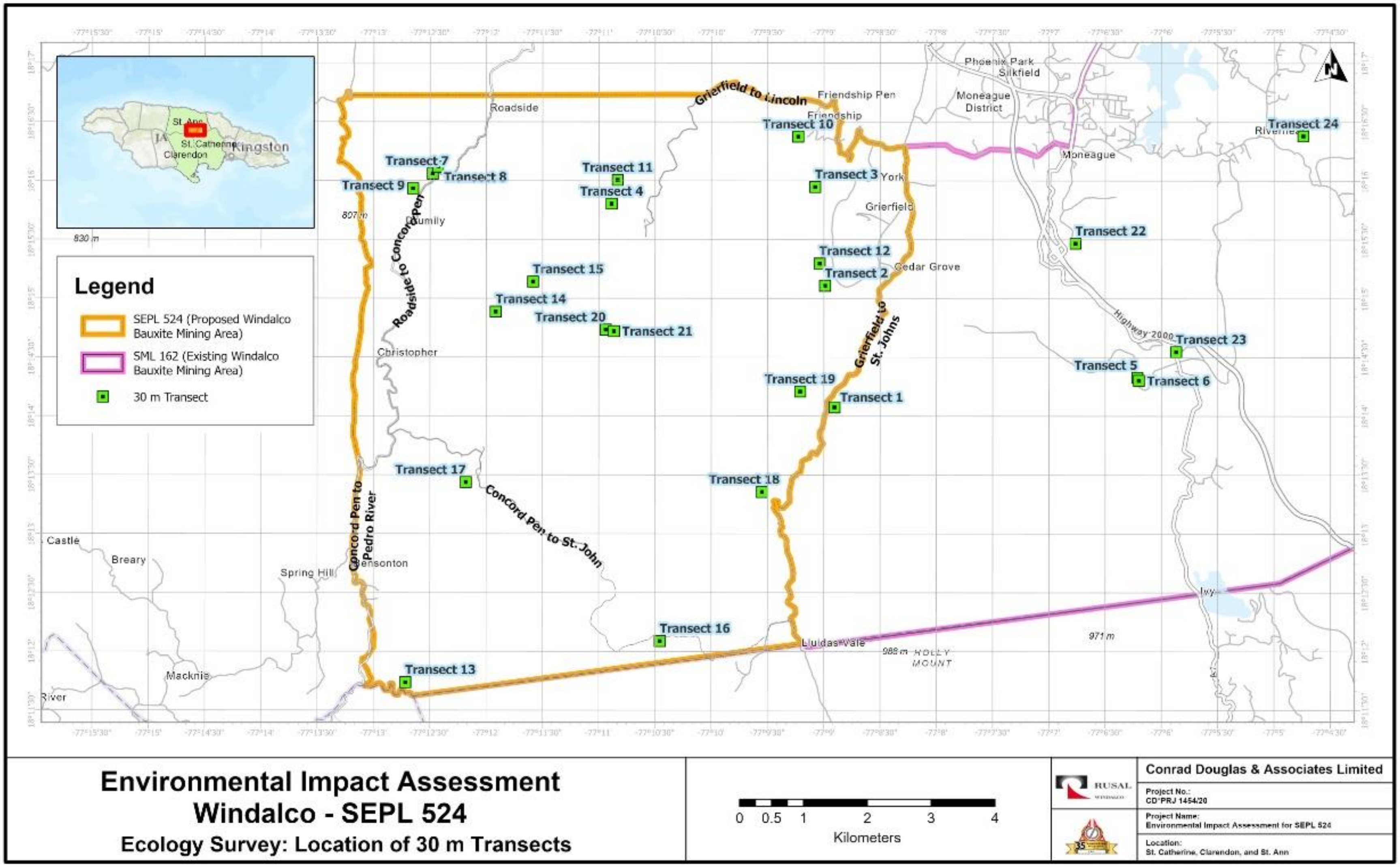


Figure 5-64: Location of 30m Transects carried out within SEPL 524

5.4.2.1. Ground Assessments – Flora and Fauna:

Data collection for the Flora/Fauna surveys were undertaken on 18 field visits between the period of August 6 – September 5, 2020 and were centered around two general areas of collection:

A plot-based method utilizing the deployment of a linear transect and the sampling of components from a defined field area was used for detailed data collection. In the case of the study, a 30-meter-long transect was used as the linear delimitation of the path of data collection, with six 5m x 5m quadrat areas being sampled along the transect, as defined on Figure 5-65 below. Thus, a total ground area of 150 square meters was assessed with each transect deployed.

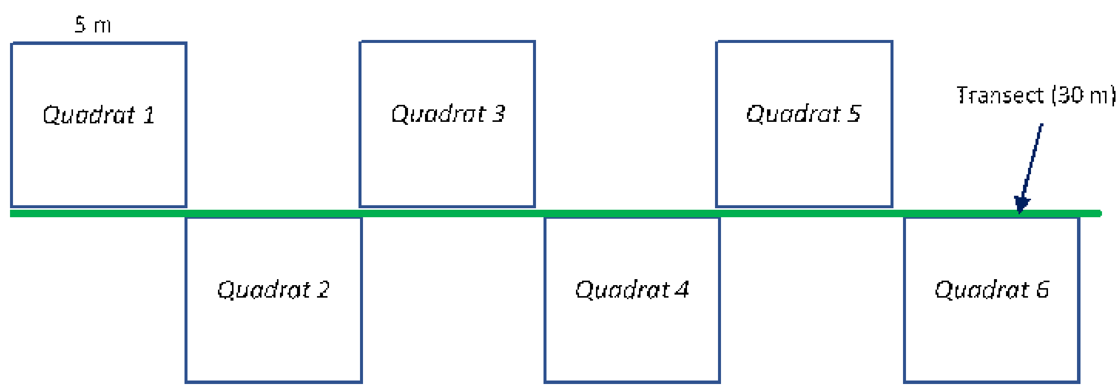


Figure 5-65: Illustration of Deployment of 5m x 5m Quadrats Along 30m Transect Line at Study Locations.

Table 5-11 shows the positions at which plot-based assessments were conducted.

Table 5-11: Positions at which plot-based assessments were conducted

Transect	Latitude/Longitude Position
Transect 1	N 18.23460 W 77.14842
Transect 2	N 18.25183 W 77.14983
Transect 3	N 18.26581 W 77.15130
Transect 4	N 18.263424 W 77.181445
Transect 5	N 18.23880 W 77.10358,
Transect 6	N 18.23837 W 77.10334

Transect	Latitude/Longitude Position
Transect 7	N 18.26768 W 77.20793
Transect 8	N 18.26865 W 77.20716
Transect 9	N 18.26558 W 77.21085
Transect 10	N 18.27294, W 77.15382
Transect 11	N 18.26679 ,W 77.18056
Transect 12	N 18.25497, W 77.15063
Transect 13	N 18.19563, W 77.21193
Transect 14	N 18.24814, W 77.19860
Transect 15	N 18.25238, W 77.19308
Transect 16	N 18.20150, W 77.17426
Transect 17	N 18.22398, W 77.20300
Transect 18	N 18.22263, W 77.15916
Transect 19	N 18.23684, W 77.15350
Transect 20	N 18.24559, W 77.18233
Transect 21	N 18.24537, W 77.18108
Transect 22	N 18.257805, W 77.112737
Transect 23	N 18.24243, W 77.09784
Transect 24	N 18.27302, W 77.07901

The transect line and plots were deployed through the floral assemblages at each of the sites visited, with the start of the transect being on relatively flat ground and the end being positioned on a hill slope. This deployment therefore facilitated sampling over a change in gradient from lowland to highland.

Plotless assessments were conducted while walking enroute between the parked vehicle and the vicinity of the plot-based survey area. Areas surveyed varied based on whether or not flora or fauna observations of note were seen either in the immediate vicinity of the path walked or as far as the item of interest could be discerned from the path.

The following methods were employed for data collection purposes within the plot-based and plot-less areas (with more detailed data collection being applied for the plot-based areas):

5.4.2.2. Flora Assessment

Flora surveys were undertaken in accordance with the methodologies of Asprey and Robbins (1953). Observations were carried out in alternating quadrats going from left to right. Within each quadrat, all flora species encountered were recorded. Using a caliper and taper, the Diameter at Breast Height (DBH) of the largest individual of each species seen was recorded. Tree height was assessed by the use of a clinometer to measure an angle between horizontal and the estimated canopy top of the tree, while maintaining a fixed horizontal distance from the base of the tree (this distance varied according to vegetation cover and hill slope). A trigonometric function was used to calculate the approximate height using distance, angle and the added height of the observer's eye from the ground.

Vascular plants observed were identified using keys and information in the Flowering Plant of Jamaica, C. D. Adams (1972) and Manual of Dendrology Jamaica, Tracey Parker (2003). For specimens and images of species that were not readily identified in the field, or with the use of the keys, were sent to the University of the West Indies (Mona) Herbarium for identification.

For the species lists generated, an indication of relative prevalence of various vegetation types observed within the property boundary was determined, as defined using the DAFOR scale system[13] defined below:

D - Dominant
A - Abundant
F - Frequent
O - Occasional
R - Rare

In this instance, for Flora, the DAFOR scale was based on percentage cover with Dominant = >75%, Abundant = 75 – 51%, Frequent = 50 – 26%,Occasional = 25 – 11%, Rare 10 – 1 %.

Value	Percentage cover
D - Dominant	> 75%
A - Abundant	51 - 75%
F - Frequent	26 - 50%
O - Occasional	11 - 25%
R - Rare	1 - 10%

[13] http://www.surreyflora.org.uk/newnotes.php

5.4.2.3. Fauna Assessment

5.4.2.3.1. Avi-Fauna Assessments:

Two methods were used for the assessment of Avi-fauna. The first was a point count, which was conducted at the start point of each of the plot-based transect deployed. After arriving at each transect start point, the observer used the first minute of observation to evaluate an ideal position to view the surrounding habitat. Following this the observer identified birds by sight and sound for the next 10 minutes continuously, with time being kept using a stopwatch. The number of each species seen/heard was recorded.

After the point count was completed the observer then walked along a path away from the point count start point to identify as many species as possible to account for any that were missed during the point count. This walking observation, or wander path count, was approximately 300m long along an orientation based primarily on the terrain and ease of access to a path (present or made). Time was spent mapping the territory of each individual so as to avoid recording the same individual multiple times. The observer aimed to cover no more than 50m in a 6-minute period. When possible, the observer drew directly onto a printed map of the study area. In the absence of this resource a hand drawn map that matched the exact shape of the area was used. The observer noted the presence of anthropogenic disturbances such as shelters and small buildings as well as farming operations. The observer noted breeding behaviour, nests as well as interactions.

The following factors were considered for both Point and Wander counts:

5.4.2.3.1.1. Point Counts

- **Timing**: The first count of each day should begin at sunrise. Driving and hiking times should be taken into consideration to allow for the observer to be at the point by sunrise. The latest that any point count should be started is 1000 as bird activity decreases after this time.
- **Weather**: Surveys are to be conducted only under satisfactory weather conditions: good visibility, little or no precipitation, and light winds. Should the weather deviate from these standards then the survey should be

postponed until ideal conditions have been resumed or done another day. Occasional light drizzle or a very brief shower may not affect bird activity, but heavy fog, steady drizzle, or prolonged rain should be avoided. Should the points be within close proximity to human settlements the observer should wait until there is no noise from that source before conducting the survey.

- **Points**: At least one (1) point count should be conducted per ore body. Additional points may be conducted only if the subsequent point is 300m or more away from the previous point. This reduces the chances of recording the same individual in multiple counts. `Each count should be conducted 4 times during a given sampling period to account for observer bias and environmental variations.
- **Survey Overview:** Each count will be conducted for 10 minutes with the count being split into two 5-minute periods separated by a 30 second waiting period. Having multiple periods allows us to estimate detectability (the probability that an individual will be detected if it is present at the survey site) for each species. Data is to be recorded in pencil on the Point Count sheets provided (See Appendix VI). Relevant information on biotic and abiotic factors is to be collected as well.

5.4.2.3.1.2. Traverse Wander Mapping

- **Timing**: Mapping should be conducted after the point count(s) are completed at each site. Mapping should be started no later than 1200. The total time taken to map any given site will be dependent on the size of each area. Surveys should be conducted twice per area, in opposing directions.
- **Weather**: Mapping is to be conducted only under satisfactory weather conditions: good visibility, little or no precipitation, and light winds. Should the weather deviate from these standards then the survey should be paused until ideal conditions have been resumed or done another day. Occasional light drizzle or a very brief shower may not affect bird activity, but heavy fog, steady drizzle, or prolonged rain should be avoided.

- **Points**: The observer should map along a traverse of up to 300m along the perimeter of the ore body in which the point counts are being conducted as well as any hillocks bordering the ore body.
- **Survey Overview:** After the point count is completed the observer will traverse 300m along the perimeter of the ore noting all birds and their relative position in the ore body and hillocks.

For avi-fauna, the DAFOR scale was based on the species abundance percentage in the table below.

Value	Species abundance percentage
D - Dominant	51-100%
A - Abundant	31 - 50%
F - Frequent	16 - 30%
O - Occasional	6 - 15%
R - Rare	1 - 5%
X - Not Present	0%

5.4.2.3.2. Arthropoda Assessments

5.4.2.3.2.1. Plotless

For the plotless assessment, the species found during the traverse from the road to the study area at each location were recorded. In some instances, the number of individuals of each species was also recorded. No samples were collected for detailed analysis and identification but were categorized into different families, with significantly different representatives noted as different species. This method had no standardized measure implied as the length of the traverse and time spent along each were different for each location. Colonial organisms such as ants, bees and termites were separated into different species, but individuals of these groups not counted for neither the plotless nor the plot-based assessment.

5.4.2.3.2.2. Plot-Based

The standard transect was constructed of a single 30 m transect line and three 25 m^2 (total 75 m^2) quadrats within, alternating on each side of the transect line. Additionally, each quadrat was spaced 5 m apart, as shown in Figure 5-66 below. Each quadrat was manually searched for 10 minutes and all arthropods were recorded and enumerated. As with the plotless assessment, no specimens were collected but were classified to the level of family and species where possible, with significantly different representatives denoted as different species. Microhabitats searched included the soil surface, leaf litter surface, rocks, on and under leaves, on plant stems, vines, tree trunks, within bromeliads and in flight. Trees above 2 m were inaccessible for assessment and in most cases, the soil and leaf litter could not be thoroughly searched within the time frame. Humidity, wind speed and air temperature readings were recorded generally for the SEPL, as well as notes on the flora and other fauna.

Additional transects, except one, maintained the search time and methodology but had either an increased number of transects or an increased number of quadrats. Where there was an increased number of transects, the number of quadrats inherently increased as well. If a location spanned two (2) vegetation types, open and canopy, the transect line was represented as in Figure 5-67 below, with each vegetation type receiving three (3) quadrats. For Location E search time was reduced to 3 minutes in each of nine 7.5 m^2 (5.0 m * 1.5 m) quadrats, as the location was a longitudinal strip of road which did not facilitate 25m^2 square quadrats. While no specimens were collected, several were photographed.

To assess the diversity of species, a rapid assessment protocol was developed, with both standardized and non-standardized methods of assessment. Species recorded as endemic or with conservation concerns were recorded where possible. Detailed information on this information is minimal for several Jamaican arthropod species and would require specialists within their taxa to ascertain definitively. After collecting, data were collated by analysing the frequencies of species, distribution and investigating relationships. Species richness and Simpson's Diversity were calculated using the samples of the populations collected.

5.4.2.3.2.3. Light Trapping

Light trapping was conducted from the night of August 18, 2020 to the morning of August 19, 2020 at Location H. A white sheet of cloth, measuring 2-3 m on each side was strung up amidst shrubs and trees at the ecotone of the valleys and hillocks, at the base of a hillock. This was done by placing the sheet over a rope tied to surrounding trees and shrubs. Each sheet was then secured with pins. A total of three sheets separated at least 100 m apart were established. At about 10 pm, a light was shone on each of the sheets and left undisturbed for a minimum of one hour. This was followed by each sheet being visited and arthropod species both on and around the sheet recorded and enumerated.

5.4.2.3.2.4. Bromeliad

Bromeliads within the area were occasionally inspected and macroscopic fauna was documented. At location F, a small sample of water was taken from 3 bromeliads. The microscopic meiofauna was observed under the microscope, within 400µL of each bromeliad sample. These were enumerated and documented

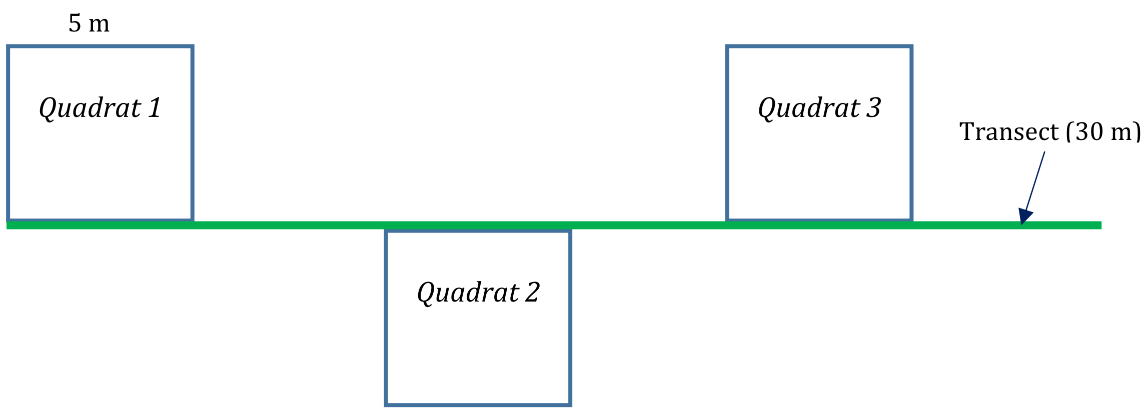


Figure 5-66: Quadrat Layout along Transect Line: 5m spaced quadrat

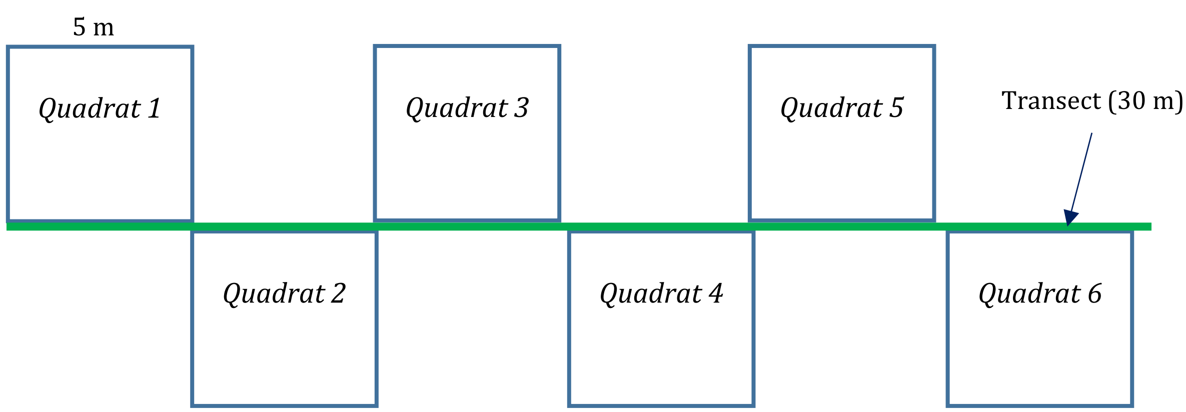


Figure 5-67: Quadrat Layout along Transect Line: Quadrat used when the location spanned two (2) vegetation types -open and canopy

5.4.2.3.3. Reptile and Amphibian Assessments:

Day surveys were conducted by establishing a 30m transect at a study area. 90 minutes was spent doing a Visual encounter survey for different reptiles and amphibian while traversing along the transect (Das, 2016).

Trees were scanned and any rock along the transect which could be flipped was flipped, and rock crevasses were checked, a stick was used to turn over leaf litter and Bromeliads that could have been accessed were checked.

Any reptile/amphibian that was seen or heard while traversing the transect were counted. The reptiles/amphibians that were seen or heard were then identified using information known by the observer and with the help of pictures that were taken.

This procedure was repeated at each location visited.

A night survey was conducted by listening for the sounds of amphibians/reptiles within the area were a light-trap was established. The reptile/amphibian was identified by its specific vocalization and the species was recorded.

5.4.2.3.4. Mammals

Identification of mammals was done at all locations visited during the study. All mammals seen during traverses between floral transect locations were identified and recorded. A more specialized method was needed for bat identification since bats are difficult to identify by observations from the traverses only and can be quite numerous. Caves within SEPL 524 are the main habitat for bats, Figure 5-68 below shows the positions of six caves within SEPL 524 that were visited during plot-based and plotless surveys. A bat survey as part of a wider fauna survey was carried out within SEPL 524 (survey area). In describing the natural environment and ecological services provided by the study area, the Terms of Reference for the EIA required:

"…A detailed qualitative and quantitative assessment of terrestrial habitats" - caves form an important habitat.

The ToRs also specified that – *"Special emphasis will be placed on rare, endemic, protected or endangered species. Migratory species will also be considered. As well as economically important species and nocturnal species.*

Bats which find habitats in the caves within the SEPL 524 (See Table 5-12 below) and serve other ecological purposes therefore required special attention for the compilation of the EIA.

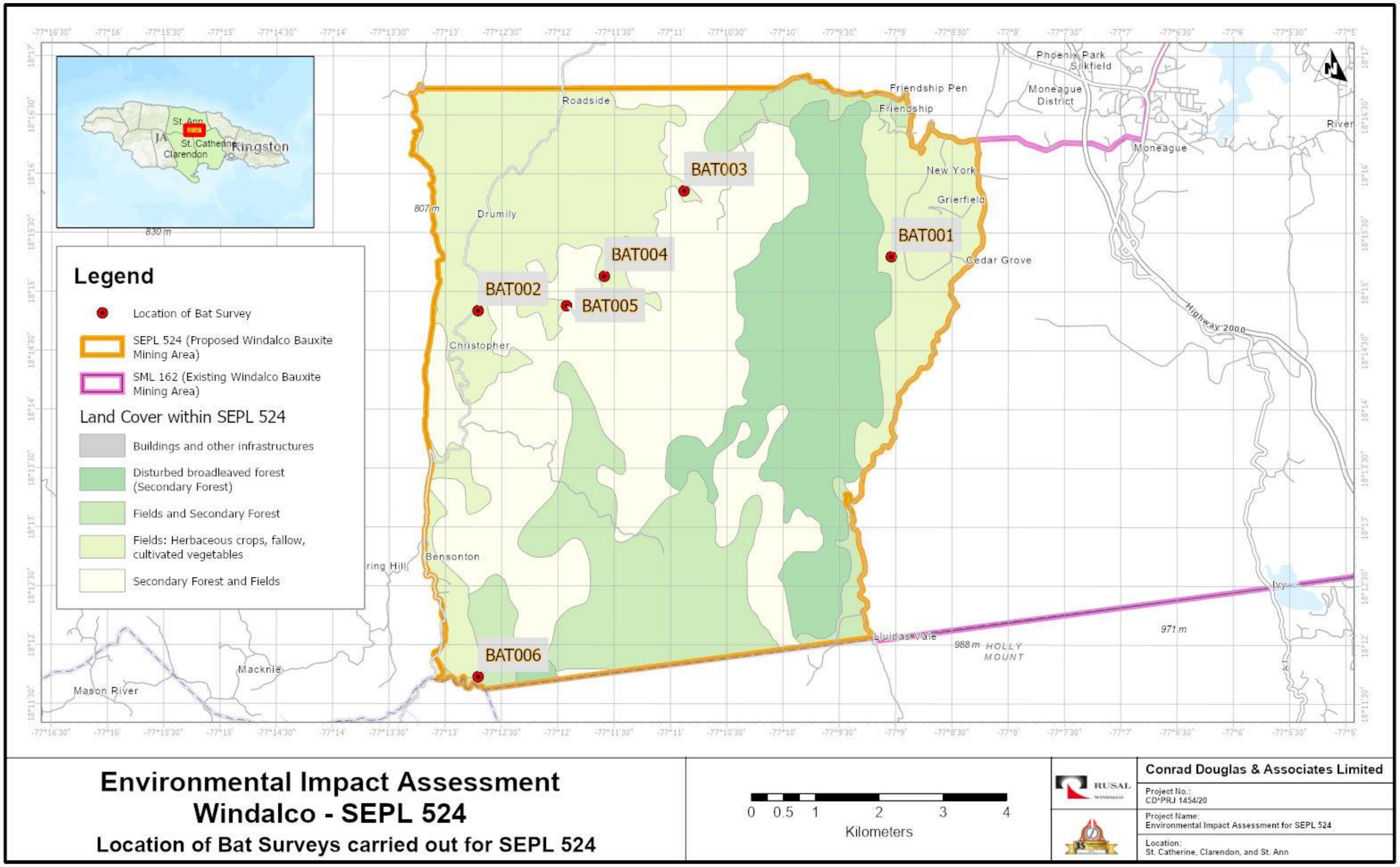


Figure 5-68: Location of Six caves within SEPL 524 that were visited during plot-based and plotless surveys

This section outlines the method and technology used to potentially identify the different bat species present mainly within the caves within SEPL 524. The detailed analysis of bat speciation was based on the frequency of echolocation, which has been identified as being uniquely related to the physiology of each bat species. The following were the objectives of this Bat Survey:

- Identify a sample of caves within the SEPL for bat analysis
- To determine the presence/absence of studied bat species within SEPL524
- To record bats in roosting environments (caves and areas in proximity) within SEPL 524
- To identify the potential bat species, present within SEPL 524 from the recordings captured

Most thorough faunal surveys now use the recording and interpretation of ultrasonic calls (echolocation) to determine the presence and diversity of bats in a natural environment (Herr et al 1997). According to Fincham (1997) over 1100 caves have been identified in Jamaica and more than 149 of them have been confirmed as bat roosts (Figure 1). Approximately eleven (11) caves have been identified within SEPL 524, six (6) of which were selected to conduct this survey. The caves in the SEPL are shown (circled in blue) in Figure 5-69 below. The six (6) caves were chosen based on bat sightings, observations of characteristic odours, and from anecdotal information obtained from members of nearby communities.

Bats are an important class of mammal in the ecosystem as they provide important ecological services such as pollination and seed dispersion. In Jamaica, there is sparse information on the bat population and distribution. To address this shortcoming the National Environment and Planning Agency has developed a Bat Management Plan for Jamaica 2012 -2017[14]. NEPA indicates that there is no information to verify whether the country's bat population is declining as is the trend in other tropical areas of the globe. The Management Plan highlights

[14] Ecosystems Management Branch, *Bat Management Plan for Jamaica 2012 -2017*, National Environment and Planning Agency (NEPA), 2011

that there is therefore a need for an understanding of the requirement for a healthy bat population in Jamaica. The gathering of information on these nocturnal animals within the SEPL is therefore necessary for preservation and conservation of these critical environmental service providers.

A Bat Survey was conducted. This was done using acoustic analysis method for bat identification to identify the presence of bats for the caves sampled within SEPL 524. This was done because:

1. NEPA's protocol require trained and permitted individuals to handle bats.
2. There exists a potential for contracting lethal diseases from bats to humans

The study was aimed at a general identification and classification of the bats within the SEPL 524.

The caves visited by the CD&A team during the initial flora and fauna assessment indicated the presence of bats from any one or a combination of the following:

- visual presence of droppings
- scent of dropping or other excrement,
- visual identification of roosting bats
- anecdotal information reported by field guides and community members.

These caves were selected as sampling points for locating the Audiomoth audio modules used to record sounds within the known frequency of bats and are listed in along with the coordinates of their locations.

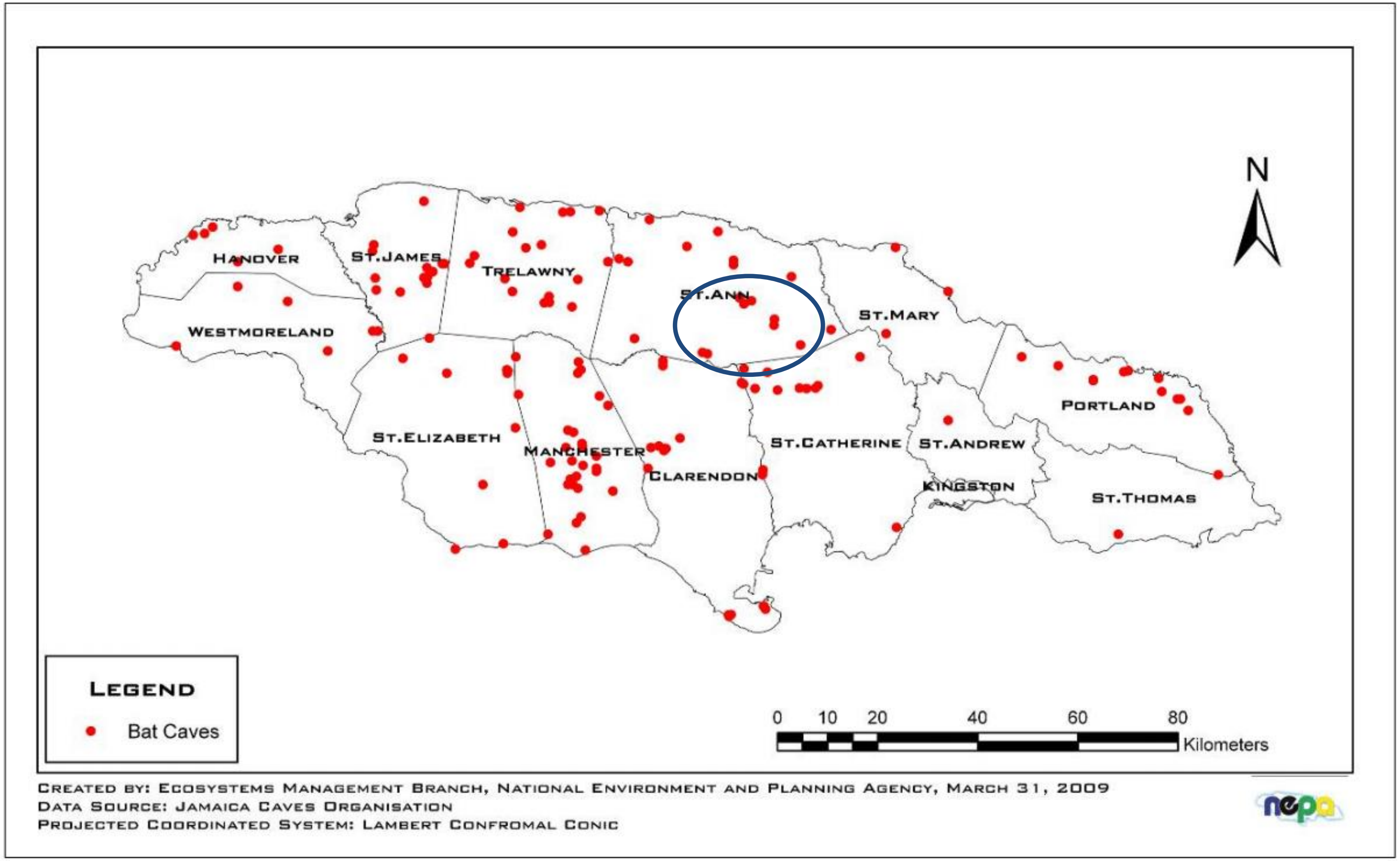


Figure 5-69: Map of Jamaica showing the distribution of known bat cave roost and the survey area (Source: Ecosystems Management Branch, National Environment & Planning Agency)

Table 5-12: Caves within SEPL 524 that were studied for bat activities

Cave ID	Audio Moth ID	Local Name	Northing	Easting
Cave 1	Bat 001	Greirfield	N 18.254985°	-77.150669°
Cave 2	Bat 002	Kenke Hole	N 18.247296°	-77.211857°
Cave 3	Bat 003	Lincoln Sink Hole	N 18.264285°	-77.181370°
Cave 4	Bat 004	Potato Piece Cave	N 18.252184°	-77.193170°
Cave 5	Bat 005	Johncrow Hole	N 18.248010°	-77.198758°
Cave 6	Bat 006	Pedro River Cave	N 18.195478°	-77.211793°

The extensive ecological survey of SEPL 524 did not identify any evidence of tree roosting bats. Therefore, no deliberate setup was done to assess the presence of this type of bat.

The procedure below describes the steps taken to conduct the capture of the bats sounds present in the caves found within SEPL 524:

- *Programming of Devices (Audiomoth):*
  - ✓ Each Audiomoth device was programmed to run for 12 hours, from 6pm to 6am. During this 12-hour period the device-initiated recordings at 5-minutes intervals to capture 1-minute recordings between each interval.
  - ✓ The sound frequency sampling range was set between 0 and 256 kHz.
- *Field Installation of Audiomoths*
  - ✓ The devices were checked to ensure they were on. (green light blinking)
  - ✓ One (1) Audiomoth device was then carefully placed into a Ziploc™ bag and folded to reduce the possibility of water reaching the recorder.
  - ✓ A suitable area at the or near the entrance of the cave was found to place the Ziploc™ bags as seen in Figure 5-70 below.

Figure 5-70: Audiomoths installed (yellow circle) at the entrance of the cave (Potato Piece Cave) – Secured with Cable Ties

- ✓ The devices were secured in place using cable ties as shown above.
- ✓ They were then checked again to ensure there was green blinking light present. This was to ensure the devices were not switched off during the installation process
- ✓ Photographs were then taken of the setup of the Audiomoth devices (equipment)
- ✓ Steps 1-6 were repeated for the other caves found within SEPL 524

- *In Office:*
  - ✓ Once the devices were returned to the office, the SD cards were removed, and the data was transferred to the computer.
  - ✓ The recordings for each cave were inputted into the Kaleidoscope software to be analysed as follows:
    - Each cave was done as a batch
    - Noise was removed from the analysis by activating the built-in noise filters. This was achieved by checking "Move noise file to NOISE subfolder"
    - The Kaleidoscope automatically sets the analysis range to a maximum of 120 kHz.
    - The longest call was set to 500 ms
    - Minimum pulse detected was set to two (2)
    - The Kaleidoscope software was run in "Auto ID for Bats" mode and the Neo tropics library was chosen for identification and all species within that group.
    - The auto ID suggestions were verified manually

The spectrograph for each recording was further investigated for call profiles that matched those from the Windsor Research Centre. This was done to capture the species that were recorded, but were not automatically identified by Kaleidoscope since these were not in the Kaleidoscope library.

5.4.3. Findings

5.4.3.1. Flora Literature Review

5.4.3.1.1. General

The 1998 Land Use/Cover Map of Jamaica[15] divides natural forest area into two main categories, namely, Open and Closed Forests. Open forests are communities with trees at least 5 meters tall with tree crowns that do not overlap with each other and are typical of forests found in dry locations (such as Tall and Short Open Dry Forests). Closed forests are communities with trees at least 5 meters tall with tree crowns that overlap.

Closed forests are typically distinguished from open forests as a consequence of the presence of prevailing rainfall conditions. Closed forests typically are found in locations receiving annual rainfall averages exceeding 100 cm and within terrain altitudes greater than 800 meters. The forest trees typically have broad leaves, which are retained throughout the year. Thus, the term Closed Broadleaf Forest has been used to describe these general categories of forests found within areas of Jamaica.

Within the broad category of Closed Broadleaf Forest are found a number of divisions of types, based on rainfall amounts, altitude, underlying geology and level of human-induced disturbance. Mesic Limestone Forests represent the first of these groups and are typically at the low end of the rainfall/altitude spectrum.

Lower and Upper Montane forests represent the mid and upper extent of forest types – based on increasing altitude and rainfall. Disturbed Broadleaf forests represent a closed forest variety which has undergone varying levels of human disturbance, with species such as the Trumpet Tree (*Cecropia peltata*) being established as indicators of disturbance while Montane rainforests represent the high-end of this type of forest. Montane forests typically receive the most rainfall and exist at the highest elevations.

[15] Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

The character of the development site matches that typical of the presence of Closed and Disturbed Broadleaf forests. These forest types typically have vertical stratification, with tall emergent trees achieving heights of 24 meters, a main tree canopy of between 16-20 meters and an understory of between 3-10 meters. Ferns are very common in these forest types as well as Lianas, Adroids and Tank Epiphytes. Camirand and Evelyn (2004) outlined that both Cedar and Sweetwood tree varieties are the species that make up the majority of these forest types by volume, thus suggesting the expected make-up of the flora to be found within the development area. Otherwise, the Forestry Department[16] has listed over 100 tree species typical of these types of forests, suggesting a diverse floral system.

5.4.3.1.2. Location Specific References – Cockpit Country

5.4.3.1.2.1. Hillocks

Asprey and Robbins (1953) defined the areas of the Cockpit Country as being comprised of "limestone hillocks surrounding circular depressions (dolinas) filled by bauxitic soils with accumulated humus from the surrounding rim of limestone rock". The vegetation composition of the hillocks is more luxuriant than the drier coastal limestone areas of the island (due to the availability of moisture) and have more forest trees, epiphytes, lianas, aroids, bromeliads and orchids present. The understory and shrub areas of these forests tend to be sparsely populated, owing to the rocky nature of the underlying substrate.

Figure 5-71 below, was extracted from Asprey and Robbins (1953). It describes a typical profile diagram of the Cockpit Country hillock area and lists tree types typically found on the hillocks of the area. Table 5-13 below lists Vines, Bromeliads, Ferns, Aroids and Mosses that would be expected within the forested hillock areas of the study site, based on its proximity and topographical/geological similarity to that of the Cockpit Country.

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[16] Forestry Department - Forest Inventories in Natural Forests [UNDP/FAO, 1972; Swedforest Consulting, 1981; FIDCO, 1982-83; TFT Project, 1998-99

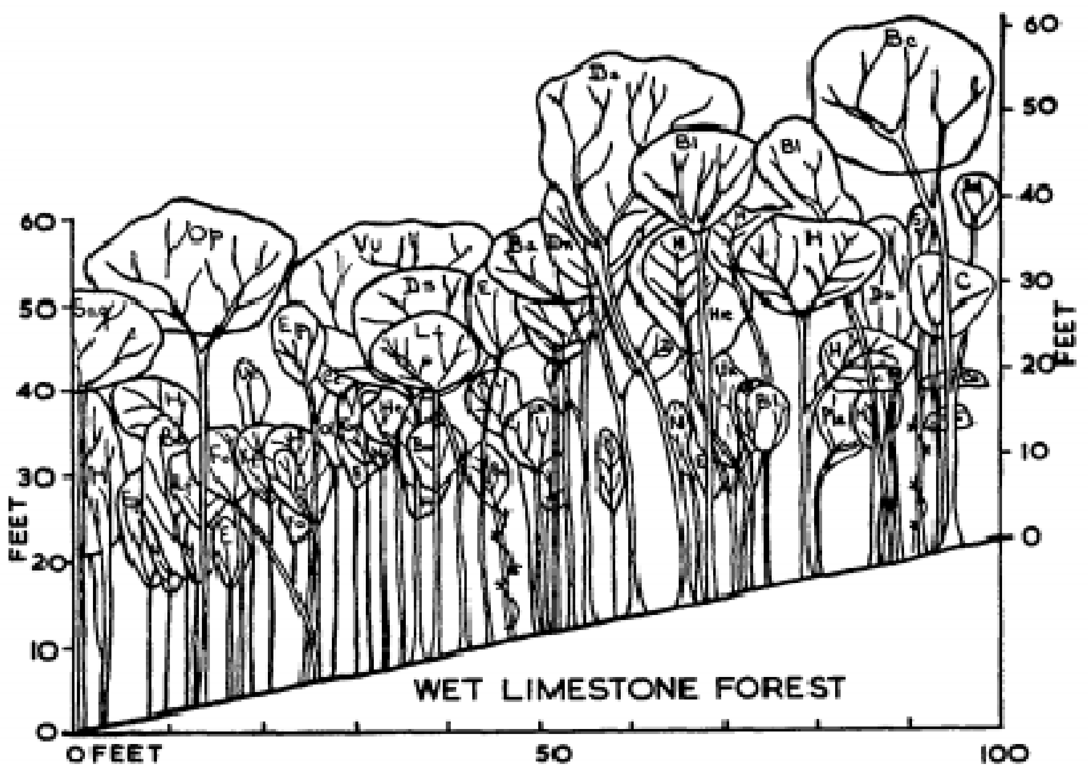

FIG. 20. Profile diagram of Wet Limestone Forest measured in the Cockpit country. The trees are included from a strip 100 ft. long and 25 ft. wide.

KEY TO SYMBOLS: Ai. *Andira inermis* (Wormwood); Ba *Brosimum alicastrum* (Breadnut); Bb *Bucida buceras* (Olive bark tree); Bc. *Buchenavia capitata* (Mountain wild olive); Bl. (Bloodwood); C. *Coccoloba* sp. (Grape); Cc. *Cinnamodendron corticosum* (Mountain cinnamon); Cs. *Comocladia* sp. (Maiden Plum); D. *Dipholis* sp. (Bulletwood); Dn. *Dipholis nigra* (Galimenta, Red Bullet); Ds. *Dipholis salicifolia* (Black bullet); E. *Eugenia* sp. (Rodwood); Ep. *Exothea paniculata* (Wild Ginep); Fo. *Faramea occidentalis* (Wild Coffee); Gg. *Guarea glabra* (Alligator, Wild akee); H. *Drypetes lateriflora* (Whitewood, Guiana plum); Kf. *Krugiodendron ferreum* (Black ironwood); Lf. *Lasiocroton fawcettii*; N. *Nectandra* sp. (Sweetwood); Ol. *Oxandra lanceolata* (Black lancewood); Op. *Ochroma pyrimidale* (Balsamwood); Pla. *Plumeria alba* (Frangipani); Si. g. *Simaruba glauca* (Bitter damson); Sj. *Sapium jamaicense* (Blindeye); Vu. *Vitex umbrosa* (Fiddlewood, Boxwood); U.K. Unidentified.

Figure 5-71: Extracted from Asprey and Robbins (1953)

Table 5-13: Vegetation Categories and Species Lists for Hillocks in Study Area (from Asprey and Robbins 1953)

Vegetation Categories	Species List
Bromeliads	*Aechmea paniculigera* *Tillandsia fasciculata* *Hohenbergia antillana* *Hohenbergia distans* *Hohenbergia eriostachya* *Broughtonia sanguinea* *Hylocelereus triangularis*
Aroids	*Aechmea paniculigera* *Anthurium grandiflora* *Philodendron laceruma* *Merremia pelata*
Mosses	*Thuidium involvens* *Leucobryum antillarum* *Entodon macropus* *Fissidens donnell* *Hookeriopsis fissidentoides* *Orthostichopsis tetragona* *Isopterygium tenerum*
Ferns	*Polypodium heterophyllum* *Thelypteris serrulata* *T. Oligophylla* *T. Patens,* *T. Venusta,* *T. Sagittata,* *T. asterothrix* *Ctenitis ampla,* *C. effusa.* *Trichomanes spp,* *Dennstaedtia bipinnata,* *D. Cicutaria and* *Pteris quadriaurita.* *Lomariopsis underwood* *Campyloneurum augustifolium* *Dennstaedtia bipinnata*
Herbs	*Rajania cordata* *Gyrotaenia spicata* *Peperomia amplexicaulis* *P. Cordifolia* *P. Crassifolia* *P. Reticulata*

Vegetation Categories	Species List
	Pilea ciliata *Boehmeria jamaicensis* *Pachystachys coccinea* *Piper nigrinodium* *Begonia glabra*
Vines	*Similax regelil* *Dioscorea polygonoides* *Rourea paucifolia*
Shrubs	*Clusia rosea* *Thrimax tesselata*

5.4.3.1.2.2. Lowlands

At the time of their descriptions, Asprey and Robbins described the cockpits as being dominated by the tree types *Terminalia latifolia* and *Cedrela odorata*. This is known to no longer be the case in current times. The presence of deep pockets of soil have resulted in most of the Cockpits being defoliated of their forest vegetation for subsistence agriculture and pastureland usage.

5.4.3.2. Fauna Literature Review

Jamaica's flora and fauna are significantly influenced by its geology, soil type, geomorphology and climate. 85% of the country's total surface area is covered by limestone deposits.

The topography and vegetation of SEPL 524 would therefore be similar to several other areas throughout the country, which consists of white and yellow limestone.

The methodology implemented by Davis, a modified point transect, will be adapted along with the methodology reported by Holmes and Sherry in 2001 that has been used for a 30-year period in the Temperate Deciduous Forest at Hubbard Brook. Holmes and Sherry were able to determine that natural forest succession and local distributions greatly affected the temporal changes in forest vegetation structure, ultimately proving to be the most important factor affecting bird abundance. For their studies Holmes and Sherry used timed censuses along transects paired with extensive territory mapping. This information was then supplemented with information on nest locations.

The method will also draw on techniques developed by Dr. Nathan Cooper used to survey for Kirtland's Warbler and the Brown-headed Cowbird on the formers breeding grounds.

Camirand and Evelyn (2004) speak generally to the presence/absence of mammals within these forested areas. Only three naturally occurring terrestrial mammals are known to frequent forest types like these. These are the rare Jamaican Hutia, the introduced and now naturalized Mongoose and up to 21 species of Bats.

Wilson, D.E. & Reeder, D.M. (2005)[17] identified five (5) orders of mammals in Jamaica. Bats represent the most numerous of Jamaica's naturally occurring mammals, with twenty-one (21) species identified as being either resident or endemic to the island[18]. These are listed in Appendix XX.

Potentially, two of the caves from the list of caves visited appears on the Jamaica Caves Organization (JCO) archives. These are Greirfield Cave and potentially Pedro River Cave. It is difficult to definitively say which cave is reported since the locations within the JCO register are acknowledged to be off by 100s m in most cases and caves are given names differently by locals and visitors. Unlike the Cockpit Country area, which has the Windsor Research facility in close proximity, no significant study has been conducted to assess the bat species within the SEPL 524 area, caves and tree dwelling. NEPA in collaboration with the JCO conducted a bat netting exercise in St. Ann in 2010. Two of the caves in SEPL 524 were assessed. The preliminary results reported by the JCO was that the Clover Hill Cave was a minor roost for *Artibeus jamaicensis* while bat netting was abandoned at the Grierfield Cave as a result of difficulty in accessing the cave.[19] [20]

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[17] Wilson, D.E. & Reeder, D.M. (Eds.) (2005) *Mammal Species of the World: A Taxonomic and Geographic Reference*. Third Edition. The Johns Hopkins University Press, Baltimore.

[18] https://www.cockpitcountry.com/batsChecklist.html

[19] http://www.jamaicancaves.org/grierfield_100211.htm

[20] http://www.jamaicancaves.org/clover_hill_100211.htm

The JCO and NEPA has published a list of caves in Manchester and St Ann that are priority for bat protection[23]. These have been put into categories by the NEPA/JCO team. These categories are high medium and low priority as outlined below:

High priority:

- McLean Cave
- Mosely Hall Cave
- New Green Cave

Medium priority:

- Coventry Cave
- Hulls Cave
- Light Hole Cave
- New Hall Cave
- Retreat Gully Cave
- Smokey Hole Cave

Low priority:

- Hopeton Bat Cave
- Thunder Cave

None of the caves in the SEPL 524 are on the list. NEPA has produced a report that details work on the priority roosting caves in St. Ann. Eleven (11) caves have been reported, however, none of the caves in the SEPL 524 was on the list investigated and reported on. These caves were: Thatchfield Great Cave, McLean Cave, Conventry Cave, Light Hole Cave, Mosley Hall Cave, Retreat Gully Cave, Guinea Corn Cave, Chesterfield Cave, Ewart Town Cave, Mount Plenty Cave and Clapham Cave. Bat species in St Ann caves included *Natalus micropus, Pteronotus macleayii, P. quadridens, P. parnellii and Artibeus jamaicensis, Mormoops vlainvillii and Monophyllus redmani, M. blainvillii, G. sorincina, C. micropus*.

[23] https://www.nepa.gov.jm/publications/bat_assessment/bats-caves-st-ann-manchester.pdf

Global bat populations have been reported as being on the decline[24]. The same may also be the case for Jamaica's bat population. Jamaica is expected to presently have a large bat population since the island is made up of large formations of karstic limestone which are known to have many caves as a distinct and common feature. The majority of Jamaica's bat species roost in caves, roofs or crevices. The Jamaica Red Bat *(Lasiurus degelidus)* is a tree dwelling bat, which is on the IUCN Red List of Threatened Species 2016, where it is classified as Vulnerable. Another tree dwelling bat is the Jamaican Fig-eating bat.

Locally, there are twenty-one (21) bat species (Appendix XX) that have been recorded as either resident or endemic to Jamaica (Genoways et al 2005). The Jamaica Cave Organization has been integral in the study of bats in Jamaica. The Windsor Research Center has also done significant work on the bat populations within the caves in close proximity to their research center in the core of the Cockpit Country. The work of these two (2) organizations along with work done by NEPA represents the majority of the available data on bat population in Jamaica.

Bats emit sound waves within unique and narrow frequency bands and use them for echolocation. This allows them to identify the location of distant objects for navigation during flight and for locating prey during hunting. The frequency of these characteristic sounds/calls has been used by researchers and other interested parties as a tool for identifying specific bat species.

There are several devices on the market that can record the sound waves produced by bats. Software is available for pre-processing and enhancing the quality of the recordings, frequency analysis and pitch of the calls. The information collected is ultimately used for species identification. This is done by carrying out comparative analyses with information within the software's built in library.

[24] O'Shea, T. J. and M. A. Bogan (eds.). 2003. *Monitoring trends in bat populations of the United States and territories: problems and prospects*. U.S. Geological Survey, Information and Technology

Kaleidoscope 5 is one of the preferred software available on the market. It is an integrated suite of software tools for efficient processing and analysis of bioacoustics, acoustic and ultrasonic recordings. In bat analysis mode the software attempts to automatically identify and classify bat species.

This Pro version of the software comes default with eleven (11) of the twenty-one (21) known species of bats in Jamaica. This software downloads, processes, and analyzes the recorded file for matching frequencies within its library and possesses a sophisticated spectrogram/waveform viewer along with a set of audio tools for quick audio-visual processing, manual verification and labelling of data.

The spectrograms produced by Kaleidoscope are available to the user for review and manual identification of bats, based on the waveforms that the spectrogram viewer produces for the sounds that the bats emit.

Windsor Research Center (WRC) has produced literature on this method of bat identification which includes the bat frequency signature of 12 local bats[25]. The accepted frequency profiles of the common bat species in Jamaica as presented by the WRC are shown in Figure 5-72 below. The bat scientific names and species codes, for each frequency, are listed in Table 5-38 below.

[25] *BATS - Their contribution to Pollination Insect Control Forest Regeneration*, Windsor Research Center, The John D ad Catherine T. MacArthur Foundation, October 2011

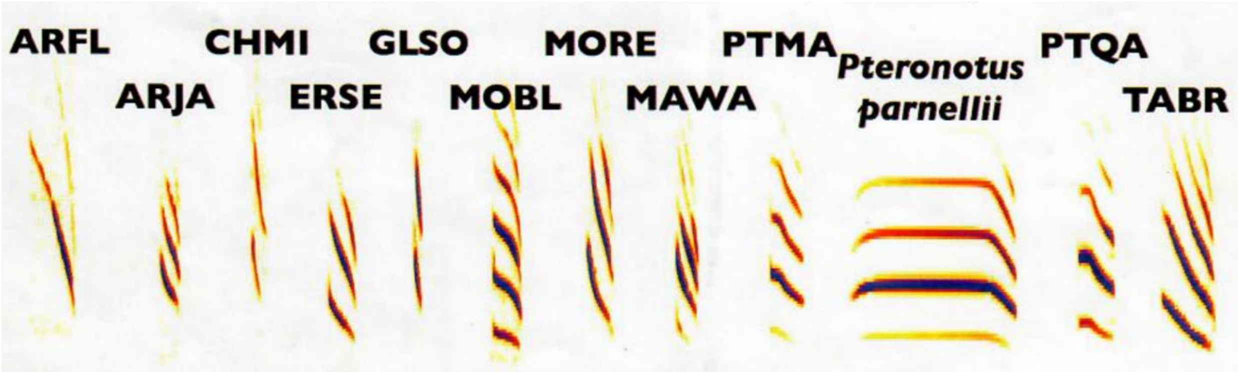


Figure 5-72: Bat Calls Frequency Profiles for Local Jamaican Bats - Windsor Research

This is not the exhaustive list for Jamaican bats, so further research is required to identify the additional nine (9) bat species. However, when combined, the species automatically identified by the Kaleidoscope library and those manually identified using the waveforms reported in the Windsor study, seventeen (17) of the twenty-one (21) local bat species can potentially be identified in this study.

Reptiles play an important ecological role in an ecosystem as they help with the dispersal of seeds, contribute to environmental heterogeneity, and help with maintaining ecosystem structure (Das, 2016). Reptiles are important predators of insects (including those which are agriculture pest), small vertebrates (such as rodents) and some may consume fruits. They are also preyed upon by mammals, birds, fish, large invertebrates (such as spiders and mantids), and larger reptiles. A majority of the world's reptiles inhabit the tropics and subtropics (Das, 2016).

Jamaica has approximately Thirty-three (33) endemic reptile species (Wilson, 2011), Two of which have habitats exclusively to the Cockpit Country. These are *Celestus fowleri* (Bromeliad Galliwasp) and *Sphaerodactylus semasiops* (Eyespot Sphaero) (Windsor Research Centre, 2014).

Amphibians can play a role as an important indicator of ecosystem condition as they all possess a thin and highly permeable skin that offers them little protection against environmental stress. This limited protection makes them sensitive to changes in aquatic and terrestrial environments (Waddle 2006,). So, they can detect changes in the environment, and act accordingly to said change. The responsiveness of the amphibian to the stress depends on the type of stress and the type of amphibian in the system (Waddle 2006). Jamaica has 21 endemic species of frogs (Windsor Research Centre, 2016).

5.4.3.3. Flora Observations

A complete list of flora species observed during the study is provided in Appendix VII. The dominant tree species varied based on each location, with plant species showing more consistency in the lowland/ore body areas and much of the variation in species occurred within the hillock.

Lowland/ore bodies were generally characterized by pasture lands, or shrubs where pasture activities were not maintained. Tree species in lowland areas were common fruit trees planted for agricultural purposes. Woody tree species were more commonly observed along the slopes of the hillocks.

All locations visited showed clear evidence of human disturbance either within or in close proximity to the study transect.

The observations made at each location are summarized below:

5.4.3.3.1. Transect 1 transect start - N 18.23460, W 77.14842

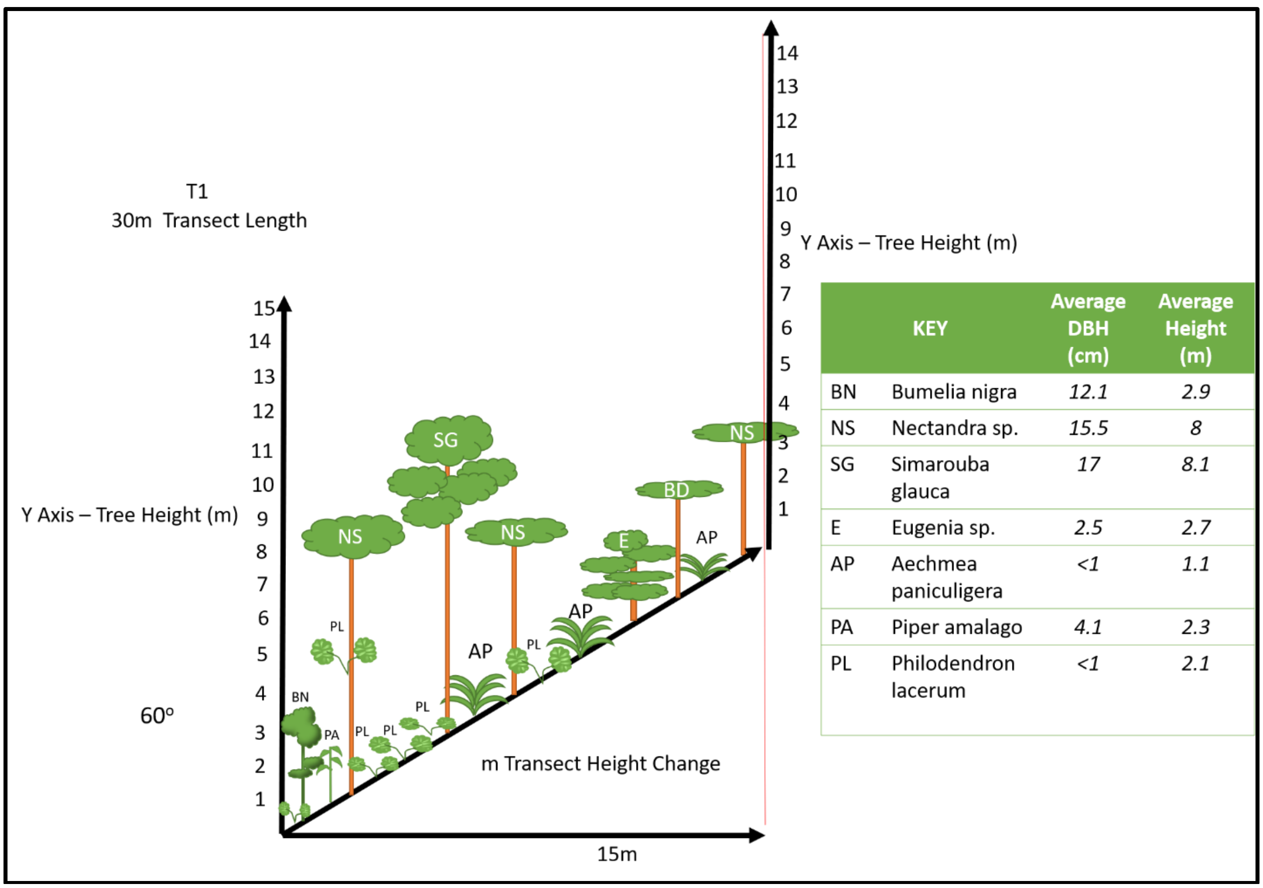
Transect 1 was established at the boundary between SEPL 524 and SML 162. A bauxite ore haul road, which will be extended from an existing roadway in SML 162 to SEPL 524, is proposed to access the SEPL near to the location of Transect 1.

On the transverse to the survey area, there was evidence of human disturbance where the land was previously cleared for pastureland for cows. Pastures extended through most of the traverse and showed low species diversity with the mainly species of shrubs and herbs being observed (*Ambrosia peruviana, Rhytidophyllum tomentosum, Lantana camara Paspalum sp*. Tree species could be observed on the neighboring hillocks. Skirted and the base of the neighboring hillocks were species of fern, *Nephrolepis*.

Figure 5-73: Field surveyors traverse through the pasture lands.

Much of the diversity was observed along the hillock where the transect line was laid. The characteristic ground flora of the canopy understory was dominated by climbing aroids and fern species (*Syngonium auritum, Campyloneurum phyllitidis, Philodendron lacerum*). Forest floor was composed of rocks and shallow depth leaf litter. Evidence of disturbance, few hardwood tree species were present. The understory composition was homogenous with climbing aroids *Syngonium auritum* and *Philodendron laceru*m being the most abundant in terms of number individuals present. Many thin-boled trees were unevenly distributed throughout the quadrats (*Piper amalago, Eugenia sp., Calyptranthes sp).* Taller tree species such as *Simarouba glauca* and *Ficus sp*. were observed around 15 meters up the slope. One bromeliad, *Aechmea paniculigera* was observed in the transect area. Figure 5-75 illustrates the vegetation profile and vegetation identification key plotted for transect 1.

Figure 5-74: Cluster of Philodendron lacerum present in cleared pathway.



KEY		Average DBH (cm)	Average Height (m)
BN	Bumelia nigra	*12.1*	*2.9*
NS	Nectandra sp.	*15.5*	*8*
SG	Simarouba glauca	*17*	*8.1*
E	Eugenia sp.	*2.5*	*2.7*
AP	Aechmea paniculigera	*<1*	*1.1*
PA	Piper amalago	*4.1*	*2.3*
PL	Philodendron lacerum	*<1*	*2.1*

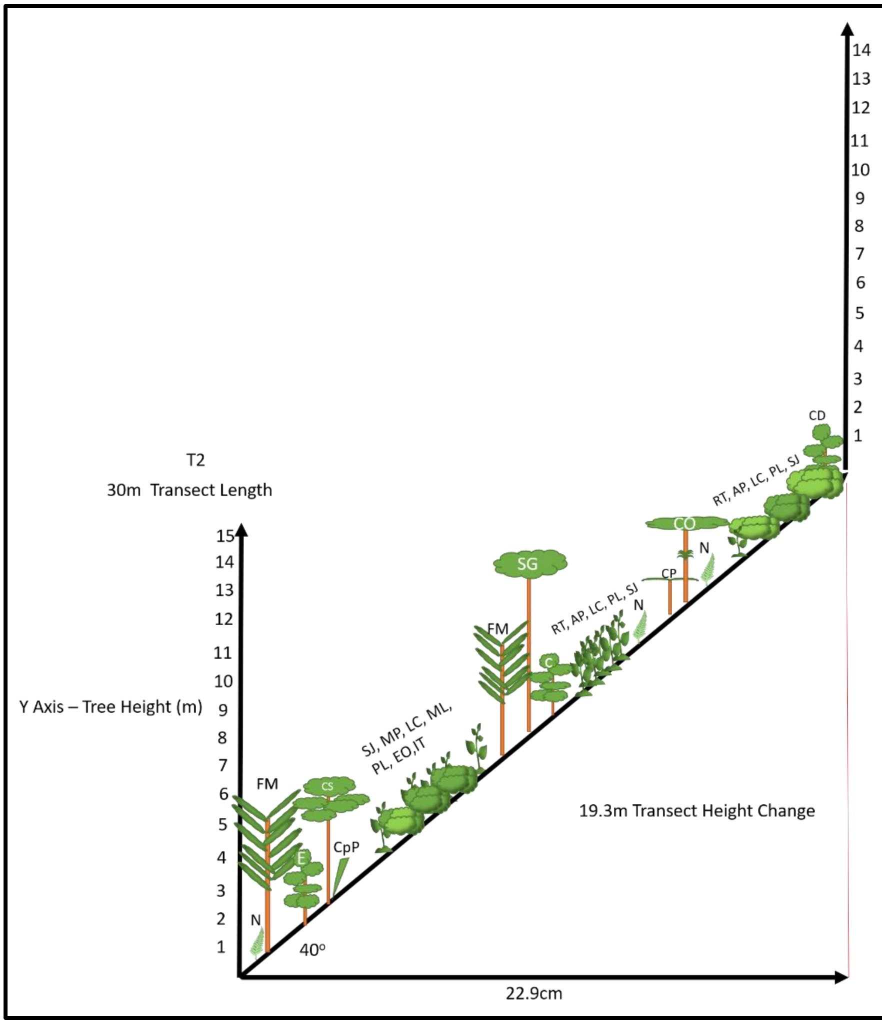
Figure 5-75: Vegetation profile and vegetation identification key plotted for Transect No. 1

Transects 2, 3, 10 and 12 were located in close proximity to the position of the proposed haul road as it would traverse a steep escarpment west of the community of Grief Field in the SEPL 524. Transect 10 was also the location of one of several lowland positions that had been labeled by Windalco as having been examined for mineralogy. These transects are described below.

5.4.3.3.2. Transect 2 transect start- N 18.25183, W 77.14983

Survey was conducted along a steep hillside slope. Land appeared to be previously cleared. Survey site appeared overgrown by weeds and shrubs species *(Nephrolepis sp, Lantana camara, Cestrum diurnum, Pentalinon luteum*). No tree species were present within this region. Juxtaposed to the cleared region was a thicket forest of thin trees and vine species which represented the original vegetation on the hillock. Discrepancies between the secondary and primary forest area could not be deducted given the thickness and density of the forest area. Hence observations were limited to the side profile of species that were readily seen. Within this region common tree species observed were *Eugenia sp.*, *Fagara martinicensis*, *Cedrela odorata, Comocladia sp.* Figure 5-77 illustrates the vegetation profile and vegetation identification key plotted for transect 2.

Figure 5-76: Survey site facing north of the transect



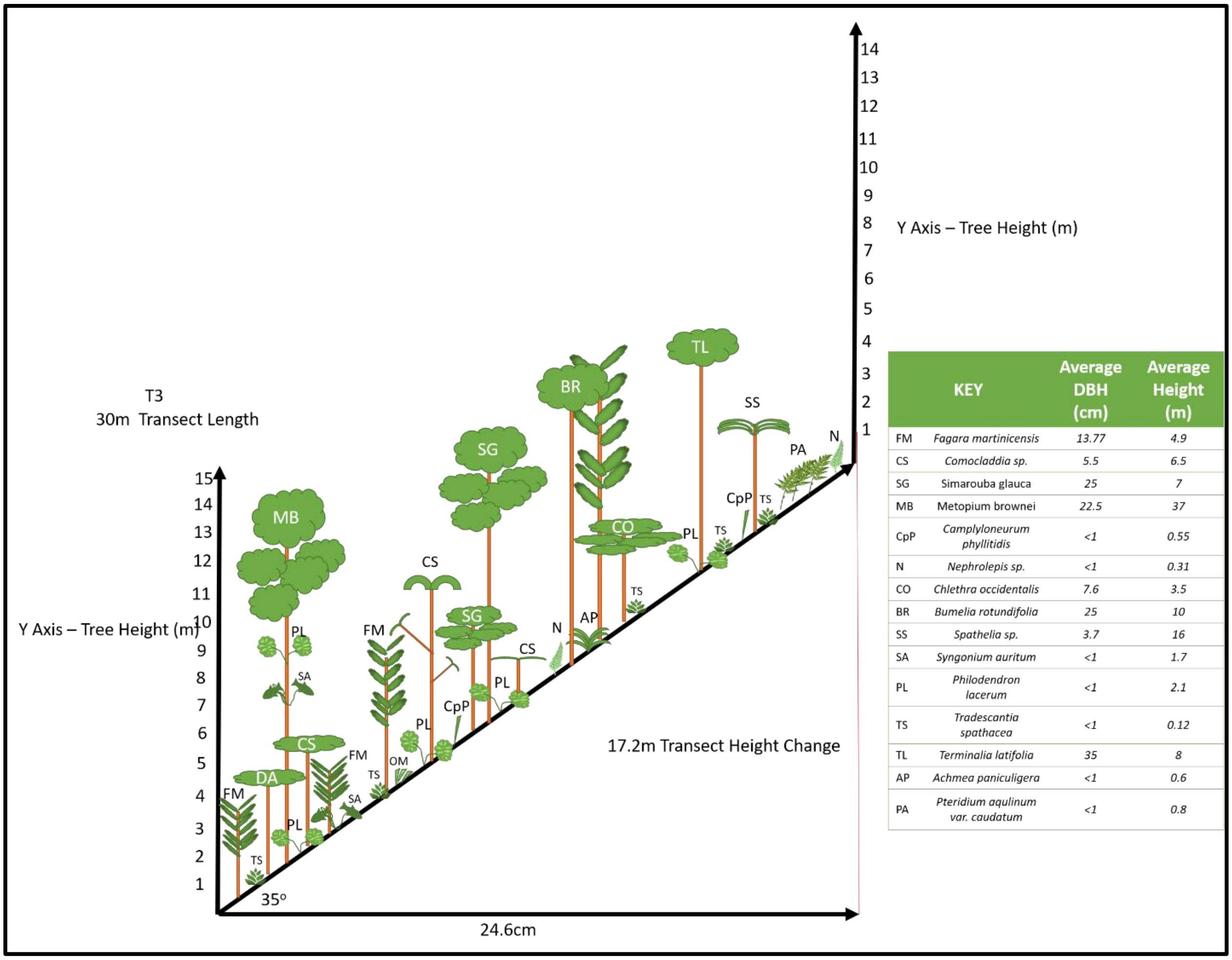
	KEY	Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	5.75	5
CS	*Coccoloba sp.*	4.1	3.4
SG	Simarouba glauca	8.1	6.1
E	Eugenia sp.	6.05	2.1
C	*Clusia flava*	8	2.3
CpP	*Camplyloneurum phyllitidis*	<1	0.72
N	*Nephrolepis sp.*	<1	0.45
CO	*Cedrela odorata*	5.7	3
SJ	*Stachytarpheta jamaicensis*	<1	0.25
MP	*Mimosa pudica*	<1	0.04
LC	*Lantana camara*	0.65	
PL	*Pentalinon luteum*	0.5	1.4
IT	*Ipomoea tiliaceae*	<1	0.7
EO	*Eupatorium odoratum*	<1	1.4
ML	*Miconia laevigata*	<1	1.08
RT	*Rhytidophyllum tometosum*	<1	1.6
AP	*Ambrosia peruviana*	<1	1.2
CD	*Cestrum diurnum*	3.1	2.1

Figure 5-77: Vegetation profile and vegetation identification key plotted for Transect No. 2

5.4.3.3.3. Transect 3 transect start- N 18.26581, W 77.1513 end of transect- N 18.26594, W 77.15141

Transect 3 survey area was forested with secondary forest species dominated by *Fagara martinicensis, Simarouba glauca*, and unknown species of the family Fabacaea. Other notable tree species were *Metopium brownei, Ocotea sp., Spathelia sp. Bumelia rotundifolia*, *Dendropanax arboreus*. Lower tree species were composed of *Coccoloba sp, Comocladia sp*. Area appeared to be disturbed with evidence of human activity, namely cattle rearing . Forest floor composition was dissimilar along the transect. The first 10 meters of the study appeared dominated by *Tradescantia spathacea, Syngonium auritum* and *Philodendron lacerum*. Species composition then transitioned to mainly fern species (*Campyloneurum* *phyllitidis, Nephrolepis sp.*) At the final quadrat of the transect was an area of rock slippage which created a gap in the canopy. Within the open area was a common indicator of disturbance, bracken fern (*Pteridium aquilinum var. caudatum)*. One species of bromeliad was observed in the survey area, *Aechmea paniculigera*. Few individuals of endemic palm, *Thrinax parviflora*, were present. Figure 5-79 illustrates the vegetation profile and vegetation identification key plotted for transect 3.

Figure 5-78: Opening in canopy made due to rock slippage



KEY		Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	13.77	4.9
CS	*Comocladdia sp.*	5.5	6.5
SG	Simarouba glauca	25	7
MB	Metopium brownei	22.5	37
CpP	*Camplyloneurum phyllitidis*	<1	0.55
N	*Nephrolepis sp.*	<1	0.31
CO	*Chlethra occidentalis*	7.6	3.5
BR	*Bumelia rotundifolia*	25	10
SS	*Spathelia sp.*	3.7	16
SA	*Syngonium auritum*	<1	1.7
PL	*Philodendron lacerum*	<1	2.1
TS	*Tradescantia spathacea*	<1	0.12
TL	*Terminalia latifolia*	35	8
AP	*Achmea paniculigera*	<1	0.6
PA	*Pteridium aqulinum var. caudatum*	<1	0.8

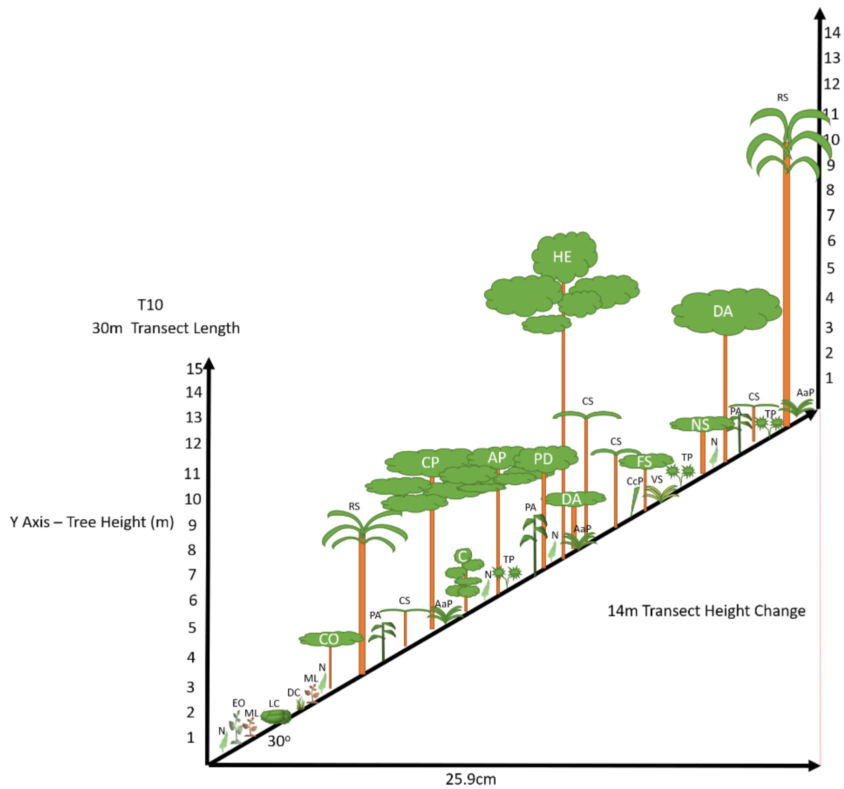
Figure 5-79: Vegetation profile and vegetation identification key plotted for Transect No. 3

5.4.3.3.4. Transect 10 transect start - N 18.27294, W 77.15382

Transect 10 area showed the transition from grassland to hillock. Field area dominated by fern species, *Nephrolepis sp.*, shrubs (*Eupatorium odoratum, Varronia bullata, Stachytarpheta cayennensis, Lantana camar*a), herbs (*Trimezia martinicensis*) and sedges (*Dichromena ciliata*). Forest area appeared relatively undisturbed. There was great variation of species within the quadrat. Understory species identified included *Piper amalago and Comocladia pinnatifolia*. The forest floor was covered by an array of bromeliads (*Aechmea* paniculigera, Vriesea sp.), ferns (*Blechnum occidentales, Campyloneurum phyllitidis, Nephrolepis sp.*), grasses (*Lasciasis divaricata*) and aroids (*Anthurium grandifolium*). Tall tree species which formed the canopy layer included *Cecropia peltata*, "Royal Palm" *Roystonea* *sp.*, *Pimenta dioica*, *Dendropanax arboreus*, "Blue Mahoe'' *Hibiscus elatus*. The endemic orchid, *Campylocentrum jamaicensis*, was frequently observed on the trunk of trees. Common vines were Passiflora rubra, *Dioscorea polygonoides*. Figure 5-82 illustrates the vegetation profile and vegetation identification key plotted for transect 3.

Figure 5-80: Photograph from elevated view showing the coverage of *Nephrolepis sp*. in the pasture area

Figure 5-81: Photograph from elevated view showing the forest floor



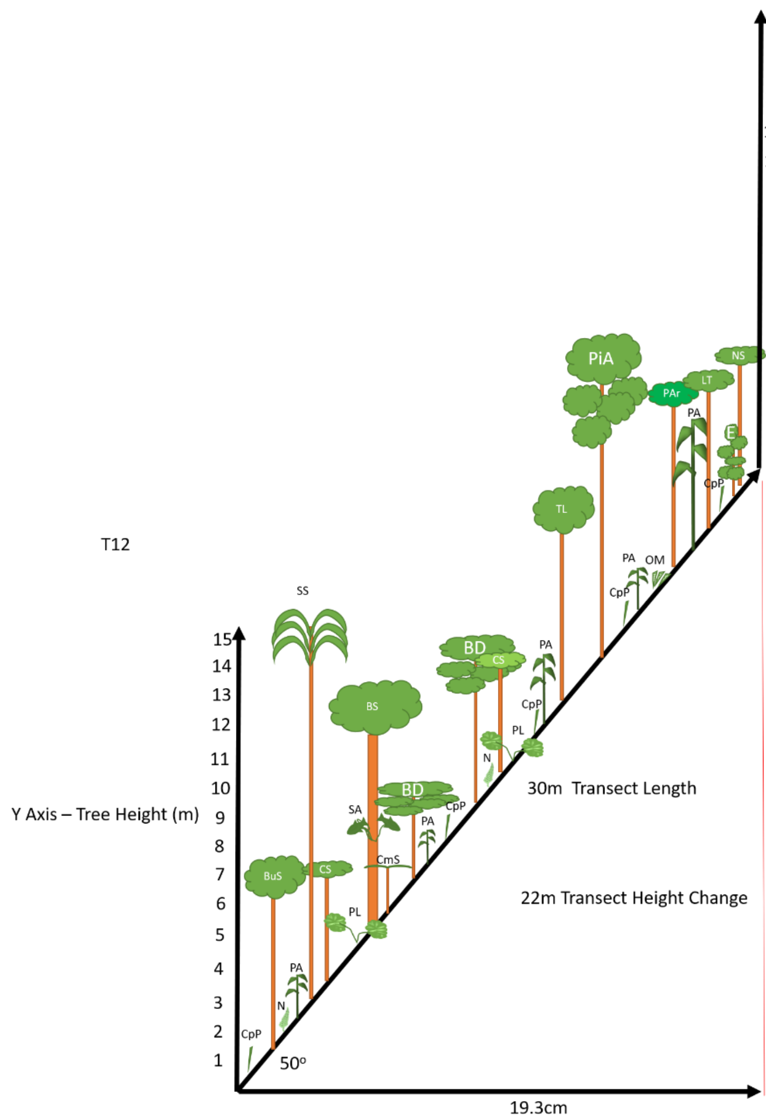
	KEY	Average DBH (cm)	Average Height (m)
CcS	*Coccoloba sp.*	<1	1.2
C	*Clusia flava*	7	2.5
CS	*Comocladdia sp.*	5	3
DA	*Dendropanax arboreus*	<1	6
AaP	*Aechmea paniculigera*	<1	0.9
PA	*Piper amalago*	2.17	2.3
VS	*Vriesea sp.*	<1	0.25
E	*Eugenia sp.*	<1	1.4
CcP	*Camplyloneurum phyllitidis*	<1	0.49
N	*Nephrolepis sp.*	<1	0.35
RS	*Roystonea sp.*	30	6.2
NS	*Nectandra sp*	4.3	2.1
ML	*Miconia laevigata*	0.42	0.2
FS	*Ficus sp.*	<1	2.7
EO	*Eupatorium odoratum*	0.56	0.3
AP	*Adenanthera pavonina*	32	5.2
AU	*Acidoton urens*	0.25	0.5
LC	*Lantana camara*	0.42	0.3
TP	*Thrinax parviflora*	19	0.4
DC	*Dichromena ciliata*	<1	0.1
HE	*Hibiscus elata*	<1	12

Figure 5-82: Vegetation profile and vegetation identification key plotted for Transect No. 10

5.4.3.3.5. Transect 12 transect start - N 18.25497, W 77.15063 end of transect

Transect 12 study area was located near a cave system. A resident farmer who guided us to the survey site, reported of previous collection of guano at the location which alluded to the presence of bats in the area. Tree species were sparsely dispersed and created an open forest area. The area appeared to be heavily disturbed as there was a clear pathway leading to the site. The distinctive, *Bursera simaruba*, with its red paper-like trunk was observed within the transect area. Its fruits are commonly eaten by a number of birds (crows, thrushes, parakeets, among others). Hardwood species were observed (*Oxandra lanceolata, Pithecellobium arboreum*). Other tree species identified were *Bauhinia divaricata, Piper arboreum, Piper amalago, Spathelia sp. Bumelia sp, Coccoloba sp., Latetita thamnia*. The forest flora showed scattered dispersion of aroids *(Philodendron lacerum, Syngonium Auritum) and ferns (Campyloneurum phyllitidis, Adiantum capillus-veneris)*. Very few herbaceous vines were observed at the study site. The endemic cactus, *Hylocereus triangularis*, was noted on a tree within the study area. At the end of the transect was a tall white cliff wall. Figure 5-84 illustrates the vegetation profile and vegetation identification key plotted for transect 12.

Figure 5-83: Open forest and typical vegetation within Transect 12



KEY		Average DBH (cm)	Average Height (m)
BS	*Bursera simaruba*	30	8
BuS	*Bumelia sp*	15	6.6
CS	*Coccoloba sp.*	7.1	7.1
PA	*Piper amalago*	0.71	3.9
PAr	*Piper arboreum*	5.8	6.2
E	*Eugenia sp.*	<1	3.7
CpP	*Campyloneurum phyllitidis*	<1	0.62
N	*Nephrolepis*	17	0.29
TL	*Terminalia latifolia*	5.9	6.7
NS	*Nectandra sp*	26	4.9
PiA	*Pithecellobium arrboreum*	<1	10.3
CmS	*Comocladia sp.*	<1	2.1
PL	*Philodendron lacerum*	<1	1.3
SA	*Syngonium auritum*	<1	1.2
OM	*Oeceoclades macu9late*	<1	0.1
DC	*Dichromena ciliate*	<1	0.11

Figure 5-84: Vegetation profile and vegetation identification key plotted for Transect No. 12

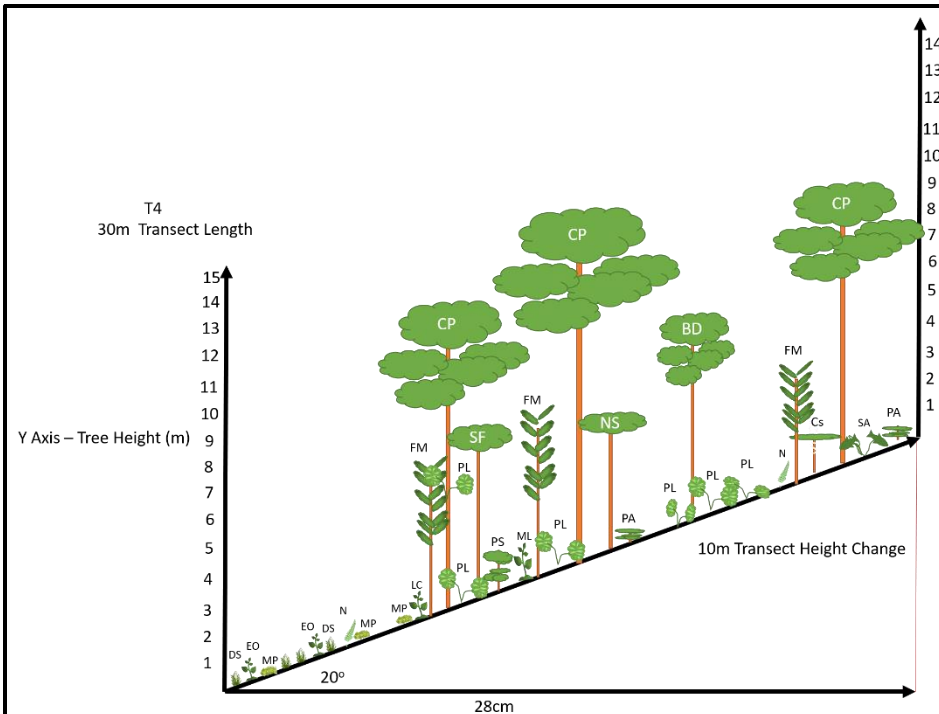
Transects 4 to 9, 11 and 13 to 21 were located at or near to proposed ore bodies or were near to features deemed to be ecologically important, such as ponds or caves. These are described below.

5.4.3.3.6. Transect 4 transect start- N 18.26340, W 77.18145 end of transect- N 18.26319, W 77.18139

Transect 4 study area showed a transition from the ore body to a hillside slope. On the transverse to the survey area, extended pasturelands were observed and were used for cattle rearing. The ore body occupied the first 10m of the transect. Within the pasture area a number of grass and small shrubs species were observed (*Desmodium incanum, Mimosa pudica Eupatorium odoratum, Sida acuta, Miconia laevigata*). Along the hillock, the larger dominant species were *Fagara martinicensis*, *Sideroxylon foetidissimum, Cecropia peltata, Bauhinia divaricata*. Understory layer of the forest was composed of smaller tree species in the genus of *Nectandra, Comocladia*, and *Coccoloba*. *Piper amalago* was also observed as an understory species. At the forest floor a number of shade tolerant species were observed comprising mainly of ferns, aroids and small plants *(Psychotria sp., Nephrolepis sp., Adiantum sp., Polypodium polypoides, Tectaria sp., Philodendron lacerum, Syngonium auritum)*. Figure 5-87 illustrates the vegetation profile and vegetation identification key plotted for transect 4.

Figure 5-85: Grassland area of ore body

Figure 5-86: Overhead shot of the forest floor occupied by numerous plant species



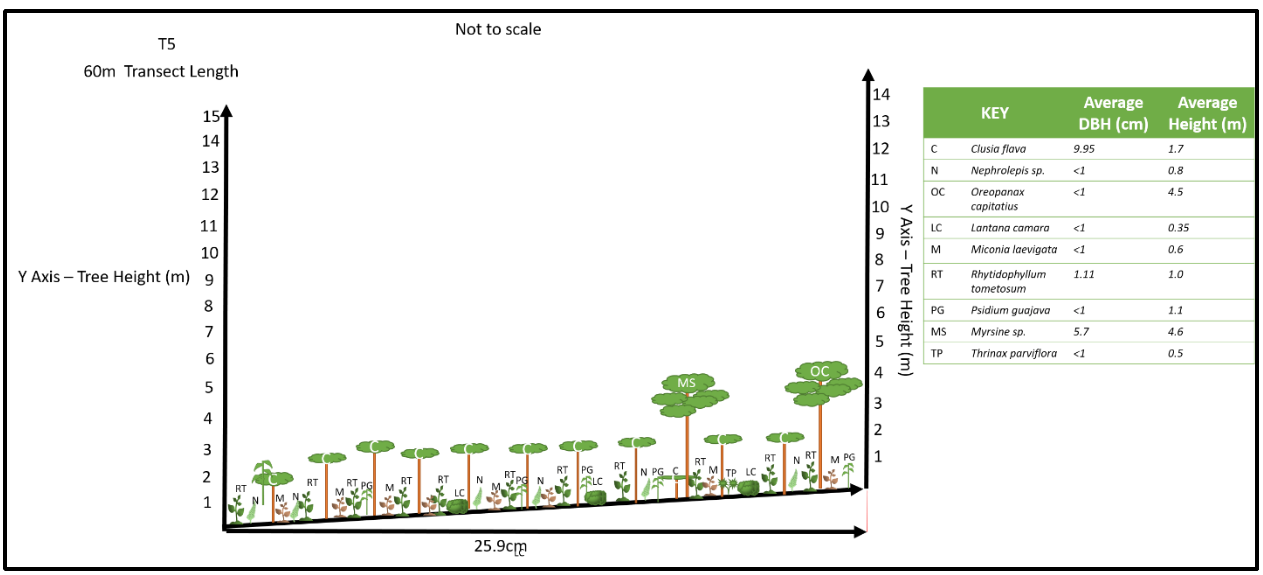
	KEY	Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	13.9	5.2
CS	*Coccoloba sp.*	5.3	
CP	*Cecropia peltata*	30.67	11
N	*Nephrolepis sp.*	<1	0.45
ML	*Miconia laevigata*	<1	0.7
MP	*Mimosa pudica*	<1	0.1
EO	*Eupatorium odoratum*	<1	0.5
SF	*Sideroxylon foetidissimum*	10.5	6.1
PS	*Psychotria sp.*	2.35	1.8
SA	*Syngonium auritum*	<1	3
PL	*Philodendron lacerum*	<1	4.2
DS	*Digitaria sanguinalis*	<1	0.07
BD	*Bauhinia divaricata*	25	7
AP	*Achmea paniculigera*	<1	0.7
PA	*Piper amalago*	1.85	0.65

Figure 5-87: Vegetation profile and vegetation identification key plotted for Transect No. 4

5.4.3.3.7. Transect 5 transect start - N 18.23880, W 77.10358, end of transect- N 18.23842, W 77.10328

Transect 5 survey site was conducted along a roadside where a roadway was cut through an old hillock. The survey area was slightly sloped (See Figure 5-88) which allowed for more settlement of soil deposits. As a result more vegetation was observed along the sloped hillside compared to the adjacent side of the road (see Figure 5-90 - Transect 6) which showed a vertical cliff face. Vegetation was composed of small trees/shrubs, vine, and herbs. Transect area showed a density of fern species in the genus *Nephrolepis*. Along with fern species, there were a number of shrub species (*Rhytidophyllum tomentosum, Lantana Camara, Panicum sp*.) at the immediate roadside. *Clusia flava* was observed nestled along the stony areas of the slope. Other tree species observed were individuals of the genus *Myrsine* and *Wallenia laurifolia*. A cluster of the endemic bromeliad, *Hohenbergia sp.*, was present at the cliff top. Another species, T*hrina parviflora*, was also identified at the cliff top. Figure 5-89 illustrates the vegetation profile and vegetation identification key plotted for transect 5.

Figure 5-88: Section view of roadway cut through a hillock



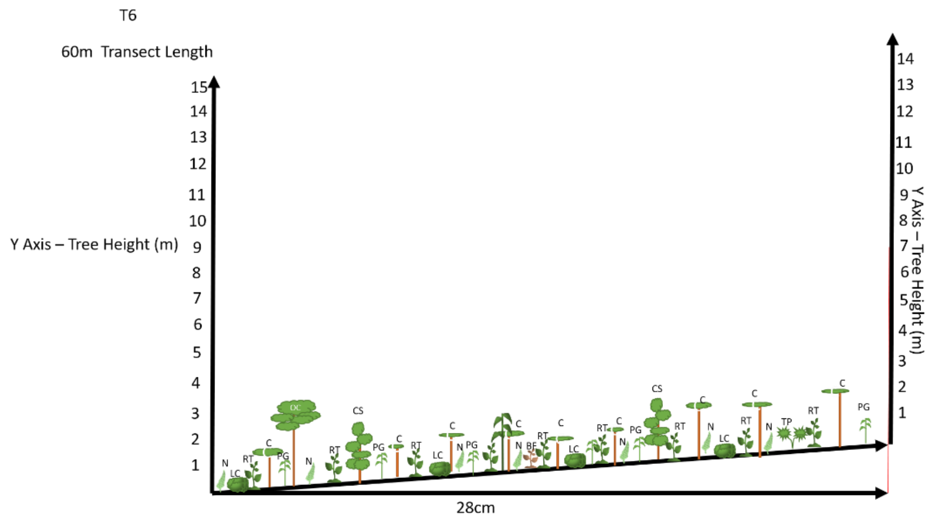
	KEY	Average DBH (cm)	Average Height (m)
C	*Clusia flava*	9.95	1.7
N	*Nephrolepis sp.*	<1	0.8
OC	*Oreopanax capitatius*	<1	4.5
LC	*Lantana camara*	<1	0.35
M	*Miconia laevigata*	<1	0.6
RT	*Rhytidophyllum tometosum*	1.11	1.0
PG	*Psidium guajava*	<1	1.1
MS	*Myrsine sp.*	5.7	4.6
TP	*Thrinax parviflora*	<1	0.5

Figure 5-89: Vegetation profile and vegetation identification key plotted for Transect No. 5

5.4.3.3.8. Transect 6 transect start - N 18.23837, W 77.10334

Transect 6 survey site showed a roadway cut through a hillock. Species composition was homogenous along the transect line. The survey area was dominated by shrub and herbaceous species. Along the cliff face, fine tree and shrub species could be observed growing in small pockets within the rocky substrate. The stony stature and vertical alignment did not appear to support vegetation growth. Vegetation was more prevalent at the base of the cliff which met the road. Survey site showed overgrowth of shade-intolerant weeds such as *Nephrolepis sp, Lantana camara, Psidium guava*, and *Rhytidophyllum tomentosum*. Endemic vine, *Galactica pendula*, was observed tangled in the foliage of a tree. Notable tree species were *Oreopanax capitatus, Citrus sp*. And *Clusia flava*. Seedlings of *Clusia flava* dominated the limestone/shale cliff face. Figure 5-91 illustrates the vegetation profile and vegetation identification key plotted for transect 6.

Figure 5-90: Section view of roadway cut through a hillock



KEY		Average DBH (cm)	Average Height (m)
C	*Clusia flava*	2.62	2.5
N	*Nephrolepis sp.*	<1	0.31
OC	*Oreopanax capitatius*	9.1	3.1
LC	*Lantana camara*	<1	0.6
RT	*Rhytidophyllum tometosum*	1.23	1.1
PG	*Psidium guajava*	3.73	0.34
CS	*Citrus species*	5.88	6
TP	*Thrinax parviflora*	<1	0.7
BF	*Bocconia frutescens*	2.6	0.64

Figure 5-91: Vegetation profile and vegetation identification key plotted for Transect No. 6

5.4.3.3.9. Transect 7 transect start - N 18.26768, W 77.20793

Species composition consistent within each quadrat composed of shrubs and herbaceous *Mimosa pudica, Eupatorium odoratum, Desmodium sp., Ambrosia and invasive species Solanum capsicoides, Solanum erianthum*. No tree species observed to create shading which allowed for overgrowth of weed species. Location was dominated by *Ambrosia peruviana*. It is reported that *A. peruviana* is a natural indicator of disturbance and pioneer species after occurrence such as forest clearing or overgrazing. Figure 5-93 illustrates the vegetation profile and vegetation identification key plotted for transect 7.

Figure 5-92: Species composition dominated by *Ambrosia peruviana* within a section of transect 7

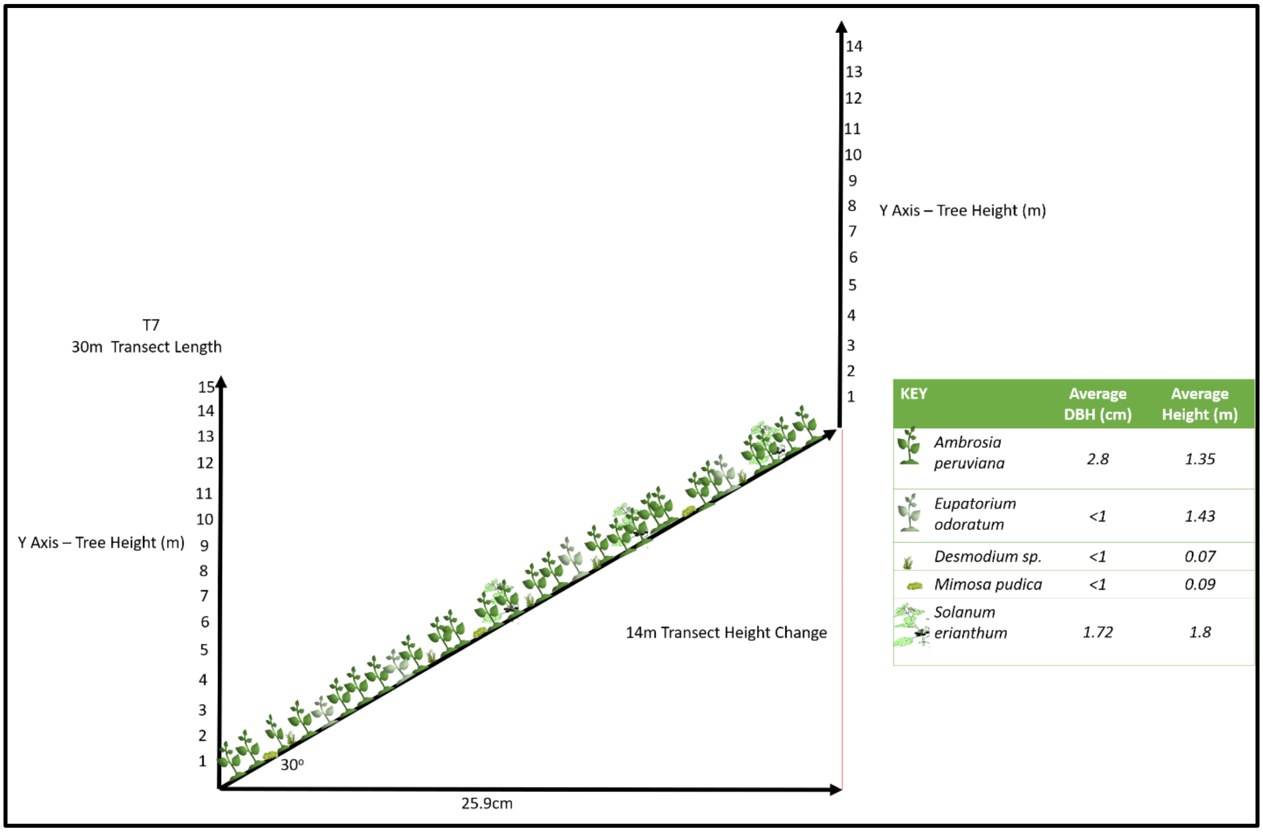
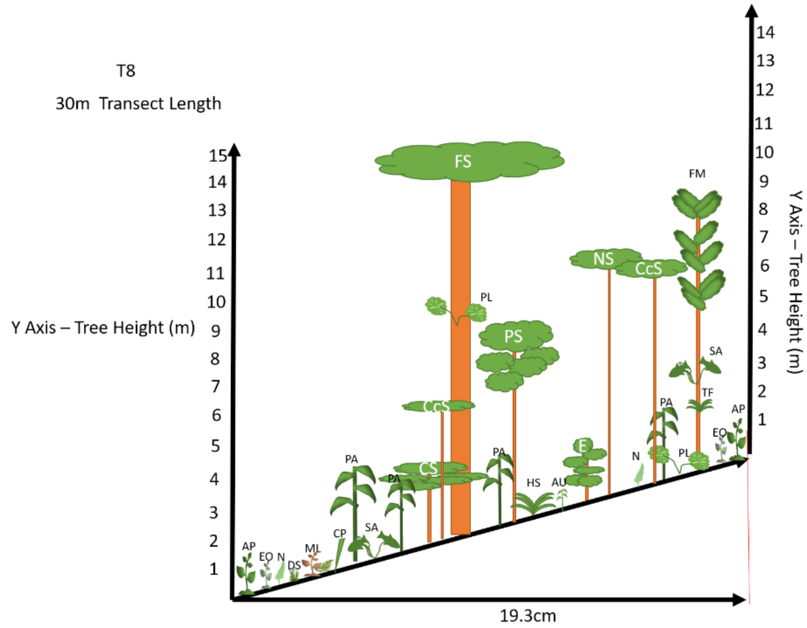


Figure 5-93: Vegetation profile and vegetation identification key plotted for Transect No. 7

5.4.3.3.10. Transect 8 transect start - N 18.26865, W 77.20716

Transect 8 survey site showed a small but highly disturbed forest area with a heavily littered forest floor due to human activity. The area was defined by the forest area being nestled with a small depression in the shrubland. As a result of varying terrain, species composition varied along the transect. A notable feature of the area was the gaps with the canopy which occurred due to removal trees. The first 5 meters was occupied by common shrub species *Ambrosia peruviana*, *Eupatorium odoratum*, *Miconia laevigata*. The area then transitioned into the forest area A tall *Piper amalago* occupied the first 10 meters of the transect. The understory layer of trees was composed of *Comocladia pinnatifolia, Coccoloba sp. Nectandra sp. Calliandra sp., Eugenia sp. and Piper amalago*. Taller tree species present were *Ficus sp., Fagara martinicensis* and *Ceiba pentandra*. The forest floor area composed of aroids (*Syngonium auritum, Philodendron lacerum*), shrubs (*Acidoton urens*) ferns (*Campyloneurum* *phyllitidis, Nephrolepis sp., Anthurium grandifolium*) and bromeliads (*Hohenbergia sp.*). Figure 5-95 illustrates the vegetation profile and vegetation identification key plotted for transect 8.

Figure 5-94: Forest area at Harmony



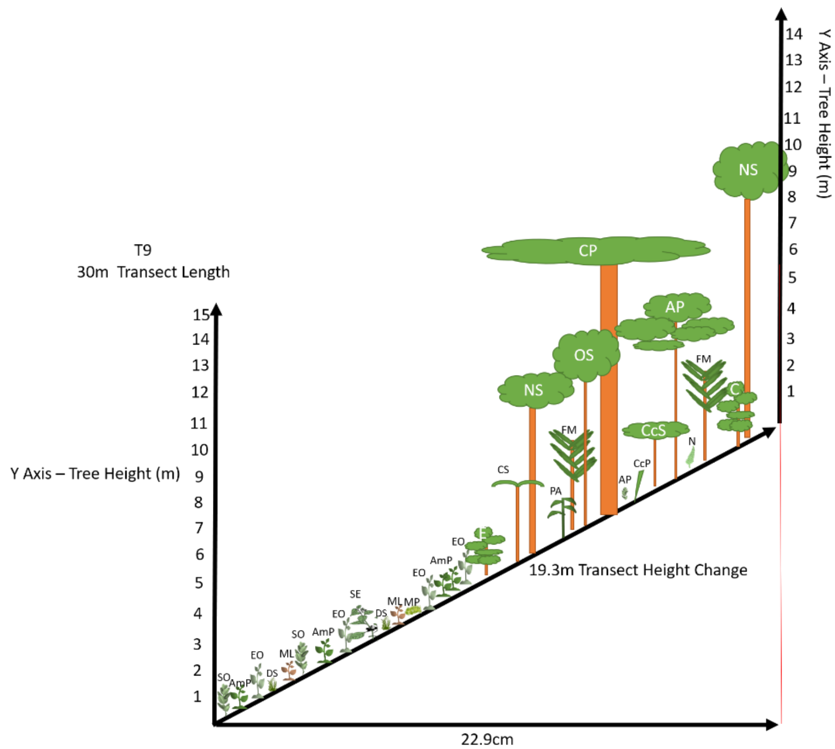
KEY		Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	21	10.5
CcS	*Coccoloba sp.*	<1	4.8
CS	*Calliandra sp.*	10.1	2.3
FS	Ficus sp.	31	13.5
E	*Eugenia sp.*	5.6	4
CP	*Camplyloneurum phyllitidis*	<1	0.5
N	*Nephrolepis sp.*	<1	0.4
SA	*Syngonium auritum*	<1	4.1
NS	*Nectandra sp*	4.5	8.5
ML	*Miconia laevigata*	0.01	0.8
PL	*Philodendron lacerum*	<1	1.1
AP	*Ambrosia peruviana*	<1	1.5
EO	*Eupatorium odoratum*	<1	0.9
AU	*Acidoton urens*	<1	0.3
PA	*Piper amalago*	2.88	2.7
TF	*Tillandisia fasciculata*	<1	0.1
HS	*Hohenbergia sp.*	<1	0.8
DS	*Desmodium sp.*	<1	0.02

Figure 5-95: Vegetation profile and vegetation identification key plotted for Transect No. 8

5.4.3.3.11. Transect 9 transect start - N 18.26558, W 77.21085

Transect 9 study area was located beside a man-made pond. Shrub species were observed around the pond. The study site presented a shrubland area which transitioned into a forest area. Within the shrubland area species observed were *Cassia occidentalis, Solanum eriathum, Solanum capsicoides, Ambrosia peruviana, Eupatorium odoratum, Eugenia sp.* At the transitional area, the introduction of shade tolerant plants such as *Nephrolepis sp.* and *Miconia laevigata* was evident. Within the forested area, the main tree species present were *Nectandra sp., Ocotea sp. Fagara martinicensis, Dipholis sp., Comocladia pinnatifolia, Picramnia sp., Piper amalago*. Forest floor was composed of ferns (*Campyloneurum phyllitidis*), and shrubs (*Miconia laevigata*). No aroid species were observed within the transect area. Figure 5-97 illustrates the vegetation profile and vegetation identification key plotted for transect 8.

Figure 5-96: *Cassia occidentalis* frequently observed at the surrounding areas and within transect.



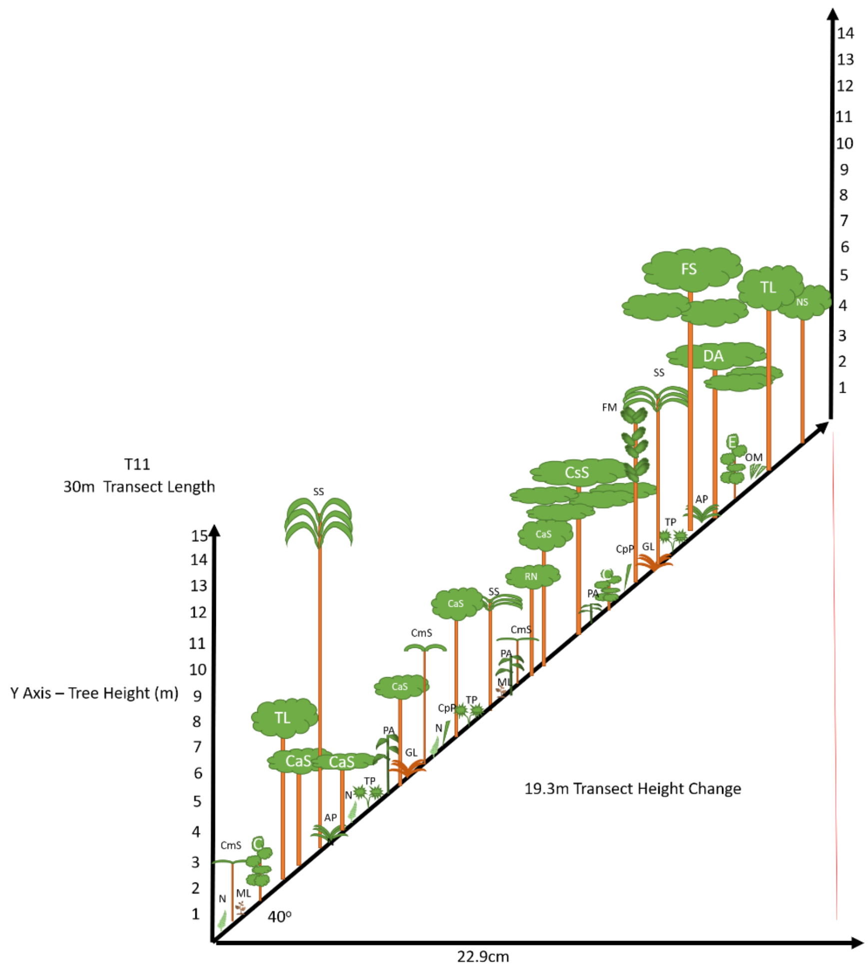
KEY		Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	14.5	3.5
CcS	*Coccoloba sp.*	4.5	2.5
C	*Clusia flava*	7.8	2.4
CS	*Comocladdia sp.*	<1	3.4
E	*Eugenia sp.*	<1	1.9
CP	*Camplyloneurum phyllitidis*	<1	0.5
N	*Nephrolepis sp.*	<1	0.7
OS	*Ocotea sp.*	26	7.5
NS	*Nectandra sp*	18	6.4
ML	*Miconia laevigata*	<1	0.3
MP	*Mimosa pudica*	<1	0.03
EO	*Eupatorium odoratum*	<1	1.2
AP	*Adenanthera pavonina*	15	6
AmP	*Ambrosia peruviana*	<1	1
AU	*Acidoton urens*	<1	0.4
SE	*Solanum erianthum*	<1	1.2
SO	*Senna occidentalis*	<1	0.38
DS	*Digitaria sanguinalis*	<1	0.04

Figure 5-97: Vegetation profile and vegetation identification key plotted for Transect No. 9

5.4.3.3.12. Transect 11 transect start - N 18.26679, W 77.18056

Transect 11 survey site was a summit of a hillock area. The vegetation type was consistent and homogenous throughout with secondary forest species. Few weed species (*Momordica charantia, Bocconia frutescens*) were present along the first few meters of the transect indicating disturbance in the forest area. The canopy layer varied between dense to open along the transect. The understory layer of the canopy was dominated by small tree species such as *Eugenia sp., Calyptranthes sp., Piper amalago, Clusia flava, Comocladia pinnatifolia*. Tree species in the Myrtle Family, Myrtaceae dominated the understory layer. The fruits of the trees could be a possible source of nutrition for frugivorous birds and other fauna. A number of unique and rare species were (*Pseudorhipsalis alata, Microgramma lycopodioides* "Clubmoss Snakefern"). Understory composition varied as some regions were dominated by different plant types. The lower level of the slop appeared to be dominated by more shade tolerant ferns and shrub species (*Acidoton urens, Nephrolepis sp., Polypodium polypoides,* *Campyloneurum phyllitidis, Adiantum capillus-veneris*). Five species of bromeliads noted (*Guzmania lingulata, Aechmea paniculigera, Vriesea sp., Tillandsia sp, Hohebergia*). A number of *Guzmania lingulata* were observed at the summit of the hill. This is a moisture-demanding species which could indicate rainfall in the area. At the top of the hillock was a gap in the canopy appeared to be caused by removal of tree species possibly for timber. An indicator species (*B. frutescens*) was present as a sign of disturbance. Taller tree species which defined the woodland area were *Fagara martinicensis, Spathelia sp., Ficus sp, Dendropanax arboreus, Nectandra sp, Ocotea sp, Terminalia latifolia, Alchornea latifolia*. Orchids in the area were observed on tree species (*Campylocentrum jamaicensis, Tolumnia tetrapetallum*) and rock substrates (*Oeceoclades maculata, Epidendrum cochleatum*). Figure 5-99 illustrates the vegetation profile and vegetation identification key plotted for transect 11.

Figure 5-98: Woodland area of study site



KEY		Average DBH (cm)	Average Height (m)
CcS	*Coccoloba sp.*	<1	5.1
C	*Clusia flava*	4.9	2.1
CaS	*Calyptranthes sp.*	4.17	4.1
CmS	*Comocladia sp.*	<1	2.3
DA	*Dendropanax arboreus*	53.67	6.6
AP	*Aechmea paniculigera*	<1	1.2
PA	*Piper amalago*	1.05	1.7
RN	*Rauvifolia nitida*	7.1	3.2
E	*Eugenia sp.*	<1	5.5
CpP	*Camplyloneurum phyllitidis*	<1	0.6
N	*Nephrolepis sp.*	<1	0.2
SS	*Spathelia sp.*	18.39	7
TL	*Terminalia latifolia*	23.2	6.5
ML	*Miconia laevigata*	0.34	0.54
FS	*Ficus sp.*	<1	10.2
OM	*Oeceoclades maculata*	<1	0.23
TP	*Thrinax parviflora*	<1	0.71
GL	*Guzmania lingulata*	<1	0.51

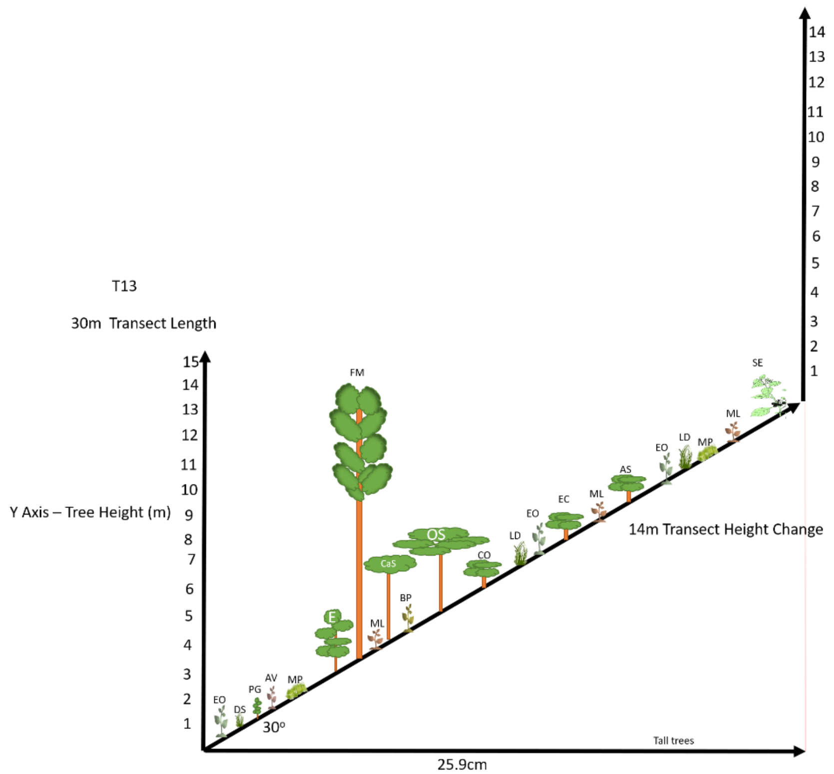
Figure 5-99: Vegetation profile and vegetation identification key plotted for Transect No. 11

5.4.3.3.13. Transect 13 transect start - N 18.19563, W 77.21193 end of transect- N 18.48226, W 77.15542

Transect 13 survey site showed a transition from ore to a highly disturbed forest region. The ore body was defined by an overgrowth of weed species of grass (*Digitalis sangulia*) and small shrubs (*Eupatorium odoratum, Mimosa pudica, Sida acuta, Amaranthus viridis, Desmodium incanum, Miconia impetolaris, Psidium guava*) present. The forest area was divided in two sections; a relic forest area and the disturbed area. Due to removal of tree species there was no true canopy and the location was dominated by shrubs (*E. odoratum, Lantana camara, Solanum erianthum, Cassia obtusifolia*) and in the disturbed region. The relic forest area showed trees such as *Fagara martinicensis, Erythrina corallodendrum, Calyptranthes sp., Eugenia axillaris, Ocotea sp.,* and *Cupania glabra.* Figure 5-102 illustrates the vegetation profile and vegetation identification key plotted for transect 13.

Figure 5-100: Image showing coverage of weed species in the ore body

Figure 5-101: Surveyed area along transect 13 – Transect Line Shown



KEY		Average DBH (cm)	Average Height (m)
FM	*Fagara martinicensis*	15	10
CO	*Cassia obtusifolia*	<1	0.3
C	*Erythrina corallodendrum*	1.3	0.42
CaS	*Calyptranthes sp.*	5.8	2.5
E	*Eugenia sp.*	<1	2.12
AV	*Amaranthus viridis*	<1	0.83
AS	*Acacia sp.*	<1	0.7
OS	*Ocotea sp.*	6	2.3
PG	*Psidium guajava*	<1	0.6
ML	*Miconia laevigata*	<1	0.7
MP	*Mimosa pudica*	<1	0.08
EO	*Eupatorium odoratum*	1.05	0.63
BP	*Bryophyllum pinnatum*	<1	0.1
SE	*Solanum erianthum*	1.38	1.09
SO	*Lasciasis divaricata*	<1	0.21
DS	*Digitaria sanguinalis*	<1	0.09

Figure 5-102: Vegetation profile and vegetation identification key plotted for Transect No. 13

5.4.3.3.14. Transect 14 transect start - N 18.24814, W 77.19860 end of transect- N 18.24835, W 77.19850

Transect 14 survey site was situated near a cave. The terrain was a steep, rocky, sloping hillside. Within the pasture area were grazing cows indicating that area was disturbed. The pasture was dominated by grass and shrub species. Along the hillside were thickets of trees that created a dense canopy layer. Figure 5-103 illustrates the vegetation profile and vegetation identification key plotted for transect 14.

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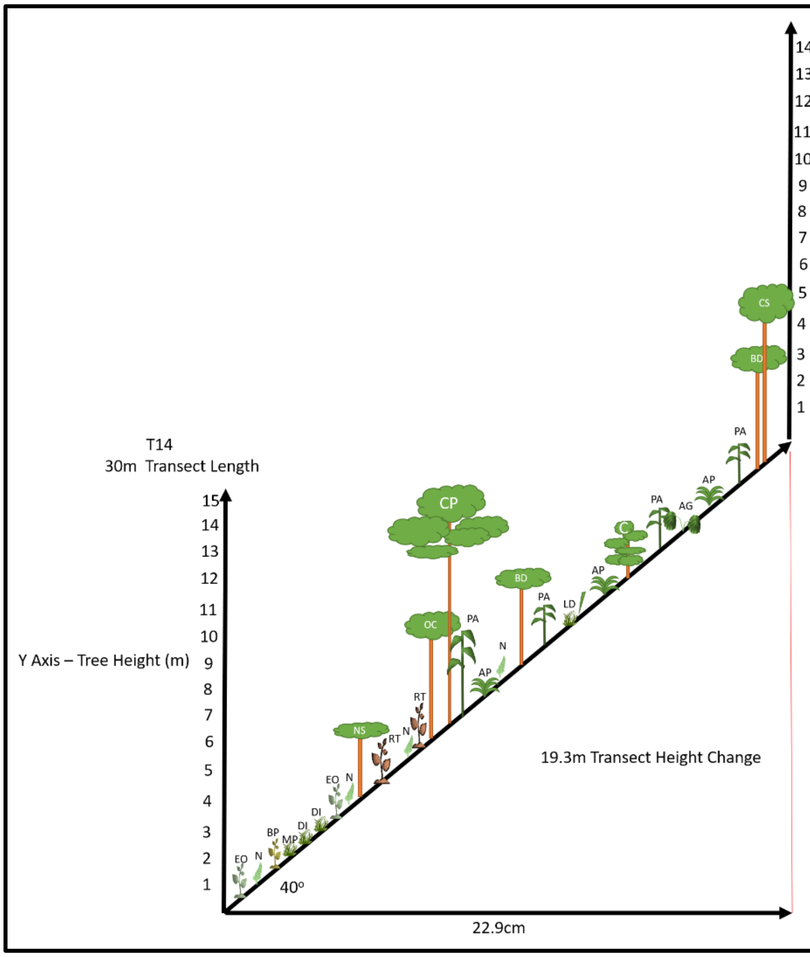


KEY<<		Average DBH (cm)	Average Height (m)
CP	*Cecropia peltata*	<1	8.2
BD	*Bauhinia divaricata*	6	4.3
C	*Clusia flava*	5.08	1.2
PA	*Piper amalago*	1.71	3.9
AP	*Aechmea paniculigera*	<1	0.45
OC	*Oreopanax capitatus*	<1	4.6
CpP	*Campyloneurum phyllitidis*	<1	0.53
AG	*Anthurium grandifolium*	<1	0.41
ML	*Miconia laevigata*	<1	0.45
MP	*Mimosa pudica*	<1	0.03
EO	*Eupatorium odoratum*	<1	1.7
BP	*Bryophyllum pinnatum*	<1	0.25
N	*Nephrolepis sp.*	<1	0.34
SO	*Lasciasis divaricata*	<1	0.21
DI	*Desmodium incanum*	<1	0.6

Figure 5-103: Vegetation profile and vegetation identification key plotted for Transect No. 14

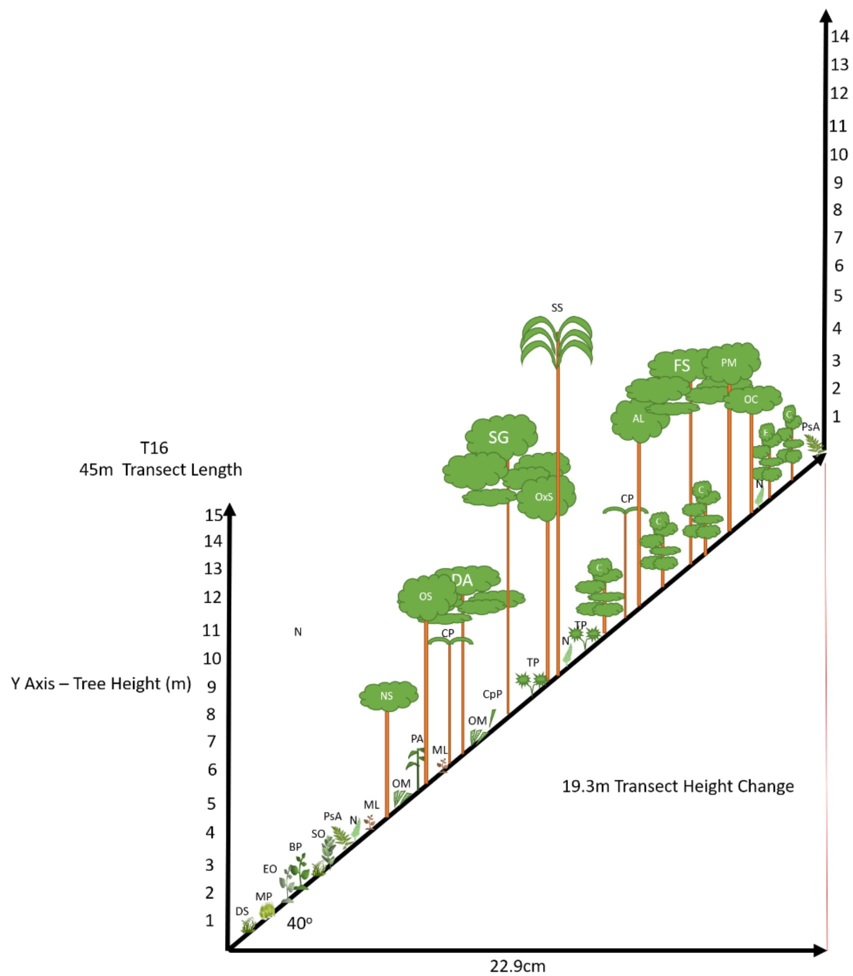
Table 5-14: Plants Species Observed per Quadrat for Transect No. 14

Species Name	Family	Growth Habit	Quadrat
Aechmea paniculigera	Bromeliaceae	Bromeliad	5,6
Anthurium grandifolium	Araceae	Aroid	5
Bryophyllum pinnatum	Crassulaceae	Herb	1
Bauhinia divaricata	Fabaceae	Tree	6
Campyloneurum phyllitidis	Polypodiaceae	Fern	6
Cecropia peltata	Urticaceae	Tree	3
Clusia flava	Clusiaceae	Shrub/Tree	4,5

Species Name	Family	Growth Habit	Quadrat
Coccoloba sp.	Polygonaceae	Tree	6
Desmodium incanum	Fabaceae	Herbaceous Shrub	1,2
Eupatorium odoratum	Asteraceae	Shrub	2
Eupatorium villosum	Asteraceae	Shrub	1
Lantana camara	Verbenaceae	Shrub	2
Lasciasis divaricata	Poaceae	Grass	4
Miconia laevigata	Melastomataceae	Shrub	2,3
Mimosa pudica	Fabaceae	Shrub	1,2
Nectandra sp.	Lauraceae	Tree	3
Nephrolepis sp.	Nephrolepidaceae	Fern	1,2,3,4
Oreopanax capitatus	Araliaceae	Tree	3
Paspalum sp.	Poaceae	Tree	1
Piper amalago	Piperaceae	Shrub/Tree	3,4,5,6
Piper arboreum	Piperaceae	Tree	4
Rhytidophyllum tomentosum	Gesneriaceae	Shrub	2,3
Tillandsia sp.	Bromeliaceae	Bromeliad	4

5.4.3.3.15. Transect 16 transect start - N 18.20150, W 77.17426 end of transect-

The canopy layer within transect 16 was relatively open allowing for light to reach the forest floor. Figure 5-104 illustrates the vegetation profile and vegetation identification key plotted for transect 16.



KEY		Average DBH (cm)	Average Height (m)
CP	*Comocladia pinnatifolia*	3.8	4.4
FS	*Ficus sp.*	20.1	7
OS	*Ocotea sp*	11	0.1
PA	*Piper amalago*	3.1	1.5
C	*Clusia flava*	7.97	2.7
AL	*Alcornea latifolia*	14	12.1
CpP	*Campyloneurum phyllitidis*	<1	0.7
OxS	*Oxandra sp.*	14	7
DA	*Dendropanax arboreus*	10.1	6.2
SS	*Spathelia sp.*	9.73	4.5
SG	*Simarouba glauca*	18.7	10.2
OM	*Oeceoclades maculata*	<1	0.1
MP	*Mimosa pudica*	<1	0.02
CaS	*Calyptranthes sp.*	4.2	2.1
NS	*Nectandra sp.*	7.1	4.4
N	*Nephrolepis sp.*	<1	0.21
PM	*Phyllanthus montanus*	8.9	6.1
TP	*Thrinax parviflora*	<1	2
E	*Eugenia sp.*	6.3	3.5
PsA	*Pteridium aquilinum var. pseudo caudatum*	<1	1.1

Figure 5-104: Vegetation profile and vegetation identification key plotted for Transect No. 16

Table 5-15: Plants Species Observed per Quadrat Transect No. 16

Species Name	Family	Growth Habit	Quadrat
Acidoton urens	Euphorbiaceae	Shrub	3,4
Adiantum tenerum			4,5
Alchornea latifolia	Euphorbiaceae	Tree	6
Calyptranthes sp.	Myrtaceae	Shrub/Tree	8
Campyloneurum phyllitidis		Fern	4
Cissampelos pareira		Herbaceous Vine	2
Clusia flava	Clusiaceae	Shrub/Tree	4,6,7
Coccoloba sp.		Tree	4

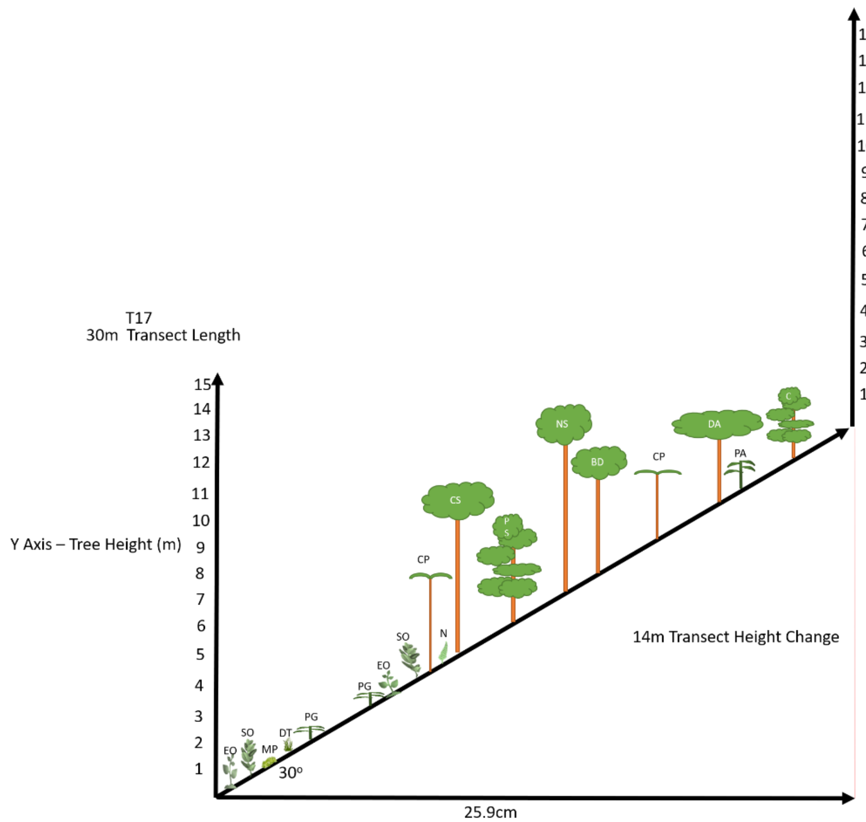
Species Name	Family	Growth Habit	Quadrat
Comocladia pinnatifolia		Tree	3,4
Dendropanax arboreus		Tree	3
Desmodium incanum		Shrub	1,2
eugenia sp.		Shrub/Tree	7,9
Eupatorium odoratum		Shrub	1
Guzmania lingulata		Bromeliad	8
Hohenbergia		Bromeliad	9
Lasciasis divaricata		Grass	2,3
Miconia laevigata		Shrub	2,4,5,6
mimosa pudica		Shrub	1,2
Nectandra sp.		Tree	3,5,6
nephrolepis		Fern	2,,6,7
ocotea sp.		Tree	3,4
Oeceoclades maculata		Orchid	2,4
Oreopanax capitatus		Tree	8
Oxandra sp.		Tree	5
Panicum sp.		Grass	1,2
Passiflora rubra		Vine	4,6
Passiflora sp.		Vine	4
Paullinia jamaicensis		Liana	4
Piper amalago	Piperaraceae	Shrub/Tree	3
Psycotria sp.		Shrub	3
Pteridium aquilinum subsp. caudatum		Fern	2,9
Rhipsalis baccifera		Cactus	9
rhytidophyllum tomentosum		Shrub	2
Senna occidentales		Shrub	2
Simarouba glauca		Tree	5
Spathelia sp.		Tree	6,7,9
thrinax parviflora		Palm	5,6,7
tillandsia		Bromeliad	9

Species Name	Family	Growth Habit	Quadrat
tillandsia bulbosa		Bromeliad	9
Vriesia sp.		Bromeliad	7,8
Phyllanthus montanus		Tree	7

Figure 5-105: View of canopy

5.4.3.3.16. Transect 17 transect start - N 18.22398, W 77.20300

Figure 5-106 illustrates the vegetation profile and vegetation identification key plotted for transect 17.



KEY		Average DBH (cm)	Average Height (m)
SO	*Senna occidentales*	<1	0.9
EO	*Eupatorium odoratum*	<1	0.71
N	*Nectandra sp.*	<1	2
BD	*Bauhinia divaricata*	7.5	4
DA	*Dendropanax arboreus*	15	3.1
PA	*Piper amalago*	<1	0.32
C	*Clusia flava*	12	2.5
CP	*Comocladia pinnatifolia*	7.2	3.3
PS	*Desmodium triflorum*	<1	0.05
MP	*Mimosa pudica*	<1	0.07
PG	*Psidium guajava*	<1	0.2
PS	*Psychotria sp.*	3.6	4.2
N	*Nephrolepis sp*	<1	0.41
E	*Eupatorium odoratum*	<1	0.71

Figure 5-106: Vegetation profile and vegetation identification key plotted for Transect No. 17

Table 5-16: Plants Species Observed per Quadrat Transect No. 17

Species Name	Family	Growth Habit	Quadrat
Acidoton urens		Shrub	3
Bauhinina divaricata	Fabaceae	Tree	3
Bryophyllum pinnatum		Herb	3
Campyloneurum phyllitidis		Fern	5
Cassia sp.		Shrub	1
Clusia flava		Shrub/Tree	5
Clusia rosea		Shrub/Tree	5
Coccoloba sp.		Tree	3
Commocladia pinnatifolia		Tree	3,5
Dendropanax arboreus		Tree	5

Species Name	Family	Growth Habit	Quadrat
Desmodium triflorum		Shrub	1
Dioscera polygonoides		Herbaceous Vine	3
Eupatorium odoratum		Shrub	1
Mimosa pudica	Mimosaceae	Shrub	1
Nectandra sp.		Tree	3
Piper amalago		Shrub/Tree	3
psidium guajava		Shrub/Tree	1
psychotria sp.		Shrub	3
Schegelia sp.		Vine	3
Senna occidentalis		Shrub	1
Tillandsia fasciculata	Bromeliadaceae	Bromeliad	5
Tolumnia tetraplelata	Orchidaceae	Orchid	5
Vitis litifolia		Vine	3

5.4.3.3.17. Transect 18 transect start - N 18.22263, W 77.15916

Transect 18 survey site was characterized by its rocky, steep hillside slope with deep depressions. Soils were variable in depth. Very few pockets of soil were scattered throughout the stony terrain. Forest area appeared relatively undisturbed. Figure 5-107 illustrates the vegetation profile and vegetation identification key plotted for transect 18.

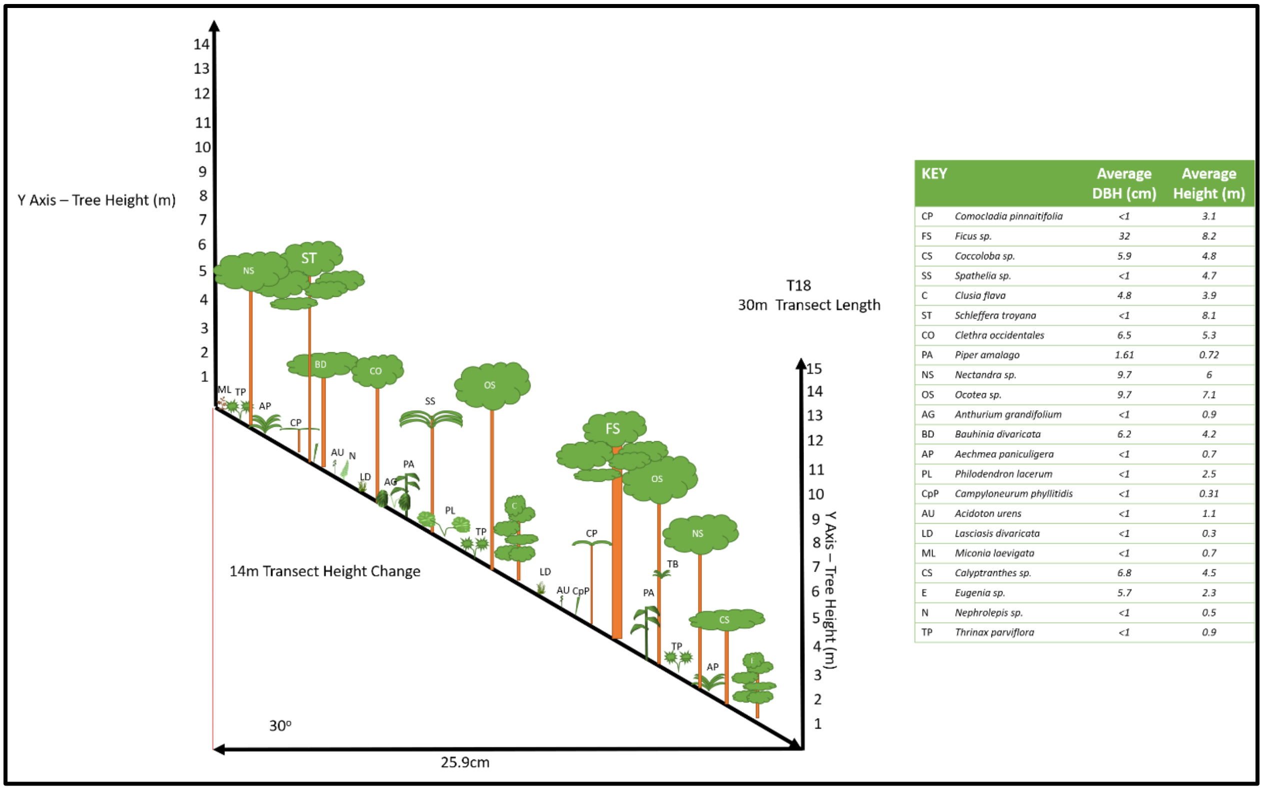


Figure 5-107: Vegetation profile and vegetation identification key plotted for Transect No. 18

Table 5-17: Plants Species Observed per Quadrat Transect No. 18

Species Name	Family	Growth Habit	Quadrat
acidoton urens		Shrub	1
adiantum tenerum	Pteridiaceae	Fern	1
anthurium grandifolium	Araceae	Aroid	1,3
bauhinia divaricata		Tree	1
Calyptranthes		Shrub/Tree	5
campyloneurum phyllitidis		Fern	5
Clethra occidentales		Tree	1
clusia flava		Shrub/Tree	3
clusia rose		Shrub/Tree	1
coccoloba sp.		Tree	1
Comocladdia sp.		Tree	1,5
eugenia sp		Shrub/Tree	5
ficus sp.		Tree	5
hohenbergia sp.		Bromeliad	1,5

Species Name	Family	Growth Habit	Quadrat
lasiacis divaricata		Grass	3
Meremia umbellata		Vine	3
miconia sp		Shrub	3
Nectandra sp.		Tree	1
neprolepis	Nephrolepidaceae	Fern	1
Ocotea sp.		Tree	3,5
passiflora sp.		Vine	1
philodendron lacerum		Aroid	3
piper amalago		Shrub/Tree	3,5
piper arboreum		Tree	1
polypodium polypoides	Polypodiaceae	Fern	1
Pyscotria sp.		Shrub	5
Rhipsalis baccifera		Cactus	1
schleffera troyana		Tree	1
spathelia sp.		Tree	3
thrinax parvifola		Palm	1,3,5
tillandsia bulbosa		Bromeliad	1,5
Tillandsia fasciculata		Bromeliad	5

5.4.3.3.18. Transect 19 transect start - N 18.23684, W 77.15350

Figure 5-108 illustrates the vegetation profile and vegetation identification key plotted for transect 19.

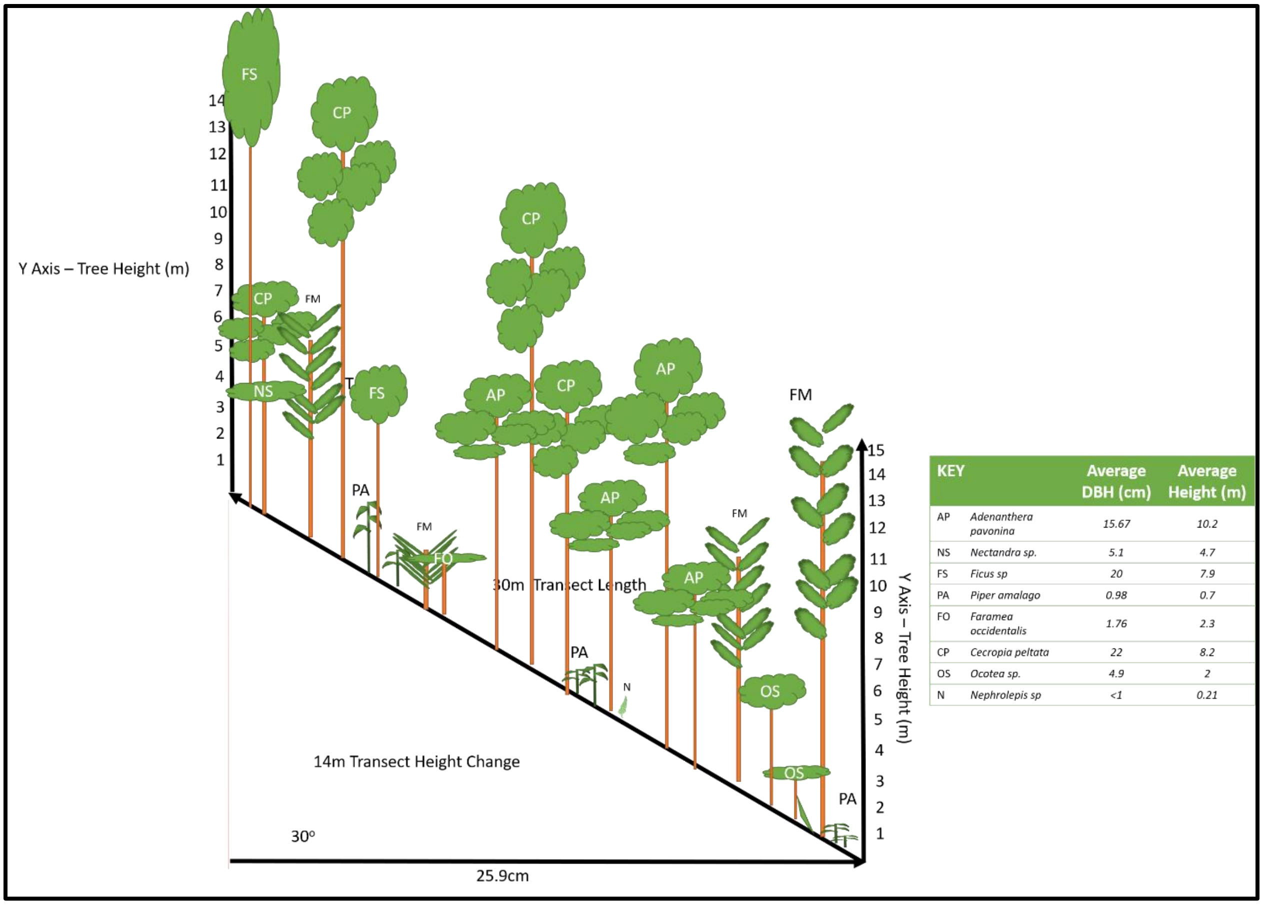


Figure 5-108: Vegetation profile and vegetation identification key plotted for Transect No. 19

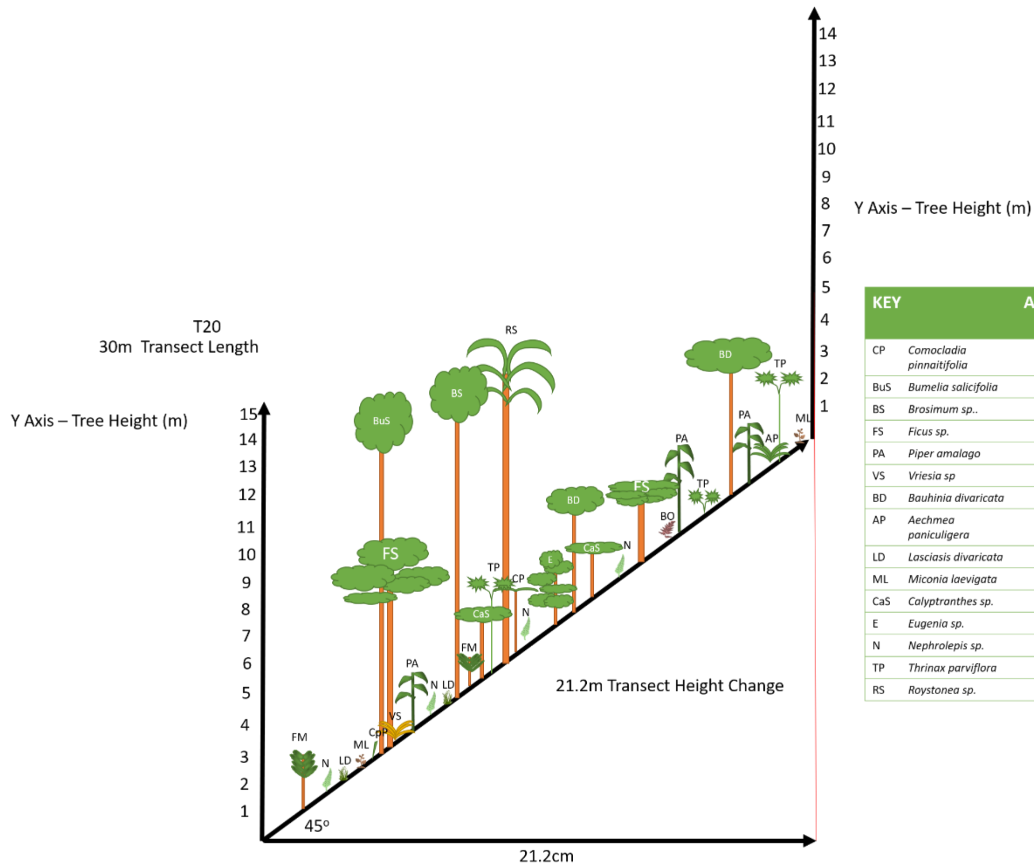
Table 5-18: Plants Species Observed per Quadrat Transect No. 19

Species Name	Family	Growth Habit	Quadrat
adenanthera pavonina		Tree	1,2
adiantum capillus-veneris		Fern	3
adiantum tenerum		Fern	1
Campycentrum jamaicensis	Orchidaceae	Orchid	3
campyloneurum phyllitidis		Fern	1
Cardiospermum sp.		Vine	3
cecropia peltata		Tree	3,5
comocladdia pinnatifolia		Tree	1

Species Name	Family	Growth Habit	Quadrat
fagara martinicensis		Tree	1,5
Faramea occidentalis		Tree	3
ficus sp.		Tree	5
lasciasis divaricata		Grass	3,5
nectandra sp		Tree	5
nephrolepis		Fern	3
ocotea sp.		Tree	1
oeceoclades maculata		Orchid	1
Phildendron lacerum		Aroid	3
Picramnia sp.		Tree	1
pimenta dioca		Tree	5
piper amalago		Shrub/Tree	1,3
Pteridium aquinuum sbsp caudatum		Tree	5
tectaria sp.		Fern	5
thrinax parviflora		Palm	3

5.4.3.3.19. Transect 20 transect start - N 18.24559, W 77.18233

Transect 20 survey area was recently cleared by fire. All tree species on hillock were completely destroyed. Vegetation was concentrated at the base of the hillock. The growth of small pioneer species was apparent (*Pteridium aquilinum var. Caudatum* “Bracken fern”, *Mimosa pudica*, and *Panicum sp*). First establishers were bracken fern given their rhizoid remains intact underground. The ore body appeared undisturbed with Guava trees (*Psidium Guajava)* scattered throughout. Figure 5-109 illustrates the vegetation profile and vegetation identification key plotted for transect 20.



KEY		Average DBH (cm)	Average Height (m)
CP	*Comocladia pinnaitifolia*	3.4	2
BuS	*Bumelia salicifolia*	27	12.1
BS	*Brosimum sp..*	25	11.2
FS	*Ficus sp.*	7.3	30
PA	*Piper amalago*	<1	1.2
VS	*Vriesia sp*	<1	1
BD	*Bauhinia divaricata*	14	4
AP	*Aechmea paniculigera*	<1	0.5
LD	*Lasciasis divaricata*	<1	0.21
ML	*Miconia laevigata*	<1	0.71
CaS	*Calyptranthes sp.*	5.8	2.7
E	*Eugenia sp.*	5.9	3.2
N	*Nephrolepis sp.*	<1	0.45
TP	*Thrinax parviflora*	6.7	3.4
RS	*Roystonea sp.*	27	11.5

Figure 5-109: Vegetation profile and vegetation identification key plotted for Transect No. 20

Figure 5-110: Location of Transect 20 Positioned on a Hillock that had been severely damaged by fire

Figure 5-111: Recolonization of fire damaged substrate at Transect 20 with light tolerant ferns

Figure 5-112: Guava tree (at base of hillock) which got caught in the fire showing evidence of regrowth.

5.4.3.3.20. Transect 21 transect start - N 18.24537, W 77.18108

Figure 5-113 illustrates the vegetation profile and vegetation identification key plotted for transect 21.

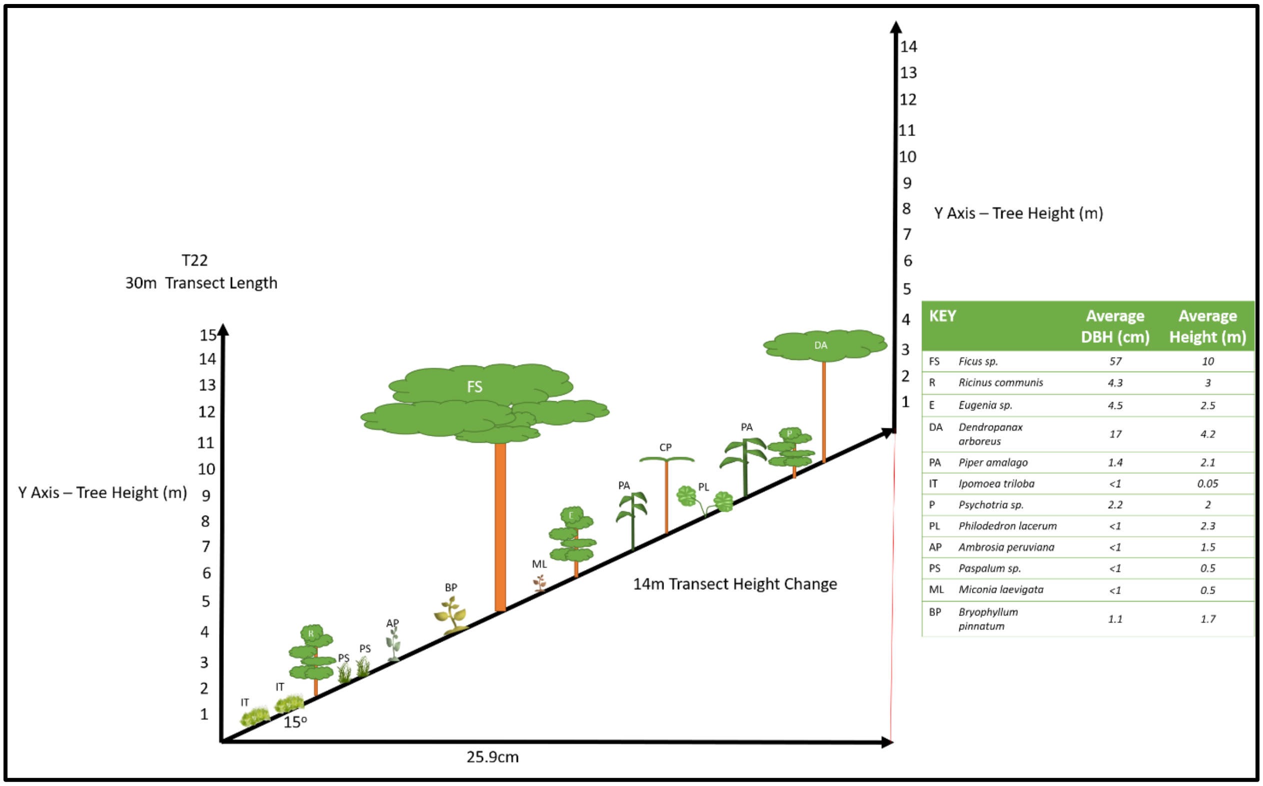


Figure 5-113: Vegetation profile and vegetation identification key plotted for Transect No. 21

Table 5-19: Plants Species Observed per Quadrat Transect No. 21

Species Name	Family	Growth Habit	Quadrat
adiantum tenerum		Fern	4
aechmea paniculigera		Bromeliad	6
bauhinia divaricata		Tree	4
Blechnum occidentale		Fern	1,5
Brosimum sp.		Tree	3
Bumelia salicifolia		Tree	2
Calyptranthes sp.		Shrub/Tree	3,4
Campyloneurum phyllitidis		Fern	1,4
cassia emarginata		Shrub/Tree	1
clusia rosea		Shrub/Tree	3
comocladdia pinnatifolia.		Tree	3
desmodium incanum		Shrub	1
dioscera bulbifera		Herbaceous VIne	5

Species Name	Family	Growth Habit	Quadrat
Eugenia axillaris		Shrub/Tree	4
fagara sp.		Tree	1
Ficus sp.		Tree	2
Ipomoea sp.		Herbaceous VIne	1
lasciasis divaricata		Grass	1,2,3
miconia sp.		Shrub	3,4
miconia laevigata		Shrub	6
nephrolepis sp		Fern	1,2,3,4
Passiflora rubra		Herbaceous VIne	4
piper amalago		Shrub/Tree	2,3,6
pisonia aculeata		Tree	
Polypodium polyploides		Fern	
psychotria		Shrub	4
Rhynchosia phaseoloides		Vine	1
Roystonea sp.		Tree	3
Tectaria sp		Fern	5
terminalia latifolia		Tree	5
thrinax parvifola		Palm	3,4,5,6
vriesia sp.		Bromeliad	2

5.4.3.4. Fauna Findings

5.4.3.4.1. Birds

A total of 46 bird species were recorded during the assessment. Table 5-20 shows the representation of numbers of bird species detected during both point and wander path counts conducted at the vicinity of the study transects. Table 5-20 is supported by Figure 5-114 and Figure 5-115 below, which show graphical representations of species numbers observed for both point count and wander traverse counts conducted.

Table 5-20: Point count and Traverse data for surveys conducted August 11-September 6, 2020

Transect	Number of species Detected during Point Count	Number of species detected during Traverse	Total Number of species detected in the area
1	8	7	13
2	6	4	7
3	8	12	15
4	11	8	14
5	9	12	15
6	9	12	15
7	5	5	7
8	3	6	7
9	8	5	9
10	6	5	10
11	6	3	9
12	6	11	15
13	6	6	10
14	5	8	10
15	6	7	10
16	6	5	10
17	6	9	12
18	8	8	15
19	8	6	12
21	4	9	10
22	4	5	9
23	3	0	3
24	4	0	4

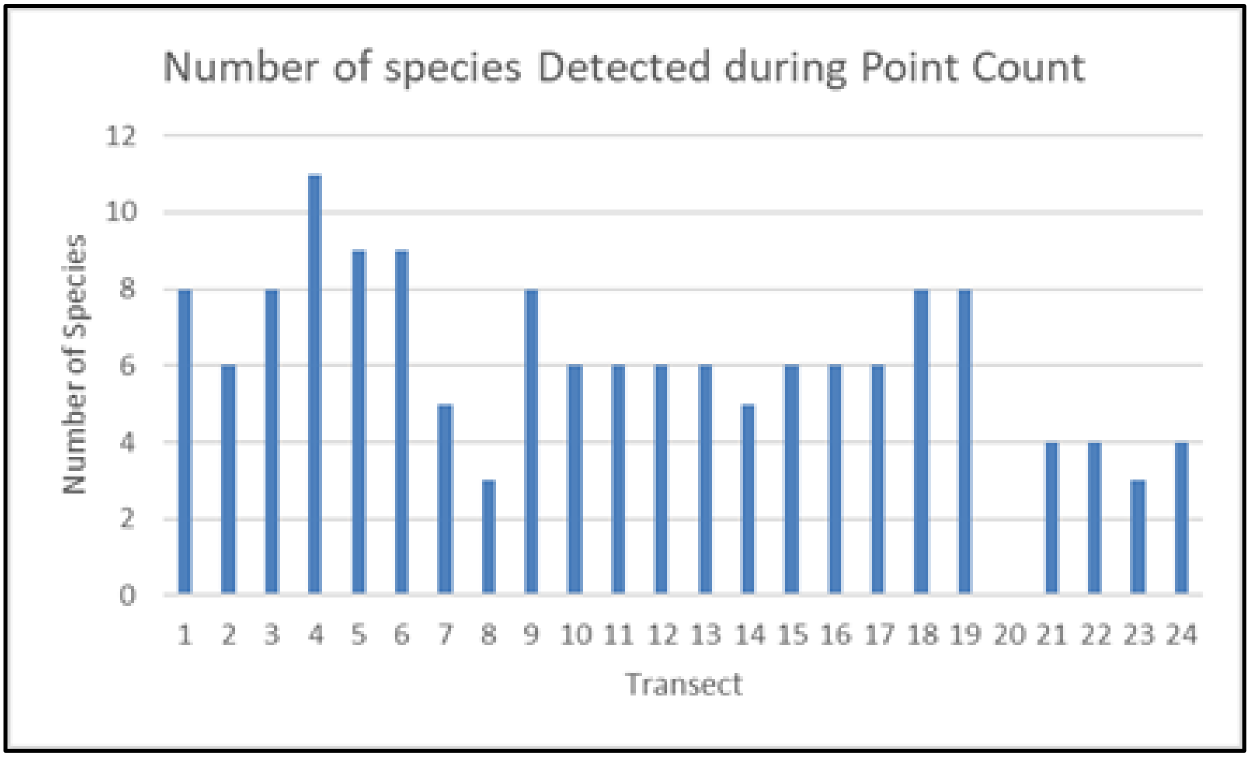


Figure 5-114: Avifauna Point Count Results

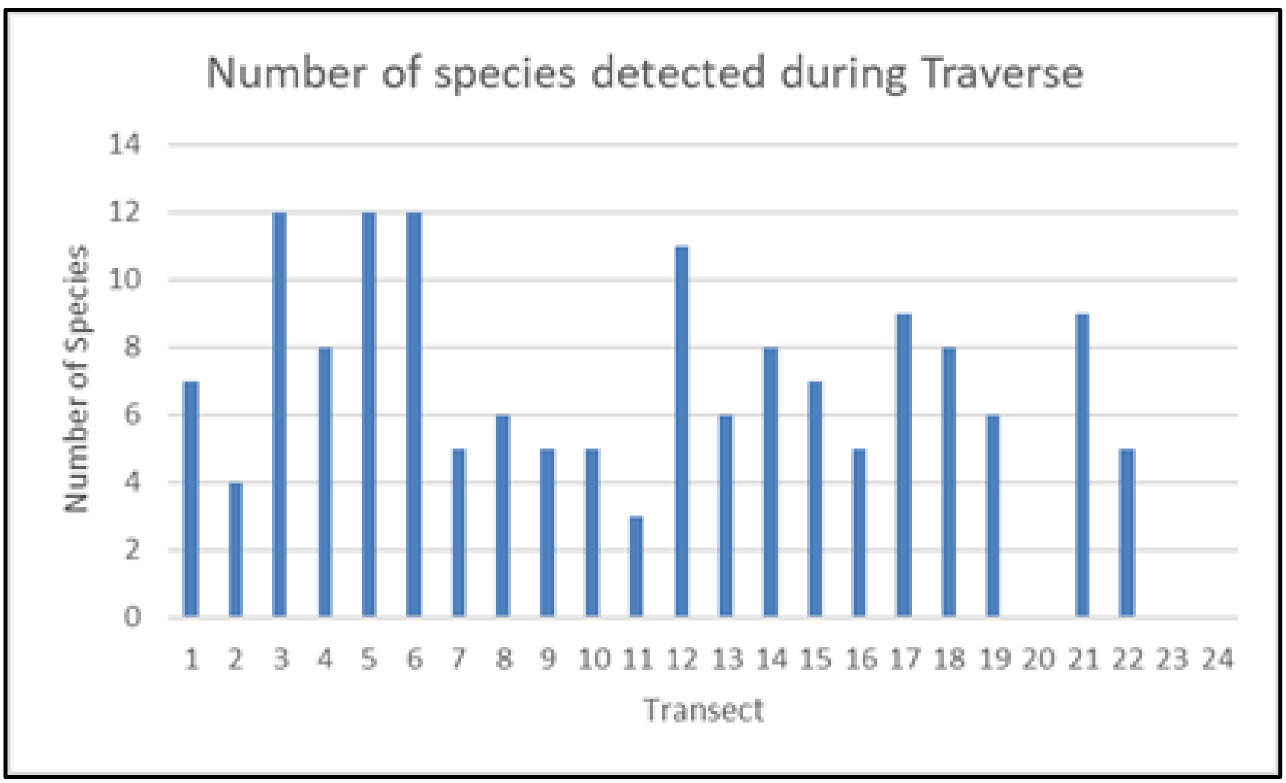


Figure 5-115: Avifauna Traverse Count Results

Figure 5-116 below shows the total number of species detected at all sites examined using both point count and wander count methods.

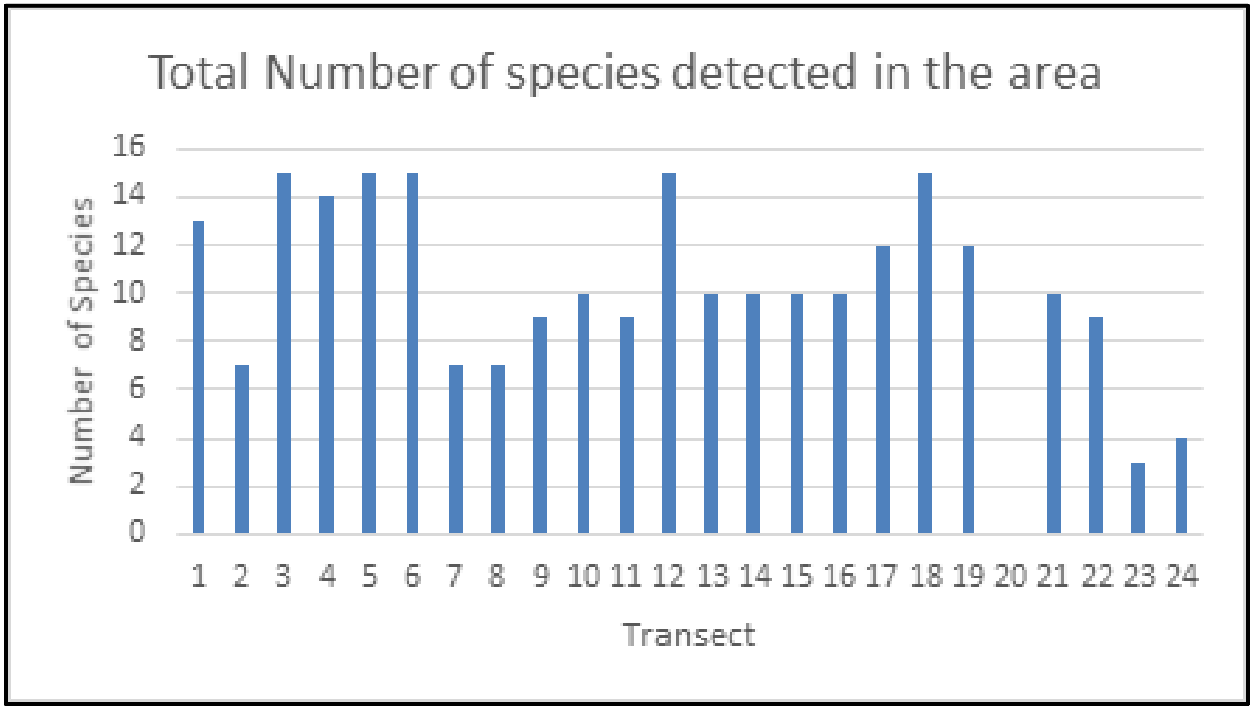


Figure 5-116: Avifauna Survey Results

An average of 10 Species were detected at each site with a maximum of 15 species recorded at 5 sites. There was no significant variation in species richness with the exception of the presence of a Killdeer at the Active Mine Site. The surveys for this assessment were conducted at this site between 0900 and 1400 and were also affected by occasionally intermittent showers of rain.

Birds such as the Yellow-Faced Grassquit (*Tiaris olivaceus*) and Black-faced Grassquit (*Melanospiza bicolor*), Red-billed Streamertail (*Trochilus polytmus*) and Loggerhead Kingbird (*Tyrannus caudifasciatus*) were among the most commonly observed species foraging near or within small agricultural plots while the Smooth Billed Anis were observed among crops on agricultural plots and occasionally along the transitional zone from Grassland/Ore body into Hillock. Olive-throated Parakeet (*Aratinga nana*), the Jamaica Crow (*Corvus jamaicensis*), Jamaican Woodpecker (*Melanerpes radiolatus)* and the Jamaican Vireos (*Vireo modestus*) were the birds most frequently detected among the hillock habitat and were mostly detected by call as they spent a significant amount of time in the upper canopy of the Hillock forests. In conducting the avifauna survey, the endemic and vulnerable Yellow Billed Parrot (*Amazona collaria*) was seen on one (1) occasion in SEPL 524. This has been classified on the basis of the DAFOR scale described (See Appendix IV of the EIA Report).

Figure 5-117: Top left: Yellow-Faced Grassquit (*Tiaris olivaceus*) | Top right: Black-faced Grassquit (*Melanospiza bicolor*) | Bottom Left:: Loggerhead Kingbird (*Tyrannus caudifasciatus*) (Source: Birds of Jamaica)

5.4.3.4.1.1. Nests and Breeding Observations

One nest was found along the start point for transect 3. The nest was active and identified as a Vervain Hummingbird (*Mellisuga minima*) nest. In that area many other birds were seen travelling and foraging in pairs. Older nests and nest platforms were noticed within the SML 162 area. However, none were active.

It is acknowledged that nesting activities which were observed could have been due to the time period in which the surveys were conducted (August to November).

Adult male. Marshall's Pen, Jamaica, November.

Figure 5-118: Left: Vervain Hummingbird (*Mellisuga minima*) (Source: Birds of Jamaica) | Right Vervain Hummingbird Nest, Font Hill, Jamaica (Source: J. Saunders)

5.4.3.4.1.2. Night-time Observations

Night observations were done at two (2) sites, namely, the vicinities of Transects 4 and 13. Both sites were disturbed with the second site displaying greater disturbance as it was an active farm with a variety of crops being grown. The first site was dedicated purely to pastureland in the orebody as well as adjacent orebodies.

No night bird detections were made at the first site while six (6) Northern Potoos (*Nyctibius jamaicensis*), were detected at site 2. One was actively foraging. Although owls were not observed, they could habituate the area.

Table 5-21: Results of Two (2) night surveys for Nocturnal Species.

DATE	Site	Point Count Coordinates		Species Detected during Point Count
18-Aug-20	Night Survey Site 1	18.2632	77.18192	0
18-Aug-20	Night Survey Site 1	18.2649	77.18243	0
28-Aug-20	Night Survey Site 2	18.1957	77.21198	1

The list below and Figure 5-119 to Figure 5-121 below encompasses all the species of birds that were observed during day and night surveys conducted across all sites as well as incidental observations observed during the commute to and from sites.

CD&A has obtained the audited bird sightings report from ebird.org. Figure 5-122 below shows the locations of bird sightings within 5km of SEPL 524. There are no bird sightings recorded in SEPL 524 as purported from the ebird data. Please note the Terms of Use Disclaimer for using data from ebird.org (See Appendix XI).

Appendix IX also lists the dietary preference of the bird, its abundance, in relation to a DAFOR scale and outlines the birds status – whether it is endemic or represented on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

1. American Kestrel (*Falco sparverius*)
2. Antillean Palm Swift (*Tachornis phoenicobia*)
3. Arrow-headed Warbler (*Setophaga pharetra*)*
4. Bananaquit (*Coereba flaveola*)
5. Black-Faced Grassquit (*Melanospiza bicolor*)
6. Black-necked Stilt (*Himantopus mexicanus*)
7. Black-whiskered Vireo (*Vireo altiloquus*)
8. Cattle Egret (*Bubulcus ibis*)
9. Cave Swallow (*Petrochelidon fulva*)
10. Chestnut-bellied Cuckoo (*Coccyzus pluvialis*)*
11. Common Ground Dove (*Columbina passerina*)
12. Gray Kingbird (*Tyrannus dominicensis*)
13. Greater Antillean Bullfinch (*Loxigilla violacea*)
14. Jamaican Crow(*Corvus jamaicensis*)*
15. Jamaican Euphonia (*Euphonia Jamaica*)*
16. Jamaican Mango (*Anthracothorax mango*)*
17. Jamaican Oriole (*Icterus leucopteryx*)*
18. Jamaican Peewee (*Contopus pallidus*)*
19. Jamaican Spindalis (*Spindalis nigricephala*)*
20. Jamaican Tody (*Todus todus*)*
21. Jamaican Vireo (*Vireo modestus*)*
22. Jamaican Woodpecker (*Melanerpes radiolatus)**
23. Killdeer (*Charadrius vociferous)*
24. Loggerhead Kingbird (*Tyrannus caudifasciatus*)
25. Northern Mockingbird (*Mimus polyglottos*)
26. Northern Potoo (*Nyctibius jamaicensis*)
27. Olive-throated Parakeet (*Aratinga nana*)
28. Orangequit (*Euneornis campestris*)*
29. Prairie Warbler(*Setophaga discolour*)
30. Red-Billed Streamertail (*Trochilus polytmus*)*
31. Rufous-tailed Flycatcher (*Myiarchus validus*)*
32. Ruddy Quail Dove (*Geotrygon montana*)
33. Saffron Finch (*Sicalis flaveola*)
34. Shiny Cowbird *(Molothrus bonariensis*)
35. Smooth-billed Ani (*Crotophaga ani*)
36. Stolid Flycathcer (*Myiarchus stolidus*)
37. Turkey Vulture (*Cathartes aura*)
38. Vervain Hummingbird (*Mellisuga minima*)
39. White-chinned Thrush (*Turdus aurantius*)*
40. White-eyed Thrush *(Turdus jamaicensis)**
41. White-Crowned Pigeon (*Patagioenas leucocephala*)
42. White-winged Dove (*Zenaida asiatica*)
43. Yellow-faced Grassquit (*Tiaris olivaceus*)
44. Yellow-shouldered Grassquit *(Loxipasser anoxanthus)*
45. Yellow-Billed Parrot (*Amazona collaria*)*
46. Zeneida Dove (*Zenaida aurita)*

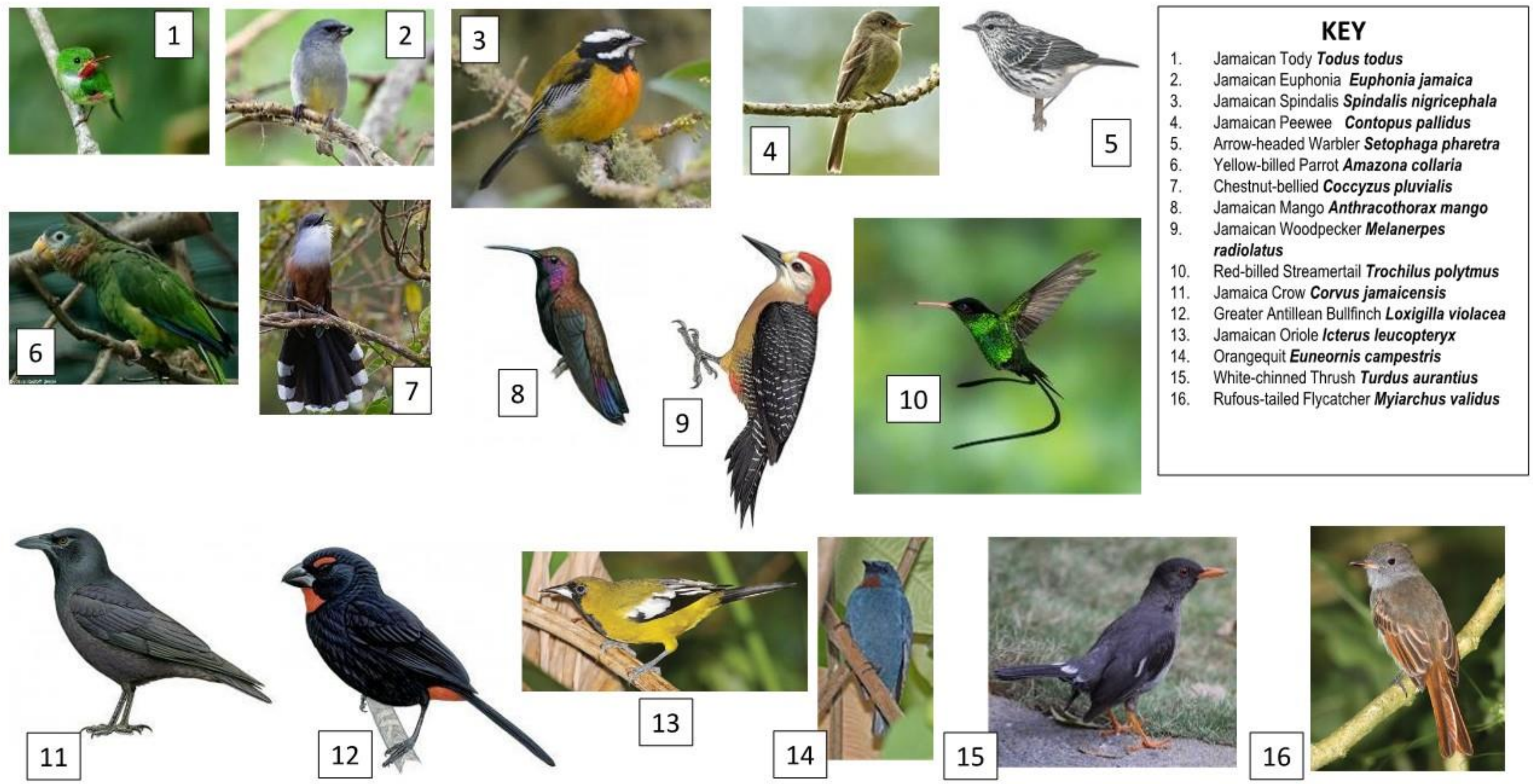


Figure 5-119: Bird species observed within SEPL 524 (images obtained from the internet and correlated with images present in "*A Photographic Guide To The Birds Of Jamaica 2009*", Sutton et al)

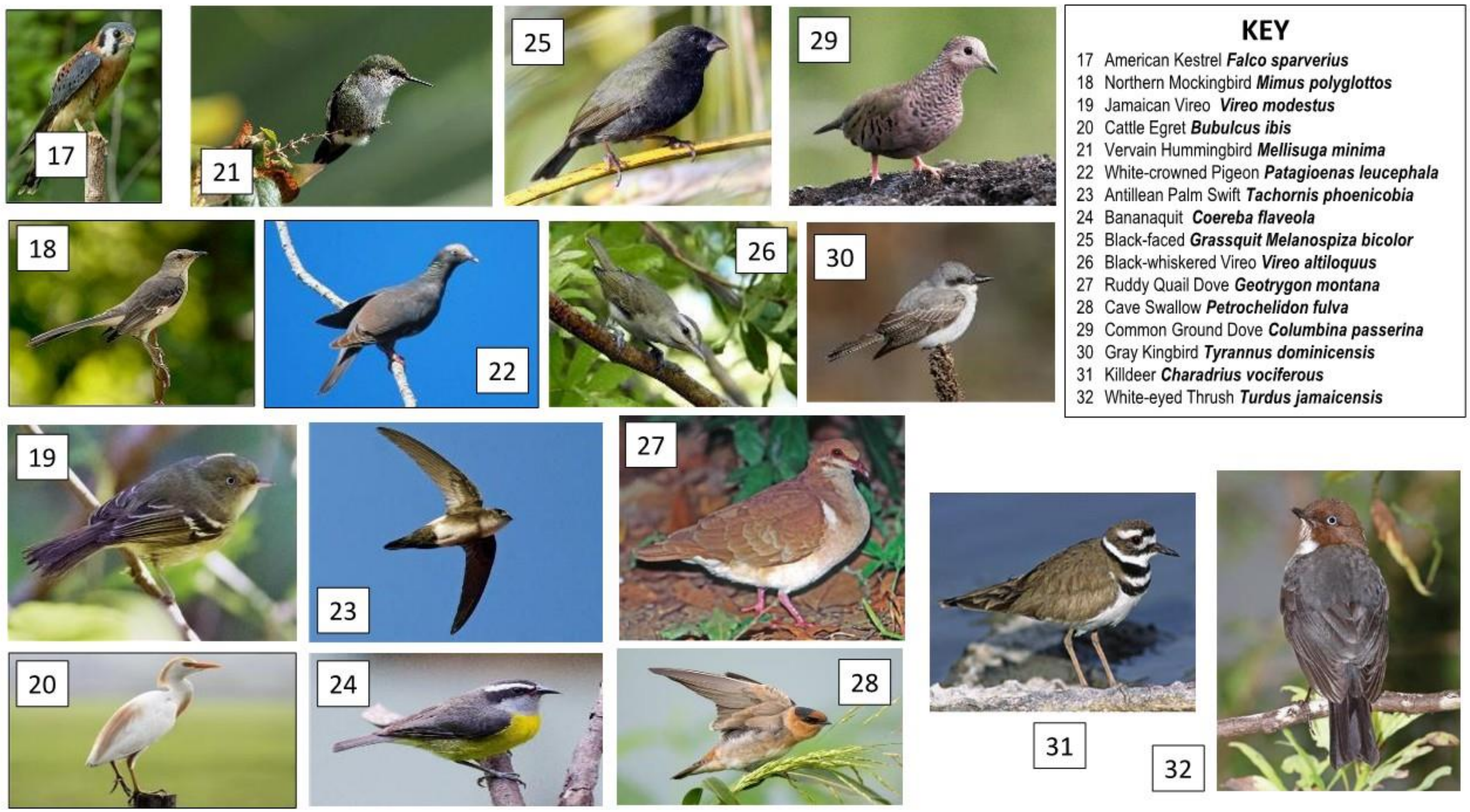
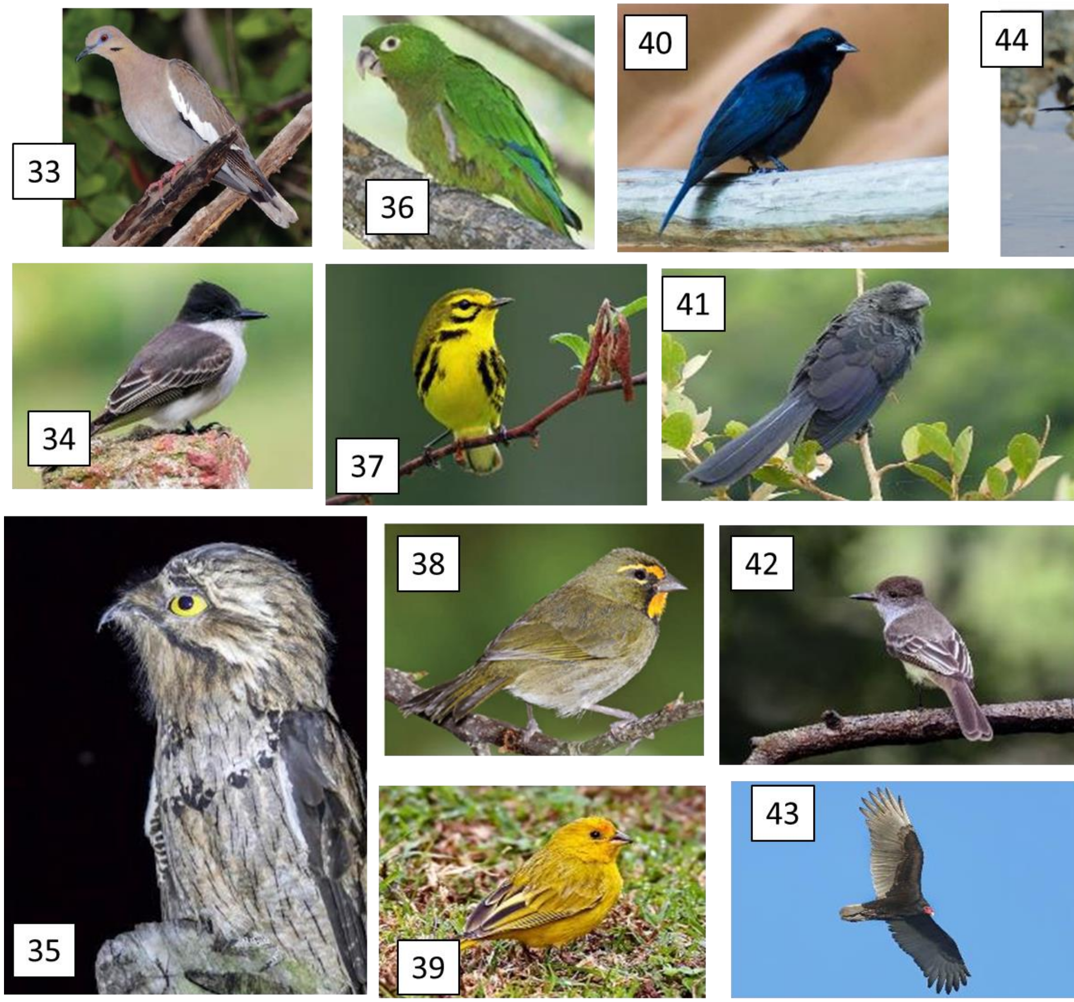


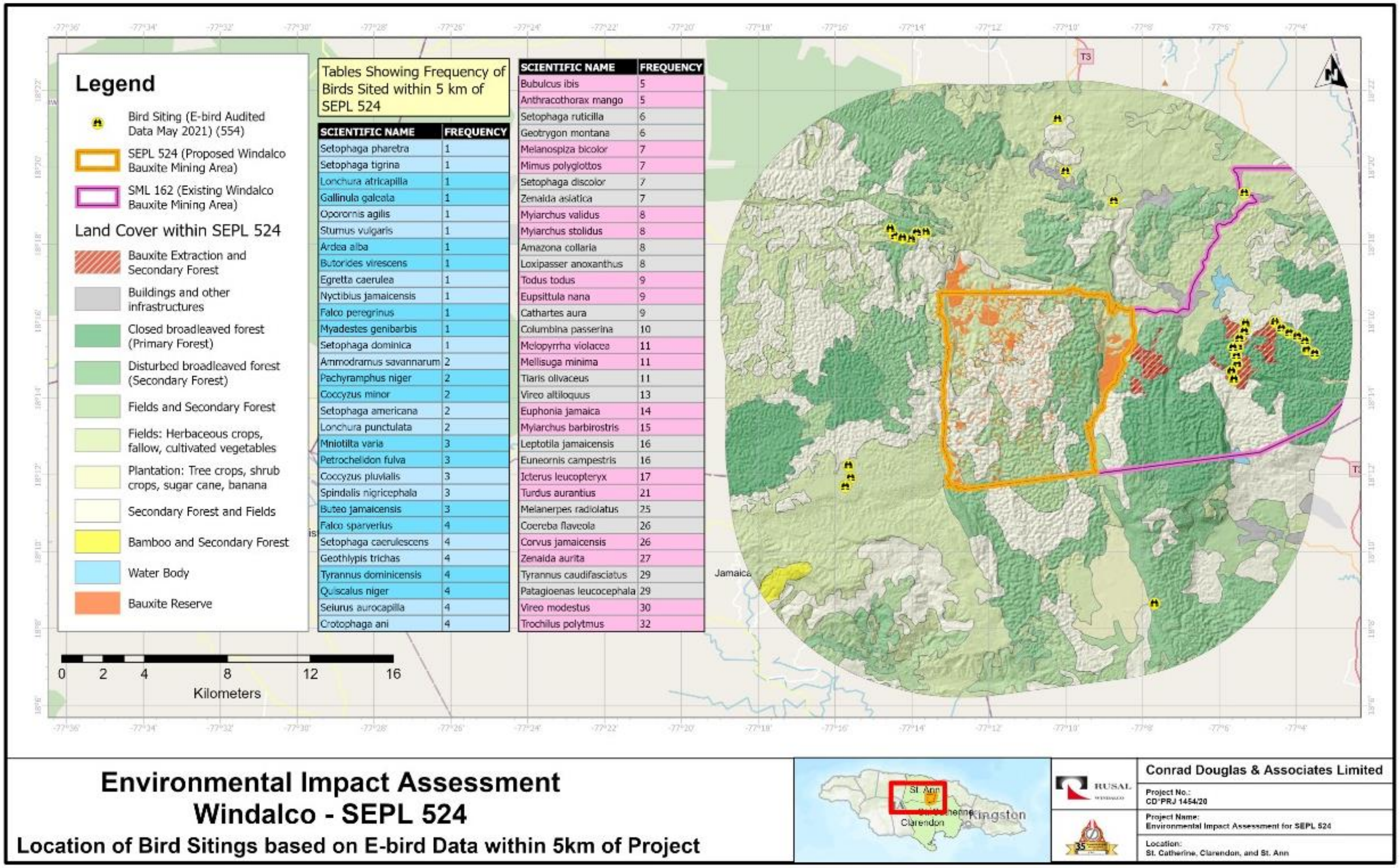
Figure 5-120: Bird species observed within SEPL 524 (images obtained from the internet and correlated with images present in "*A Photographic Guide To The Birds Of Jamaica 2009*", Sutton et al)



KEY

33. White-winged Dove ***Zenaida asiatica***
34. Loggerhead Kingbird ***Tyrannus caudifasciatus***
35. Northern Potoo ***Nyctibius jamaicensis***
36. Olive-throated Parakeet ***Eupsittula nana***
37. Prarie Warbler ***Eupsittula nana***
38. Yellow-shouldered Grassquit ***Loxipasser anoxanthus***
39. Safron Finch ***Sicalis flaveola***
40. Shiny Cowbird ***Molothrus bonariensis***
41. Smooth-billed Ani ***Crotophaga ani***
42. Stolid Flycatcher ***Myiarchus stolidus***
43. Turkey Vulture ***Cathartes aura***
44. Black-necked Stilt ***Himantopus mexicanus***
45. Yellow-faced Grassquit ***Tiaris olivaceus***
46. Zenaida Dove ***Zenaida aurita***

Figure 5-121: Bird species observed within SEPL 524 (images obtained from the internet and correlated with images present in "*A Photographic Guide To The Birds Of Jamaica 2009*", Sutton et al)



SCIENTIFIC NAME	FREQUENCY
Setophaga pharetra	1
Setophaga tigrina	1
Lonchura atricapilla	1
Gallinula galeata	1
Oporornis agilis	1
Sturnus vulgaris	1
Ardea alba	1
Butorides virescens	1
Egretta caerulea	1
Nyctibius jamaicensis	1
Falco peregrinus	1
Myadestes genibarbis	1
Setophaga dominica	1
Ammodramus savannarum	2
Pachyramphus niger	2
Coccyzus minor	2
Setophaga americana	2
Lonchura punctulata	2
Mniotilta varia	3
Petrochelidon fulva	3
Coccyzus pluvialis	3
Spindalis nigricephala	3
Buteo jamaicensis	3
Falco sparverius	4
Setophaga caerulescens	4
Geothlypis trichas	4
Tyrannus dominicensis	4
Quiscalus niger	4
Seiurus aurocapilla	4
Crotophaga ani	4

SCIENTIFIC NAME	FREQUENCY
Bubulcus ibis	5
Anthracothorax mango	5
Setophaga ruticilla	6
Geotrygon montana	6
Melanospiza bicolor	7
Mimus polyglottos	7
Setophaga discolor	7
Zenaida asiatica	7
Myiarchus validus	8
Myiarchus stolidus	8
Amazona collaria	8
Loxipasser anoxanthus	8
Todus todus	9
Eupsittula nana	9
Cathartes aura	9
Columbina passerina	10
Melopyrrha violacea	11
Mellisuga minima	11
Tiaris olivaceus	11
Vireo altiloquus	13
Euphonia jamaica	14
Myiarchus barbirostris	15
Leptotila jamaicensis	16
Euneornis campestris	16
Icterus leucopteryx	17
Turdus aurantius	21
Melanerpes radiolatus	25
Coereba flaveola	26
Corvus jamaicensis	26
Zenaida aurita	27
Tyrannus caudifasciatus	29
Patagioenas leucocephala	29
Vireo modestus	30
Trochilus polytmus	32

Figure 5-122: Location of Bird Sitings Based on E-Bird Data within 5km of Project (Source: *eBird Basic Dataset. Version: EBD_relMar-2021. Cornell Lab of Ornithology, Ithaca, New York. Mar 2021***)**

5.4.3.4.2. Reptiles

Table 5-22 **to** Table 5-33 **below** list the types and numbers of reptile and/or frog species observed at each of the study transect sites.

Table 5-22: Types and numbers of reptile and/or frog species observed at transect 1 and 2

SPECIES SEEN	SPECIES NUMBER	
	Transect 1	Transect 2
Anolis garmani (Giant anole)	1	0
Anolis grahami (Turquoise anole)	1	0
Anolis opalinus (Opal anole)	2	1

Table 5-23: Types and numbers of reptile and/or frog species observed at Transects 3 (jn traverse to 3), 3 and 4

SPECIES SEEN	On Traverse to Transect 3	Transect 3	Transect 4
	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER
Anolis lineatopus (Gray anole)	1	0	0
Anolis sagrei (Brown anole)	2	2	2
Anolis lineatopus (Gray anole)	0	0	0
Anolis grahami (Turquoise anole)	0	1	1
Anolis opalinus (Opal anole)	0	2	1

Table 5-24: Types and numbers of reptile and/or frog species observed at Transects 5, 6, 7, 8 and 9

	Transect 5	Transect 6	Transect 7	Transect 8	Transect 9
SPECIES SEEN/HEARD AUGUST 13 2020	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER
Anolis opalinus (Opal anole)	2		No Reptiles Seen	1	
Anolis grahami (Turquoise anole)	2	2			
eleutherodactylus johnstonei (Vocals)	1				
Anolis garmani (Giant anole)				1	
Trachemys terrapen (Jamaican Slider)				1 (Pet that was owned)	
Rhinella marina (Cane Toad)					3

Table 5-25: Types and numbers of reptile and/or frog species observed at Transects 10

SPECIES SEEN	Transect 10
	SPECIES NUMBER
Anolis garmani (Giant anole)	2
Anolis sagrei (Brown anole)	2
Anolis opalinus (Opal anole)	5
Anolis grahami (Turquoise anole)	3

Table 5-26: Types and numbers of reptile and/or frog species observed at Transects 11

SPECIES SEEN/HEARD	Transect 11
	SPECIES NUMBER
Anolis grahami (Turquoise anole)	4
Anolis sagrei (Brown anole)	6
Anolis opalinus (Opal anole)	8
Anolis garmani (Giant anole)	1
Eleutherodactylus gossei	Several
Eleutherodactylus johnstonei	Several

Table 5-27: Types and numbers of reptile and/or frog species observed at Night Transect 4

SPECIES SEEN/HEARD	Night Survey Transect 4
	SPECIES NUMBER
Eleutherodactylus johnstonei	Several
Eleutherodactylus gossei	Several
Osteopilus ocellatus	Several
Osteopilus crucialis (Snoring frog[26])	4
Rhinella marina	5
Aristelliger praesignis	Several
Eleutherodactylus luteolus	1

[26] Endangered

Table 5-28: Types and numbers of reptile and/or frog species observed at Transects 12 and 13

SPECIES SEEN/HEARD	Transect 12	Transect 13
	SPECIES NUMBER	SPECIES NUMBER
Eleutherodactylus johnstonei	Several	Several
Eleutherodactylus gossei	Several	Several
Anolis lineatopus (Stripe foot anole)	8	0
Celestus crusculus (Common Galliwasp)	1	0
Anolis opalinus (Opal anole)	4	0

Table 5-29: Types and numbers of reptile and/or frog species observed at Transects 14, 15 and 16

SPECIES SEEN/HEARD	Transect 14	Transect 15	Transect 16
	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER
Anolis opalinus (Opal anole)	2	7	1
Anolis lineatopus (Stripe foot anole)	1	0	0
Anolis garmani (Giant anole)	1	0	1
Eleutherodactylus johnstonei		several	several
Eleutherodactylus gossei	several	several	several
Anolis sagrei (Brown anole)	1	0	0
Eleutherodactylus luteolus	0	0	1
Anolis grahami (Turquoise anole)	0	1	2

Table 5-30: Types and numbers of reptile and/or frog species observed at Transects 17 and 18

SPECIES SEEN/HEARD	Transect 17	Transect 18
	SPECIES NUMBER	SPECIES NUMBER
Anolis garmani (Giant anole)	3	0
Eleutherodactylus johnstonei	several	several
Anolis sagrei (Brown anole)	1	0
Anolis opalinus (Opal anole)	1	0
Eleutherodactylus gossei	several	several

Table 5-31: Types and numbers of reptile and/or frog species observed at Transects 19, 20 and 21

SPECIES SEEN/HEARD	Transect 19	Transect 20	Transect 21
	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER
Eleutherodactylus gossei	several	several	several
Anolis garmani (Giant anole)	1		
Anolis sagrei (Brown anole)	2	3	2
Anolis opalinus (Opal anole)	3	3	2
Anolis grahami (Turquoise anole)	2	3	0
Eleutherodactylus johnstonei	several	0	several
Osteopilus crucialis (Snoring frog)	1 heard while collecting data logger		

Table 5-32: Types and numbers of reptile and/or frog species observed at Burnt Hillock

SPECIES SEEN/HEARD	Burnt Hillock
	SPECIES NUMBER
No Species seen/heard	0

Table 5-33: Types and numbers of reptile and/or frog species observed at Transects 22, 23 and 24

SPECIES SEEN/HEARD	Transect 22	Transect 23	Transect 24
	SPECIES NUMBER	SPECIES NUMBER	SPECIES NUMBER
Eleutherodactylus gossei	1	3	0
Anolis garmani (Giant anole)	1	0	0
Anolis opalinus (Opal anole)	1	0	3

DAFOR listings for the reptiles observed at the site are presented below:

D – Dominant, A – Abundant, F – Frequent, O – Occasional, R – Rare.

- *Celestus barbourin* (Limestone Galliwasp) - Rare
- *Celestus crusculus* (Common Galliwasp) - Rare
- *Celestus hewardii* (Red-spotted Galliwasp) – Rare
- *Anolis garmani* (Giant anole) - Occasional
- *Anolis grahami* (Turquoise anole) - Frequent
- *Anolis lineatopus* (Gray anole) - Occasional

- *Anolis opalinus* (Opal anole) - Dominant
- *Anolis valencienni* (Twig anole) - Rare
- *Anolis sagrei* (Brown anole) - Frequent
- *Aristelliger praesignis* (Croaking lizard) – Abundant (During the Night)
- *Sphaerodactylus argus* (Stippled Shpaero/Polly lizard) - Rare
- *Sphaerodactylus goniorhynchus* (Forest Sphaero) – Rare
- *Sphaerodactylus oxyrhinus* (Sharp noise Sphaero) - Rare
- *Epicrates Red-spotted* (Jamaican Boa) - Rare
- *Hypsirhynchus callilaemus* (Red racer) - Rare
- *Hypsirhynchus funereus* (Black racer proxy) - Rare
- *Tropidophis stejnegeri* (Eyespot Trope) - Rare
- *Typhlops jamaicensis* (Blind Snake) - Rare
- *Trachemys terrapen* (Jamaican Slider) - Rare

DAFOR listings for the amphibians observed at the site are presented below:

D – Dominant, A – Abundant, F – Frequent, O – Occasional, R – Rare.

- *Rhinella marina* (Cane Toad) – Occasional
- *Osteopilus crucialis* (Jamaican Snoring Treefrog) - Rare
- *Osteopilus ocellatus* (Jamaican Laughing Treefrog) - Occasional
- *Osteopilus marianae* (Jamaican Yellow Treefrog) - Rare
- *Osteopilus wilderi* (Jamaican Green Treefrog) - Rare
- *Eleutherodactylus cundalli* – Rare
- *Eleutherodactylus fuscus* (Jamaican Ear-spot Frog) - Rare
- *Eleutherodactylus gossei* (Jamaican Forest Frog) – Abundant
- *Eleutherodactylus grabhami* (Jamaican Pallid Frog) - Rare
- *Eleutherodactylus jamaicensis* (Jamaican Bromeliad Frog) - Rare
- *Eleutherodactylus johnstonei* (Lesser Antillean Frog) – Dominant
- *Eleutherodactylus junori* (Rock Pocket Frog) - Rare
- *Eleutherodactylus luteolus* (Jamaican Masked Frog) - Rare
- *Eleutherodactylus pantoni* (Jamaican Yellow-bellied Frog) - Rare
- *Eleutherodactylus planirostris* (Cuban Flathead Frog) - Rare
- *Lithobates catesbianus* (Bull Frog) - Rare

Figure 5-123: *Anolis garmani*

A. garmani were mostly observed in the Highest section of trees, high trunks, and branches. They were mostly seen at a height above 1.75 meters.

Figure 5-124: *Anolis Opalinus*

A. opalinus were mostly seen on the trunks of trees. They were mostly seen at a height of 1 meter or below.

Figure 5-125: *Anolis lineatopus*

A. lineatopus were mostly seen on the lower trunk section of trees and also on the ground. They were mostly seen at a height below 1 meter.

Figure 5-126: *Rhinella marina* (Cane Toad)

R. marina was mostly seen at night and pond locations with water.

Figure 5-127: ***Eleutherodactylus luteolus***

E. luteolus was seen while conducting the night survey

Figure 5-128: Anolis grahami

A. grahami were mostly seen on tree trunks. They were mostly seen at a height of 1 meter

Figure 5-129: *Anolis sagrei*

A. sagrei were mostly seen on tree trunks. They were mostly seen at a height of 1 meter or below.

Figure 5-130: *Trachemys terrapen*

This *T. terrapen* was owned by a child that lived in the region. The turtle came from a pond in the region.

Figure 5-131: *Trachemys terrapen* footprints

T. terrapen footprints found at a pond at Transect 9.

Figure 5-132: Unfertilized frog eggs

Unfertilized frog eggs were observed in a bromeliad at Transect 15. The bromeliad was located in the Hillock section of the transect.

A *Celestus crusculus* (Common Galliwasp) was seen hiding between rock crevasses and leaves.

All the Anole species that were seen in Transect 1 – 4, were found at the hillock side of the transect. The Anole species that were seen at Transect 5 & 6 were observed on the trees of the area, the trees were growing out of the rock face near the haul road.

No reptiles were seen at Transect 7. This could be due to the lack of tall trees in the region; however, Anoles were observed at Transect 8. The vegetation type at Transect 8 resembled that of a hillock with several tall trees.

One vulnerable species was identified at Transect 8 and was stated that it could be found in the pond at Transect 9 and other ponds around the region, *Trachemys terrapen* (Jamaican Slider) has been categorized as Vulnerable (VU) by the IUCN meaning that the species is facing a high risk of extinction in the wild in the medium-term future, as defined by IUCN criteria (A to E) (IUCN, 2019).

Rhinella marina (Cane Toads) were observed in the pond at Transect 9 along with Turtle tracks as seen in figure 9 above. No anole species were seen in the area. The majority of the vegetation type resembled that seen at Transect 8.

All Anole species at Transect 10 were seen in the Hillock section of the transect. All organisms at Transect 11 were seen and heard while ascending the Hillock.

Four endangered species were identified while conducting the night survey at Transect 4 location (N 18.26340, W 77.18145). *Osteopilus crucialis* (Jamaican Snoring frog) has an International Union for Conservation of Nature (IUCN) status of Endangered (EN) meaning that they are very likely to become extinct in the future (IUCN, 2019).

The vocal calls of *Aristelliger praesignis* (Croaking lizard) and several amphibian species could be heard throughout the area. *A. praesignis* is known to be found on trees, so it can be assumed that the majority of *A. praesignis* was vocalizing from a tree branch or tree trunk within the hillock.

Transect 12 was established within a Hillock. All the organisms that were seen and heard occurred while traversing the transect within the hillock. No reptiles were seen at Transect 13, only the vocals of *E. johnstonei* and *E. gossei* could be heard.

Transect 14 was established at a disturbed section of a hillock. The few Anole species that were seen were very small. All Anole species that were seen at Transect 15 were found within the hillock side of the transect. Frog eggs were observed in a Bromeliad within the hillock as seen in figure 10. The eggs have not been fertilized by a male so the have a white color. Several Anole species were observed on trees at Transect 16, the trees that were seen in the transect were spaced randomly. The vocal calls of *E. johnstonei* and *E. gossei* were heard while conducting the transect.

All organisms that were seen and heard while traversing Transect 17 occurred at the hillock side of the transect. No reptiles were observed at transect 18. All frog vocals in the area could be heard within the hillock end of the transect.

All organisms that were seen and heard while traversing Transects 19 – 21 occurred within the hillock end of each transect.

No reptile or amphibian was seen at the Burnt Hillock.

Transect 22 was established in an active mine site. All the organisms seen while traversing the transect were in the vegetation side of the transect. All anoles were seen on trees in the densely vegetated area that resembled a hillock. Less amphibian vocals were heard while traversing the transect.

Transect 23 was established at a rehabilitated mine. No anole species were seen while traversing the transect. Only a few amphibian species were heard while traversing the transect. The vocal calls could be heard coming from the tall open grass field.

Transect 24 was established at a recently rehabilitated mine. No amphibian species were heard while traversing the transect. The few reptile species seen were found at a small cluster of trees.

Anolis opalinus (Opal anole) was the most seen reptile while conducting the reptile survey. *Eleutherodactylus gossei* and *Eleutherodactylus johnstonei* were the most heard amphibian species while conducting surveys in the different regions.

Other reptiles such as *Anolis garmani* (Giant anole) and *Anolis lineatopus* (Gray anole) were seen occasionally, while *Anolis grahami* (Turquoise anole) and *Anolis sagrei* (Brown anole) were seen frequently.

All Anole species were seen on trees within the hillock section of each transect. Each Anole tends to occupy a different section of a Tree, as seen in figure 1. Most *A. garmani* tend to occupy a section of a tree that is greater than 1.75m. So, anole observation is constrained to a vertical observation of a tree. Most trees in the area are found at the hillocks of the region.

Celestus crusculus (Common Galliwasp) which was seen once, was found on the ground of the hillock, between rock crevasses as seen in figure 12.

T. terrapen, however, is found at ponds. The ponds of the region are located in the ore bodies.

Frog species were heard mostly inside of hillocks due to bromeliads being found within hillocks. The bromeliads collect water which is needed for frogs to survive. A few frogs could be heard in the ore bodies.

It can be assumed that the reptiles and amphibians present in the area are very dispersed throughout the region, however, the hillocks of the region may be the habitat type that is preferred by most reptiles except *T. terrapen* which needs a body of water to live so its habitat type excludes that of a hillock.

5.4.3.4.3. Arthropods

The table below gives the location of Arthropod study evaluations.

Table 5-34: Location of Arthropod study evaluations

Transect	Location Code	GPS Coordinates
T1	A	N 18.23460, W 77.14842

Transect	Location Code	GPS Coordinates
T2	B	N 18.25183, W 77.14983
T3	C	N 18.26581, W 77.1513
T4	D	N 18.26340, W 77.18145
T5	E	N 18.23880, W 77.10358
T6	F	N 18.23837, W 77.10334
T7	G	N 18.26768, W 77.20793
T8	H	N 18.26865, W 77.20716
T9	L	N 18.26558, W 77.21085
T10	N	N 18.27294, W 77.15382
T11	O	N 18.26679, W 77.18056
T12	P	N 18.25497, W 77.15063
T13	Q	N 18.19563, W 77.21193
T14	R	N 18.24814, W 77.19860
T15	SC	N 18.25238, W 77.19308
T16	T	N 18.20150, W 77.17426
T17	U	N 18.22398, W 77.20300
T18	V	N 18.22263, W 77.15916
T19	W	N 18.23684, W 77.15350
T20	PP	N 18.24559, W 77.18233

Cumulatively, a conservative number of arthropods assessed totaled 2,243 specimens belonging to 281 species among 20 locations within SEPL 524. The average number of species within the plot-based assessments for all locations was 35 with a standard error of 3 species. Location H had the greatest species richness due to the variety of data collection methods, day and night collection. Light trapping added 33 species and accounted for 38% of the arthropods collected at the location. Plotless assessments were typically fewer species-rich than plot-based assessments when recorded.

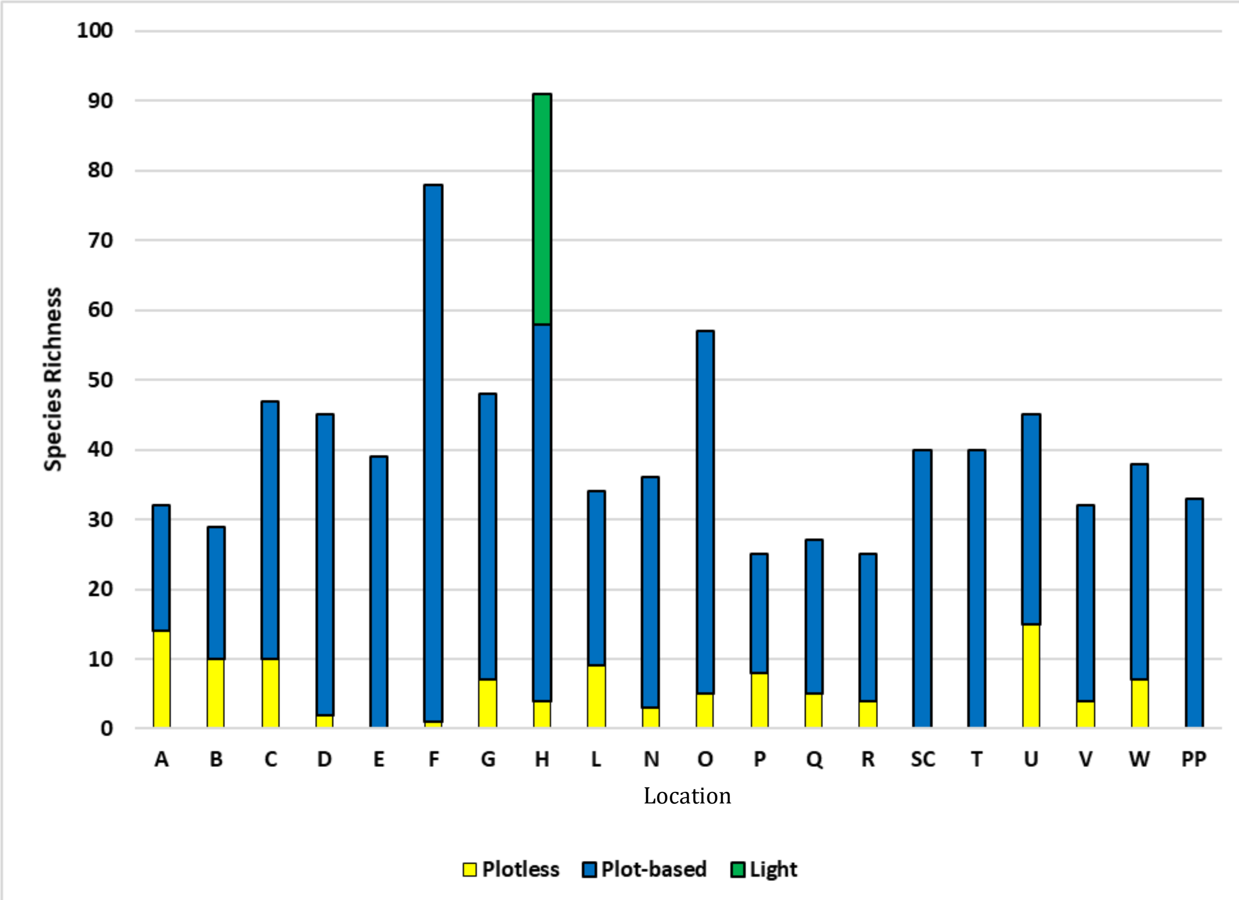


Figure 5-133: Cumulative Species Richness per Location

In assessing the frequencies of the arthropods within SEPL 524, insects (Insecta) dominate with 87% representation, followed by arachnids (Arachnida) at 12%. Crustaceans and millipedes (Diplopoda) represented 1% each.

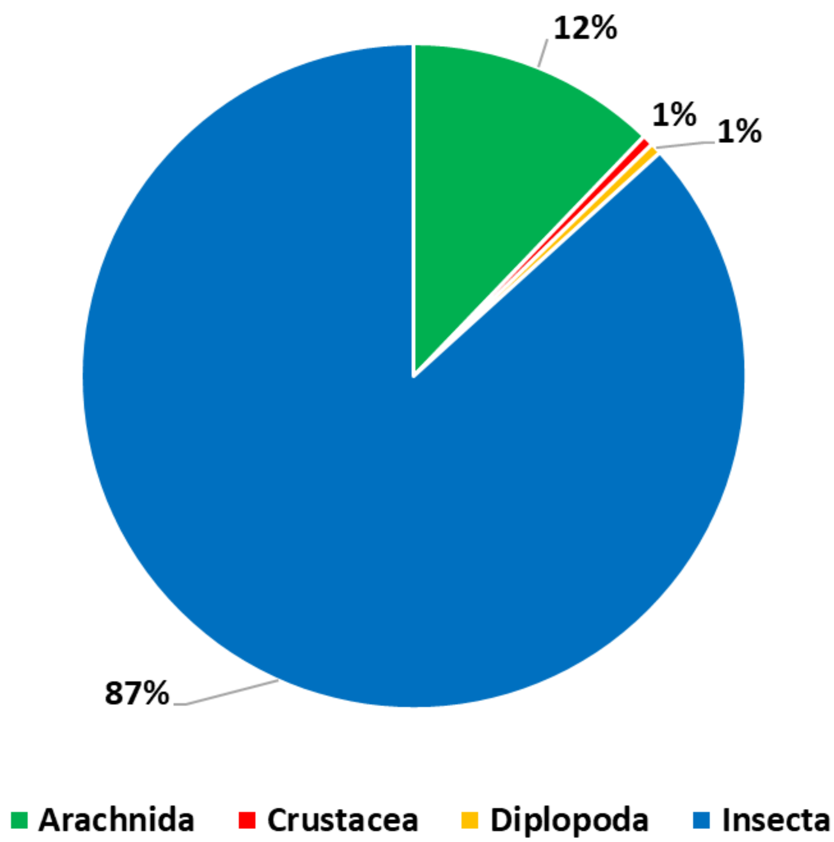


Figure 5-134: Arthropod Class Frequencies

5.4.3.4.3.1. Plot-based

Table 5-35 below represents the area sampled quantitatively at each location and species richness calculated among the standard transect of three 25 m^2 quadrats (total 75m^2) along a 30 m transect. Mean species richness was 29 species per standard transect. Location U was the most species-rich with 45 species, while Location O was the least species-rich with 19 species.

Table 5-35 - Species Density by Location

Location	Area (m^2)	Species Density (species richness/75m^2)
A	75	32
B	75	29
C	100	35

Location	Area (m^2)	Species Density (species richness/$75m^2$)
D	150	23
E	75	39
F	225	26
G	150	24
H	300	23
L	75	34
N	75	36
O	225	19
P	75	25
Q	75	27
R	75	25
SC	150	20
T	150	20
U	75	45
V	75	32
W	75	38
PP	75	33
Total	**2,350**	
Mean		**29**

When comparing average standard transects and average additional transects, the additional transects contained more species 70.3% more species than the standard. Bars present represent the standard error of the transect types, which were ±2 species for the standard and ±5 species for the additional. The non-overlapping bars indicate the significant difference between the 2 groups with their species richness. Of the standard transects, Location U was the most species-rich, with 45 species, well above the mean of 26 species. The lowest species richness for additional transect was Location A, with 32 species.

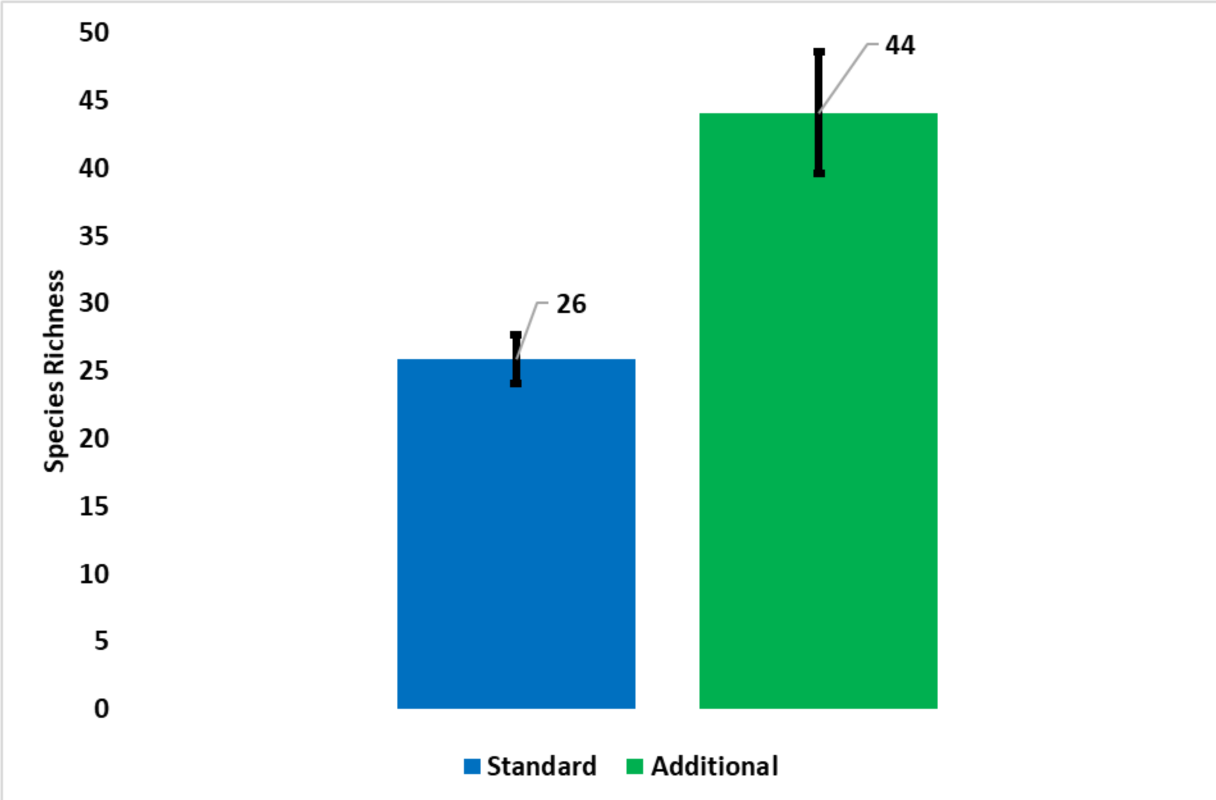


Figure 5-135: Mean Species Richness in Standard and Additional Transects

Assessment of the frequencies of arthropod orders sees Hymenoptera the most frequent, followed closely by Diptera. Distantly, but still fairly high are Lepidoptera (See Figure 5-138 below showing species observed) and Araneae. Hemiptera, Homoptera, Coleoptera and Orthoptera are moderately represented, with all other orders sparsely represented.

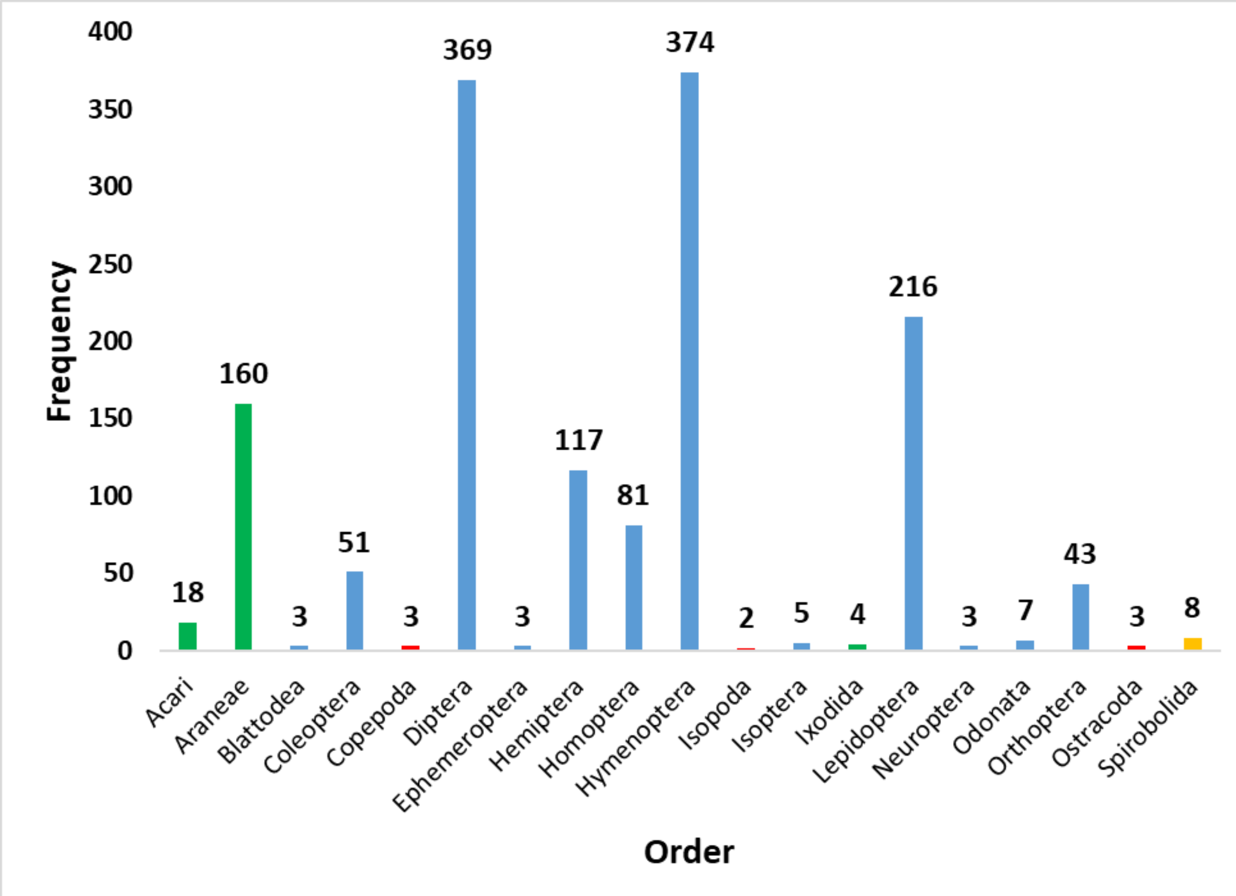


Figure 5-136: Arthropod Order Frequencies

Species richness for the entire SEPL 524 was high, with 281 species. Of those, the species richness was highest in the orders Araneae, Diptera, Lepidoptera and Hymenoptera.

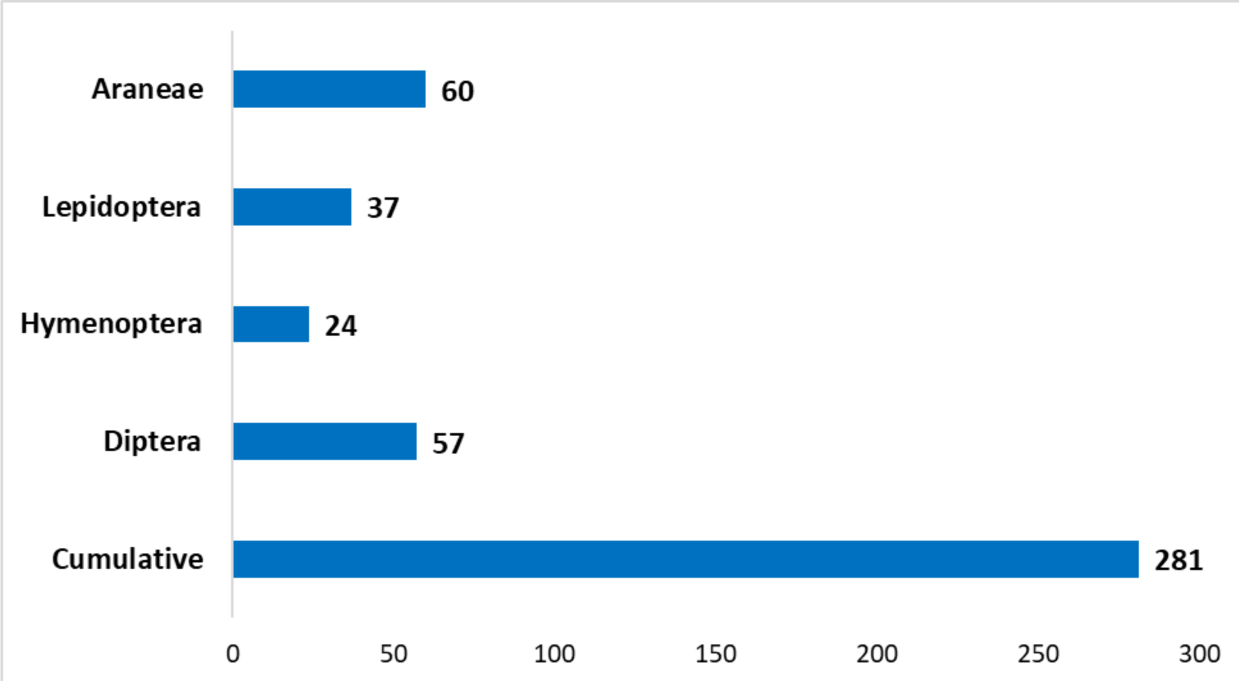
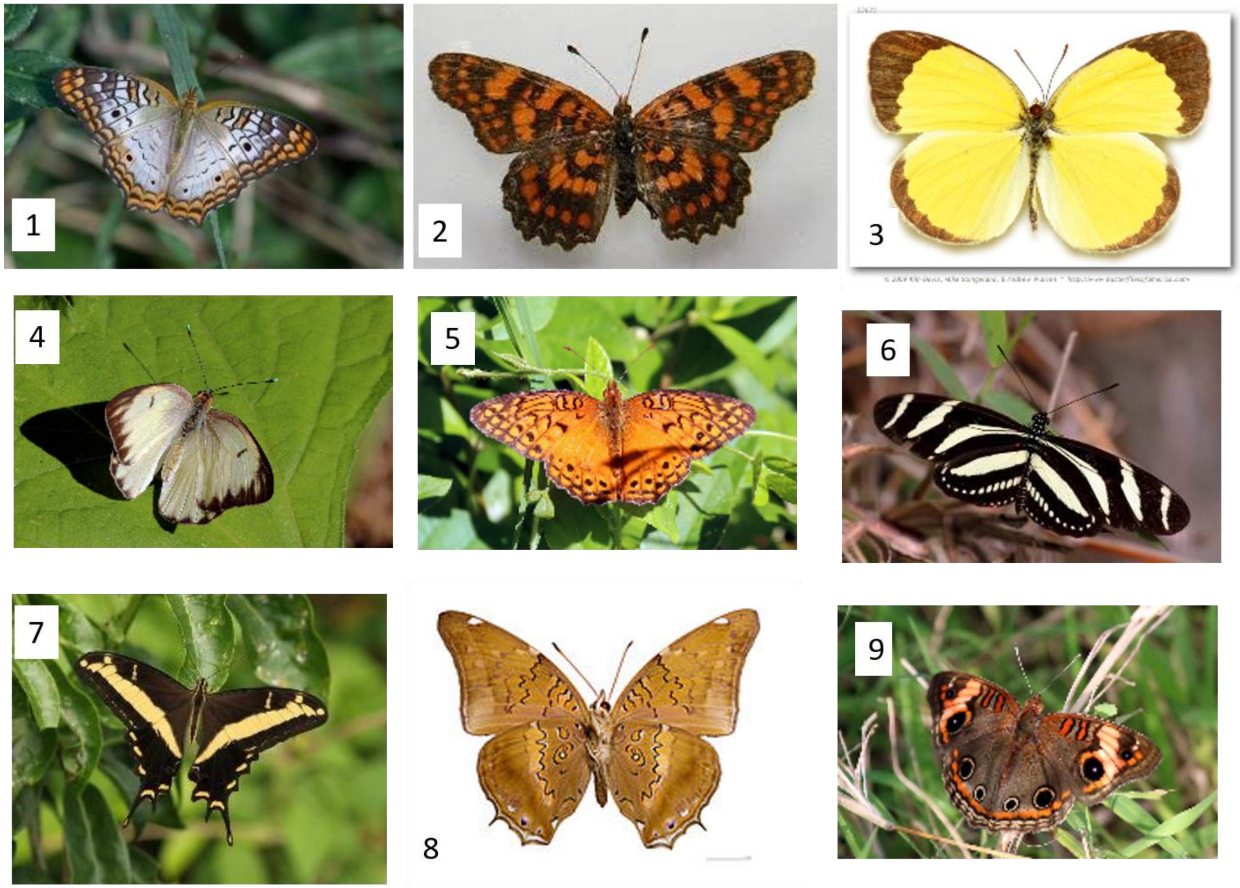


Figure 5-137: Species Richness Cumulatively and Among the Most Frequent Orders



KEY

1. White Peacock ***Anartia jatrophae saturata***
2. Jamaican Checkerspot ***Atlantea pantoni***
3. Grass Yellow ***Eurema sp.***
4. Florida White ***Glutophrissa drusilla castalia***
5. Gulf Fritillary ***Agraulis vanillae***
6. Zebra Heliconian Longwing ***Heliconius charithonia simulator***
7. Bahaman Swallow-tail ***Heraclides andraemon andraemon***
8. Tailed Cecropian ***Historis acheronta cadmus***
9. Tropical Buckeye ***Junonia zonalis***
10. Jamaican Mestra ***Mestra dorcas***

Figure 5-138: Species of the Lepidoptera Order Observed within SEPL 524

Biodiversity, as measured by Simpson's index was very high for the entire area, as well as for the 4 most frequent and species-rich orders. The lowest biodiversity value was measured by Lepidoptera, with 0.8920. Cumulative diversity only runs for the 261 non-colonial species.

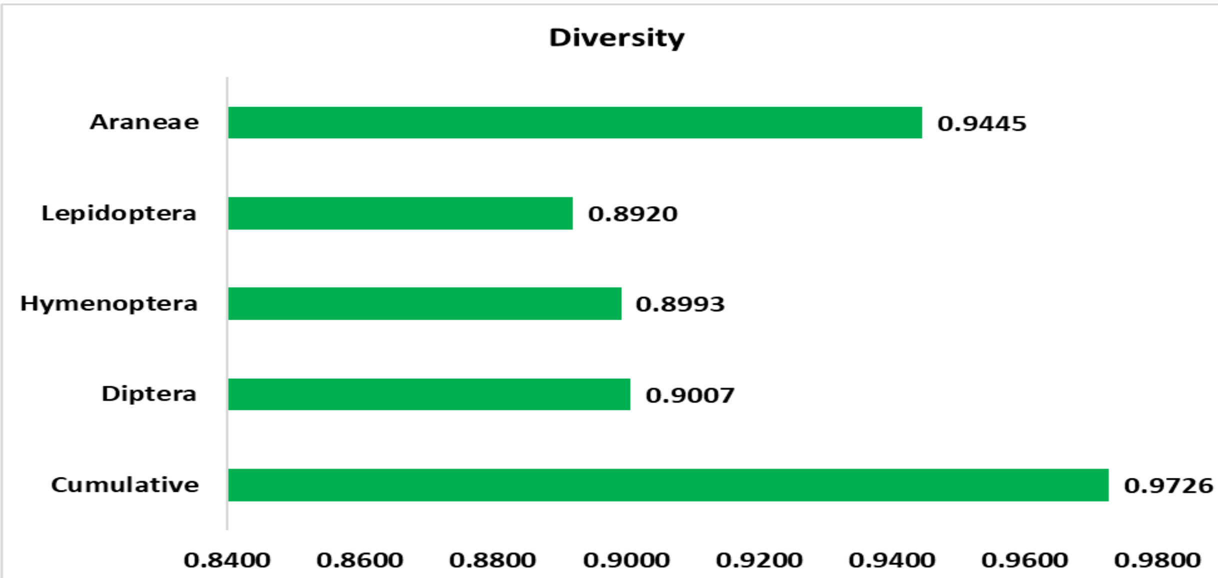


Figure 5-139: Biodiversity Cumulatively and among the Most Frequent Orders

Table 5-36: Cross Reference of the Frequencies of Species within Orders at All Locations

Order	Location																			
	A	B	C	D	E	F	G	H	L	N	O	P	PP	Q	R	SC	T	U	V	W
Acari								4	3		7					3	1			
Araneae	4	4	4	9	7	18	7	17	7	4	11	3	9	3	5	10	8	7	3	8
Blattodea			1				1													
Coleoptera		1	1	1	3	14	1	2	1	2		1	3			1		1		5
Copepoda			1				1													
Diptera	9	9	16	18	9	24	19	31	11	8	35	8	14	13	6	19	27	10	5	11
Hemiptera	7	1	3	8	12	9	6	14	1	6	6	1	1	4		5	3	1	4	7
Homoptera	1			2	9	7	5	2	2	2	3	3	3	2	2	4	7	4	2	3
Hymenoptera	8	8	19	21	41	34	12	33	13	8	35	2	7	11	13	24	20	13	13	2
Isopoda										1	1									
Isoptera	1		1					1												
Ixodida						1					3									
Lepidoptera	1	2	7	10	11	22	11	6	2	7	5	1	5	1	2	5	7	4	10	8
Neuroptera						1				1	1									
Odonata							1													
Orthoptera			2	2		5	2	2		3	5	1	1	1	1	2	5	2	3	1
Spirobolida		1				1				1	1				1	2				

Table 5-37: Cross Reference of the Abundance of Orders at All Locations

Order	Location																			
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**L**	**N**	**O**	**P**	**PP**	**Q**	**R**	**SC**	**T**	**U**	**V**	**W**
Acari								6	2		12					6	1			
Araneae	5	4	4	8	9	24	8	24	10	3	11	3	14	3	6	13	9	13	4	8
Blattodea			1				1													
Coleoptera		1	1	1	3	20	1	2	1	2		1	34			1		1		15
Copepoda			2																	
Diptera	25	14	44	54	11	65	22	56	19	21	82	24	92	30	12	38	91	28	23	19
Hemiptera	17	2	7	27	13	15	9	25	2	6	10	1	2	7		6	36	1	7	15
Homoptera	1			4	7	9	4	2	2	2	2	5	5	1	3	11	27	8	7	6
Hymenoptera		1	1	2	1	3									1	2		2		
Isopoda										2	3									
Isoptera																				
Ixodida						1					2									
Lepidoptera	1	2	10	14	16	33	14	16	2	8	6	1	6	1	2	7	8	6	15	12
Neuroptera						1				1	1									
Odonata							1													
Orthoptera			2	2		6	2	2		4	9	1	1	2	1	2	9	6	3	1
Platyhelmintes			1																	
Spirobolida		1				1				1	1				1	4				

5.4.3.4.3.2. Light Trapping

The arthropods from light trapping were dominated by Diptera and Homoptera. Of the Diptera, 10 species were present and for Homoptera, 6 species were present, representing nearly half of the 33 species collected. Lepidopteran moths represented 10 species overall.

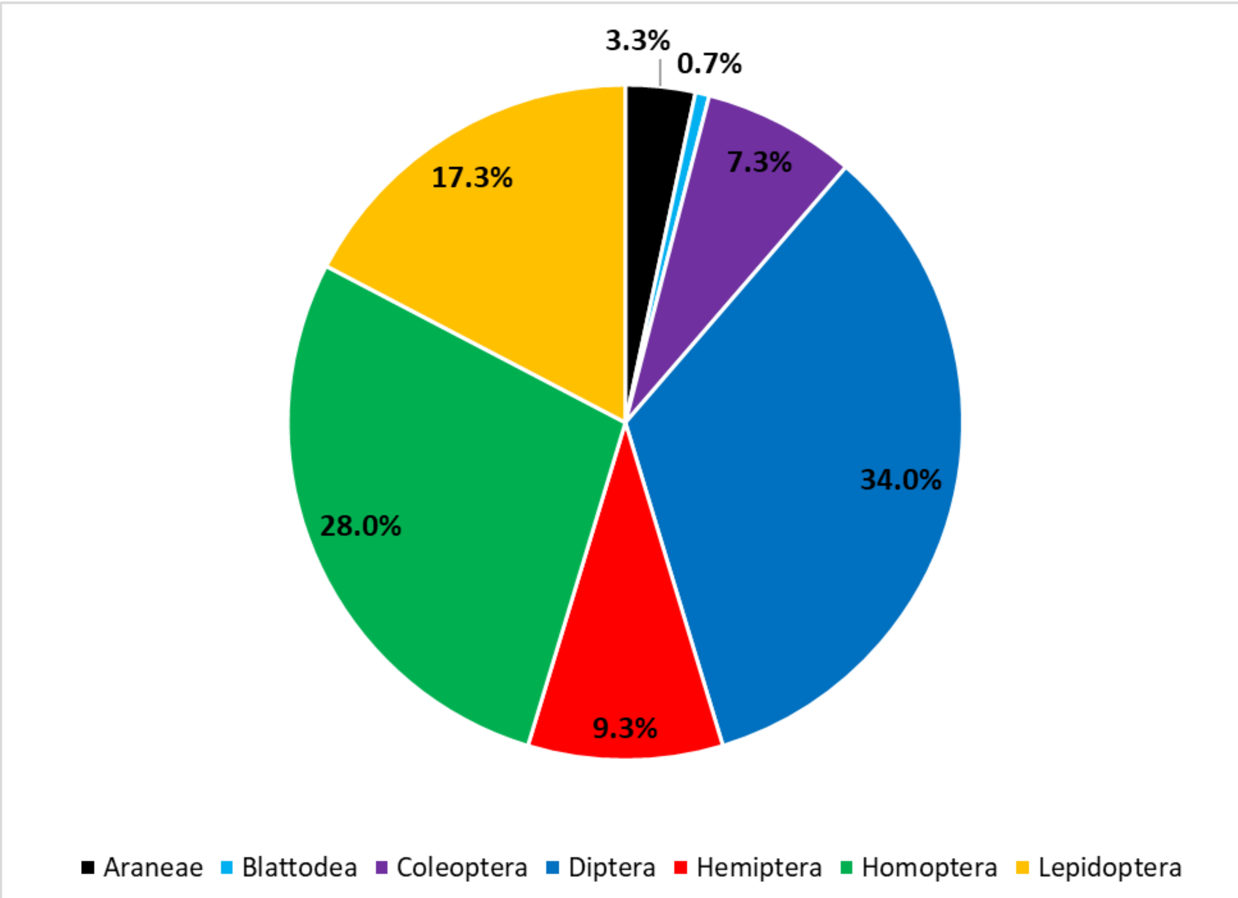


Figure 5-140: Light Trapping

5.4.3.4.3.3. Bromeliad

Figure 5-141 presents the frequency of species associated with the bromeliads. Among the bromeliads assessed, Culex A was the most frequent non-microscopic organism recorded in and around the bromeliads. Also associated with the bromeliad was Formicidae B, recorded thrice. The asterisks in Figure 5-141 denote the non-arthropod fauna which were associated with bromeliads. Tadpoles of frogs of the genus *Osteopilus* were seen within the leaf axil of one plant, as was the flatworm *Planaria sp*.

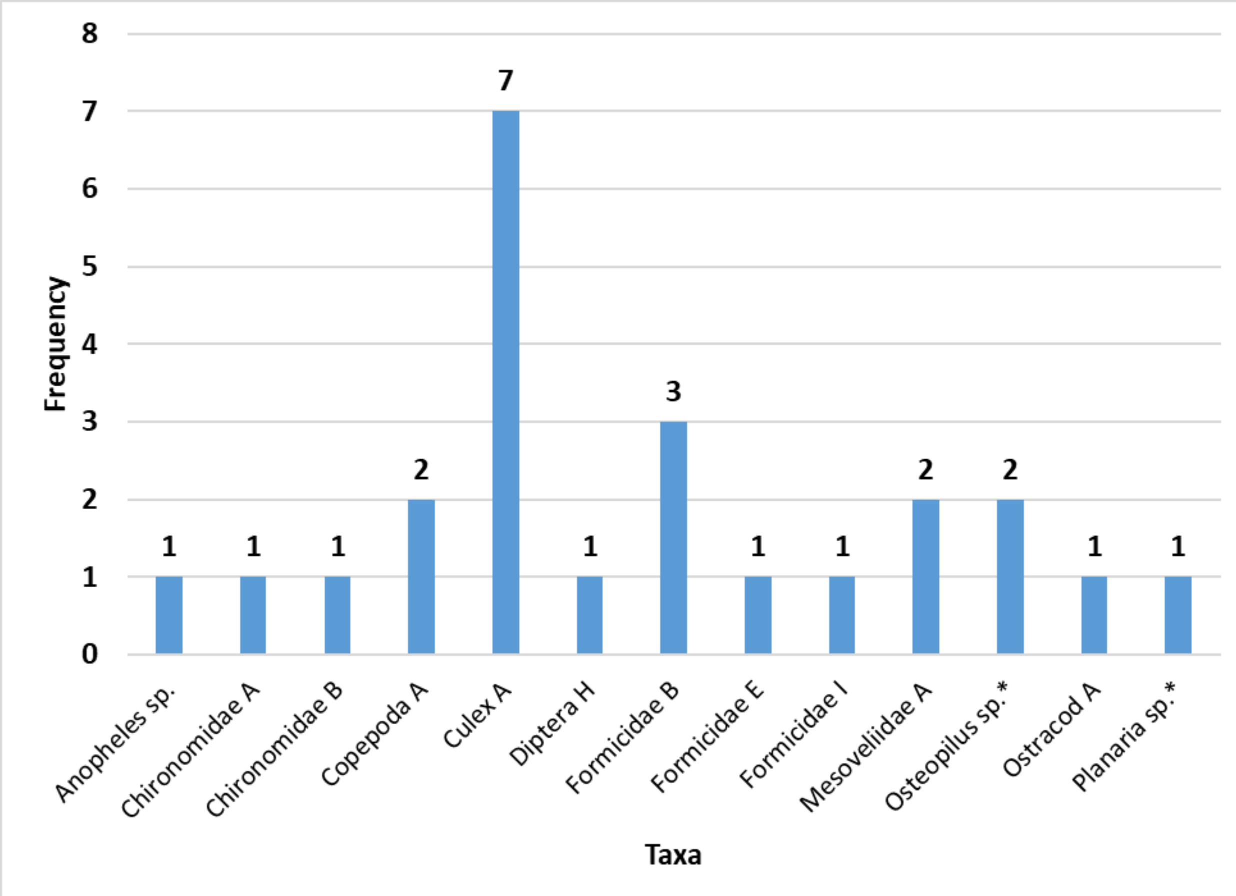


Figure 5-141: Species Associated with Bromeliads

Figure 5-142 illustrates the distribution of specimen within 3 bromeliads sampled at the same location. Bromeliads 1 and 2 were less than 1 m apart, while Bromeliad 3 was approximately 80 away from 1 and 2. Bromeliad 1 supported mosquito larvae, copepods and a chironomid, while Bromeliad 2 supported copepods and rotifers. Bromeliad 3 supported no multicellular organism and had none of the spiral protists shared by Bromeliads 1 and 2.

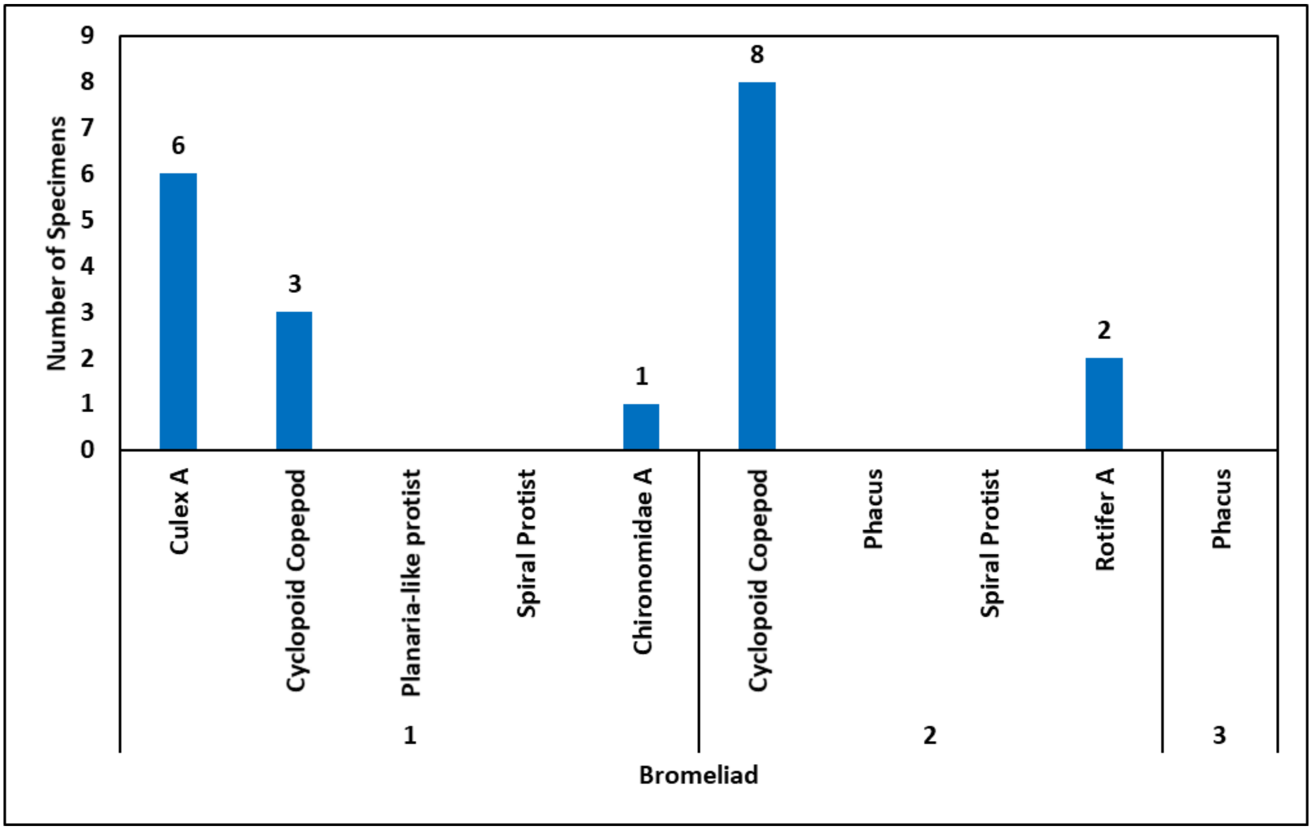


Figure 5-142: Bromeliad Meiofauna

5.4.3.4.4. Gastropods

Nine (9) species of terrestrial snails were observed and identified during inspections conducted within the study area. These are the Giant African Snail (*Achatina fulica), Pleurodonte amabilis, Pleurodonte candescens, Thelidomus cognata, Orthalicus undatus, Pleurodonte peracutissima*, *Sagda foremaniana, Pleurodonte invalida and pleurodonte sp.* Four (4) individuals were observed but were not identified. All examples, both live and shell remnants, were observed within the forested areas of all of the transects surveyed. Please see Figure 5-143 to Figure 5-146 below.

Giant African Snail ***Achatina fulica*** ***Pleurodonte amabilis*** ***Orthalicus undatus***

Pleurodonte amabilis ***Pleurodonte candescens*** ***Pleurodonte candescens***

Figure 5-143: Species of terrestrial snails Identified in SEPL 524

Pleurodonte sp

Pleurodonte ambilis

Pleurodonte ambilis

Unidentified

Pleurodonte sp

Pleurodonte sp

Figure 5-144: Species of terrestrial snails identified in SEPL 524

Pleurodonte sp

Unidentified

Unidentified

Unidentified

Pleurodonte sp

Unidentified

Figure 5-145: Species of terrestrial snails identified in SEPL 524


Unidentified


Unidentified


Unidentified


Pleurodonte invalida

Figure 5-146: Species of terrestrial snails identified in SEPL 524

5.4.3.4.5. Mammals

Rodents (field mice –the Brown Rat *Rattus norvegicus*) and mongooses (*Herpestes javanicus*) were observed during traverses of the low laying areas of the study area (See Appendix VIII).

At dusk, bats were observed flying around in populated areas of the SEPL, as well as, in the vicinity of low-lying depressions in the remote parts of the SEPL. The identity of these bats could not be ascertained from visual observations at dusk.

Flying bats were observed during the at a number of sampling sites for the ecology studies within the SEPL and the adjourning SML 162.

Table 5-38: Bat Scientific names and species code

Scientific Name	Species Code	Scientific Name	Species Code
Noctilio leporinus	**NOCLEP**	*Erophylla sezekorni*	**EROSEZ**
Mormops blainvillei	**MORBLA**	*Phyllonycteris aphylla*	**PHYAPH**
Pteronotus parnell	**PTEPAR**	*Natalus jamaicensis*	**NATJAM**
Pteronotus macleay	**PTEMAC**	*Chilonatalus micropus*	**CHIMIC**
Pteronotus quadridens	**PTEQUA**	*Eptesicus fuscus (lynni)*	**EPTFUS**
Macrotus waterhous	**MACWAT**	*Lasiurus degelidus*	**LASDEG**
Glossophaga soricina	**GLOSOR**	*Tadarida brasiliensis*	**TADBRA**
Monophyllus redmani	**MONRED**	*Nyctinomops macrotus*	**NYCMAC**
Artibeus jamaicensis	**ARTJAM**	*Eumops auripendulus*	**EUMAUR**
Ariteus flavescens	**ARIFLA**	*Eumops glaucinus*	**EUMGLA**
		Molossus molossus	**MOLMOL**

Table 5-38 contains the scientific name and the equivalent code used by the Kaleidoscope software for species of bats that have been reported as being resident locally in Jamaica. The findings from all analyses using Kaleidoscope and visual interrogation of spectrogram are presented in Table 5-39 below.

The Kaleidoscope software automatically identified eight (8) species of bats within the six caves sampled. These are shown in Table 5-39 below.

Table 5-39: Bat Species detected by Kaleidoscope Pro Software from the three Cave sampled

Caves	Species detected by Kaleidoscope Pro Software					
Greirfield	MOLMOL	NOCLEP	NYCMAC	PTEMAC	PTEPAR	TADBRA
Kenke Hole						
Lincoln Sink Hole	NOCLEP	PTEMAC	PTEPAR	TADBRA		
Potato Piece Cave	NOCLEP	TADBRA				
Johncrow Hole	EPTFUR	MOLMOL	PTEPAR	TADBRA		
Pedro River Cave	MOLMOL	MORBLA	PERMAC	PTEPAR		

5.4.3.5. Abiotic Findings – Measurement of Physical Parameters

Table 5-40 gives the physical data for SEPL 524 over the data collection period along various transects. Light intensity ranged from 104 to 1.28 kLux. Wind speed ranged from 0.25 to 1.68 m/s. Air temperature ranged from 34.05 to 28.74^{o}C and relative humidity ranged from 63.12 to 84.35%RH.

Table 5-40: Mean Physical Data for SEPL 524

Location	GPS Coordinates	Light Intensity (kLux)	Wind Speed (m/s)	Air Temperature (°C)	Humidity (%)
T1	N 18.23460, W 77.14842	2.16			
T2	N 18.25183, W 77.14983	22.48	0.27	29.87	84.35
T3	N 18.26581, W 77.1513	7.67			

Location	GPS Coordinates	Light Intensity (kLux)	Wind Speed (m/s)	Air Temperature (°C)	Humidity (%)
T4	N 18.26340, W 77.18145	51.32	1.22	32.14	66.80
T5	N 18.23880, W 77.10358	13.95			
T6	N 18.23837, W 77.10334	101.97	0.98	30.15	73.73
T7	N 18.26768, W 77.20793	56.73			
T8	N 18.26865, W 77.20716	33.03	0.25	34.05	66.29
T9	N 18.26558, W 77.21085	2.67			
T10	N 18.27294, W 77.15382	41.04	1.68	29.36	63.12
T11	N 18.26679, W 77.18056	47.56			
T15	N 18.25238, W 77.19308	8.15			
T16	N 18.20150, W 77.17426	16.97	0.67	32.03	69.78
T17	N 18.22398, W 77.20300	1.28	0.46	28.74	79.86
T18	N 18.22263, W 77.15916	40.68	0.41	30.14	72.02
T20	N 18.24559, W 77.18233	104.00	1.03	31.32	68.42

5.4.4. Habitat Delimitations

The results of the study of the flora and fauna of SEPL 524 indicate the general characterization of the habitats within SEPL 524 into four (4) main categories, namely:

1. Naturally occurring/disturbed hillock vegetation:
2. Severely disturbed lowland areas comprised of agricultural/grassland vegetation
3. Naturally occurring grass/shrub/fern transitional vegetation between hillock and lowland vegetation types
4. Caves and sinkholes

The figures below present the situation at sections within SEPL 524. These are habitat maps for the species that co-exists in the ecosystem of a group of hillocks and adjacent depressions. All habitats characterization were captured. The hillock habitat has been separated into two types. These are:

1. Those still under natural vegetation
2. Those that have been disturbed and are undergoing secondary regrowth

The lowlands have been subdivided in

1. Pasture/agricultural lowland
2. Bare substrate (influenced by fire)

The arrows indicate the movement of each species within the areas. They move for food, mating and socializing. The maps illustrates the interrelationship of the species

Figure 5-147 shows a section of SEPL 524 centered around transect survey positions at N 18.24814, W 77.19860 (Transect 14) and N 18.25238, W 77.19308 (Transect 15) which were used as a means of illustrating the various floral and cave/sinkhole assemblages listed above. Two cave locations were represented within the borders, of the Figure 5-147.

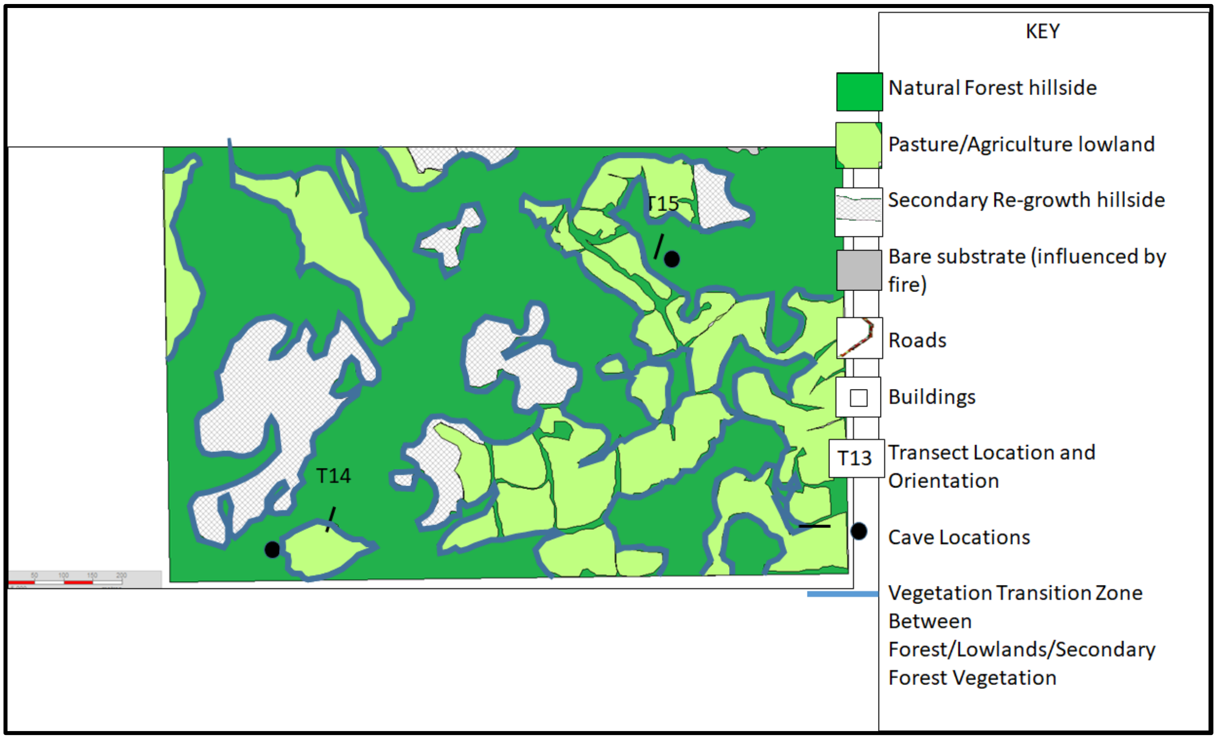


Figure 5-147: Habitat Characterization Reference for Areas Surrounding Transects 14 and 15

It was hypothesized that the plant habitats listed above and depicted on Figure 5-147 provided the foundational habitats for the sustenance and survival of fauna, while the cave locations represented a special faunal habitat.

5.4.4.1. Delimitation of Avi-Fauna Habitats

This study has shown that 49% of the bird species observed were insectivores, 20% were herbivorous, 18% were omnivorous and 13% were either frugivorous or granivorous.

The range of occurrence of insectivorous, herbivorous and omnivorous avifauna is indicated on Figure 5-148 below.

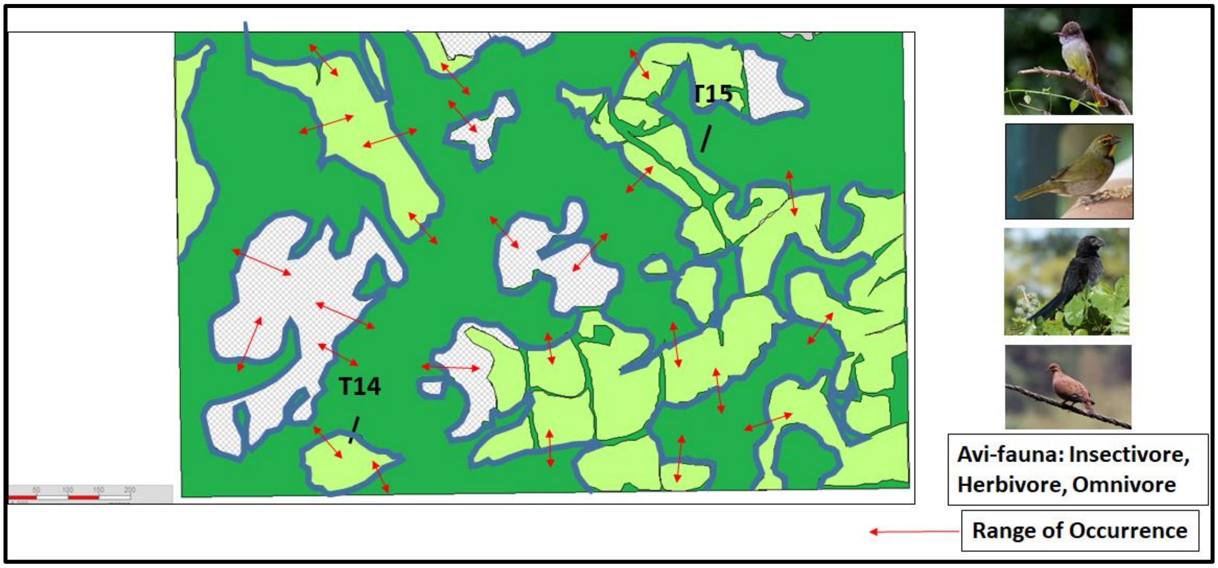


Figure 5-148: Approximate Range of Occurrence of Insectivorous, Herbivorous and Omnivorous Birds Observed During Observations Within the SEPL 524.

The zone of occurrence would provide sustenance for insectivores as well as the herbivores and omnivores. It was therefore surmised that the area defined in the figure (and probably by extension the SEPL study area in general) served as vital feeding areas for 87% of the birds observed within the study area.

Frugivorous and granivorous birds, such as the Jamaican Crow (*Corvus jamaicensis*) and the Yellow-Billed Parrot (*Amazona collaria*) were seen exclusively at or near to the summits of the hillocks within the study area, leading to the interpretation that its primary food sources were near to or at those locations. Thus, it was surmised that the summits of the hillocks represented a floral habitat that supported the sustenance of these bird types, with these birds ranging between hillock tops in search of food (see habitat range illustration on Figure 5-149).

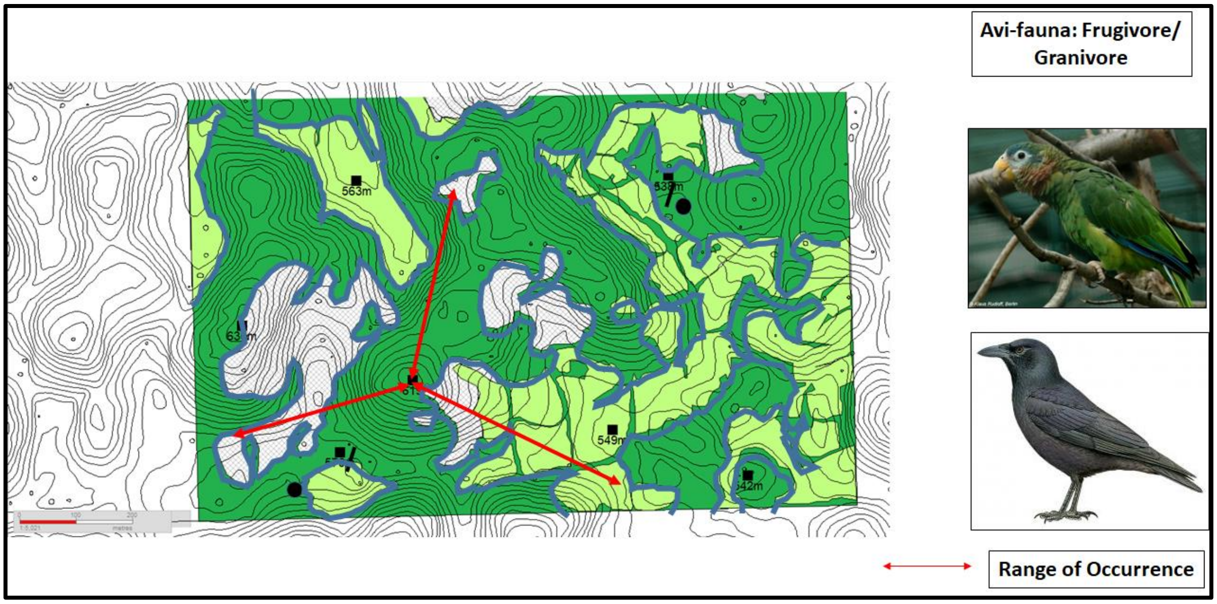


Figure 5-149: Approximate Range of Occurrence of Frugivorous and Granivorous Birds Observed During Observations Within the SEPL 524

5.4.4.1. <u>Delimitation of Insect and other Arthropod Habitats:</u>

Figure 5-150 shows the location of insect and other arthropod sightings throughout the study area. The majority of these insects were observed within or close to the vegetation transitional areas between lowlands and hillocks.

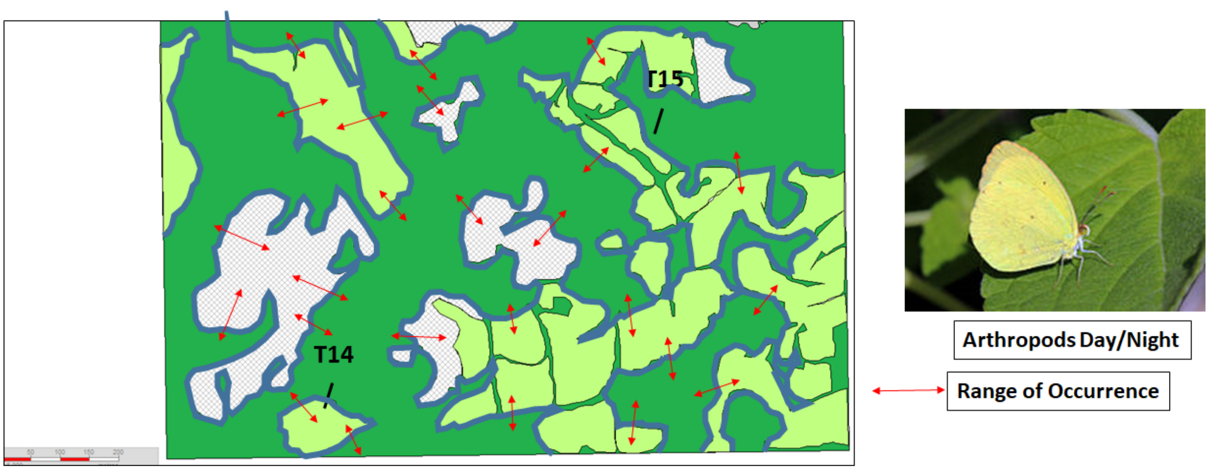


Figure 5-150: Approximate Range of Occurrence of Arthropods Observed During Day and Night Observations Within the SEPL 524.

5.4.4.2. Delimitation of Reptile, Amphibian and Gastropod Habitats:

Figure 5-151 below shows the locations of reptile, amphibian and gastropod sightings within the representational study area. Note that reptile habitat areas coincide with that of the areas of arthropod observations- from the vegetation transition zone at the edge of the hillock forest and extending into the forest area itself.

Insects are the primary source of food for the reptiles and amphibians. Trees are the primary living support for both faunal groups. Gastropods are primarily scavengers or herbivores and those found within the SEPL study area were either arboreal or lived in the leaf litter on the forest floor. Therefore, there appears to be a strong link between food type, living support type and range of motion for all three faunal lifeforms.

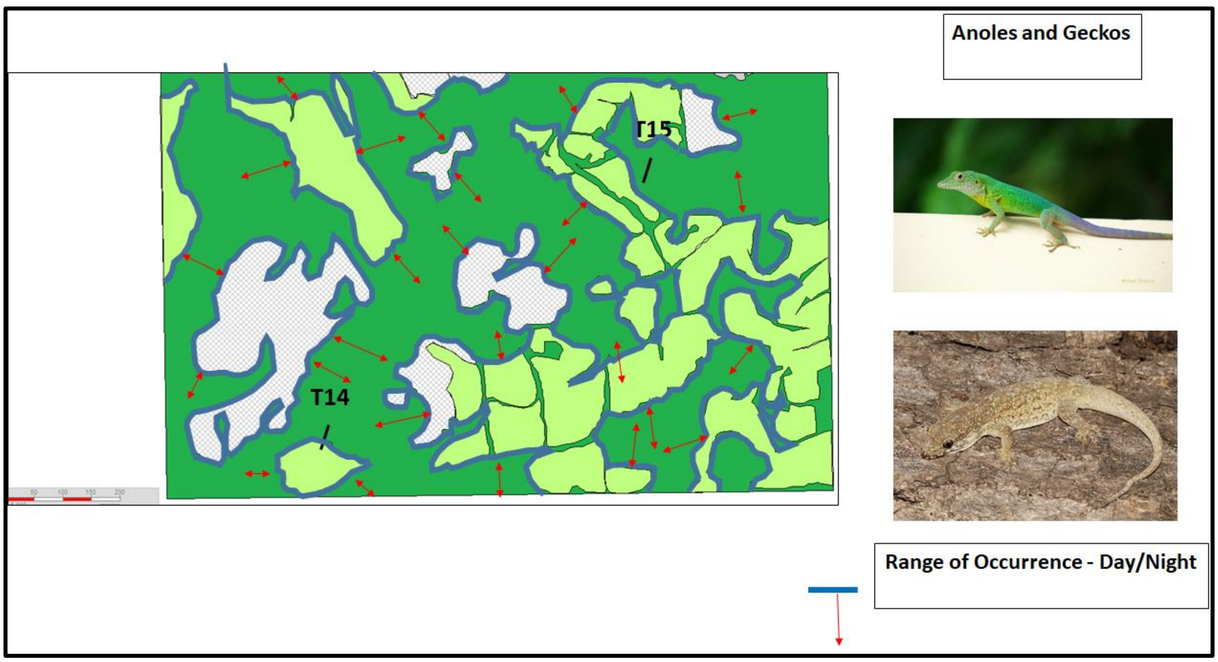


Figure 5-151: Approximate Range of Occurrence of Reptiles Observed During Observations Within the SEPL 524

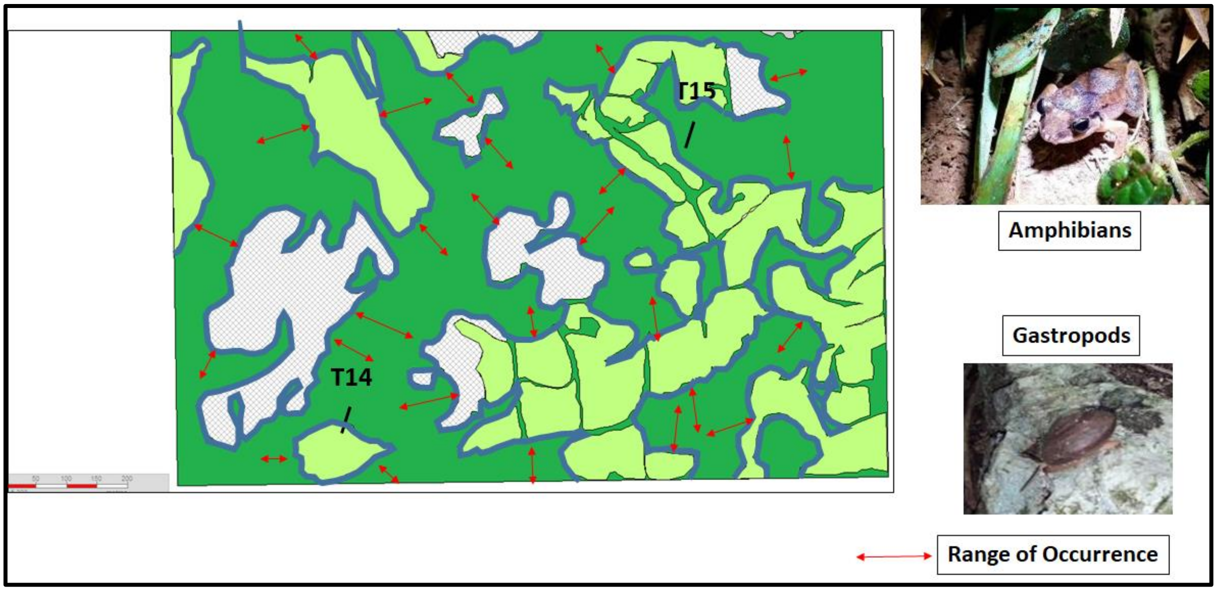


Figure 5-152: Approximate Range of Occurrence of Amphibians and Gastropods Observed During Observations Within the SEPL 524

5.4.4.3. Delimitation of Mammal Habitats:

Two mammalian habitats could be discerned during surveys conducted within the SEPL. The first habitats are defined on Figure 5-153 below, which encompasses ranges over which ground-dwelling mammals were observed. Note that these ranges overlap with those of avi-fauna, insects and reptiles.

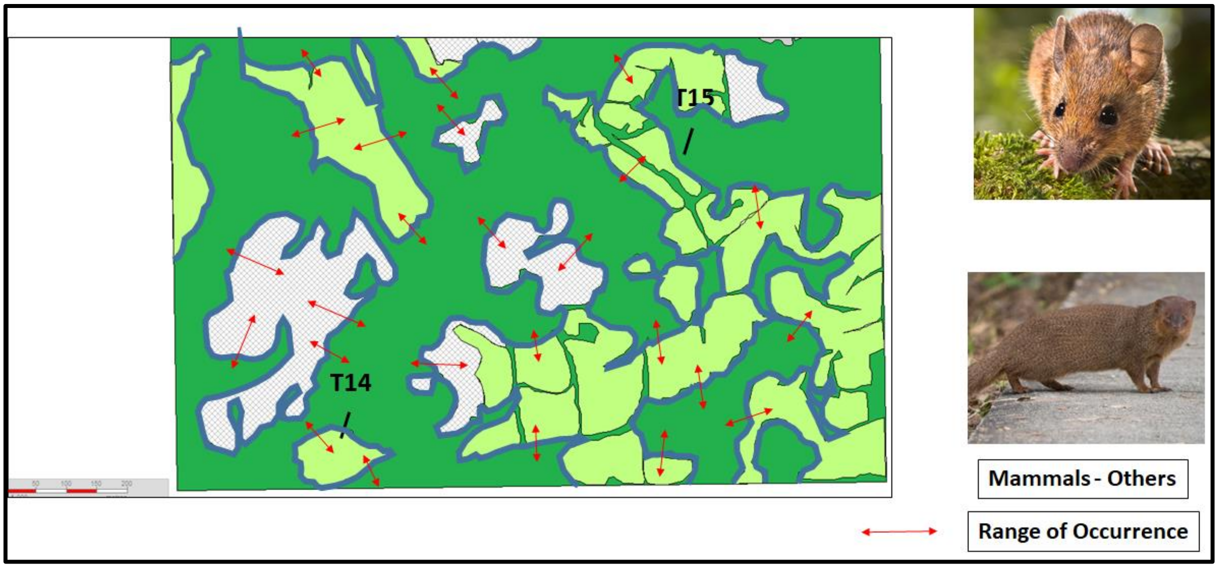


Figure 5-153: Ground-Based Mammal Habitat/Observation Ranges Within the SEPL 524 Area

The second habitats are defined for Bats on Figure 5-154 below, which encompasses two important components. The first are roost habitats, which are represented as points where these can be identified (as outlined on Figure 1 69 below). The second habitat relates to where these bats, which were determined to be insectivores, were seen flying (and possibly feeding). Note that the terminal end of the range from the caves is within that of the insects.

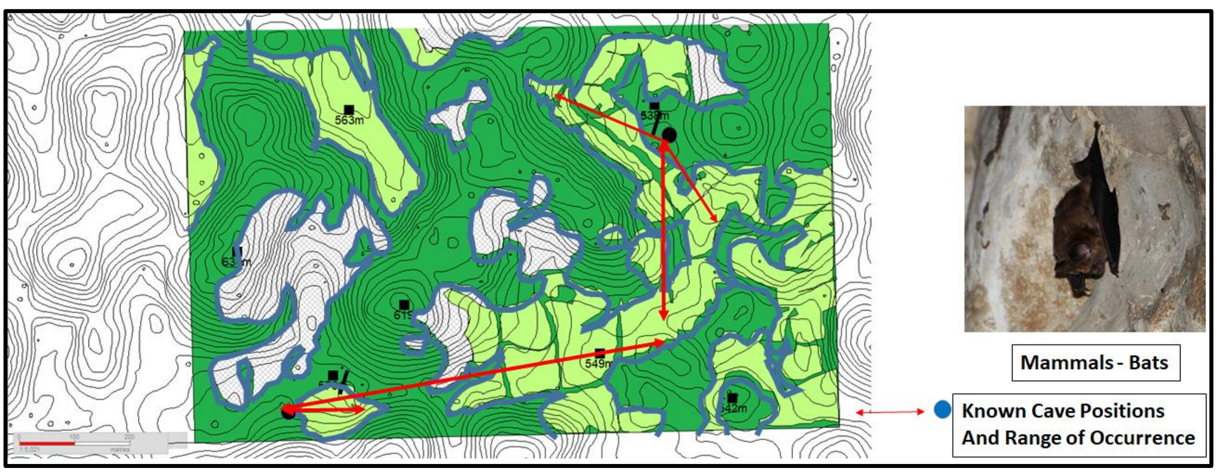


Figure 5-154: Approximate Range of Occurrence of Bats Detected Within the SEPL 524

5.4.4.4. Overlapping Habitats:

The following faunal groups were examined within the area represented in the figures above (and by extension throughout the SEPL):

1. Arthropods divided between the following sub-groups:

    - Hymenoptera - Wasps, Bees and Ants
    - Diptera - Flies and Mosquitoes
    - Lepidoptera - Butterflies
    - Hemiptera- with plant-piercing/sucking mouth parts
    - Homoptera - related to Hemiptera
    - Coleoptera - Beetles
    - Orthoptera - Grasshoppers Locusts and Crickets

2. Avi-fauna divided between:

    - Insectivores
    - Herbivores
    - Omnivores
    - Frugivores
    - Granivores

3. Reptiles
4. Amphibians
5. Gastropods
6. Mammals divided between:

    - Ground dwelling omnivores
    - Ground dwelling carnivores
    - Airborne insectivores.

Examining the various fauna listed above, it was clear that, where diet was concerned:

A. Two of the five avi-fauna groups divided according to diet depended on insects
B. Two of the three non-mammal fauna groups examined depended on insects
C. One of the three non-domestic mammal groups examined depended on insects.

Insects resided within an area of the SEPL habitat occupied by or foraged by all fauna types examined. This area was defined by the hillock forests and the shrub/grass/fern vegetation transition zone existing between the forests and lowland vegetation. Herbivorous avifauna appeared to prefer the zone of vegetation transitioning from the forest edge to the edge of the lowland grass vegetation area while frugivorous/granivorous avifauna preferred the tops of the forested hillock areas. Insectivorous Reptiles and Amphibians preferred the trees of the hillock forests. Herbivorous and scavenging non-avifauna preferred the forest floor or tree-trunk areas for their dietary requirements.

It was opined that the hillock forest and vegetation transition zone area provided dietary support for all of the animals observed within the SEPL. It was also apparent that the hillock forest and vegetation transition zone area provided additional life support in the form of nesting/breeding sites for fauna. Thus, the areas defined in dark green and blue on Figure 5-155 below represent areas where the preservation and/or maintenance of floral elements will have the greatest impact on the preservation and maintenance of fauna present within the SEPL.

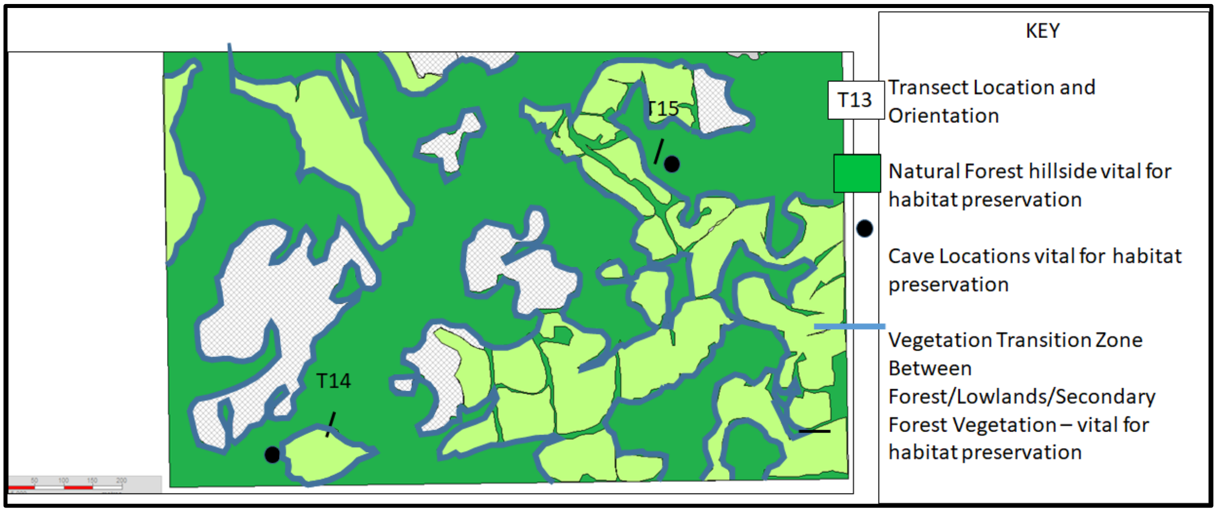


Figure 5-155: Delimitation of Floral Areas Within SEPL Vital for Habitat Preservation

5.5. Archaeological Heritage

In keeping with the requirements of NEPA, the historical heritage of SEPL 524 has been assessed in detail by the Jamaica National Heritage Trust. The Heritage Survey, is submitted as an accompanying document with this EIA, as Volume I and titled, "Heritage Survey Proposed Bauxite Mining Operations Special Exclusive Prospecting Licence (SEPL 524) St. Ann WINDALCO," dated July 2020.

5.6. Socio-Economic and Cultural Environment

5.6.1. Demography

According to the 2011 census report (STATIN, 2012), the population of the study area is approximately 11,121 persons. The area is confined to the south-eastern end of the parish of St. Ann and northern portions of St. Catherine and Clarendon. The distribution of the population in the study area is illustrated in Table 5-41 and Figure 5-156. It indicates that the largest number of individuals are living in Moneague, Gibraltar and Bensonton, all of which have a population greater than 1,600 persons, with 1,747, 1,806 and 1,961 persons respectively. The geographic extent of these areas includes several other smaller residential settlements, whose population size cumulatively contribute to the overall demographic profile of the area. The communities of Faith's Pen and the portion of Ewarton found within the study area has the lowest population of no more than 400 individuals. Between 2001 and 2011, the parish of St. Ann endured a population growth rate of 0.35 percent, while St. Catherine experienced the highest growth rate in the country of 0.72 per cent (STATIN, 2012). St. Ann dominates the population within the study area, with the areas in St. Catherine and Clarendon totaling 1,780 persons, accounting for only 16% of the population for the project impact area. The remaining 84%, a total of 9,341 individuals are residents within the communities in the parish of St. Ann.

Table 5-41: Population in Project Area by EDs and Communities

Parish and Enumeration District	ED Communities	Population
St. Ann		
SOUTHEAST 55, 56, 58, 60	Moneague	1,747
SOUTHEAST 57, 59	Claremont	512
SOUTHEAST 61, 62, 63, 77, 79	Bensonton	1,961
SOUTHEAST 64, 65, 68	York Castle	935
SOUTHEAST 66, 67	Alderton	786
SOUTHEAST 72, 75, 76	McNie	1,276
SOUTHEAST 80, 81, 82, 83	Gibraltar Moneague	1,806
SOUTHEAST 85	Faith's Pen	318
St. Catherine		
NORTHWEST 1, 5, 6	Lluidas Vale	654
NORTHWEST 7	Ewarton	287
Clarendon		
NORTH 30, 31	Kellits	839
TOTAL		**11,121**

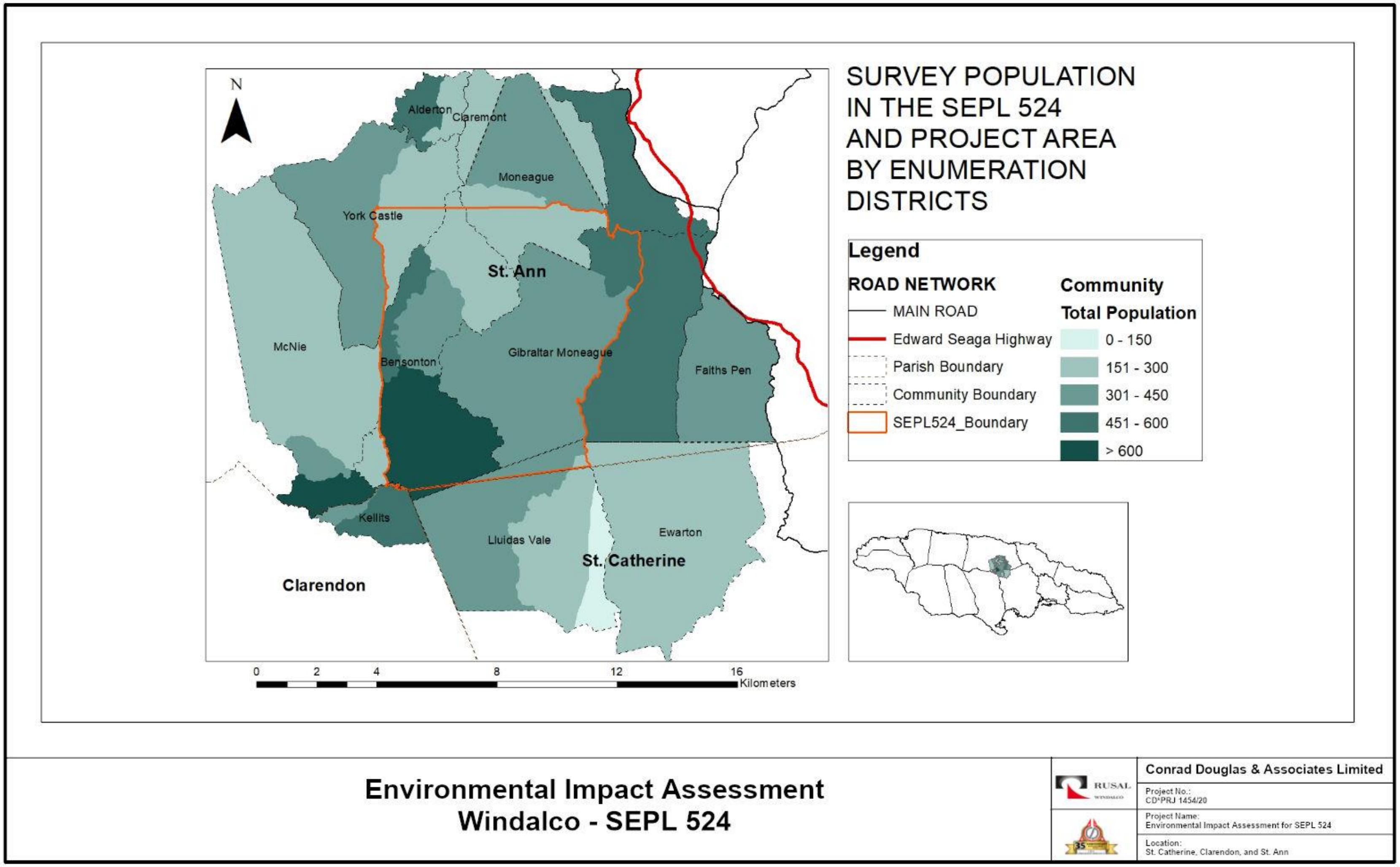


Figure 5-156: Survey Population in the SEPL 524 and Project Area by Communities

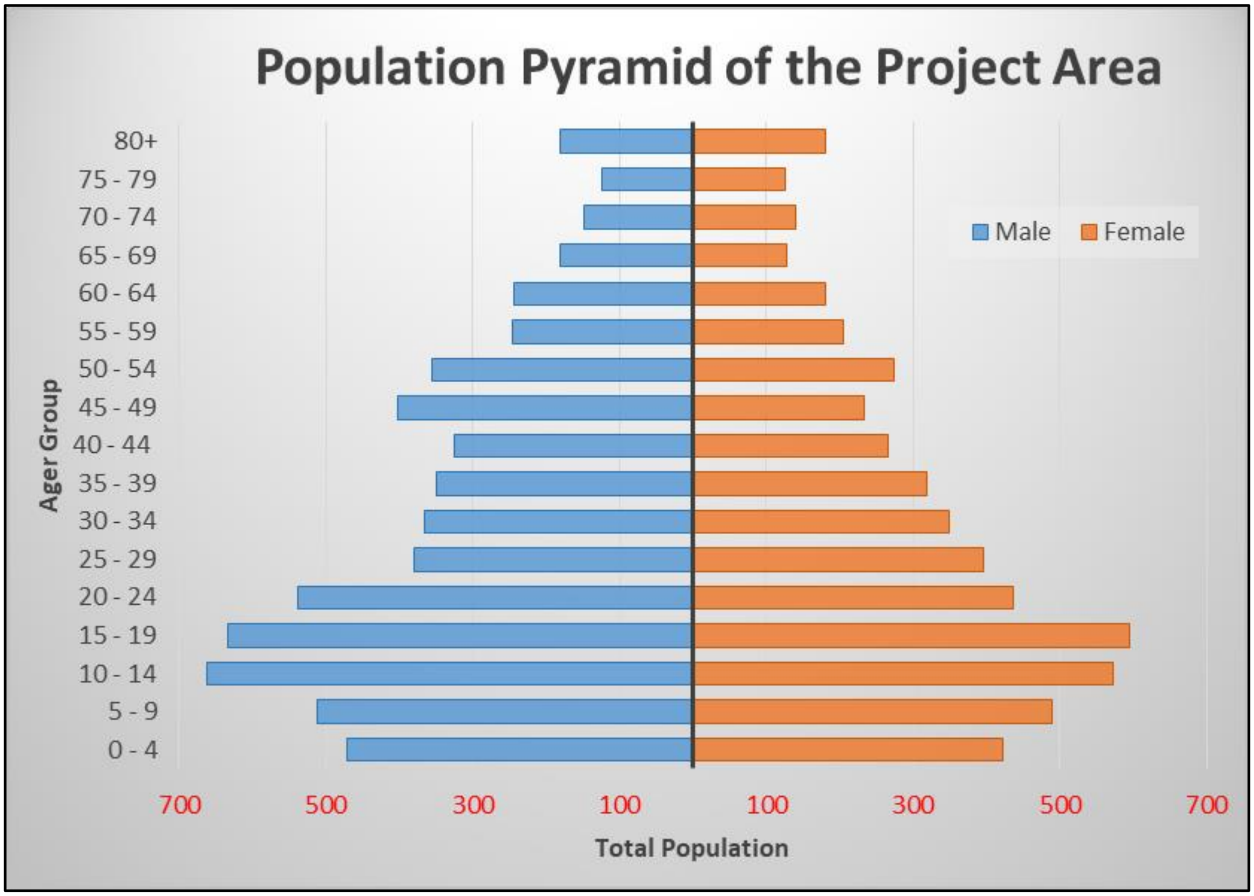


Figure 5-157: Figure 1 Population Pyramid for Project Area. Source: Census 2011 Report, STATIN 2012

Figure 5-157 above illustrates the structure of the population that make up the study area. The population pyramid reflects the transitional nature of demographic transition currently being experienced in Jamaica, consisting of a large but declining youthful population, a dominant working population and a growing ageing population. It highlights a large youthful population in the communities with under the age of 15 years account for approximately 28% of the population, which is indicative of high child dependency. Although most of the population fall within the economically active age group (61% of the population), the area still has a very high level of dependency. Generally, the age dependency ratio (ADR), according to the data for STATIN 2012, was at approximately 64% That is, 64 dependents (persons aged 0-14 and over 64) for every 100 person in the economically active population (person aged 15-59). This is consistent with the findings of the Jamaica Survey of Living

Conditions (JSLC) (STATIN 2015), and the Economic and Social Survey (2017) which indicated a decline in ADR nationally while highlighting that the ADR in rural areas remained higher than the national average of 60.3 in 2015 and 43.6. Child dependency is high with the current ratio standing at approximately 46% which means that for everyone hundred person of working age, there are 46 persons aged under 14 years. Elderly dependency in the area is comparatively lower, with 18 elderly persons to every 100 person of working age.

The 2011 Census Report indicates a sex ratio of 97.9 males per 100 females, which represented an increase from 96.9 from 2001. The ratio of males to females in the population of the area is not a mirror of the distribution observed nationally. Males significantly outnumber females in the communities within the study area with a ratio of approximately 115.3 males for every 100 females. This is synonymous with the national trend where male population is growing faster than the female population and the excess of women over men declined considerably over the period 2001 to 2011. As shown in Table 5-42, males outnumbered females in every age cohort with the exception of the 25 -29 age group where there are 96.2 males for every 100 females. Equilibrium in the distribution of males and females exist in the most elderly cohorts between 75 and over 80 years of age.

Table 5-42: Sex Ratio of the Population in the Study Area

Age Group	Male	Female	Males per 100 Females
0 - 4	472	422	111.8
5 - 9	512	489	104.7
10 - 14	663	573	115.7
15 - 19	633	595	106.4
20 - 24	539	437	123.3
25 - 29	380	395	96.2
30 - 34	365	349	104.6
35 - 39	350	318	110.1
40 - 44	326	266	122.6
45 - 49	403	234	172.2
50 - 54	356	273	130.4
55 - 59	246	204	120.6
60 - 64	244	181	134.8
65 - 69	180	128	140.6
70 - 74	148	139	106.5

75 - 79	125	125	100.0
80+	180	180	100.0

5.6.2. Housing

The housing information from the 2011 census shows in that there have been significant changes in the total number of housing, dwelling units and household sizes since the previous census in 2001. Table 5-43 below illustrates the nature and extent of change experienced at the national level and within parishes that make up the study area over that time period. Generally, there has been an increase in the number of dwelling units and the number of households, while the average household size is getting smaller. In the parish of St. Ann, where the SEPL 524 is entirely situated, the total number of dwelling units and households both increased by approximately 15%, which is similar to the national rates. On the other hand, the average household sizes in the parish declined by 0.5% over the period. According to the JSLC 2015, the trend continued and is attributable to a decline in the proportion of children in the population which has contributed to the change in the size and structure of households, leading to smaller households with fewer children. Average household size in the country fell to 3.0 and the mean number of children fell from 1.0 in 2006 to 0.8 in 2015 (STATIN, 2015). There is also the prevalence of people living alone, with single-person households being the most common type of household by size, contributing to a decline in the average household size.

Table 5-43: Housing Data for Jamaica and Select Parishes 2001 - 2011

Location	Dwelling Units		Number of Households		Average Household Size	
	2001	2011	2001	2011	2001	2011
Jamaica	723,041	853,660	748,326	881,078	3.5	3.1
St. Ann	43,964	51,984	45,380	53,654	3.7	3.2
St. Catherine	128,974	156,961	134,377	163,215	3.6	3.2
Clarendon	62,843	74,563	64,668	76,880	3.7	3.2

Table 5-44: Housing and Tenure in Select Communities 2011

Development Area	Housing Units	Dwelling Units	Households	TENURE			
				Owned	Leased	Rented	Squatted
Claremont	464	540	545	**302**	**7**	**139**	**0**
Moneague	1125	1241	1273	**723**	**2**	**333**	**7**
Ewarton	2882	3193	3393	**2131**	**76**	**512**	**12**
Lluidas Vale	654	713	732	**523**	**2**	**73**	**8**
Kellits	655	745	768	**518**	**0**	**104**	**4**

Table 5-44 above demonstrates housing information gathered in 2011 for development areas found in the study area. While Ewarton has the largest number of households and dwelling units, the area found within the project area has a small population and similar to Kellits and Lluidas Vale, is outside of the boundaries of the SEPL 524. Claremont and Moneague development areas encompass the communities in St. Ann which dominate the project area. Moneague has a greater number of household than Claremont, but home ownership appears to be equally high in both area with the majority of the units occupied by owners followed by those who rent. Leasing and squatting appear to be more popular in Ewarton. See Figure 5-158 below which highlights the distribution of households by tenure within development areas that constitute the project area.

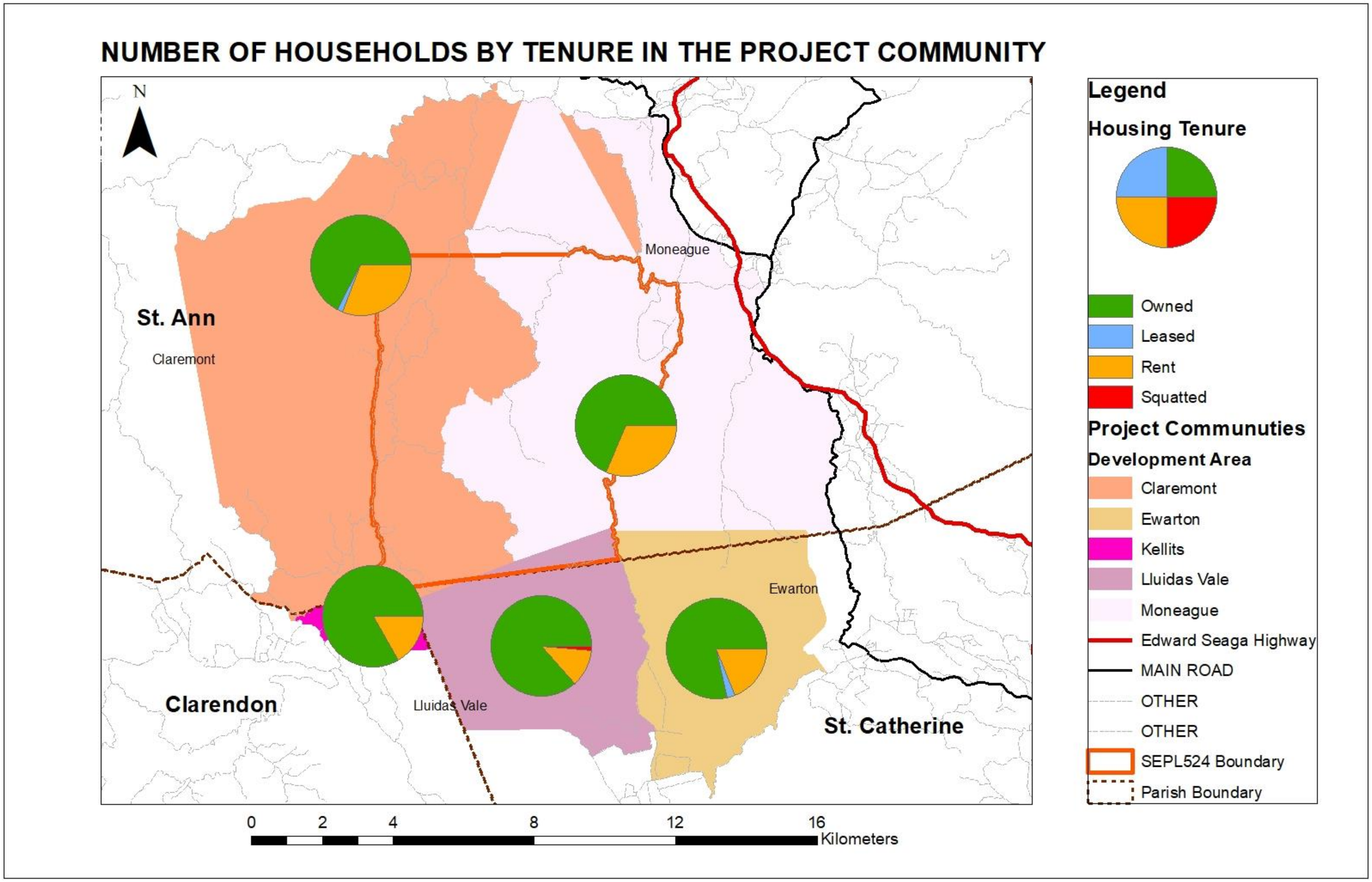


Figure 5-158: Number of Households by Tenure in the Project Community

5.6.3. Health and Emergency Services

There are no hospitals or fire stations in the study area. The nearest hospitals are located in St. Ann's Bay and Linstead, with the latter being location of the nearest fire station along with Ocho Rios. Health care is provided in the study area by Type I public health centres in Mcnie and Gibraltar, while Type II facilities exist in Moneague and Bensonton (see Figure 5-159 below). A Type I Health Centre is a facility serving no more than 4,000 persons with basic maternal and child health, while Type II facilities provides a higher level of expertise than a Type I facility and is equipped with a resident staff nurse who is able to provide simple treatment for common illnesses. Outside of the immediate study area, there is a Type I health centre in Kellits, a Type II facility and private provides in Ewarton. Ewarton and Moneague highlight the locations with Police Stations within the study, but there is also one in Claremont just outside project area.

5.6.4. Historical/Heritage Sites

As is illustrated in Figure 5-159 below, there are several sites of historical and cultural importance within and just outside of the project area. These areas are described in greater detail below:

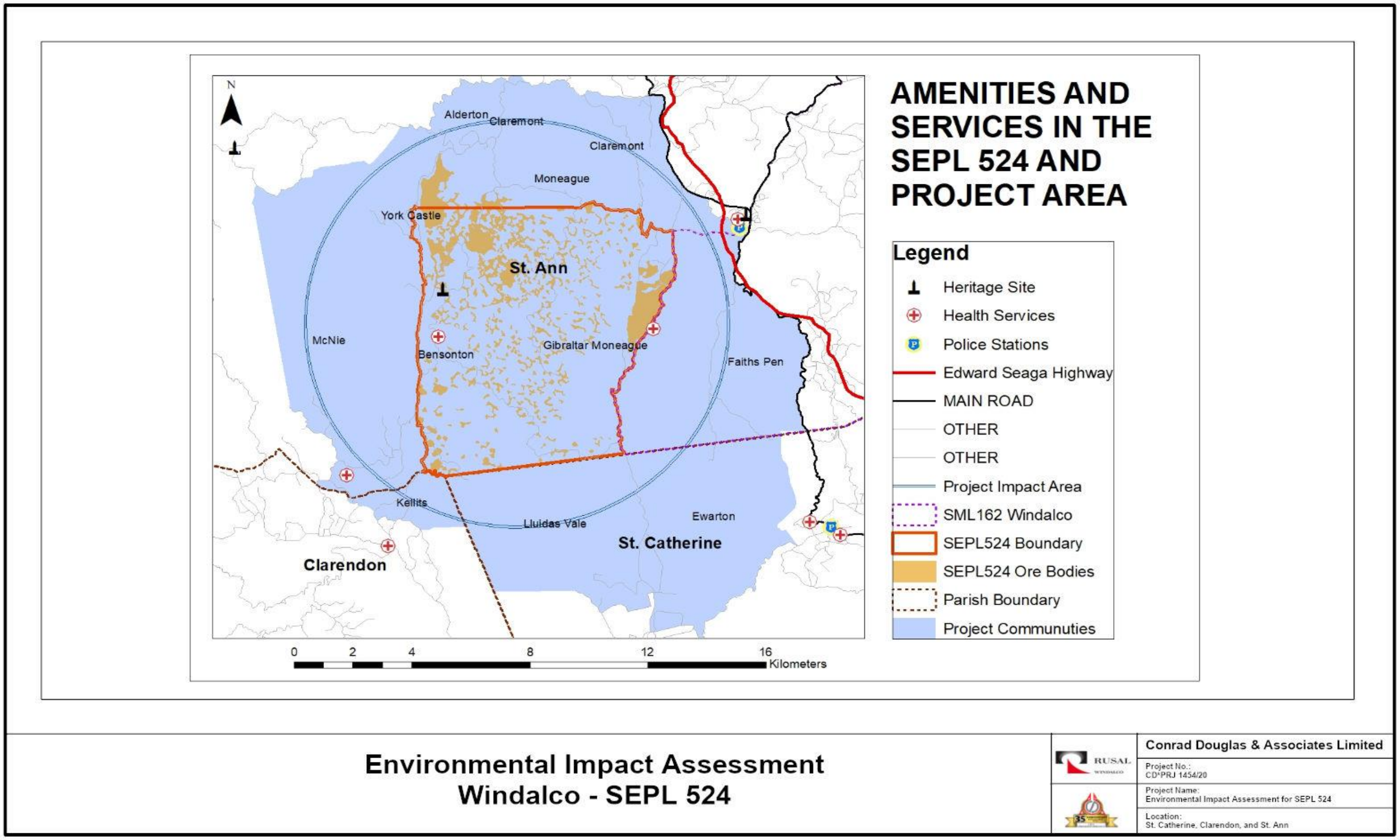


Figure 5-159: Amenities and Services in SEPL 524 and Project Area

5.6.4.1. The Edinburgh Castle

Edinburgh Castle, situated in Pedro district, near Drumily, St. Ann, was built by Lewis Hutchinson, who is Jamaica's earliest recorded serial killer. Hutchinson, a Scottish Doctor came to Jamaica in the 1760's and later became known as "*the mad doctor*", who would kill any lone passer-by and have his slaves discard the bodies in nearby sinkholes. The two story *'castle'* has two circular loop holed towers placed diagonally at opposite corners. The remains of the castle now stand in ruins, where artefacts and other remains have been discovered and the JNHT has plans to establish organized tours at the location.

5.6.4.2. The Moneague Inn

The Moneague Inn has a recorded history going back to 1844. In 1860 it was described as "*the best hotel in the island*" and was important because of its location on the main highway between the North coast and the then capital Spanish Town. The inn was the most important place to take a night break during the three-day journey. The Moneague Inn was surpassed by the Moneague Hotel in 1890, which was the largest hotel at that time and was declared a National Monument by the Jamaica National Heritage Trust on May 13, 1999.

5.6.4.3. Bob Marley Museum (Resting Place)

Situated in the community of Nine Mile, just outside of the project area to the north-west, is a rural chapel near the birthplace & childhood home of the Legendary Reggae Singer and Superstar, Bob Marley. Bob Marley and several family members are buried in this location. Reggae music is identifiable with Jamaica's culture internationally and accounts for the site attracting thousands of visitors yearly.

5.6.5. Educational Institutions

Educational institutions in the study area provide a wide range of services from infant/all-age level to the tertiary. While there are twelve (12) schools within the designated project impact area, there are an additional ten (10) in immediate environs (see Figure 5-160 below). The Moneague Community College is the only tertiary institutions in the area, and while high schools exist in York Castle, Claremont, Kellits, and Ewarton, these are areas on the periphery of the project area. The project impact area and the SEPL 524 is dominated by all age schools.

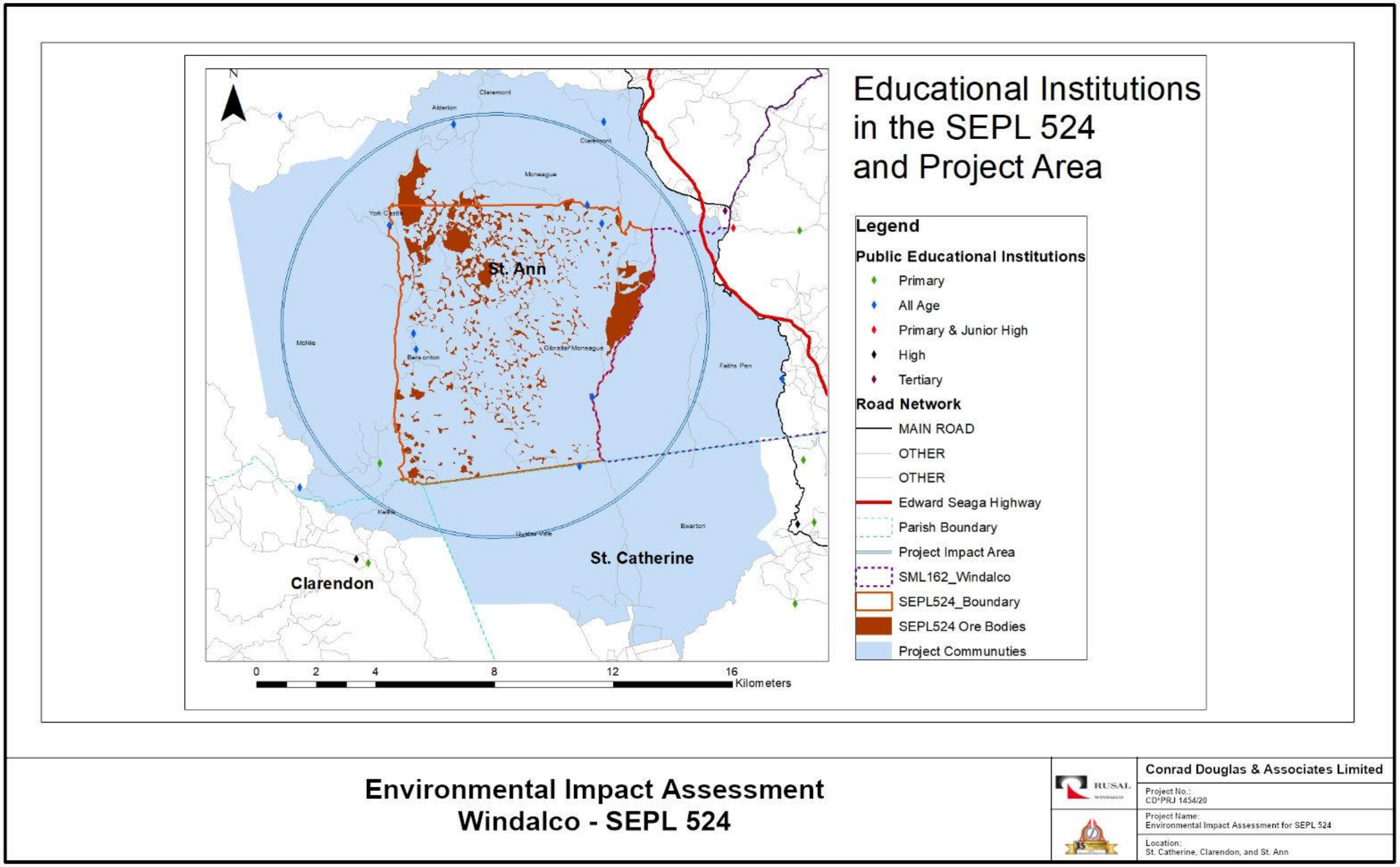


Figure 5-160: Educational Institutions in the SEPL 524 and Project Area

5.6.6. Infrastructure

From a regional perspective, there is high level of access to electricity, which is consistent with national figures, according to the Census in 2011. In the parish of St. Ann, approximately 91% of the households report electricity as their main source of lighting, just slightly less that the national figure. Although access to electricity has increased over the previous census by 6%, the use of electricity in the project area is significantly below national and parish levels, at approximately 82% of the households. The use of kerosene as a source of lighting in the area is conversely higher than the national average, with the majority of such households located in Lluidas Vale, Bensonton and Gibraltar. See Table 5-45 for details related to the percentage households by source of lighting within the parishes of the project area.

Table 5-45: Percentage Household by Source of Lighting

Source of Lighting	Jamaica	St. Ann	St. Catherine	Clarendon	Project Area
Electricity	91.9	90.8	93.6	89.6	81.7
Kerosene	5.5	6.6	4	7.8	15.5
Other	0.8	1.2	0.6	0.9	1.4
Not Reported	1.8	1.4	1.8	1.7	1.4

Unlike the standards established nationally and at the parish level, where the majority households receive water from the National Water Commission (NWC), the majority of the household in the project area receive water from private sources. In Table 5-46 below, it can be seen that approximately 58% of the households in receive water from private sources, significantly exceeding the average numbers for the country. Spring or rivers, accounting for 12.2% of the households, provide water to more households than public sources piped into dwelling. Having water piped into dwelling or the yard is not very common in the communities in the project area, as indicated by the 10.4% and 2.3% of the households in the area. Piped water into dwelling in mostly prevalent in Moneague and Claremont while the more deprived communities such as Bensonton, Gibraltar, York Castle, Kellits and Lluidas Vale rely mostly on private catchments or springs. Figure 5-162 below illustrates the percentage households based on water piped into dwelling by communities within the project area. An example of the rainwater catchment located in the project area is shown in Figure 5-161 below.

Table 5-46: Percentage Household by Source of Water Supply

Source of Water		Jamaica	St. Ann	St. Catherine	Clarendon	Project Area
Public	Piped into Dwelling	49.7	38.9	63.5	36.6	10.4
	Piped into Yard	16.5	7.5	16.1	16.4	2.3
	Standpipe	7.1	5.2	1.8	11.6	5.0
	Catchment	2.2	2.8	0.9	2.1	5.4
Private	Piped into Dwelling	6.4	12.4	4.4	5.0	14.7
	Catchment	9.8	26.0	3.6	11.5	43.4
	Spring or River	3.0	3.5	3.1	7.7	12.2
	Trucked	2.1	1.0	3.7	4.1	1.3
	Other	1.8	1.7	1.6	3.8	3.8
	Not Reported	1.3	1.1	1.2	1.2	1.6

Table 5-47: Households by Method of Sewage Disposal

Community Name	Number of Households by Method of Sewage Disposal			
	Water Closet	Pit Latrine	No Facility	Not Reported
Moneague	340	160	2	40
Claremont	108	35	2	7
Bensonton	263	221	17	5
York Castle	138	114	2	17
Alderton	132	93	9	6
McNie	82	206	3	23
Gibraltar Moneague	302	296	9	8
Faith's Pen	71	8	1	4
Lluidas Vale	65	182	8	22
Ewarton	49	45	1	0
Kellits	74	169	1	7
TOTAL	1624	1529	55	139
PERCENTAGE TOTAL	**48.5**	**45.7**	**1.6**	**4.2**

Figure 5-161: Catchment in the Project Area

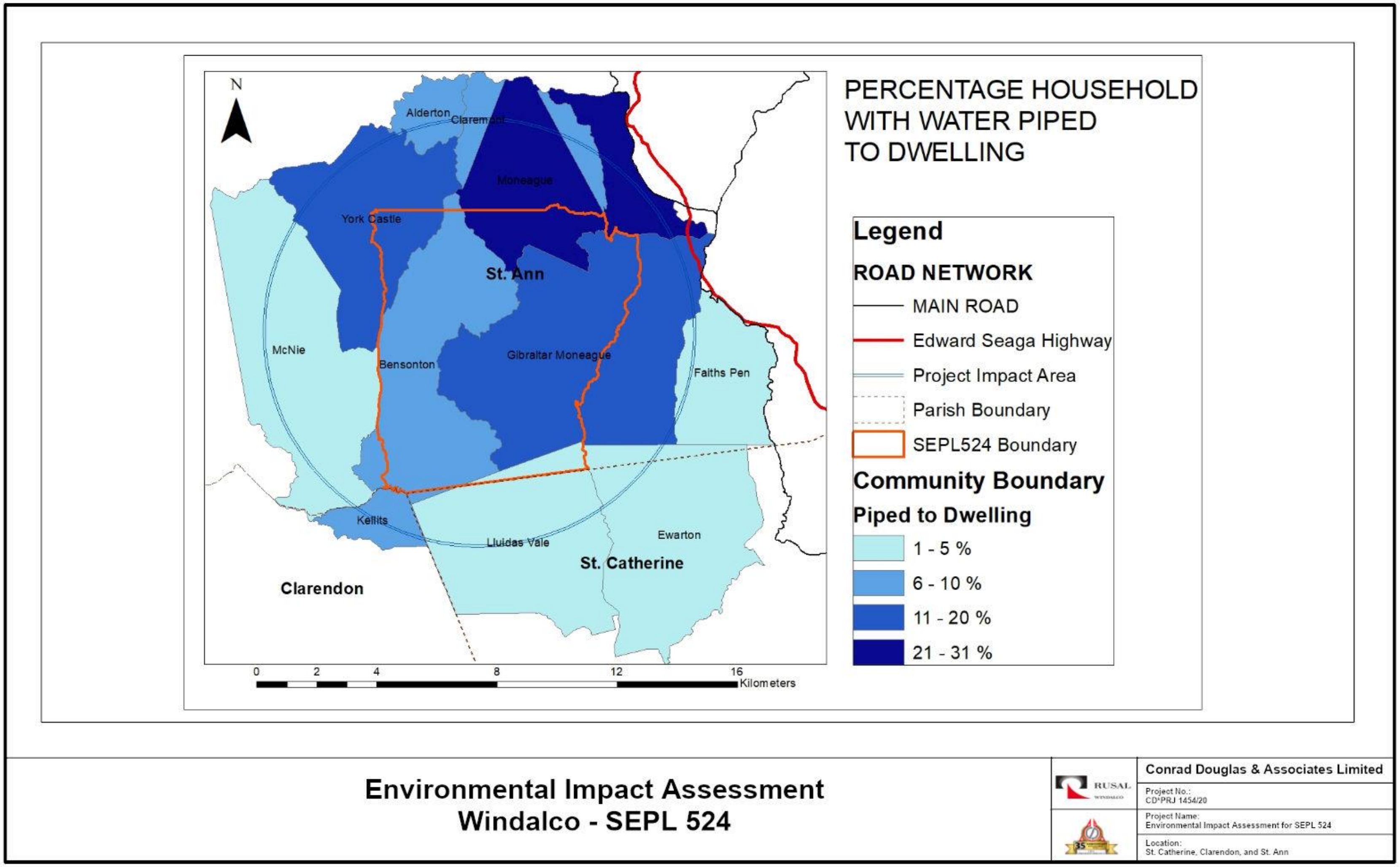


Figure 5-162: Percentage Household With Water Piped to Dwelling

The availability of waste disposal facilities in the project area is satisfactory. Only 1.6% of the households report having no access and 4.2% having not reported. Table 5-46 highlights the majority households using water closet as toilet facility, found mostly in Moneague, Gibraltar, Bensonton and York Castle. Pit Latrines dominate in the communities McNie, Kellits and Lluidas Vale.

5.6.7. Perception Survey

The primary objective of the survey is to gather information about the possible impacts and implications of the proposed SEPL 524 and bauxite mining operation local resources and livelihoods groups. This is expected to feed into informing the decision-making process regarding to minimizing impacts and, where possible, proposing alternatives. In keeping with maintaining the good community relations between the West Indies Alumina Company (WINDALCO) and the areas in which it operates, it was deemed necessary to sample the perspectives and concerns of the communities in and around the SEPL 524. To this end, communities were identified and surveyed in July 2020. Socio-economic data collection was done over a period of seven (7) days.

Table 5-48: Sample Survey Population

Parish	ED Communities	Population	Sample Population (1.50%)
St. Ann	Moneague	1747	26
	Claremont	512	8
	Bensonton	1961	29
	York Castle	935	14
	Alderton	786	12
	McNie	1276	19
	Gibraltar Moneague	1806	27
	Faith's Pen	318	5
St. Catherine	Lluidas Vale	654	10
	Ewarton	287	4
Clarendon	Kellits	839	13
TOTAL		**11121**	**167**

The SEPL 524 is in parish of St. Ann with the proposed project impact area includes also straddling the parishes of St. Catherine and Clarendon. Table 5-48 above indicates the communities that constitute the project impact area, which includes communities with a history of (and familiarity with) bauxite mining operations such as Ewarton, Gibraltar and Moneague. The survey population was devised from a 1.5% sample of the total population within the area according to the 2011 Population Census. A total of 167 surveys were conducted in the Enumeration Districts (EDs) as outlined by STATIN, which were within and on the periphery of the project site (See Table 5-41 above). The selection of the areas for interviewing was based on EDs as defined by STATIN.

5.6.7.1. Demographic & Social Profile

The respondent population is comprised predominantly of males, who account for approximately 52% of the persons interviewed, while females make up 47%. There were more males interviewed than females, which is a reflection of the high male to female ratio observed in the project area. The male to female ratio of the respondent population is approximately 110%, where there 110 males to every 100 females respondents. The age structure of the respondent population is also consistent with the demographic profile the area. Table 5-49 below shows that the majority of the persons interviewed belong to the economically active age groups between 20 and 59 years of age. Very few persons under the age of 20 years of age were interviewed, while person aged 60 years or more accounted for only 7.7% of the respondents. Most of the persons interviewed are aged 20-39 years (34%) and 40-49 years (27%).

Table 5-49: Respondent Population by Age Group and Community

Parameter	Community											Total
Age range	Moneague	Claremont	Bensonton	York Castle	Alderton	McNie	Gibraltar Moneague	Faith' s Pen	Ewarton	Lluidas Vale	Kellits	
Under 20	1	0	3	0	0	1	1	0	0	1	0	7
20 - 39	9	1	13	5	2	6	8	3	0	6	4	57
40 - 49	8	5	6	0	1	5	9	1	1	3	6	45

Parameter	Community											Total
Age range	Moneague	Claremont	Bensonton	York Castle	Alderton	McNie	Gibraltar	Moneague Faith's Pen	Ewarton	Lluidas Vale	Kellits	
50 - 59	4	2	3	6	7	6	7	0	0	0	3	38
60 & Over	2	0	1	3	2	1	1	0	3	0	0	13
Not Stated	3	0	3	0	0	0	1	0	0	0	0	7
Total	**27**	**8**	**29**	**14**	**12**	**19**	**27**	**4**	**4**	**10**	**13**	**167**

Educational attainment among the respondent population is illustrated in Figure 5-163. Only a very small number of respondents indicated not having any formal education. The majority of the person interviewed, approximately 60% of the have at completed secondary level education. Vocational and primary level education is found among relatively the same number of individuals, while tertiary education is the least popular among respondents.

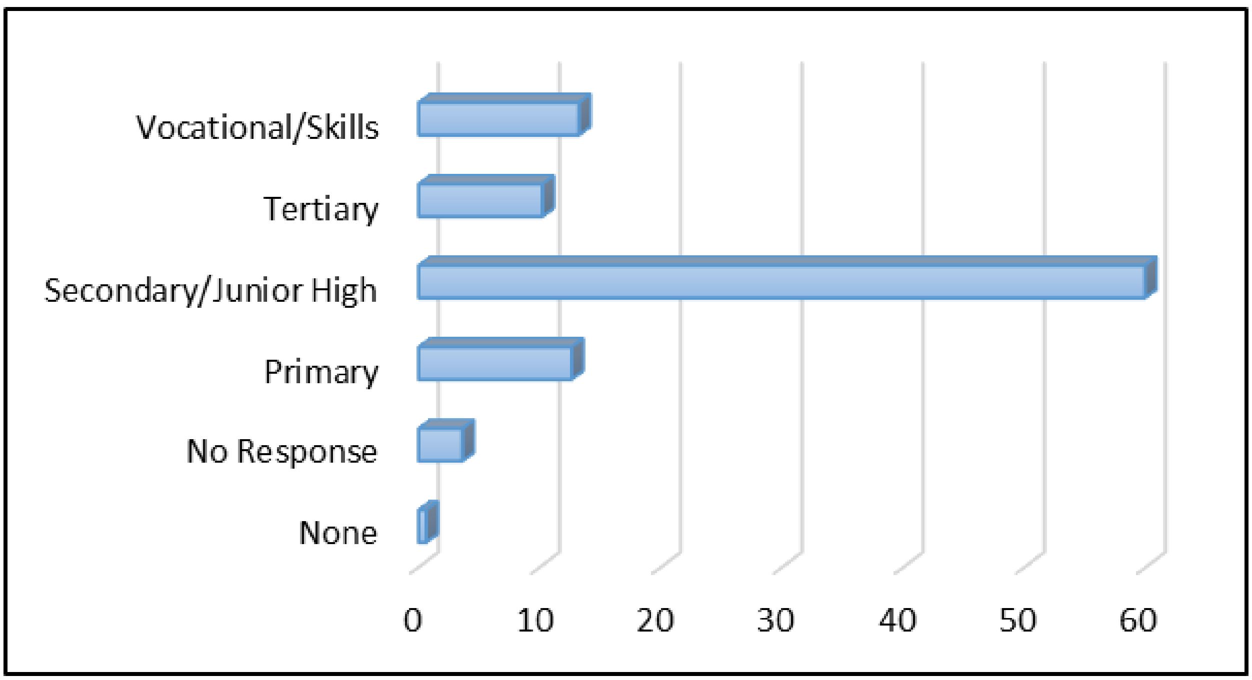


Figure 5-163: Percentage Respondent Population by Level of Education

The respondents have suggested that the majority are currently in employment, with 42% being self-employed and another 29% having full-time employment. Figure 5-164 below shows the respondent population by employment status. While 5% of the respondents gave no response, it can be deduced that these persons account for those who are unemployed. A total of nine (9) persons confirmed not having a job. Farming dominates the occupation landscape in the area, accounting for 35% of the respondents. Other self-employed occupations cited frequently amongst respondents include taxi operator, mason, mechanic and shop owner/keeper. Police officer, nurse, accountant are among the full-time employment occupation listed by respondents.

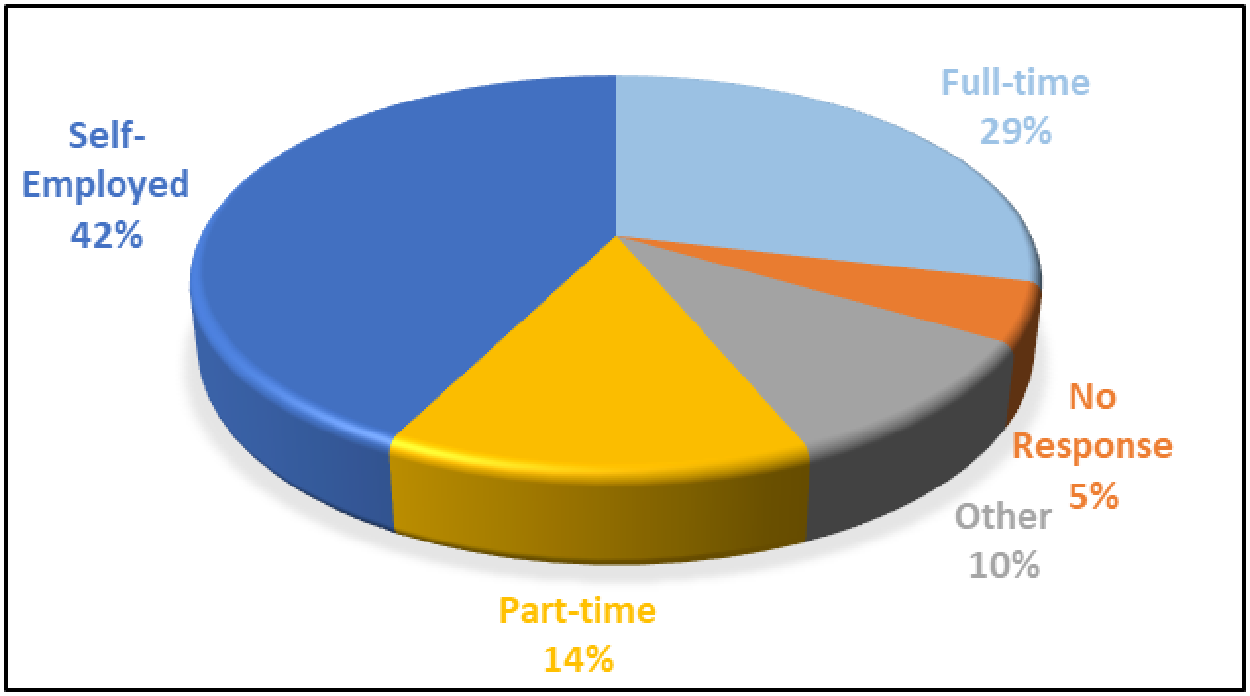


Figure 5-164: Respondent Population by Employment Status

The majority of the respondents opted not to provide information regarding their monthly income. Figure 5-165 below shows the income reported by the respondent population and highlights that most the persons interviewed earn a monthly income of less than J$50,000.00. Only 5 % of the respondents earn more than J$100,000.00 on a monthly basis.

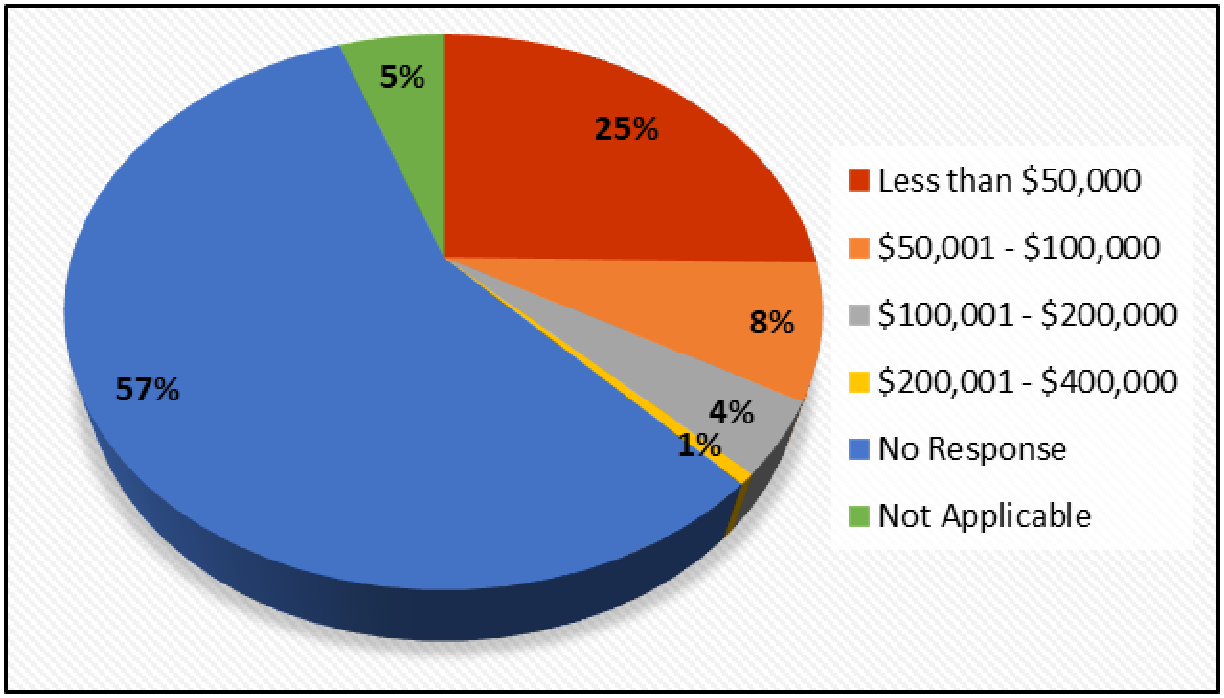


Figure 5-165: Respondent Population by Monthly Income

Most of the respondents live in male-headed households as indicated by 53% of the persons interviewed, most of whom were the household heads themselves. Figure 5-166 displays the head of households by gender. A total of one hundred and fifteen (115) individuals (69%), identified themselves as the head of the household. Of the females interviewed, 63% are the head of household, while 75% of the male respondents are the head of the household. It appears that there are more male–headed households with household sizes of 1-2 persons and those with 9+ individuals are most common among households comprising of four and five individuals were the most dominant in the area. According to Figure 5-167, the household sizes in the project area range from one individual to as much as nine individuals.

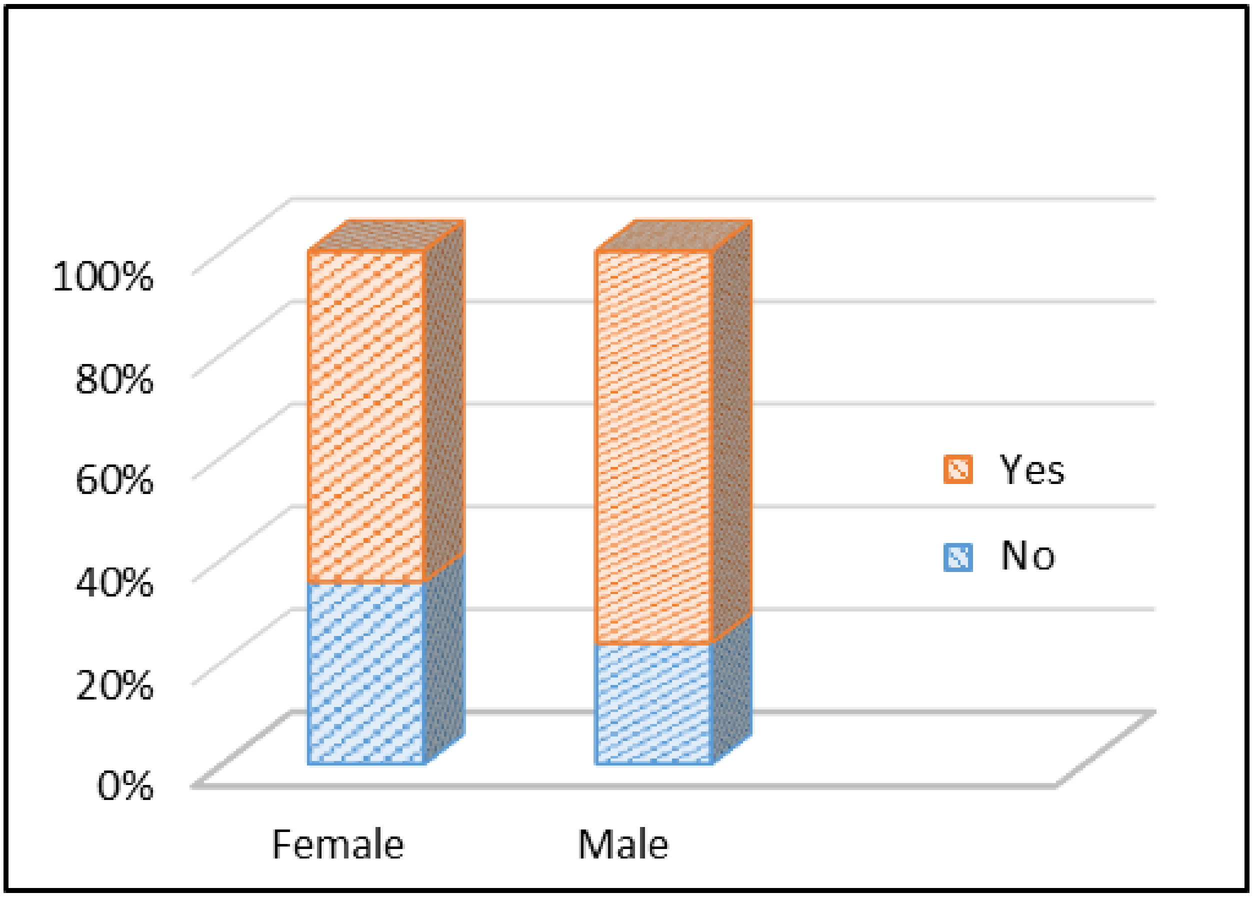


Figure 5-166: Head Of Household By Gender

While the majority of the respondents (39%) live in households of 3-4 persons, there are many smaller household with two persons or less which account for 26% of the persons interviewed. Large households are not common based on the minimal number of respondents in household larger than four persons. Only 22% of the respondents love in households of 5-6 people, while approximately 12% occupy households exceeding 6 persons.

Home ownership is high among the respondent population with the majority (67%) indicating that they owned the property while rental properties, the second most popular, accounted for 19%. Table 5-50 below displays the housing tenure by communities. What is obvious is that communities such as Moneague and Bensonton recorded the largest number of homeowners, but the percentage of home ownership among respondents was highest in Faith's Pen (100%), York Castle (93%), McNie and Kellits. Rented housing was most common among residents of Moneague and Gibraltar, both of which are the popular areas for lease properties as well.

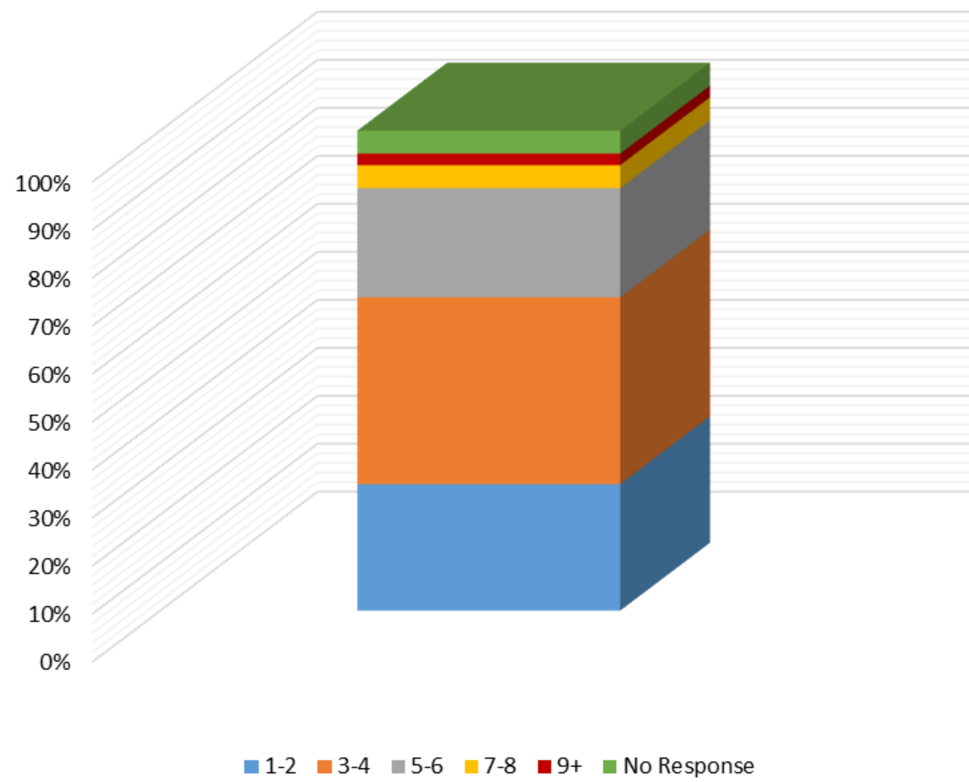


Figure 5-167: Respondent Population by Household Size

Table 5-50: Property Tenure by Community

Community	Property Tenure				
	Lease	No Response	Own	Other	Rent
Alderton	0	1	8	0	3
Bensonton	0	2	15	11	1
Claremont	0	0	6	0	2
Ewarton	0	0	3	0	1
Faith's Pen	0	0	4	0	0
Gibraltar	6	0	13	0	8
Kellits	0	0	10	0	3

Community	Property Tenure				
	Lease	No Response	Own	Other	Rent
Lluidas Vale	0	2	7	0	1
Moneague	1	0	17	0	9
McNie	0	0	15	0	4
York Castle	0	1	13	0	0
TOTAL	**7**	**6**	**111**	**11**	**32**

According to Figure 5-168, indoor tap and rainwater (tank/drum), are the most common sources of water among the respondent population. Although most resident indicated multiple water sources, indoor tap and rainwater is used by 41% of the survey population. Trucked water is the next most popular water source, followed by spring, outdoor private and public standpipe in descending order.

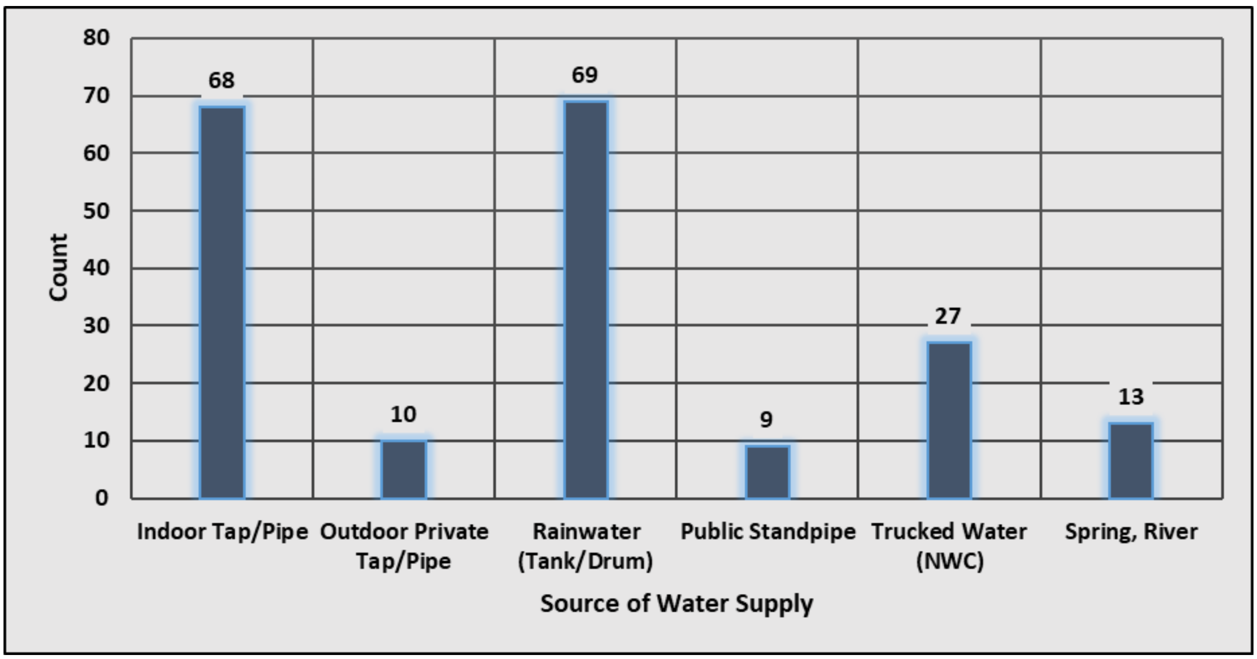


Figure 5-168: Source of Water Supply

Any relationship between water sources and the quality and reliability of water in the communities can be observed by correlating and analyzing the location of the respondents and their assessment of the water in their community. Residents were asked to rank their water quality and reliability on a scale of 1 to 5, where 1 is very poor and 5 is excellent. Figure 5-169 and Figure 5-170 below illustrates spatial the variations in the perception of water quality and reliability among the respondents. In Bensonton for example, where all of the respondents' source of water is rainwater (tank/drum), there is a high level of dissatisfaction with water quality. Sixty-nine percent (69%) of the respondents rank water quality in the area as either poor or very poor. High levels of dissatisfaction with water quality also exists in Gibraltar and McNie. McNie also has the greatest level of dissatisfaction with the reliability of water among the respondents, with 79%, followed by Gibraltar with 44%. The highest level of satisfaction is expressed by residents of Alderton (100%), Lluidas Vale (100% and Moneague (74%). These communities also seem to enjoy the most reliable supply of water, with Alderton maintaining its 100% satisfaction rating among the respondents. Drought conditions, the unreliable nature of rainfall and extent of treatment (too much chlorine, or none at all) are among reasons given for poor ratings for water in the area.

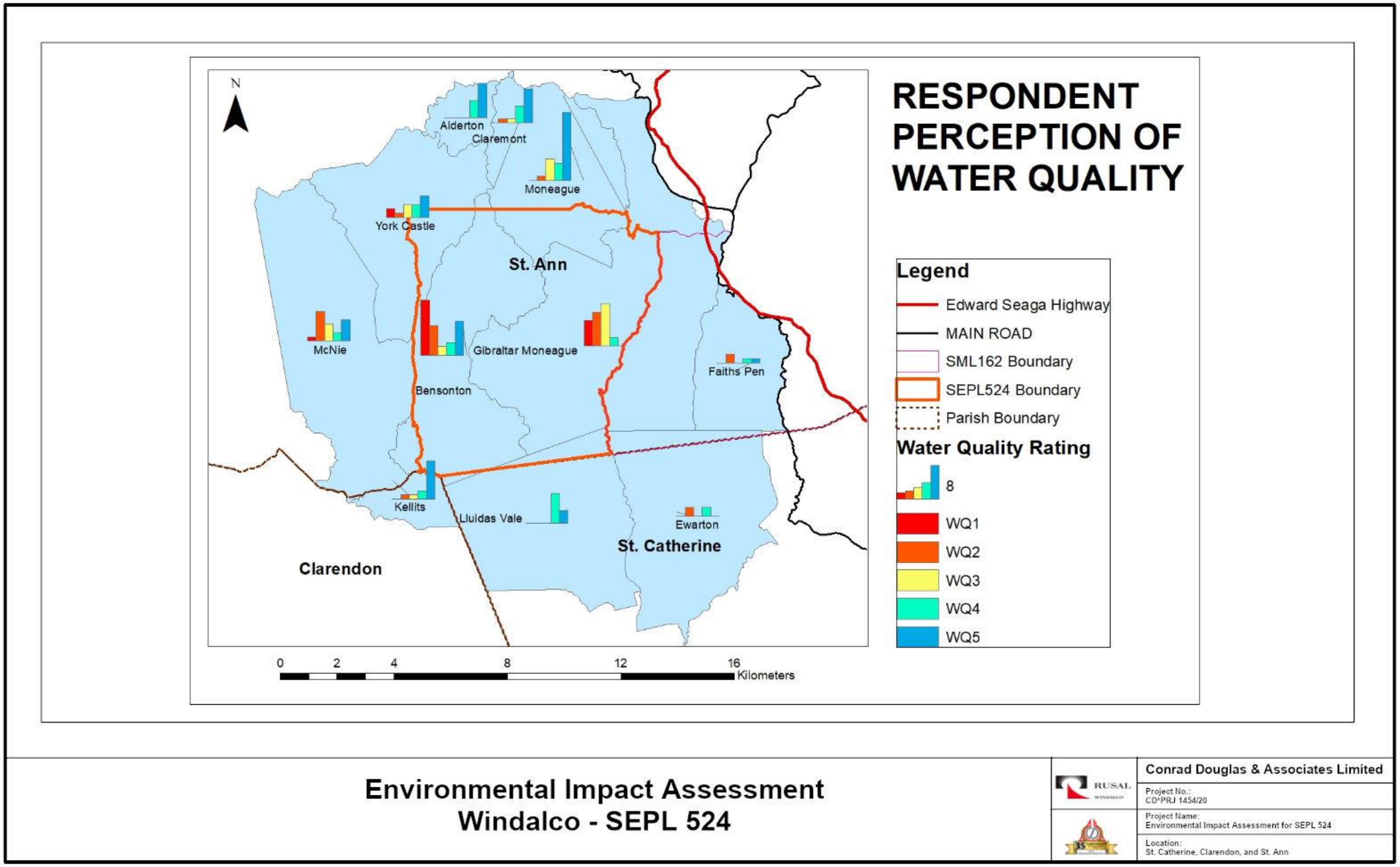


Figure 5-169: Respondent Perception of Water Quality

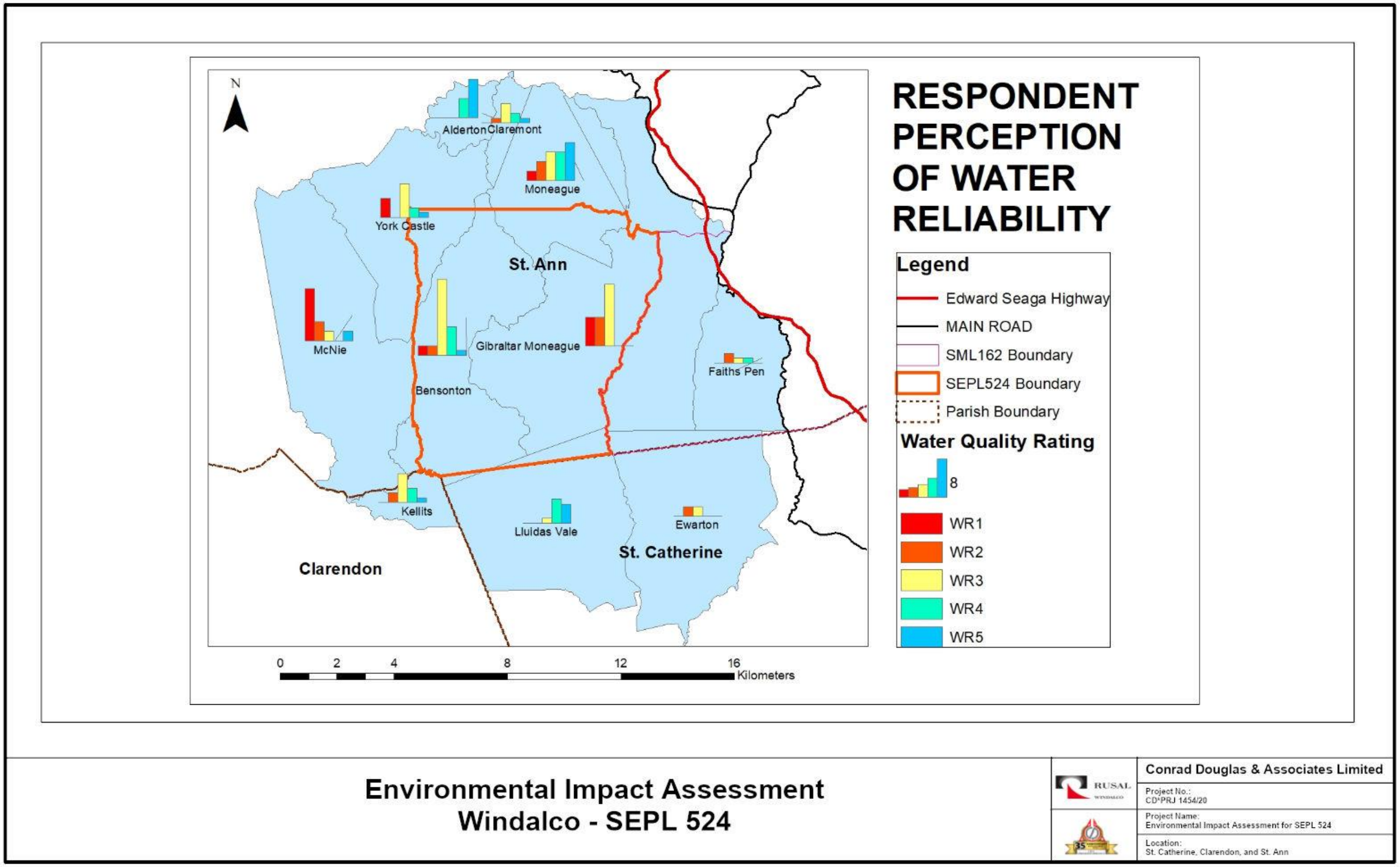


Figure 5-170: Respondent Perception of Water Reliability

Access to electricity is highly satisfactory in the project area, with 99% of the respondents having electricity as the main source of lighting. The few exceptions were residents of Alderton and York Castle and indicated candles and kerosene and their lighting source.

5.6.7.2. Community Attributes

Based on the feedback from respondents, it would be fair to say the communities that make up the project area is a safe, friendly and aesthetically pleasing place to live. When asked about their community likes and dislikes, the respondents were able to give multiple responses which are summarized in Figure 5-171 below. The majority of the respondents (82%) echoed the lack of crime as a favoured attribute of the community, which was further reinforced by the few (2%) who suggested it was an issue. The availability of farmland acknowledged mostly by respondents from Gibraltar, Alderton and York Castle, was the least popular of the liked community attributed at 41%. The poor conditions of the roads and lack of employment opportunities were concerns resoundingly expressed by respondents. Unemployment was identified by 78% of the persons interviewed, while 75% alluded to the poor roads as community attributes that require attention. The lack of utilities was a distant third among the disliked attributes and was most popular among respondents from Gibraltar. Consequently, most respondents expressed desires to see the roads improve (59%) and more employment opportunities (53%). Additionally, it must be noted that among the desired community improvements noted by respondents were:

3. Improvement in the provision of services such as health care, water, internet (31%)
4. Sports and community facilities (11%)
5. Skills/vocational training opportunities (10%).

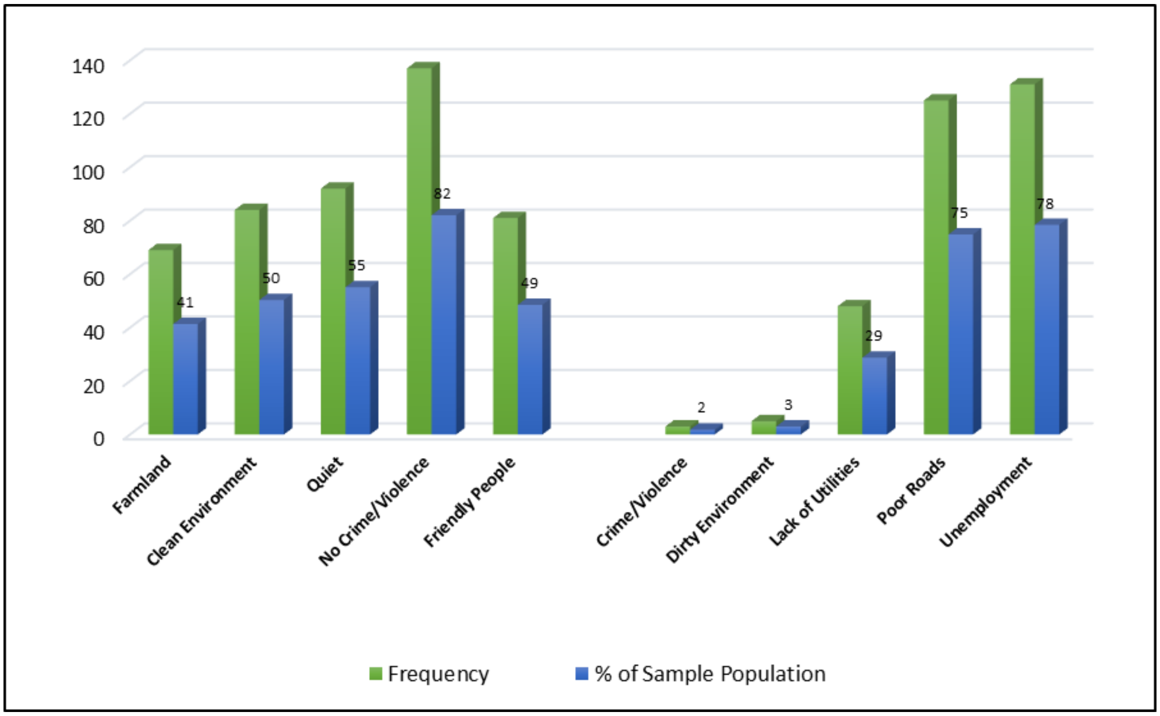


Figure 5-171: Community Attributes

There are mixed perceptions on traffic in the communities. Approximately 51% of the respondents contend that there is there is little to no traffic in the area while another 19% suggested that traffic was either heavy of very heavy. While concerns regarding traffic were expressed mainly by respondents from Moneague and Bensonton, traffic is most common in the morning, according to 75% of the respondents.

Use of the areas in close proximity to the SEPL 524 for livelihood purposes, with the exception of the established settlements, is limited to approximately 13% of the respondent population, all of whom use or lease land for farming (cattle, cash crops). Respondents identified specific areas in Bensonton, Penny, Drumily, Bamboo Pond, Grass Piece and lands owned by the Alumina Company.

5.6.7.3. Knowledge, Attitudes and Perceptions towards Proposed Development

Just over half of the respondent population (55%) expressed prior knowledge of plans to mine bauxite in the SEPL 524, mainly through interactions with community members (29%)

and WINDALCO representative (19%). Figure 5-172 summarizes the respondents' attitude towards bauxite mining.

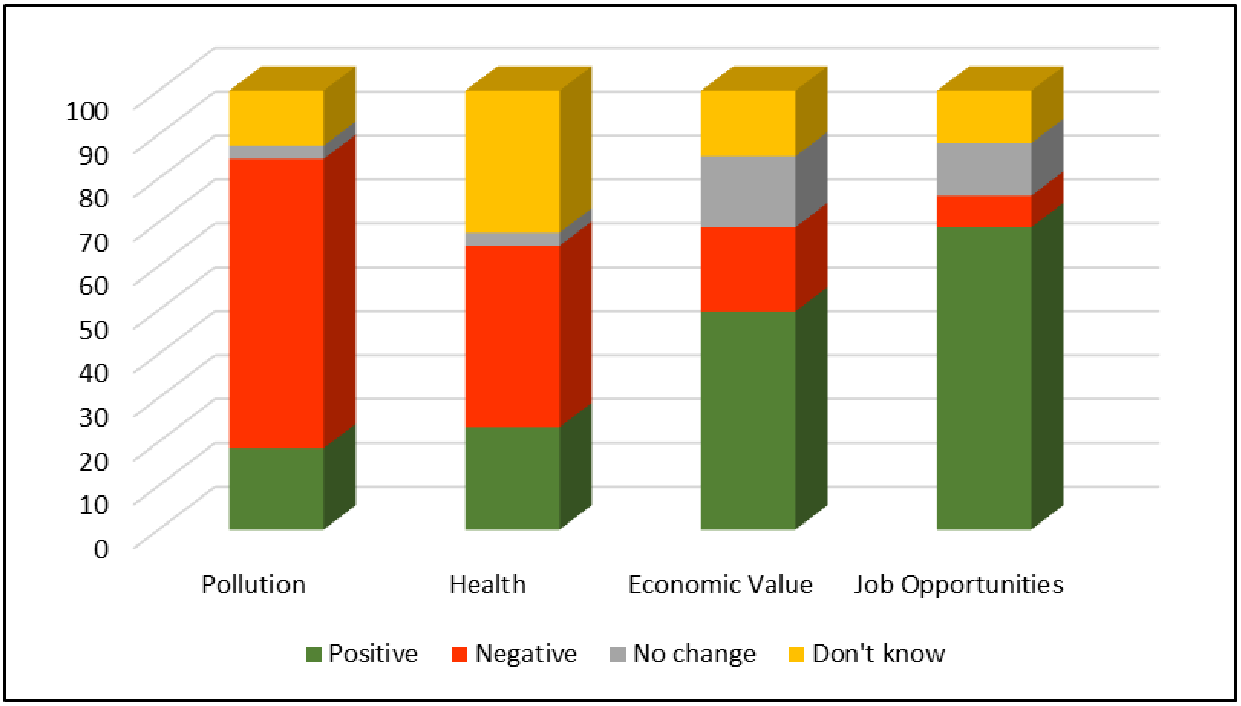


Figure 5-172: Attitude towards Bauxite Mining

There is positivity associated with bauxite mining due to perceived benefits associated with job opportunities (69%) and increased income/economic value within the community (50%). However, there are concerns among the residents which is illustrated by the high level of negative connotations levied at bauxite mining as it relates to pollution and the health of individuals. Sixty-six percent (66%) of the respondents feel that mining has negative impact of pollution compared to only 3% who feel it brings no change in this regard. Negative implications for health are echoed by 41% of the respondents.

The views on bauxite mining vary. There are persons who clearly stated that they "*have no problem with it*" (18%), supported by those citing potential benefits to the community and the economy. Conversely, there are those who specifically the quote impacts of dust and implications for health and respiratory illnesses (19%), supported by those with concerns for loss of farmland, water resources and damage to their houses.

Figure 5-173 below displays the perceived impacts of bauxite mining among respondents. The positive impacts that most respondents identified with are employment (68%) and increased government revenue (58%). Very few persons believe that mining will increase the value of the land or contribute to community projects. Most respondents (86%) believe that the proposed activity will lead to dust pollution, while just about half of the respondents fear serious health issues and destruction to farms. The loss of land resources and water pollution are also impacts anticipated by over 30% of the respondent population.

While the majority of respondents (40%) do not believe the project will affect them personally, there were 34% who were uncertain and another 26% lamented that they would be affected. The specific nature of how respondents would be personally affected are summarized below in Figure 5-174. Most persons, (51%), specifically indicated that they would be affected by health concerns citing respiratory illnesses such as asthma and sinusitis. These concerns can also be connected to the issue of dust, which was the next most popular personal impact identified. Eighteen percent (18%) of those who would be personally affected were farmers who use lands in the area for cattle of crop production. Property loss and damage was also mentioned.

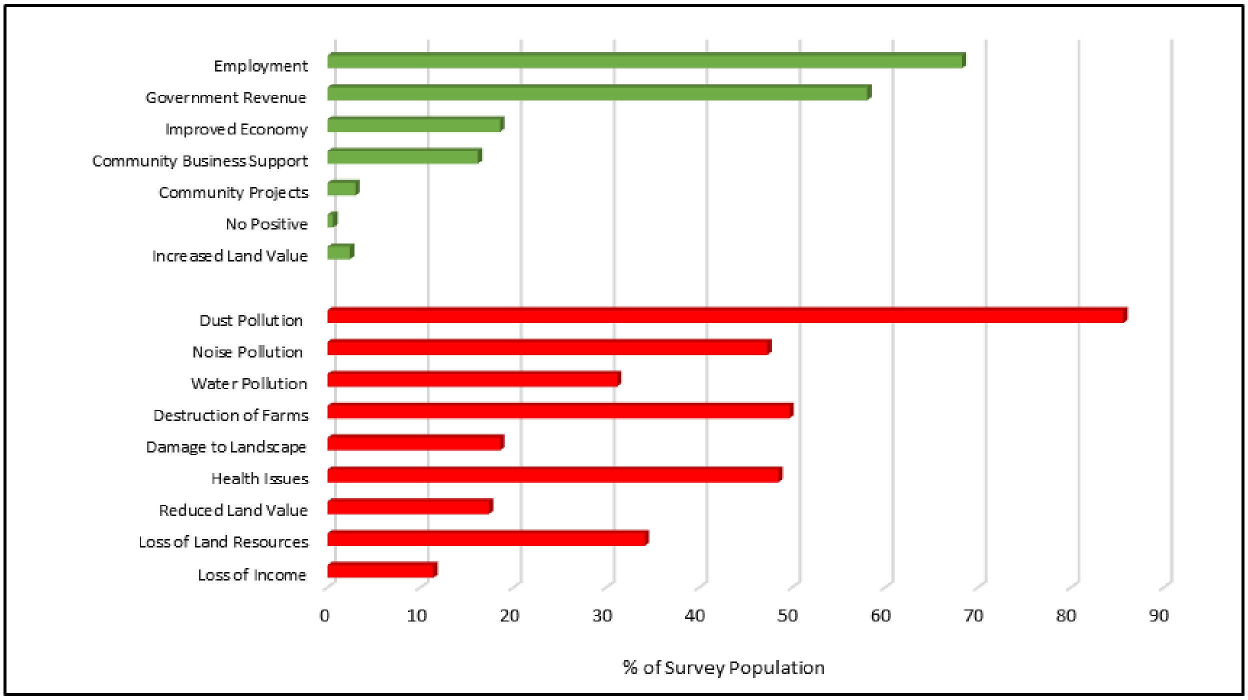


Figure 5-173: Perceived Impacts of Bauxite Mining

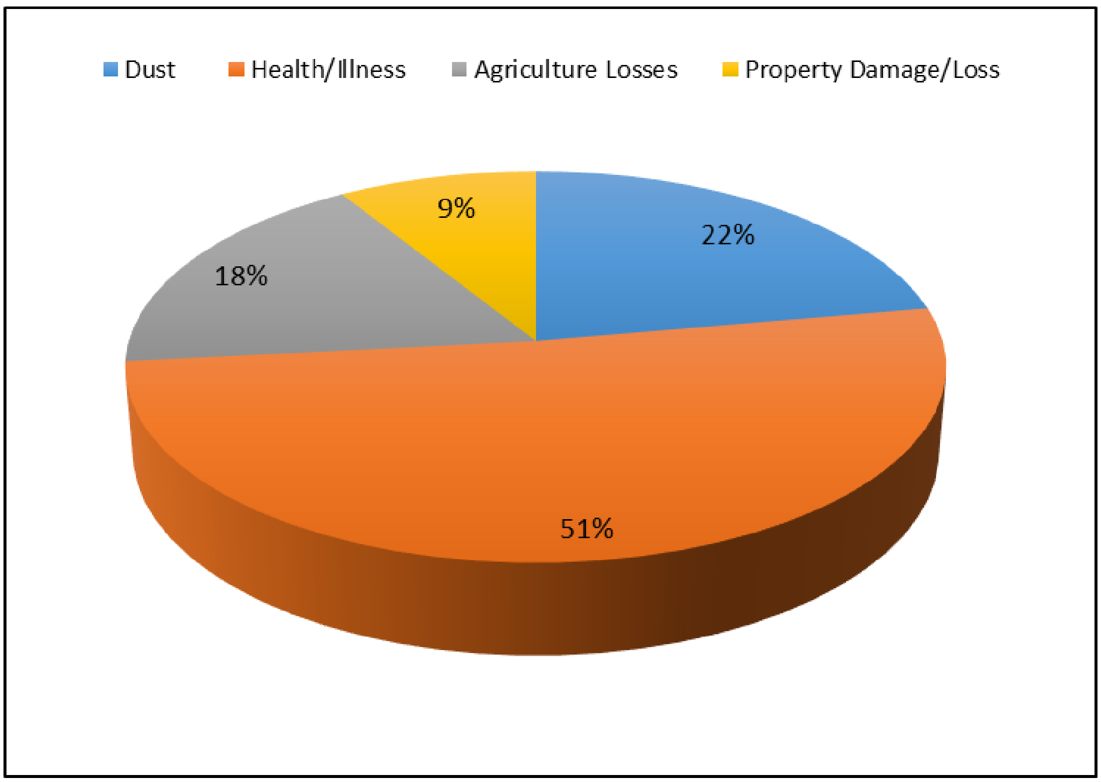


Figure 5-174: Personal Impacts of Bauxite Mining in SEPL 524

The impact on the community is more popular among respondents since more believe the project will affect the community. Thirty-nine percent (39%) of the population surveyed thinks that the proposed project will affect the community while only 20% believe it will not. These expectations are consistent with those mentioned above and is primarily concerned with health and loss of farmlands. The disparities in the perception of the residents towards the project and its significance is tangible. There is a bias in the beliefs of the residents that the project will be more beneficial to the national economy that than the local one. Table 10 highlights the importance rating given to the proposed project by the respondent population. It is apparent that most of the respondents believe the project is important to national development (61%) than those who think it is important to community development (42%). Respondents who gave the project the lowest score for community development (23%), is twice the number of those in the same category for national development and account for only 11% of the respondent population.

Table 5-51: Importance of Project to Community and National Development

RESPONDENT'S PERCEPTION OF THE IMPORTANCE OF PROJECT TO COMMUNITY DEVELOPMENT			
Parameters		**# OF RESPONDENTS**	**% SAMPLE**
IMPORTANCE RANKING	Not Important	38	22.8
	Somewhat Important	33	19.8
	Important	27	16.2
	Very Important	44	26.3
	No Response/Don't Know	25	15
	Total	**167**	**100**
RESPONDENT'S PERCEPTION OF THE IMPORTANCE OF PROJECT TO NATIONAL DEVELOPMENT			
Parameters		**# OF RESPONDENTS**	**% of SAMPLE**
IMPORTANCE RANKING	Not Important	19	11.4
	Somewhat Important	22	13.2
	Important	57	34
	Very Important	45	27
	No Response/Don't Know	24	14.4
	Total	**167**	**100**

To date, most of the respondents have not had any encounter with bauxite mining operations in the area. The majority, approximately 64%, indicated that they currently do not face any threat from the existing bauxite mining in the adjacent areas. It must be noted that all of these respondents were residents of the communities of Alderton, Bensonton, McNie, Kellits and Lluidas Vale which are furthest away from the existing mining lease area SML 162. Most of the respondents who have faced threats associated with bauxite mining operations in the area have indicated that dust is a major issue (18%), while damage to house and property (7%) and flooding (7%) were also identified. Respondents did, however, indicate that WINDALCO addresses such occurrences appropriately by providing compensation for damage and dust (64%). One third of the respondents also acknowledged the community support provided by Windalco through community sponsorships and education programs.

5.6.8. Identification of Potential Impacts

Table 5-52: Impact Matrix for Phases of Bauxite Mining Operation

Phase of Operation	Affected Area	NATURE OF IMPACTS: Direction		Scale		Location		Duration		Magnitude		Significance	
		Positive	Negative	Local	Regional	Direct	Indirect	Short	Long	Major	Minor	Large	Small
Vegetation Clearance	Employment	√			√	√		√			√	√	
	Livelihoods		√	√		√			√	√		√	
	Traffic		√			√		√			√		√
	Community Displacement		√		√	√			√	√		√	
	Public Health		√	√			√	√			√		√
	Historical Sites		√	√		√			√	√		√	
Mining Operation	Employment	√			√		√		√		√		√
	Livelihoods		√	√		√			√	√		√	
	Traffic		√		√	√			√		√		√
	Road Improvement	√		√			√		√	√		√	
	Dust		√		√	√			√	√		√	
	Noise		√	√		√		√			√		√
	Community Displacement		√		√	√			√	√		√	
	Public Health		√	√			√		√	√		√	
	Historical Sites		√	√		√			√	√		√	
Rehabilitation	Livelihoods	√		√			√		√	√		√	
	Services and Amenities	√		√			√		√	√		√	
	Public Health	√		√			√		√		√		√
	Community Displacement	√		√			√		√	√		√	

5.7. Land Use

5.7.1. Introduction

The assessment of the current land uses in the study area demanded a multi-faceted approach for collating land use information for the area. This included:

1. Review and analysis of aerial photographs,
2. Review and analysis of satellite imagery of the area dating 2020 (Google Earth),
3. Spatial analysis using Geographic Information System (GIS), and
4. The use of field surveys to incorporate regional observations and documentation of existing land use, while providing verification of land use patterns depicted on the maps.

An extensive area has been established as the project area of the proposed mining operations in SEPL 524. The area currently straddles three parishes, namely St. Ann, St. Catherine and Clarendon, in the rugged and hilly interior, adjacent to rural communities and existing bauxite mining operations of the Rusal Jamaica Limited (WINDALCO). This Land Use Study includes a description of the general land use and land cover in the area as well as an analysis of potential land use conflicts which may exist during the operational or rehabilitation phases of the proposed operation. Historical and current land use policy and plans for the area also provided context for discussion and analysis.

Land use was examined from a regional perspective with analysis of the area within the SEPL 524 and communities, which are adjacent to the proposed project area, as indicated on Figure 5-175 and Figure 5-176 below. The settlements within the project impact area fall within larger categories of communities which include Moneague, Gibraltar Moneague, Bensonton, McNie and Claremont in St. Ann. Lluidas Vale and Ewarton of St. Catherine and Kellits of Clarendon form the southern limits of the area. The smaller settlements within these communities include Pedro River, Spring Hill, Cedar Grove, New Hall, Friendship, Harmony Vale and Gravel Hill.

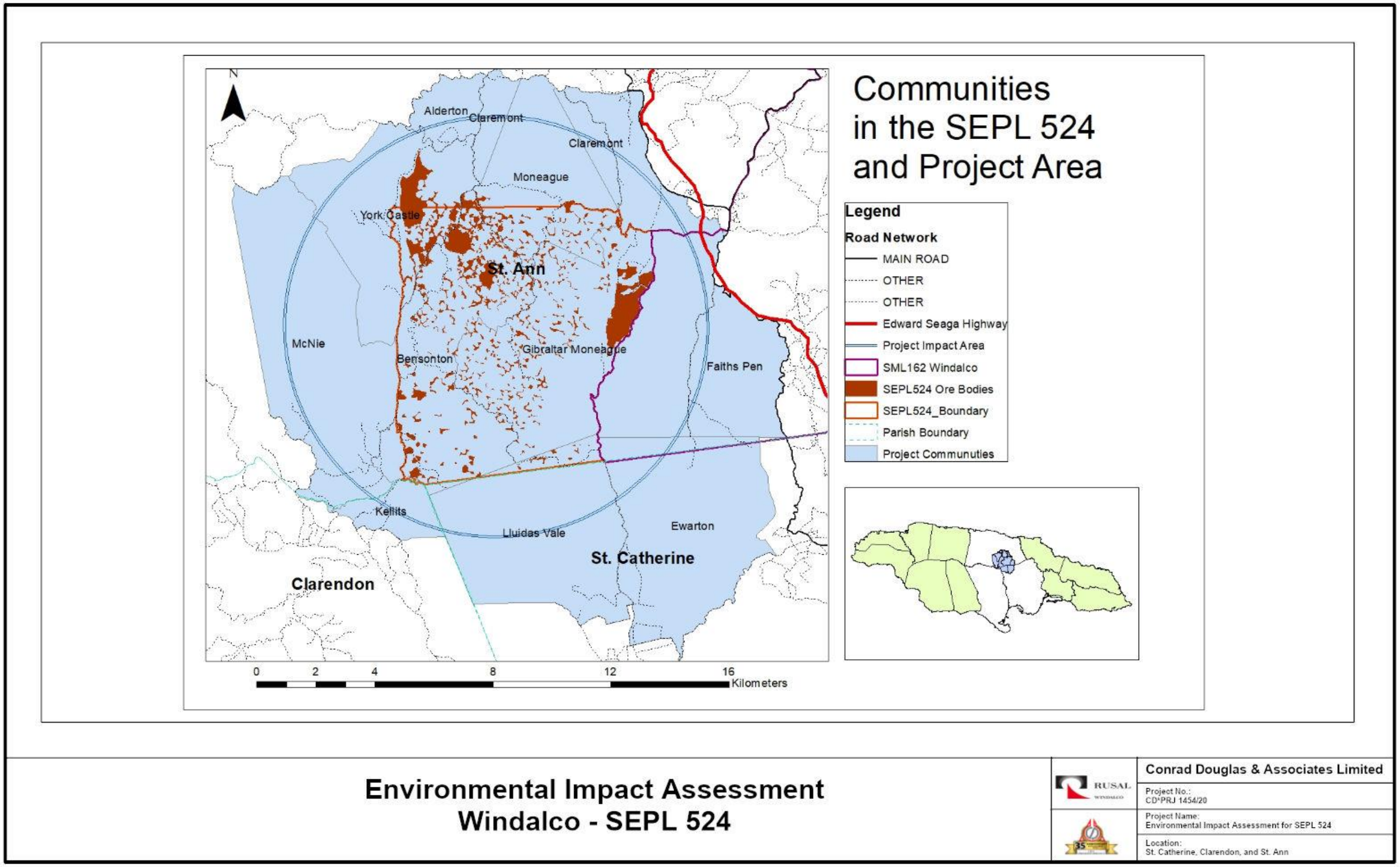


Figure 5-175: Communities in SEPL 524 and the Project Area

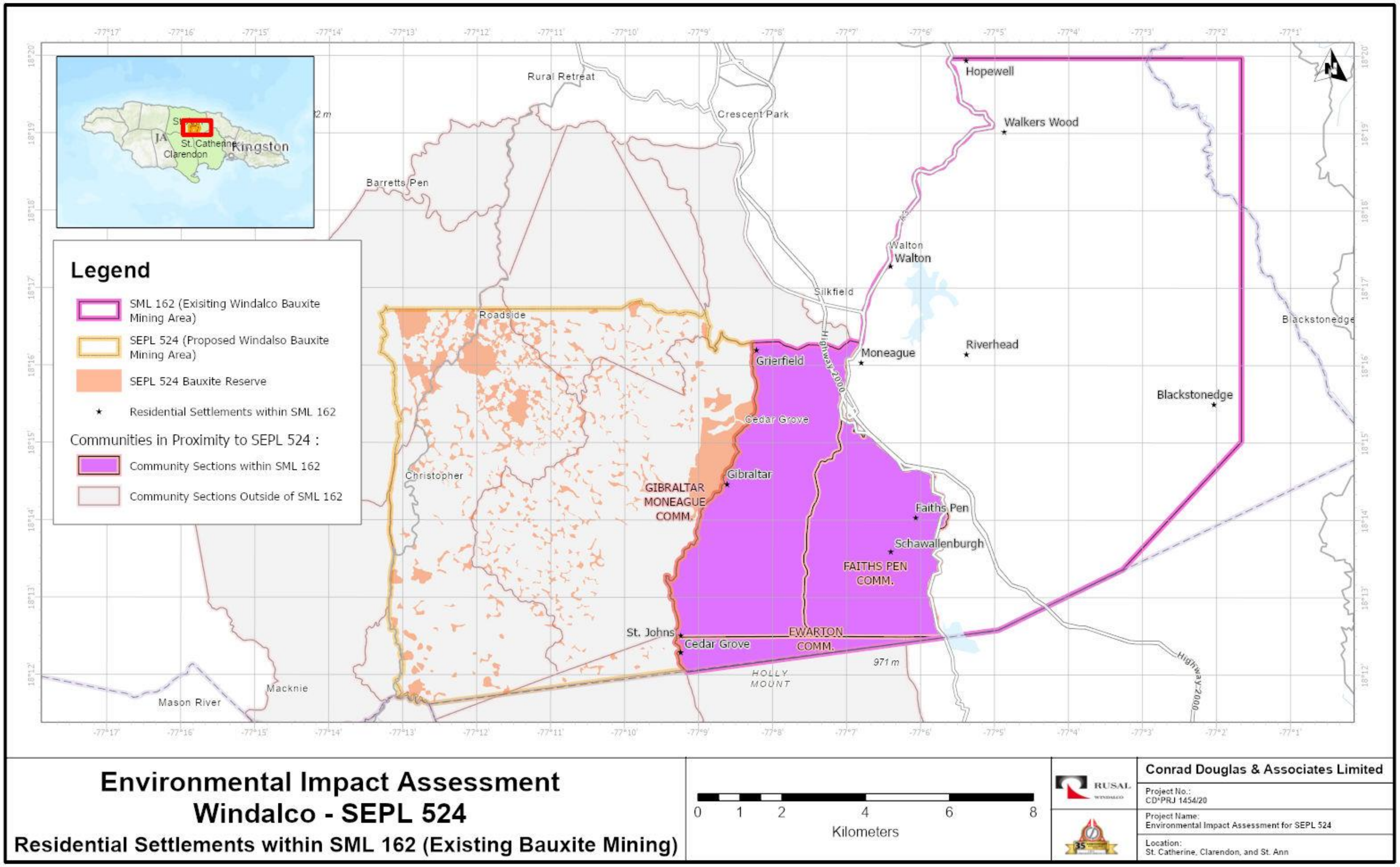


Figure 5-176: Residential Settlements in SEPL 524 and Project Area

5.7.2. Literature Review

5.7.2.1. Land Use Policy Overview

All the parishes which make up the study area are covered by a land use zoning and planning policy under Development Orders, which falls under the aegis of the Town and Country Planning Act. Each policy speaks to the terms and guidelines to which development in the respective parish must comply based on their own unique (and some shared) socio-economic and physical characteristics; but most importantly provides stipulations directly relevant to the proposed mining operations and the associated disturbance to conservation areas and potential changes to the existing settlement patterns.

5.7.2.1.1. St. Ann

The Town and Country Planning (St. Ann Parish) Confirmed Development Order, 2000 is the main policy governing planning and development in St. Ann. There are ten (10) Local Planning Areas (growth centres) established in the parish with Moneague and Claremont being the closest to SEPL 524 (See Figure 5-178). There are two (2) areas in the southern section that is zoned forestry/conservation. Additionally, a large section of the SEPL 524 area also falls within an area zoned as bauxite bearing deposits. Bauxite mining is not a new enterprise and is acknowledged as the primary industrial activity in St. Ann. Any downturn in the industry is viewed as having potential to result in significant negative effects on the lives of people and communities. As such, the Confirmed Development Order, 2000 (Government of Jamaica, 1999), establishes as a primary objective "*to guard lands of significant mineral wealth against encroachment by other uses or development which would prevent their exploitation*". Economic activity and the extent of bauxite mining activities in the area is further supported by the Development Order which encourages the diversification of the employment base and rural economy through the exploitation of mineral resources. The establishment and mining of Special Mining Lease Area (SML) 162 (See Figure 5-177) is testament to adherence to such a land use policy, with the area having been mined and operated by the WINDALCO over the past 20 years. Communities such as Schwallenburgh, Faiths Pen, Moneague, Unity Valley and Riverhead currently co-exist in and around past and current bauxite mines. With the addition of the Alumina Plant at Ewarton, this reflects parity with the policy objective of locating *“manufacturing establishments derived from mining as close to communities as is feasible so that they can reap the economic benefits”*.

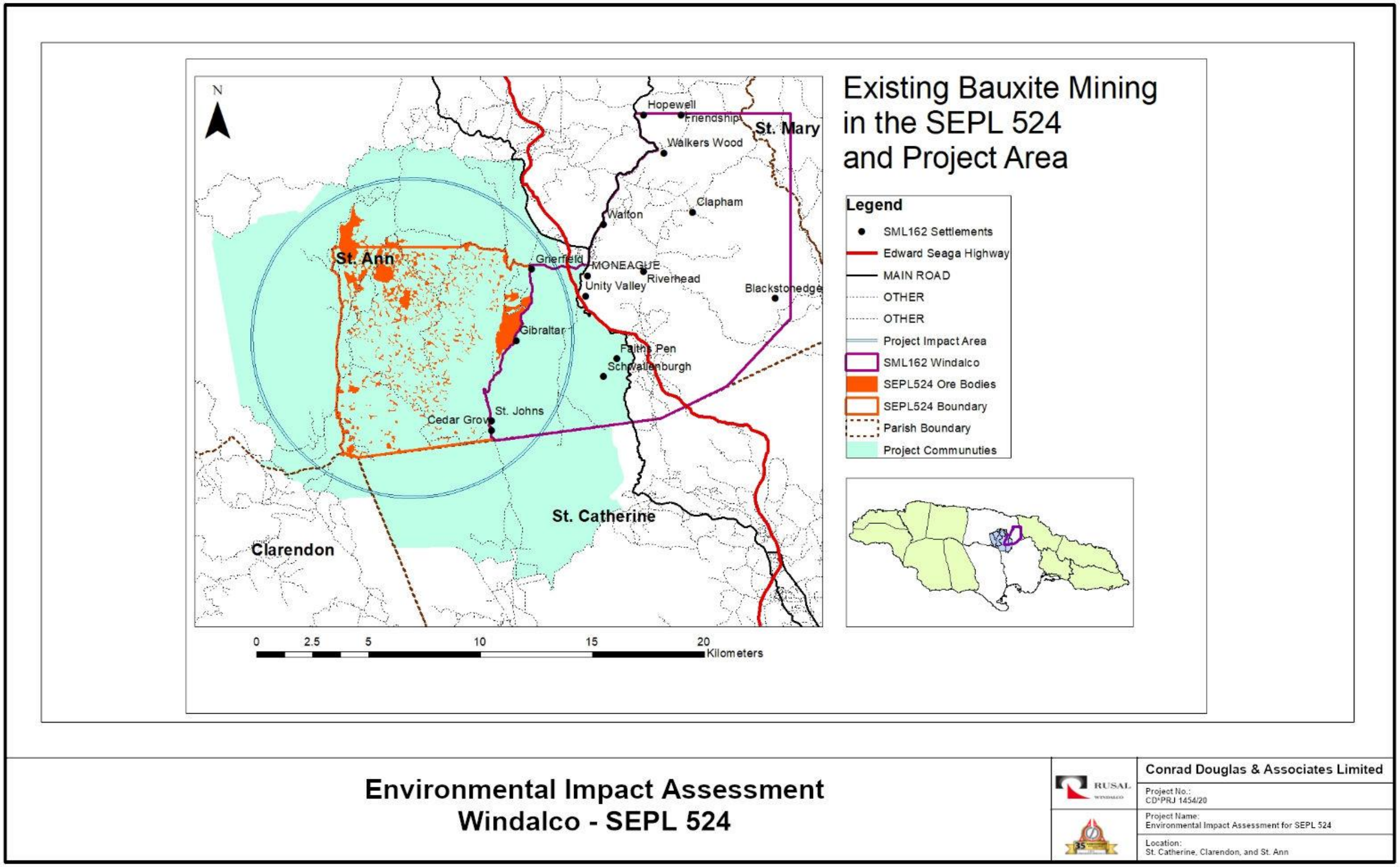


Figure 5-177: Existing Bauxite Mining in proximity to the Project Area

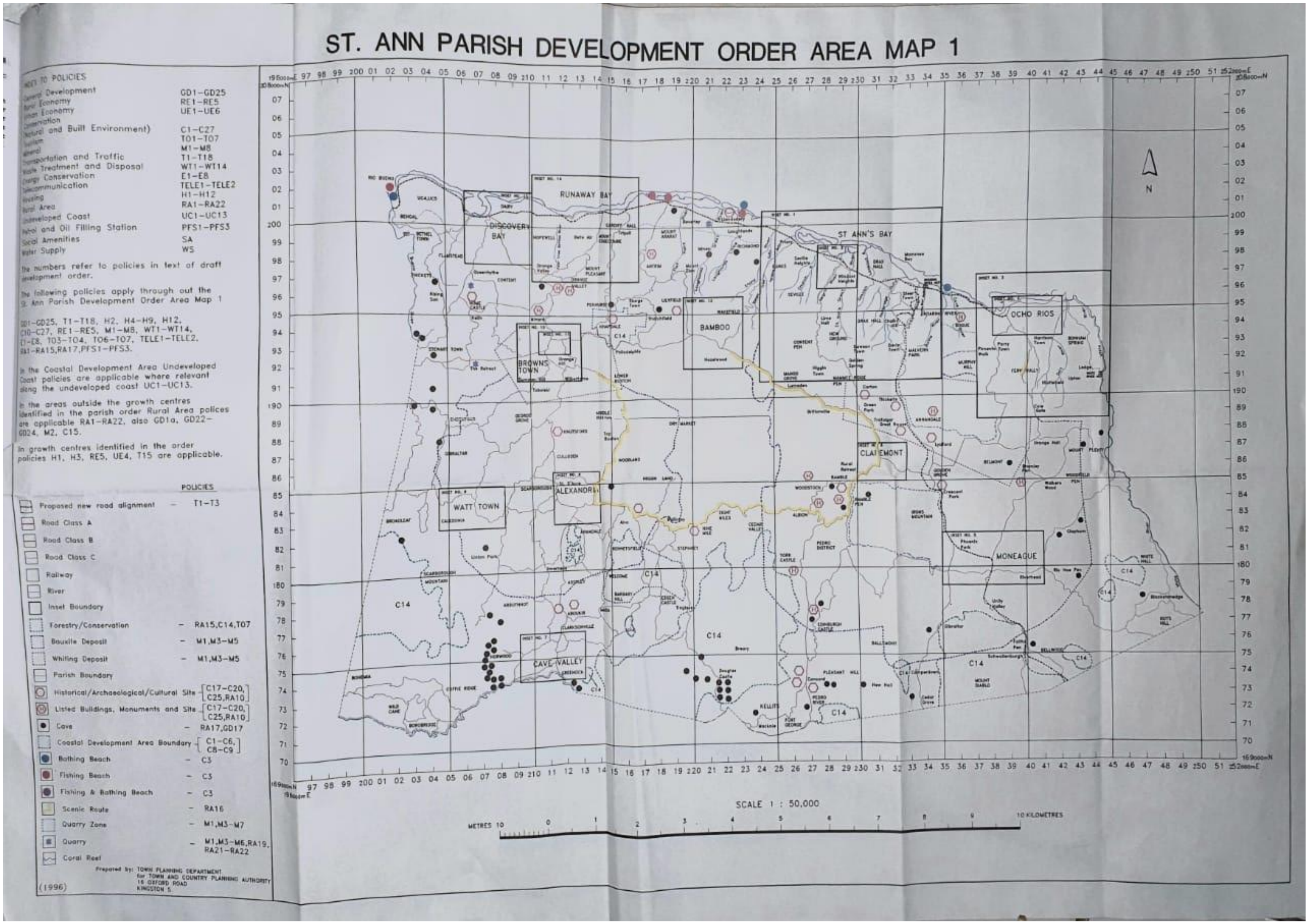


Figure 5-178: St. Ann Parish Development Order Map (Source: Town and Country Planning (St Ann Parish) Confirmed Development Order, 2000)

On the other hand, it is noted that among its (Government of Jamaica, 1999) aim is guarding "*against all forms of pollution resulting from mining activities.*" The policy seeks to preserve, to as much as is possible, agricultural lands by restricting the conversion of agricultural lands for use as mud lakes and stipulates that mined out areas must be properly restored and satisfactorily revegetated. Moreover, the policy seeks to "*protect the countryside and prevent the coalescence of existing towns and settlements*" and therefore encourages the resettlement in communities which already exist where communities have to be relocated because the land is needed for mining.

5.7.2.1.2. St. Catherine

Planning and development in St. Catherine is governed by the Town and Country Planning (St. Catherine) Confirmed Development Order, 2019, (Government of Jamaica, 2017b). The policy identifies Ewarton as a major urban centre in the parish and part of the Linstead-Bog Walk-Ewarton Growth Centre, which has experienced significant population growth between 1991 and 2011. Ewarton is the growth centre in closest proximity to SEPL 524. According to the policy, "*mineral resources should be protected from sterilization by urban and other development*" but also emphasizes the need for mineral extraction to be carried out in a sustainable manner. The Development Order acknowledges that the parish has been "*severely scarred*" by mining and denotes the importance of protecting natural areas with the designation of protected areas (Forest Reserves), two of which are located in the project impact area, namely, the Mount Diablo and Kellits-Camperdown Forest Reserves (see Figure 5-179). All points are consistent with the policy objectives which includes but is not limited to the following:

- ✓ To ensure that development is sensitive to the preservation of the major landscape and vegetation features of the development order area.
- ✓ To protect areas of high landscape and amenity value
- ✓ To ensure that the unique flora and fauna of the development order area are maintained and that the freshwater resources are protected from degradation
- ✓ To ensure that mining is undertaken in a way that will enhance rather than destroy the environment.

- ✓ To guard against all forms of pollution resulting from mining activities.
- ✓ To ensure minimal adverse effects on communities, the landscape, wildlife and habitats during mineral extraction.

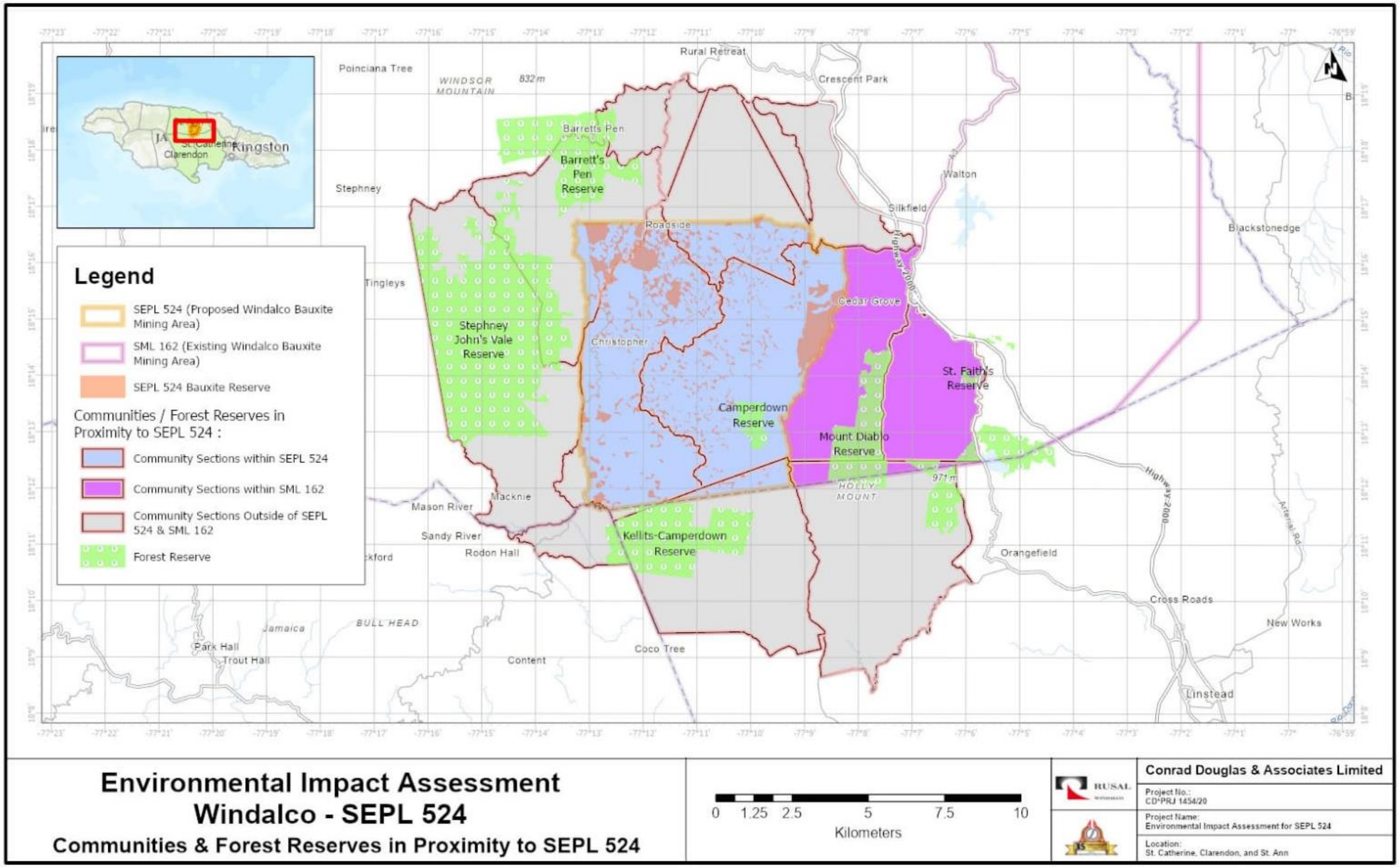


Figure 5-179: Conservation Areas in and in proximity to the SEPL 524 Project Area

5.7.2.1.3. Clarendon

The Kellits growth centre is the closest recognized by the Town and Country Planning (Clarendon) Confirmed Development Order, 2019 to the project impact area. Although the parish accounts for a very small portion of the project impact area, it is important to acknowledge the regulations governing land use in the parish. The Clarendon Development Orders reflects the national commitment to the conservation of the natural environment while sustainably maximizing any potential for mineral extraction. According to the Town and Country Planning (Clarendon) Confirmed Development Order, 2019 (Government of Jamaica, 2017a), the land use objectives includes, but is not limited to the following:

- ✓ To ensure that the unique flora and fauna of the parish are maintained.
- ✓ To preserve and develop recreation areas and green spaces.
- ✓ To support the replanting of forest for restoration of habitats, sustainable craft and industries, protection of water supplies and reduction in sediment transport and debris flow.
- ✓ To ensure that land uses are allocated in a manner which does not compromise the quality and quantity of usable water; and protects aquifers, wells, watersheds and other sources of water.
- ✓ To guard lands of significant mineral wealth against encroachment by other uses or development that would prevent their exploitation.
- ✓ To guard against all forms of pollution resulting from mining or quarrying activities, and to achieve satisfactory standards in the restoration of mined out lands.

5.7.2.2. Conservation Areas

According to Jamaica's Policy Framework for the National System of Protected Areas (1997) (National Environment and Planning Agency, 1997), a protected area is "*an area of land or water that is managed for the protection and maintenance of its ecological systems, biodiversity and/or specific natural, cultural or aesthetic resources.*" The four principal government agencies with powers and responsibilities for these areas are the National Environment and Planning Agency (NEPA), Forestry Department (FD), Jamaica National Heritage Trust (JNHT) and Fisheries Division (FD). Figure 5-180 below illustrates the protected areas in Jamaica and highlights the small area in which the proposed SEPL 524 is located. The protected areas with the project impact area are recognized as Forest Reserves, which according to the Forestry Act, 1996 is declared by the Minister to be established on either Crown land, or private land and "*may be used for conservation of naturally existing forests, establishment of forest plantations, generation of forest products, conservation of soil and water, recreation, and protection of flora and fauna.*" Those highlighted in Figure 5-180 below is shown is more detail in Figure 5-179 above, and like the project area, straddle the three parishes of St Ann, St. Catherine and Clarendon. It includes portions of the Stephney John's Vale Forest Reserve in St Ann, and both the Kellits-Camperdown Forest Reserve and the Mount Diablo Reserve. With the exception of the first, these areas are recognized by the St. Catherine Provisional Development Order (2017) (Government of Jamaica, 2017b) as important habitat for a number of endemic species and a major part of the water catchment system for the Rio Cobre and its tributaries, which is an important source for the residential water supply in the parish. The JNHT also holds interests in the SEPL 524 with the heritage site at Edinburgh Castle in the Pedro District near Drumily and currently have plans involving developing the site for organized tours.

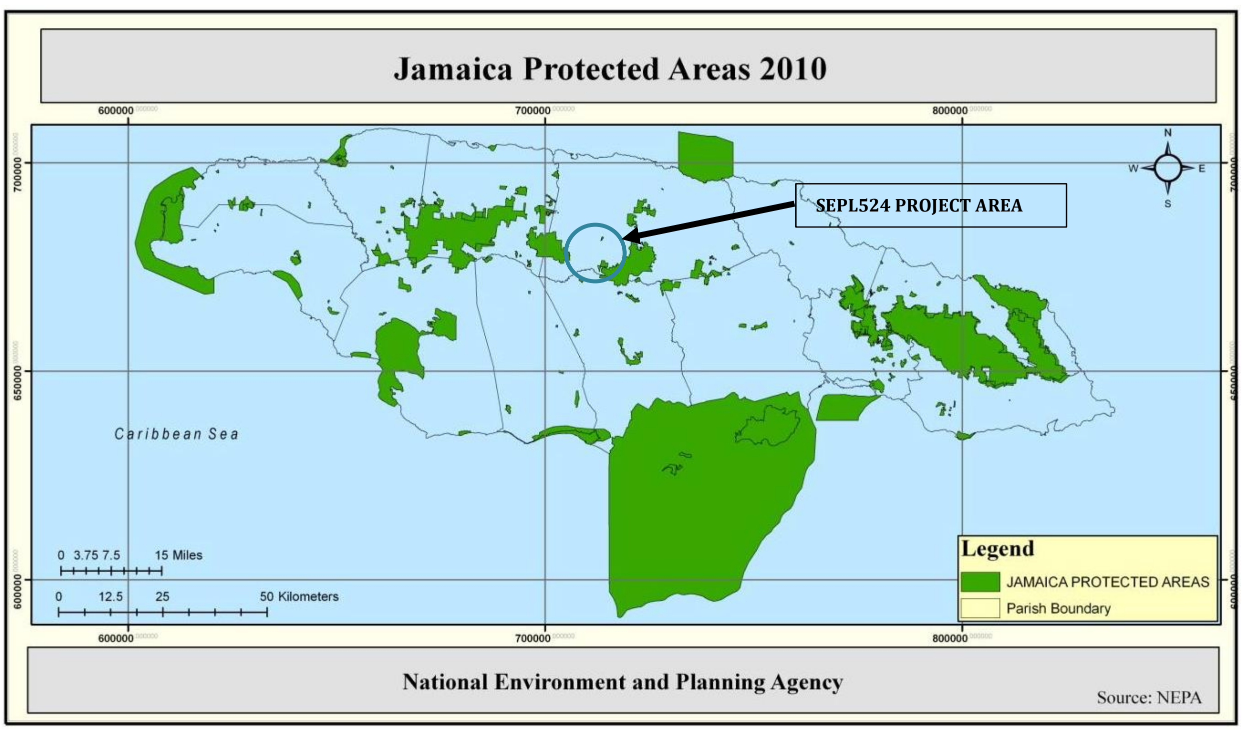


Figure 5-180: Jamaica Protected Areas 2010 (Source: *The National Environment & Planning Agency)*

5.7.2.3. Land Use: Overview, Conflicts & Solutions

As illustrated in Figure 5-181 below, the project impact area for SEPL 524 is dominated by forest. According to the National Forest Management and Conservation Plan (2017) (Forestry Department, 2017), the area is comprised mainly of closed and disturbed broadleaf forest, with the latter accounting for a larger area. This is consistent with the forest distribution nationally where 59% is classified as broadleaf forest, which comprised closed broadleaf (19%) and disturbed broadleaf (40%) forests (Forestry Department, 2017). Generally, within the SEPL 524 area, the forested areas are seconded by cattle ranches or pastures which have since been abandoned or converted and interspersed with housing and subsistence farming. Residential areas exist predominantly in a linear pattern along roadways and with the exception of Moneague, Alderton and York Castle, exhibit limited signs of nucleation.

The Forestry Department in their 2017 report (Forestry Department, 2017) suggests that the destruction of forests by the mining industry is a case of great concern to the people of Jamaica because bauxite mining and associated access development are currently the most significant agents of deforestation in the country. The report suggests that much of the forestry resources occurs in the limestone areas adjacent to bauxite deposits and disturbed by road developed for pit access. The report however, indicates that while the reclamation of pits is legally required, the presence of the haul road provides access to forest resources that were once inaccessible and this presents additional potential for degradation, afforded by increased access via haul roads and this does presents a challenge. The Forestry Department has identified two strategies for ameliorating this situation:

6. Mining lessees are already required by law to remove trees only subject to the direction of the Conservator of Forests.

7. A no-net-loss policy will be vigorously applied. Where destruction of forest is unavoidable, the industry should compensate the loss by reforesting an equivalent area elsewhere. The restoration may be undertaken directly by the industry, or be financed by the industry through another party.

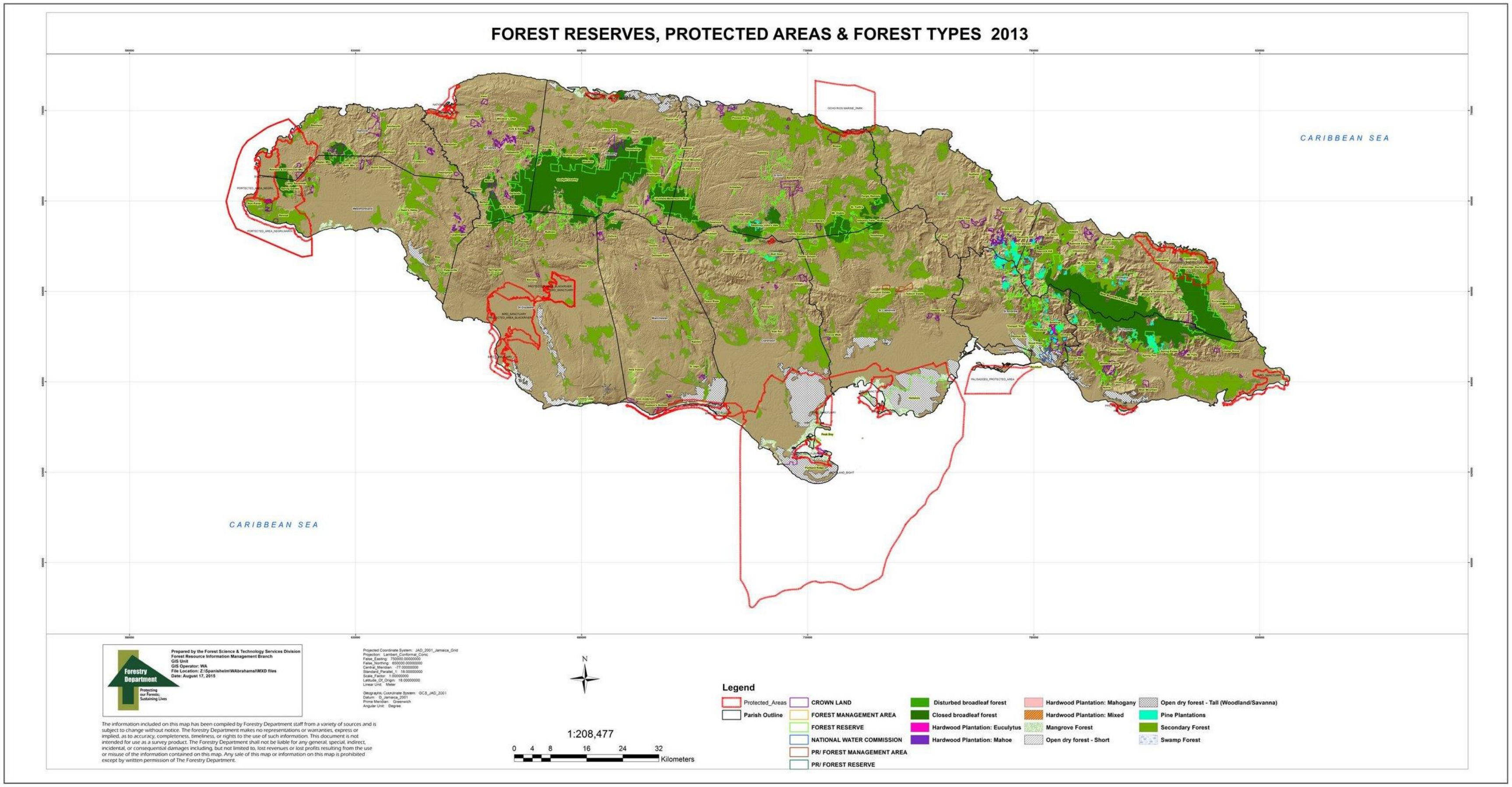


Figure 5-181: Forest Reserves, Protected Areas & Forest Types, 2013. (Source: *Forestry Department*)

Another popular area of concern noted as a source of conflict is the relocation of residents and/or settlements. However, in reality, in most cases the policy on resettlement focuses on land vendors or owners remaining, rather than moving away from their communities. Such examples exist west of the SEPL 524 with the development of recent subdivisions built at nearby Hyde Park and Friendship Cottage on mined out lands in the mining areas of the Noranda Jamaica Bauxite Partners II (NJBP II). Additionally, (Nieta, 2019) noted in the Jamaica Observer, that lands are leased for mining (after receiving approval from NEPA) where the bauxite company does not own the land. In such cases, "*owners of the land are compensated for disturbance of surface rights, crops, yield, livestock, trees and buildings, and have their lands returned to them as rehabilitated and renewed for farming or occupational use*". Similarly, bauxite mining operators historically integrate and contribute to community development such as the development of community playing fields in Linton Park and Caledonia on mined out lands, training and support for farmers in the use of Greenhouse Technology in Watt Town and Tobolski, while the Lime Tree Garden community's restored lands are considered to be model reclaimed land areas in the industry (Nieta, 2019).

Concerns regarding bauxite also related to the perceived impacts on water resources (groundwater) and may be cited as potential conflict to water resources. However, reports from the Water Resources Authority (WRA) indicates a slight increase in groundwater flow within the Rio Bueno Catchment despite bauxite mining operations in the upper watershed areas over the past 50 years. Additionally, the Resource Monitoring Unit of the WRA 2014/2015 annual report showed increasing groundwater levels at several wells in bauxite mining basins such as the Upper Rio Cobre basin and the Black River basin (Water Reseources Authority, n.d.). It must also be noted that there has not been any report of bauxite contamination of water from mining as seen in spring flows, well discharges and river systems in many years.

The conservation and preservation of areas of historical and cultural significance will be of paramount concern. Land clearance and excavation during the mining process threaten to remove or destroy important buildings, structures or artefacts and so any potential for risk to such sites have to be considered as a major conflict to historical and cultural interests.

5.7.3. Current Land Use/Cover

As illustrated in Figure 5-182 below, the land cover in the area can be generally classified as, but not limited to the following:

- Urban/Industrial Areas
- Lowland/Sub-montane Evergreen Forest
- Mixed Woodland/Shrubland/Subsistence Plantation
- Mixed Shrubland/Subsistence Plantation and Grassland
- Sugar Cane Cultivation

5.7.3.1. Built-Up/Industrial

This land cover includes planned and unplanned residential and mixed residential/commercial areas. Currently, it constitutes the smallest proportion of the study at 1 km^2 in size and accounts for just 1% of the project impact area (1%). Most of the built-up areas are outside of the SEPL 524 and is predominantly comprised of both planned and unplanned settlements developing in a linear pattern along the roadways. Major nucleation exists only in Moneague, Alderton and parts of York Castle. Moneague is the largest urban centre, where residential activity is well developed enough for commercial and institutional services to establish themselves in support of the increase in size and population. Other smaller residential areas exist in ribbon development along minor roads. Several such communities are within the SEPL 524 such as Bensonton, Harmony Vale, Drumily, Lincoln, New Hall and Friendship.

5.7.3.2. Lowland/Sub-montane Evergreen Forest

Evergreen Forests cover an area of approximately 109 km^2 and is classified as disturbed or closed based on the extent of human influences and access. Together, these forested areas account for 20% of the total project area and 19% of the area within the SEPL 524 (see Table 5-53 below). The lowland sub-montane forest is dominated by closed broadleaf forests, covering 64 km^2 of the study area and 11 km^2 within the SEPL 524. Within the SEPL 524, disturbed forest accounts for approximately 3% of the area while the closed broadleaf forest makes up 16% of the lands within the SEPL 524 boundary.

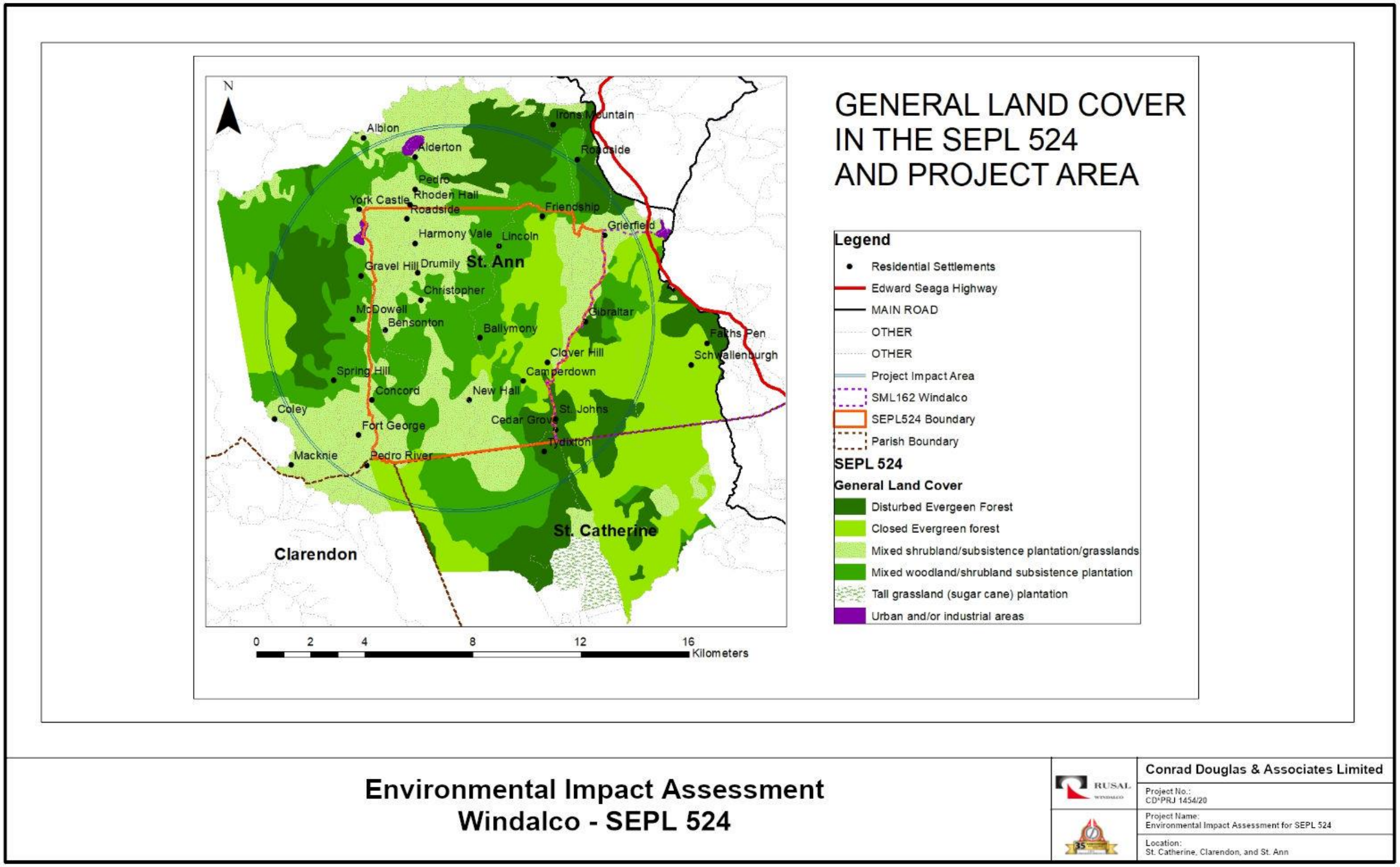


Figure 5-182: General Land Cover in and in proximity to the SEPL 524 Project Area

Table 5-53: General Distribution of Land Cover within the SEPL 524 Area

Land Use	Total Coverage within Project Area (km^2)	Land Use Distribution within the SEPL 524		
		Total Coverage within SEPL (km^2)	% of Total SEPL 524 Area	% of Total in Project Area
Disturbed Evergreen forest	45	2	3	3
Evergreen forest	64	11	16	17
Sugar Cane Plantation	4	0	0	0
Mixed woodland/shrubland/ subsistence plantation	70	26	37	37
Mixed shrubland subsistence plantation, and grasslands	69	30	43	43
Urban	1	0.1	0.1	
Total	**253**	**69**		

5.7.3.3. Mixed Woodland/Shrub/Subsistence Plantation and Grassland Vegetation

These areas include grassland/brush, shrub and woodland vegetation which dominates the area and accounts for 80% of the total land area within the sphere of influence and within the SEPL 524. An area totalling 56 km^2 in size is currently under woodland, shrub, grassland vegetation and partially explains the large area allocated to cattle ranching, grazing and pastures in the area (See Figure 5-183 below). These areas exist extensively along the periphery of the SEPL 524, and in or adjacent to the communities of Gibraltar, Grierfield, Roadside, Harmony Vale and Christopher. Woodland areas exist mostly in the interior areas in closest proximity to Concord, Bensonton, Ballymony and Lincoln. Grassland and brush areas exist on gentler slopes and depressions found among the conical hills while accommodating some subsistence agriculture and scattered residential development. As is also visible in Figure 5-183 below, the shrubland/grassland areas facilitate mixed residential development in the smaller and more scattered communities along the boundary and in the interior of SEPL 524.

5.7.3.4. Sugar Cane

There are 4 km^2 of lands under sugar cane plantation in areas around Lluidas Vale in St. Catherine and accounts for just 2% of the project impact area. No sugar cane cultivation exists within the SEPL 524 boundary.

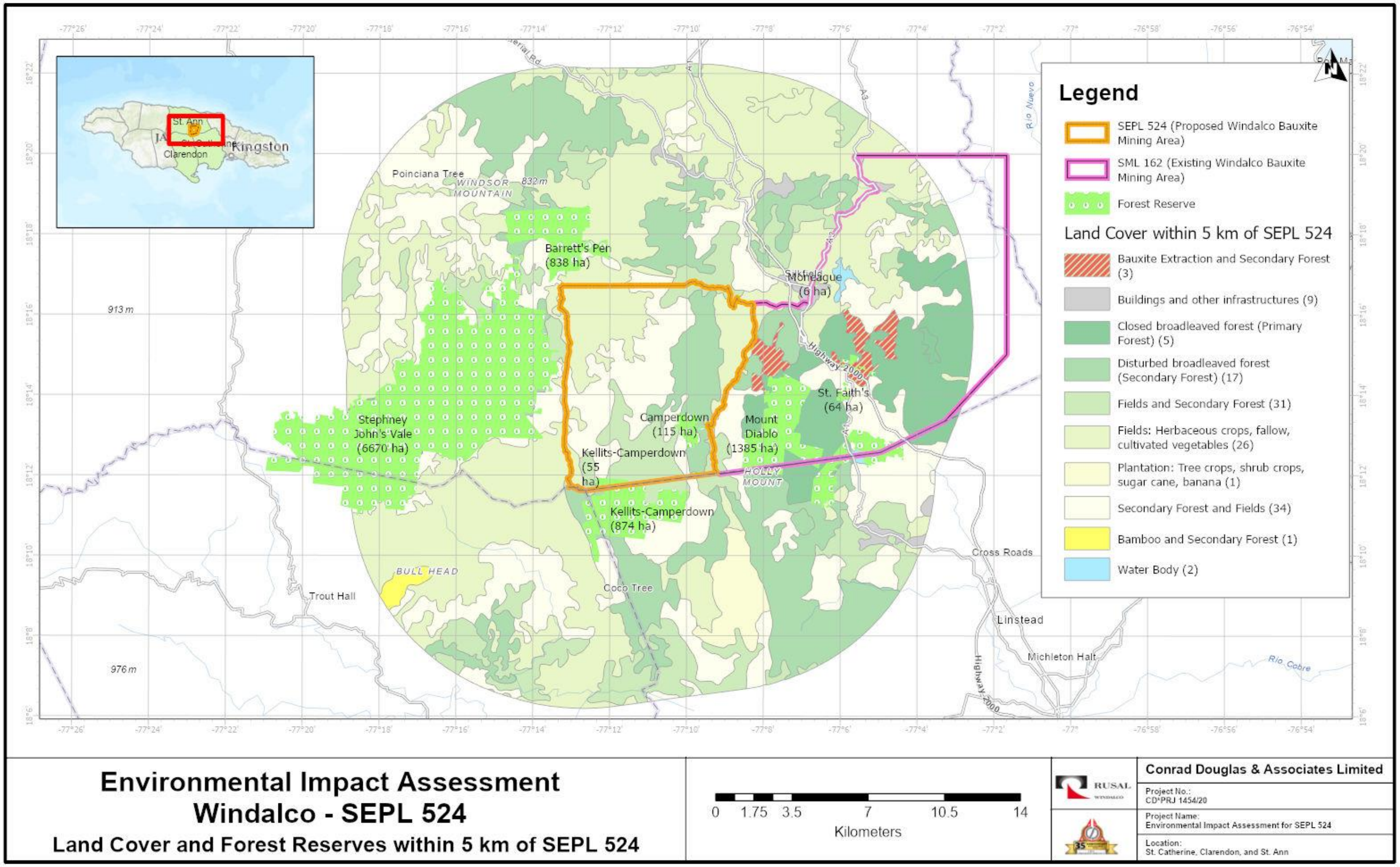


Figure 5-183: Land Use Cover within the SEPL 524 Boundary

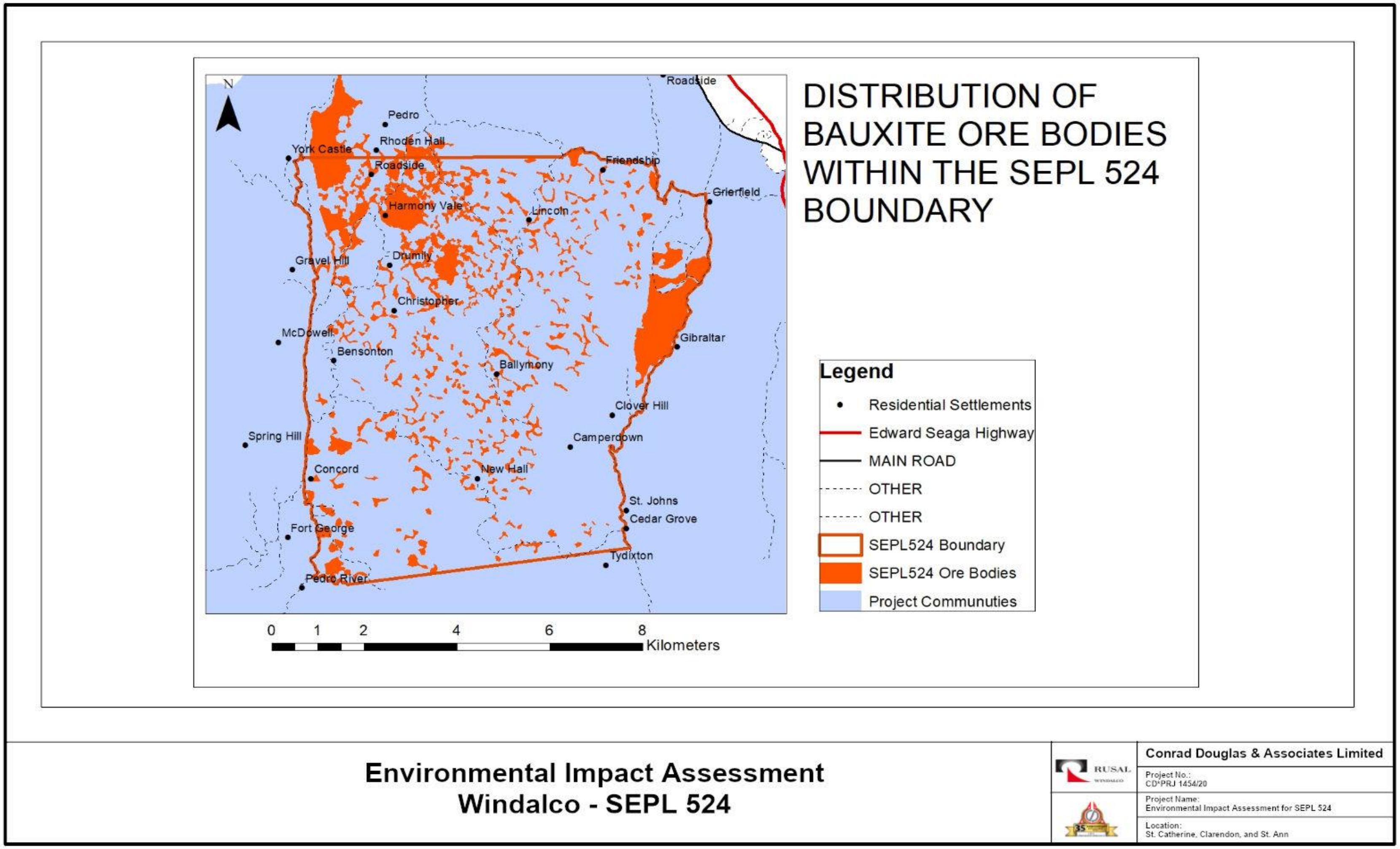


Figure 5-184: Distribution of Bauxite Orebodies within the SEPL 524 Boundary

5.7.3.5. Land Use Conflicts

The interaction between various land uses in the SEPL 524 and proposed operations will be based primarily on the location of the bauxite ore bodies (see Figure 5-184 above), which in itself will influence the nature, extent and scale of mining activities in the area. The distribution of bauxite ore covers a total area of approximately 11km^2, which accounts for 16% of the SEPL area, and is predominantly in the lowland areas under mixed woodland, scrubland, grassland, and is dominated by shrub vegetation and grasslands. In addition, there are several residential areas within SEPL 524 in a linear or scattered pattern, where their location intersects with potential mining sites. The distribution of bauxite ore within SEPL 524 interacts with various land uses in various locations depicted in Figure 5-185 to Figure 5-188 below. The locations were selected based on the amount/extent of bauxite ore deposits present and the presence and extent of multiple land uses in close proximity to bauxite reserves. These will form the basis for discussion on potential land use conflicts based on the following:

5.7.3.6. Residential Settlements

Settlements in the area are relatively small, linear and dispersed in pockets of shrub or grassland such as in the communities of Lincoln, Drumily and Harmony Vale, while that largest nucleation occurs in Gibraltar. The conflict between residential settlements and bauxite mining relate primarily to the instances where relocation is required during the mining operation. As is visible in Figure 5-185 and Figure 5-186 below, large deposits of bauxite ore interact with the locations of Harmony Vale and Gibraltar, where consolidated settlements have emerged amidst of extensive pastures and grasslands. The community of Drumily does not sit on any reserve but is actually surrounded, while Lincoln and New Day (see Figure 5-187 and Figure 5-188 below) are examples of communities where bauxite ore is in small pockets in their vicinity. Noise and dust nuisance, along with potential health issues, presents a conflict for all communities during the mining and transportation phases of the bauxite operations.

5.7.3.7. Heritage Sites

The Edinburgh Castle is among the heritage sites protected by the JNHT Act, 1985 and as such its location relative the bauxite mining operations are of major importance. Figure 5-185 highlights the location of the castle in and amongst bauxite ore deposits, and with the plans for developing the site for further preservation and organized tours, bauxite mining on this site is not permissible and could be a contravention of the JNHT Act if not properly managed. Any operation in its vicinity cannot have any impact on the site that may cause affect existing or future plans for the area.

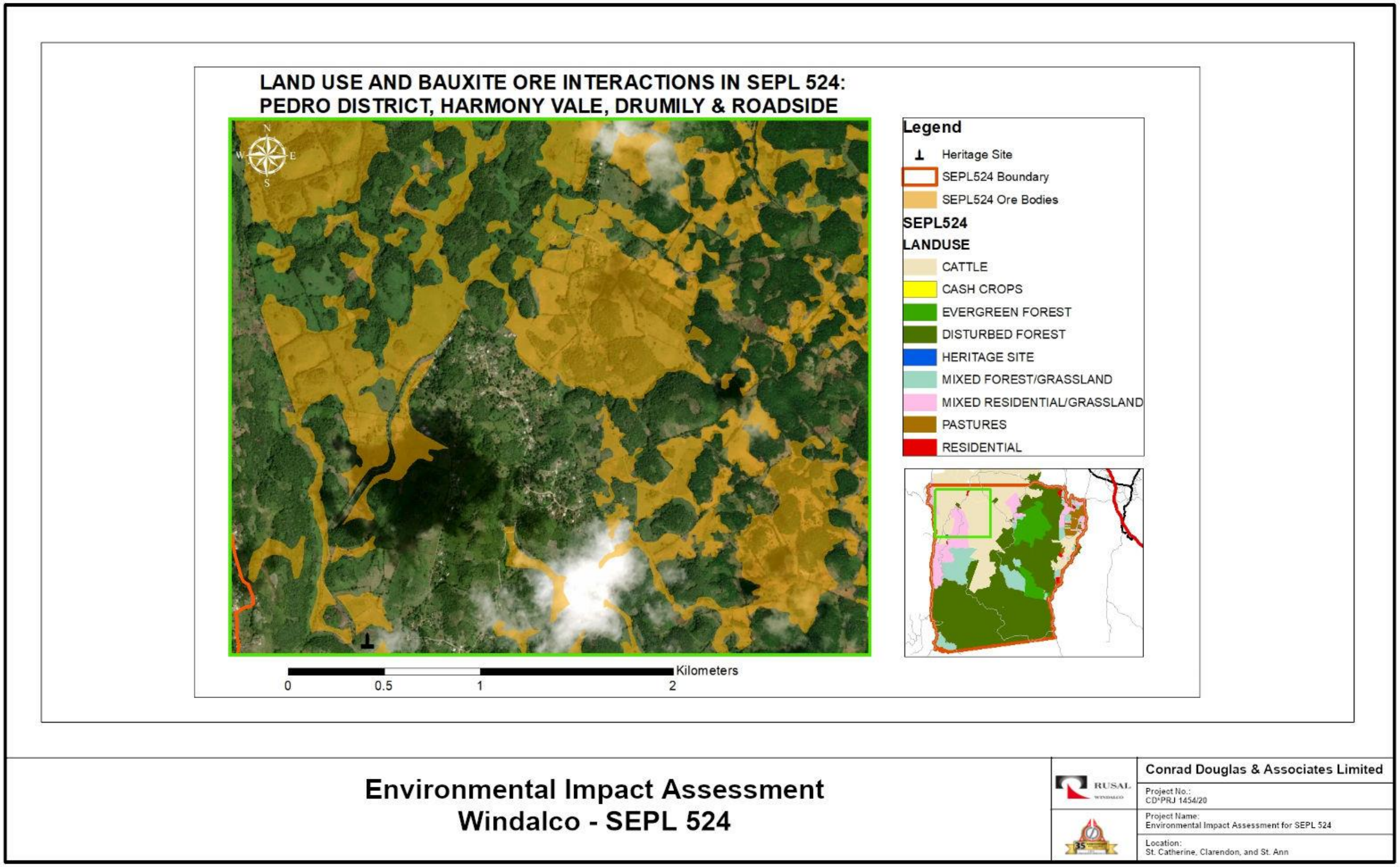


Figure 5-185: Land Use and Bauxite Ore Interactions in SEPL 524 Pedro District, Harmony Vale, Drumily & Roadside

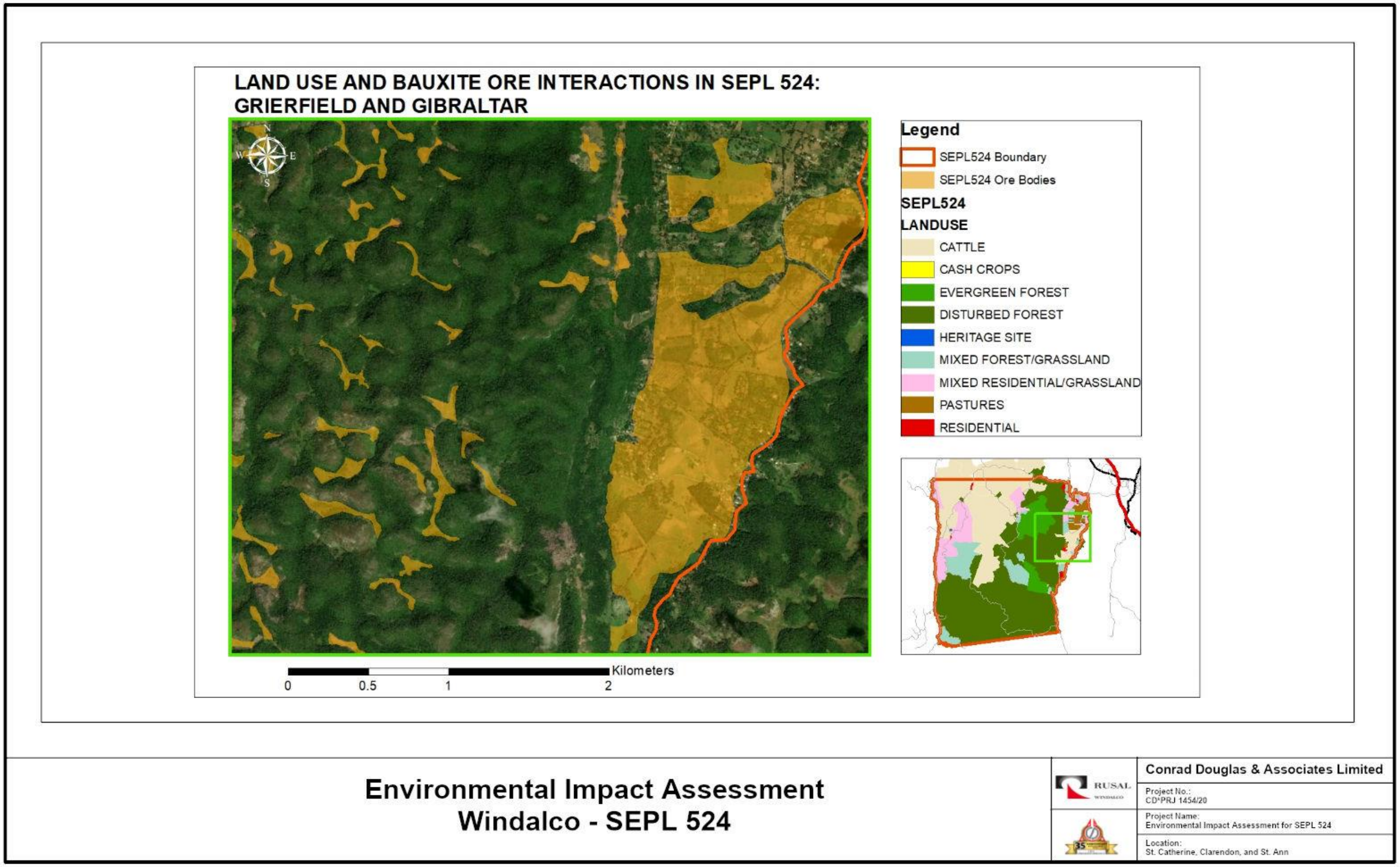


Figure 5-186: Land Use and Bauxite Ore in Interactions in SEPL 524: Grierfield and Gibraltar

5.7.3.8. Agriculture

Agricultural activity in the SEPL 524 is dominated by cattle ranching and the associated pasturelands. While there are a few small farmers producing cash crops, the land coverage by these activities are significantly dwarfed by cattle farms and pastures. Figure 5-185 above highlights the extensive areas of cattle ranching in Pedro District comprising Harmony Vale, Roadside, Drumily and parts of York Castle and Gravel Hill. Bauxite deposits exist in extensively in these areas while avoiding the areas under settlement. Cattle farmers in the area, especially those who are actively using these lands will experience major challenges with bauxite mining in these areas. Notwithstanding the loss of the physical space being a major interest to cattle herders, the loss of vegetation in these grasslands, which is major source of food for their herds, will be an additional sore point derived from mining in these areas.

It has been efficiently demonstrated for more than 60 years that rehabilitated bauxite lands is excellent for use as pastures in cattle rearing. In fact, this has formed the basis over several decades for supporting some of the largest dairy and beef cattle herds in Jamaica. Jamaica Is internationally recognized as having the largest and best herd of red poll cattle throughout the world.[27] In addition, Windalco presently has cattle and a tenant farming programme on mined out lands, as part of their commercial operations.[28]

5.7.3.9. Forest

Forests in the SEPL 524 can be characterized as disturbed or enclosed. Disturbed forests typically include secondary forest and those have endured disturbance from residential settlements or agricultural activity, while enclosed forest is in relatively undisturbed state due to limited access and minimal (if any) human activities. Forested areas are under threat

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[27] Private communications with The Honourable Dr. Karl Wellington, OJ internationally renowned Jamaican cattle breeder and geneticist. Several other sources within the Ministry of Agriculture, Bodles Agricultural Station and unpublished information.

[28] Windalco's internal database.

primarily in areas where there in limited access to ore deposits or where deposits exist in the heavily forested areas. In the New Hall and Ballymony areas illustrated in Figure 5-187 below, deposits exists mostly in the grassland areas at low elevation, already experiencing disturbance from settlements and agricultural activity. The existence of minor roads in the area may allay concerns associated with new access routes. However, for some of the area west of Gibraltar (see Figure 5-186 above) and east of Lincoln (see Figure 5-188 below), where bauxite ore deposits exist interspersed with a closed forest with no existing roadways and access. Mining operations in this area may result in some loss of forest cover.

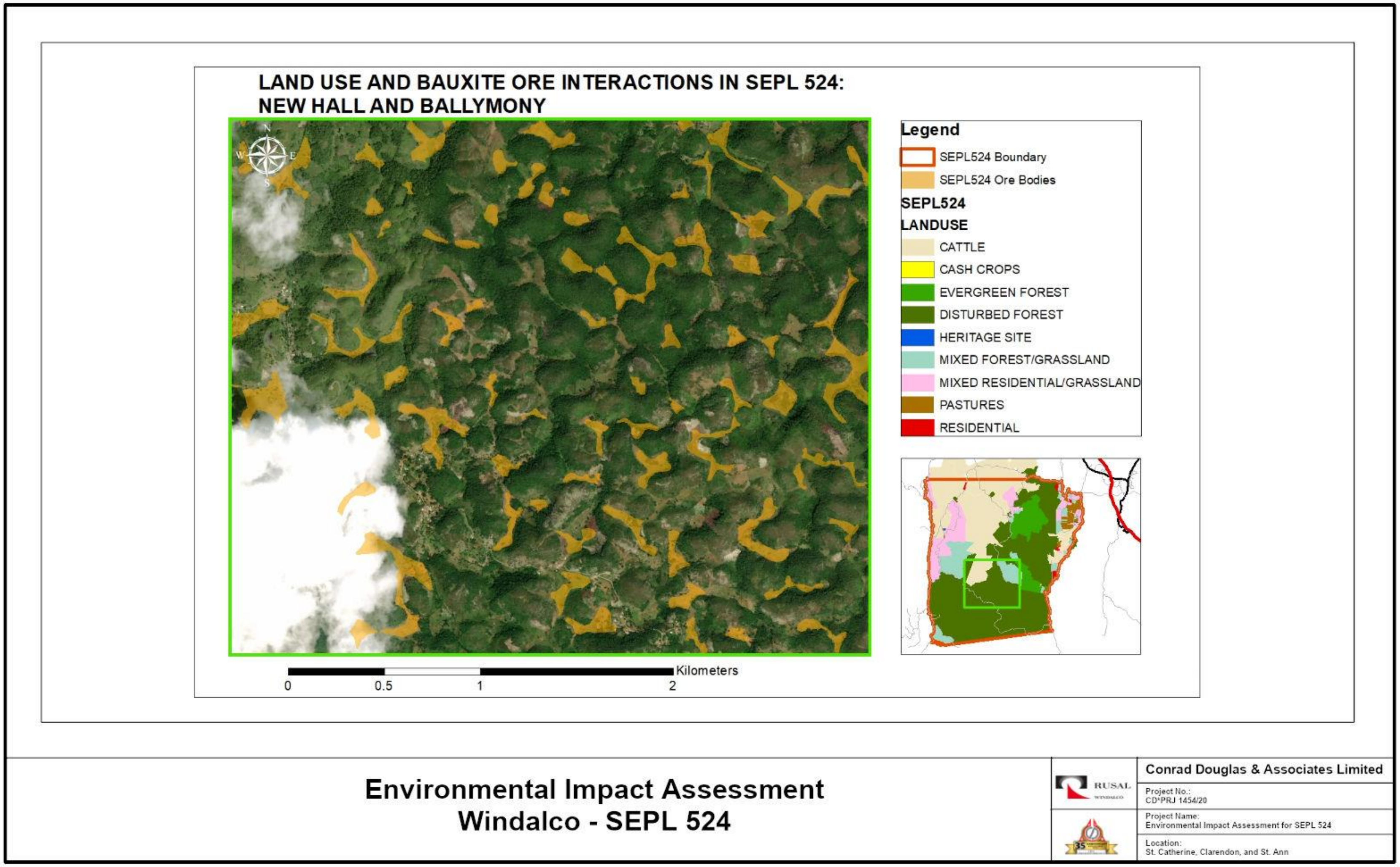


Figure 5-187: Land Use and Bauxite Ore Interactions in SEPL 524: New Hall and Ballymony

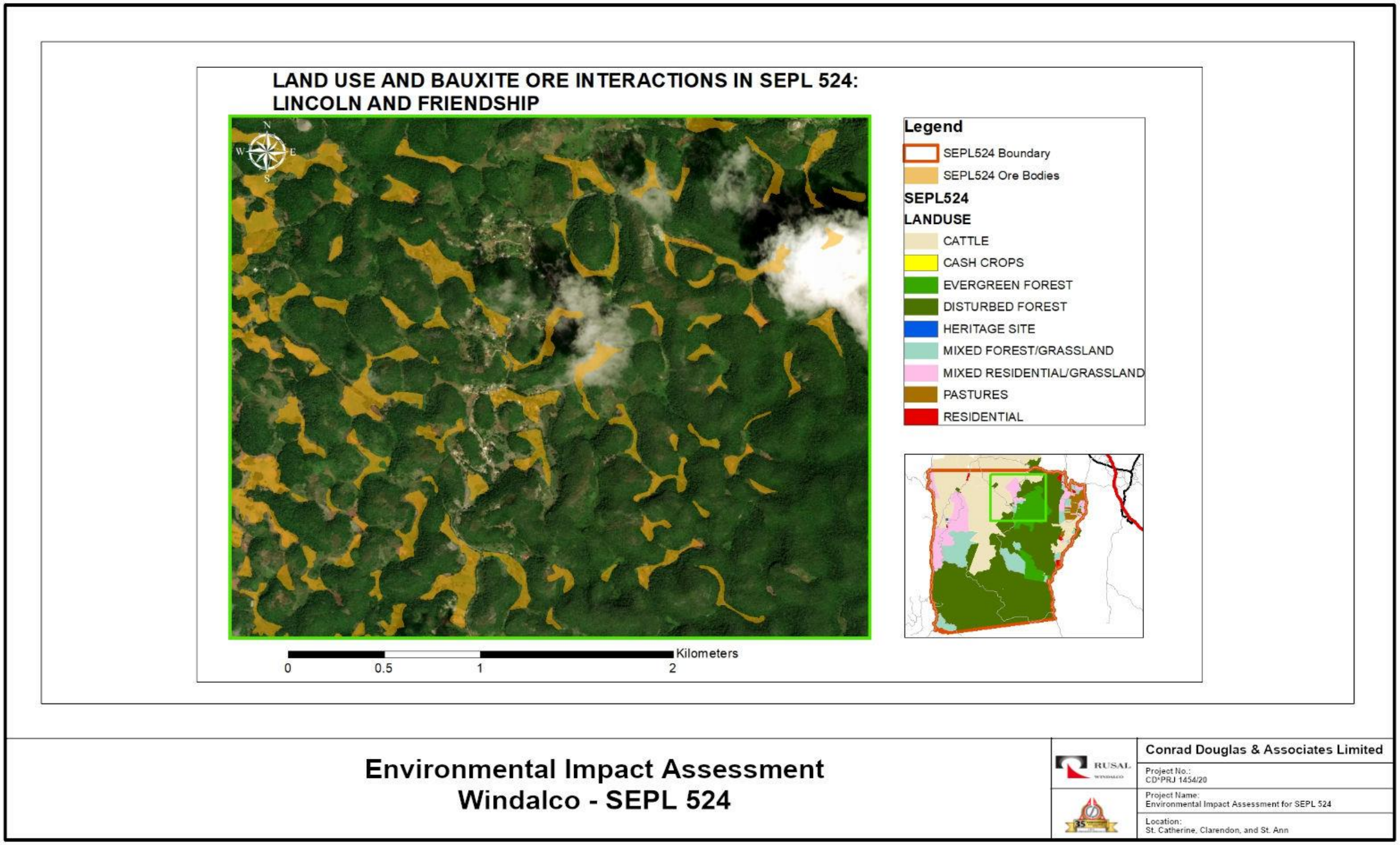


Figure 5-188: Land Use and Bauxite Ore Interactions in SEPL 524: Lincoln and Friendship

Table 5-54: Nature of Potential Land-Use Impacts and Mitigation Strategies

Phase of Operation	Affected Land Use/Area		Nature of Potential Impacts	Mitigation Strategies
Land/Vegetation Clearance	Woodland/Shrub Vegetation	Within SEPL Boundary	○ Loss of woodland/shrub/grassland cover and ecosystem functions (habitat, food, shelter etc)	○ Limit vegetation clearance to site of bauxite ore ○ Appropriate reclamation practices
	Forests	Within SEPL Boundary	○ Loss of forest cover and ecosystem functions (habitat, food, shelter, watershed etc)	○ Limit vegetation clearance to site of bauxite ore ○ Avoid creation of new access roads ○ Reforestation in suitable sites
	Residential	Within SEPL Boundary	○ Displacement of residents within the SEPL who may be required to relocate	○ Mine to the extent that minimize the need for relocation ○ Develop incentives for relocating those who choose/have to relocate ○ Purchase lands from individuals who chose/have to relocate
	Agriculture	Within SEPL Boundary	○ Displacement of cattle farmers and loss of livelihood ○ Loss of pastured and feeding grounds for cattle ○ Loss of prime agricultural lands	○ Limit vegetation clearance to site of bauxite ore ○ Appropriate reclamation practices ○ Develop incentives for relocating those who choose to ○ Purchase lands from individuals who chose to
	Heritage & Cultural Site	Within SEPL Boundary	○ Destruction or damage to Heritage Site of Historic and Cultural Importance (The remains of the Edinburgh Castle) ○ Loss/damage to artefacts that may be buried in the vicinity of the site.	○ In consultation with JNHT, establish appropriate buffer zone around Heritage Site ○ AVOID AREAS IN PROXIMITY TO SITE
Mining Operation	Residential	Within SEPL Boundary	○ Noise and dust nuisance from heavy trucks movement and other machinery	○ Apply water on roads to minimize dust ○ Schedule and announce haulage periods ○ Compensate for damages

Phase of Operation	Affected Land Use/Area		Nature of Potential Impacts	Mitigation Strategies
	Heritage & Cultural Sites	Within SEPL Boundary	○ Destruction or damage to Heritage Site of Historic and Cultural Importance (The remains of the Edinburgh Castle) ○ Loss/damage to artefacts that may be buried in the vicinity of the site. ○ Restricting access to Patronage (Organized Tours)	○ In consultation with JNHT, establish appropriate buffer zone around Heritage Site ○ AVOID MINING IN AREAS IN PROXIMITY TO SITE
Rehabilitation	Residential	Other towns in & around the SEPL	○ Increased pressure on other residential areas to accommodate relocated residents ○ Increased demand on already limited social and economic amenities.	○ Develop and implement relocation plan in conjunction with local planning authorities
	Forests	Within SEPL Boundary	○ Increased access provided by haul roads encourage encroachment from other land uses, which may undermine efforts for regeneration of ecosystem functions (habitat, food, shelter, watershed etc)	○ Restrict access to rehabilitated areas ○ Allow for regeneration of vegetation and ecosystems in rehabilitated areas
	Agriculture	Other towns in & around the SEPL	○ Further encroachment from residential uses	○ Restrict access to rehabilitated areas ○ Monitor and enforce any such breaches

5.8. Comparative Baseline

A comparative investigation was carried out between the following types of areas within Windalco's Special Mining Lease (SML) 165:

1. area being actively mined – Transect 22 (T22)
2. A fully rehabilitated area – Transect 23 (T23)
3. previously mined area undergoing rehabilitation – Transect 24 (T24)

These areas are shown in Figure 5-189 to Figure 5-191 below.

Figure 5-189: Active mine at T22

Figure 5-190: Rehabilitated mine at Schwallenburgh Housing Scheme - T23

Figure 5-191: Rehabilitated mine at T24

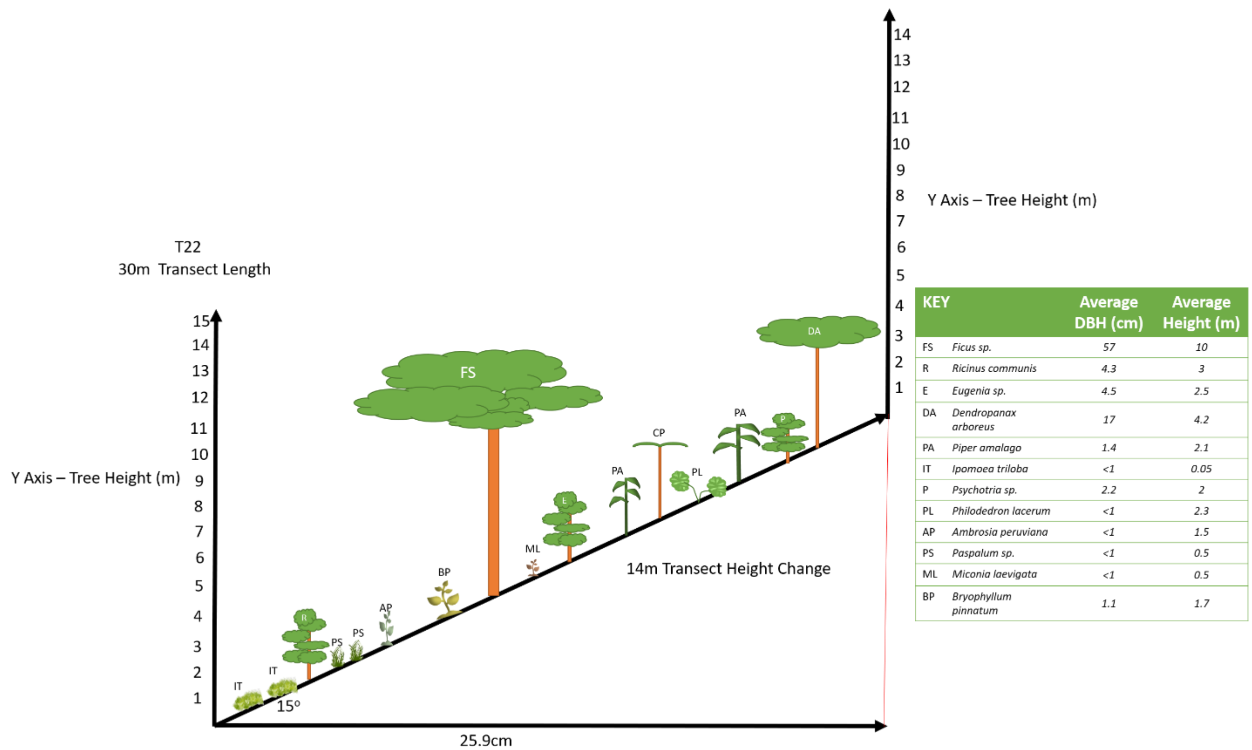
5.8.1. Observations

5.8.1.1. Transect 22

The vegetation type was heterogeneous along the transect. The study area showed a steady transition of shrubland to a woodland area. The shrubland area showed various herbaceous species including *Ipomoea triloba, Ambrosia peruviana, Bocconia frutescens,* and *Solanum erianthum*. Herbaceous climbers, *Dioscorea sp.,* and aroids (*Philodendron lacerum, Anthurium scandens*) were draped around taller tree species. The woodland area was dominated by a large Ficus tree. Smaller trees species identified were *Piper amalago, Comocladia pinnatifolia*. Seedlings of *Ficus sp.* and *Piper amalago* along with individuals of *Psychotria sp*. dominated the forest floor.

Table 5-55: Flora Species Identified in Transect 22

Species Name	Growth Habit	Quadrat
Ambrosia peruviana	Herb	2
Anthurium scandens	Aroids	3,4,5
Bocconia frutescens	Herb	3
Bryophyllum pinnatum	Herb	1,2
Comocladia pinnatifolia	Tree	5
Dendropanax arboreus	Tree	6
Dioscorea sp	Climber	3,4,5
Eugenia sp.	Shrub	4
Ficus sp	Tree	3
Ipomoea triloba	Herb	1
Miconia laevigata	Shrub	3
Paspalum sp	Grass	1,2
Piper amalago	Tree	4,5
Philodendron lacerum	Aroid	5
Psychotria sp.	Shrub	6
Ricinus communis	Shrub	1
Solanum erianthum	Herb	1,2



KEY		Average DBH (cm)	Average Height (m)
FS	*Ficus sp.*	*57*	*10*
R	*Ricinus communis*	*4.3*	*3*
E	*Eugenia sp.*	*4.5*	*2.5*
DA	*Dendropanax arboreus*	*17*	*4.2*
PA	*Piper amalago*	*1.4*	*2.1*
IT	*Ipomoea triloba*	*<1*	*0.05*
P	*Psychotria sp.*	*2.2*	*2*
PL	*Philodedron lacerum*	*<1*	*2.3*
AP	*Ambrosia peruviana*	*<1*	*1.5*
PS	*Paspalum sp.*	*<1*	*0.5*
ML	*Miconia laevigata*	*<1*	*0.5*
BP	*Bryophyllum pinnatum*	*1.1*	*1.7*

Figure 5-192: Vegetation profile and vegetation identification key plotted for Transect No. 22

5.8.1.2. Transect 23

The study area showed a transition from a dense shrub land to hillock area.The dominant species in the shrub land area was *Nephrolepis sp.* creating thickets which were entangled with *Panicum sp.*, *Bidens pilosa*, *Miconia sp.*, *Pentalinon luteum* and *Eupatorium odoratum*. A paved roadway laid between the shrub and the woodland area. No vegetation was present on the stony roadway. At the border of roadway leading to the woodland were a number of grasses (Panicum sp.) and shrubs (Desmodium sp., Psidium guajava). The woodland area was defined by taller tree species such as *Cecropia peltata, Leucaena leucocephala, Terminalia latifolia, Cedrela odorata* and *Colubrina arborescens*.

Table 5-56: Flora Species Identified in Transect 23

Species Name	Growth Habit	Quadrat
Bidens pilosa	Herb	1
Cecropia peltata	Tree	2
Cedrela odorata	Tree	3

Colubrina arborescens	Shrub	5
Desmodium sp	Herb	5
Eupatorium odoratum	Shrub	1
Hohenbergia sp	Bromeliad	3
Leucaena leucocephala	Tree	3
Miconia sp.	Shrub	2
Nephrolepis sp	Fern	1,2
Panicum sp.	Grass	1
Pentalinon luteum	Vine	4
Psidium guajava	Shrub	3
Terminalia latifolia	Tree	3

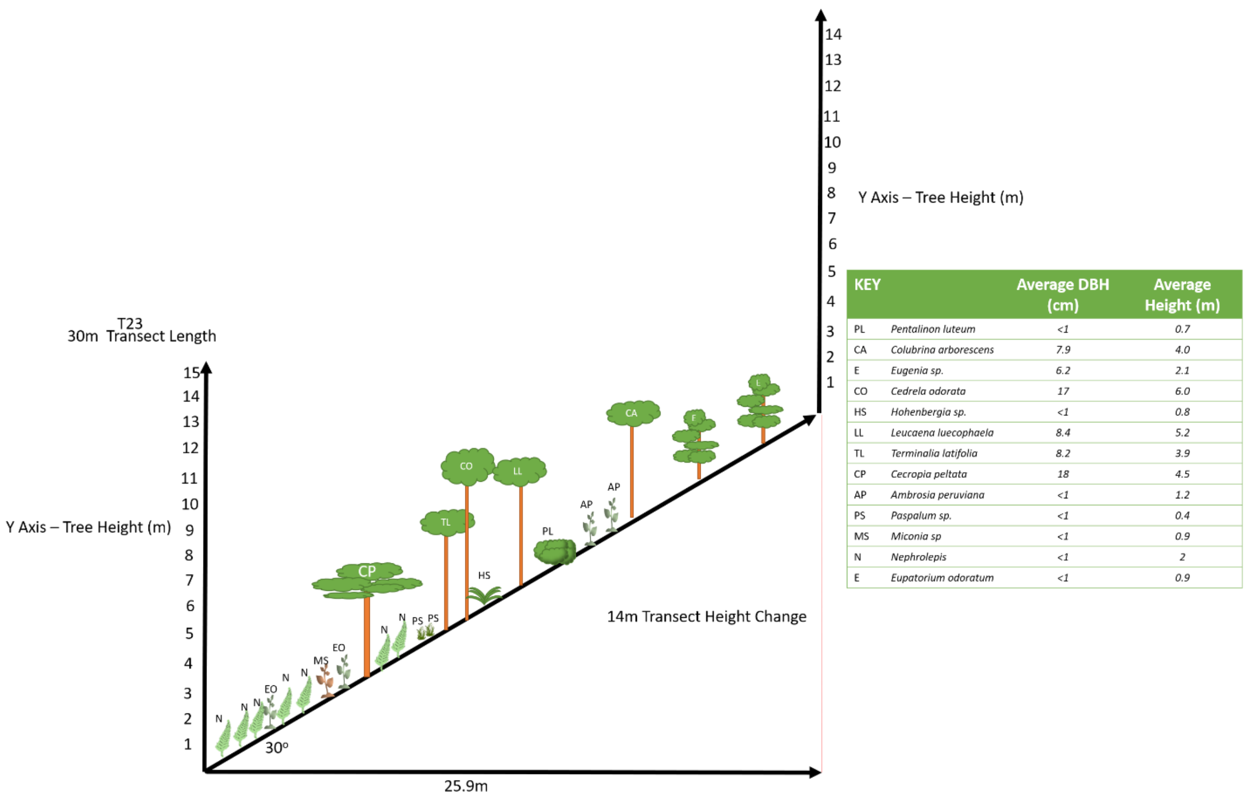


Figure 5-193: Vegetation profile and vegetation identification key plotted for Transect No. 23

5.8.1.3. Transect 24

The study area showed evidence of disturbance as the vegetation appeared patchy in its distribution. A roadway separated the survey into different areas of succession. On one side of the roadway was an area of shrubs and low lying vegetation. This region was dominated with the species *Ambrosia peruviana*, a common indicator of ecological disturbance. Individuals of this plant species were young and indicated recent reestablishment. The roadway remained void of any plants. On the alternate side of the road species composition was different and showed more variation. This area was characterized by tall shrubs and trees such as *Nephrolepis sp., Rhytidophyllum tomentosum, Miconia laevigata, Fagara Martinicensis, Cecropia peltata, Eugenia sp.* and *Albizia julibrissin*.

Table 5-57: Flora Species Identified in Transect 24

Species Name	Growth Habit	Quadrat
Ambrosia peruviana	Herb	1,2
Albizia julibrissin	Shrub	5,6
Cecropia peltata	Tree	4,6
Comocladia pinnatifolia	Tree	5
Eugenia sp.	Shrub	6
Fagara Martinicensis	Shrub	4
Miconia laevigata	Shrub	3
Nephrolepis sp.	Fern	3
Rhytidophyllum tomentosum	Herb	2,3

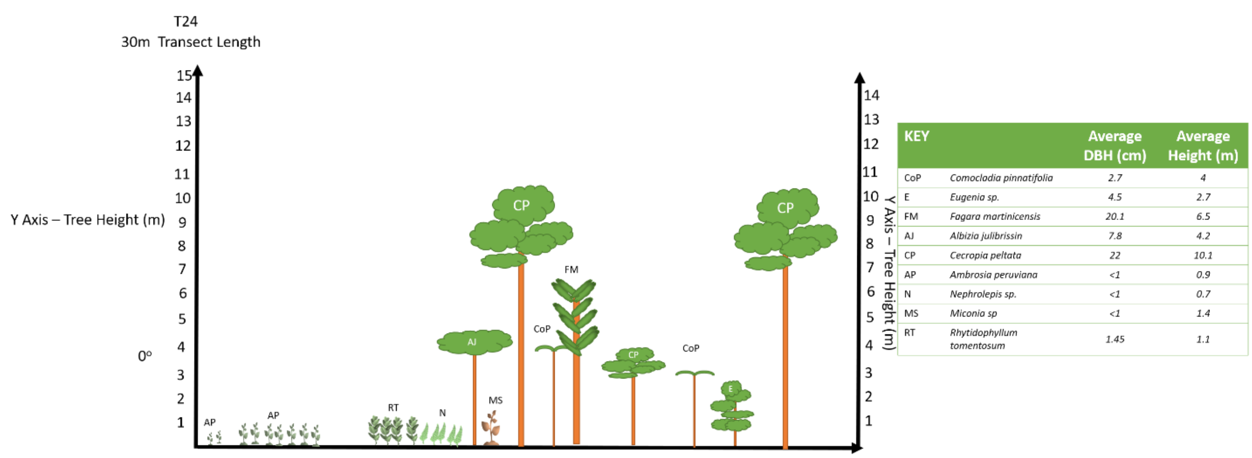


Figure 5-194: Vegetation profile and vegetation identification key plotted for Transect No. 24

Table 5-58 below illustrates the numbers of bird species observations made at the active/rehabilitated mining areas.

Table 5-58: Bird species observations made at the active/rehabilitated mining areas.

Site	Number of species Detected during Point Count	Number of species detected during Traverse	Total Number of species detected in the area	PC Detectability (Percentage)	Traverse Detectability
Active Mine	4	5	9	44.44	55.56
Rehabilitated Mine	3	0	3	100.00	0.00
Rehabilitated Mine Expanse	4	0	4	100.00	0.00

Figure 5-195: Species observed at active and rehabilitated sites. Left: Killdeer (*Charadrius vociferous*) | Right: Black-necked Stilt (*Himantopus mexicanus*) (Source: Birds of Jamaica)

When comparing the frequencies of the orders of arthropods among locations, the active mine site (Location U) is in line with frequencies from non-mine sites, ranging from 1 to 41 when present among orders.

The insect abundance of mine associated sites and non-mine associated sites were similar, ranging from 1 to 92 members of the order when present at a site. All main orders were well represented at the mine associated sites.

At the species level, the active mine had high numbers of the orb weaver spider. The mine associated sites had low species richness values for Diptera and Araneae.

6.0. Public Participation

6.1. Introduction

In keeping with best practices as recommended in Agenda 21 of the EIA and environmental permitting process Voluntary Stakeholder Consultations for within and in proximity to SEPL 524 were planned, these were however not convened due to the Coronavirus pandemic restrictions.

6.2. Background

The National Environment & Planning Agency (NEPA) stipulates one mandatory public consultation to be implemented no sooner than 21 days after the Draft EIA has been placed in the public domain.

However, best practice involves conducting voluntary public consultation during the EIA development phase to provide public awareness of the project and most importantly to get feedback from the potentially impacted population regarding their knowledge of the area and perception of the project and the concerns they may have regarding project implementation. This approach is also stated in the United Nations Agenda 21. These consultations are also very useful to assist in developing a sustainable project since the concerns of the receptors are incorporated in the project planning phase.

CD&A also executed a comprehensive socio-economic survey as a part of the environmental setting and baseline of the EIA. The Voluntary Consultations can be considered an extended activity of the socio-cultural and economic analysis of the project.

CD&A was not able to execute the meetings due to the coronavirus pandemic restrictions. In this case the meetings were limited to online meetings with the main Government of Jamaica stakeholders the Forestry Department (FD) and the Water Resource Authority (WRA).

6.3. Meetings with Governmental Organizations

6.3.1. Forestry Department Meeting

This meeting was convened on the August 19, 2020 online via the Microsoft Team platform. The detail notes of the meeting are presented in Appendix XXI. The main takeaways from the meeting are:

1. The Forestry Department wants to be included in the development of Terms of References for project which potentially could impact the natural resources under their management.
2. The Forestry Department wants no net loss of Forest Cover across the SEPL;
3. The Forestry Department wants no mining in the Forestry Department resources;
4. The Forestry Department wants it be stated that some of the areas to be mined falls within these resources description (3 above) and No mining should be conducted in the Forestry Reserve.
5. The Forestry Department wants it to be stated that important resources are not only in Camperdown but parts of Kellits-Camperdown and Barret's Pen to the North.
6. There is a project in Stephany John's Vale that is being undertaken by the FD and this project in close proximity is also a concern.

6.3.2. Water Resource Authority Meeting

A meeting was convened on July 23, 2020 at the Water Resource Authority offices. The main takeaways from the meeting are:

- This is an important area (North Clarendon, North St. Catherine and Southern St Ann) for the WRA since your teams are doing dye studies on the Pedro River
- The WRA are in the process of determining the flow directions of ground water in the area covered by the SEPL
- The Pedro River sinks at the Bridge at the boundary of the SEPL
- There are a number of active Wells in the SEPL for which the WRA has detail information.

- WRA can provide us with the information they have regarding water features in the SEPL if we supply them with the Shape files for the SEPL.
- The sinkholes in the SEPL haven't been mapped so as they are identified by the CD&A Team these sinkholes and other features should be tagged (also the caves since WRA uses the JCO data which may not be comprehensive)
- WRA is desirous of a representation of the SEPL relative to the CCPA.
- Potential impacts of mining on ground water should be addressed. Sinkholes in the area could feed the Rio Cobre as well as Dunns and other rivers to the North.
- Sinkholes to the west of the SEPL has been dye traced and they flow to the northwest to Pear Tree etc.
- The geology and the fault lines should be presented relative to ore bodies to discuss potential impacts.
- Mr. Marshall indicated that their main concern would be the impact of mining of an untouched area. CDA indicated that from extensive visits there are few areas that could be considered untouched. Since all depression areas were cleared for farming or ranching.
- WRA website would be a good source of data however new information from recent and ongoing investigations may not be presented there.

6.4. Voluntary Stakeholders Consultation Meeting

The Voluntary Stakeholder Consultations, which CD&A normally carries out in keeping with international best approaches and practices, were severely constrained as a result of the rapidly spreading COVID-19 pandemic in Jamaica. In this regard, it was critically important to comply with the requirements of the Disaster Risk Management (Enforcement Measures) Order, 2020. For this reason, an alternative methodology for Voluntary Public Consultation was employed with key stakeholders within the SEPL 524 and its immediate sphere of influence using the following media:

- ✓ telephone calls,
- ✓ zoom meetings, and
- ✓ limited face-to-face meetings.

Every effort was made to conduct these voluntary stakeholder consultations earlier in implementation of the project in July 2020. Planning and implementation of the voluntary stakeholder consultations were also impacted by the General Elections of September 2020, which affected engaging the communities by normal methods. Contact was made with the political directorate and community leaders during the EIA process. Examples of invitations to the political directorate and community leaders are provided in Appendix XXII.

A series of voluntary consultations were carried out in May 2021 with members of the communities, the political directorate and institutional stakeholders who were sensitized on the project proposal. Their comments were duly recorded and reported on below.

For the Voluntary Consultation Meetings, a total of thirty-eight (38) persons within proximity to SEPL 524 were interviewed and informed on the proposed mining of bauxite in the Special Exclusive Prospecting License 524 (SEPL 524) area. Consultations were done with persons from the following communities and institutions:

- ✓ Gibraltar,
- ✓ Bensonton,
- ✓ Greirfield/Schwallenburgh,
- ✓ Moneague/Claremont,
- ✓ Drumily,
- ✓ Waltham,
- ✓ Harmony Vale,
- ✓ Cross Roads, and
- ✓ Social Development Commission (SDC)
- ✓ Rural Agricultural Development Authority (RADA)

The major views and opinions from the stakeholders are shown in Figure 6-1 below.

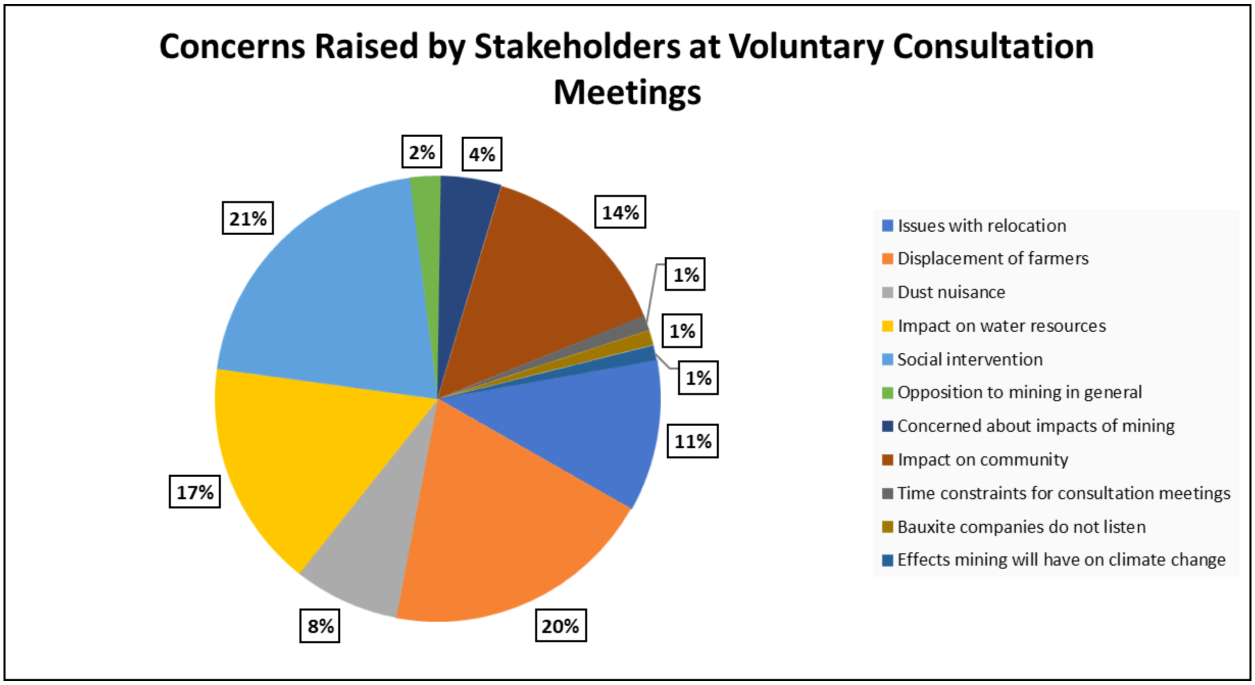


Figure 6-1: Concerns Arising from Voluntary Consultation Meetings

Social Intervention

Among the social intervention concerns were the need for new infrastructure, skill training and development for persons within the community, and health benefits for any potential long-term effects from bauxite mining.

Farming

Farmers were mainly concerned with the effects of mining on the soil quality, poor crop yield due to improper rehabilitation of land previously used for mining, displacement due to mining, and access to technology such as greenhouse development.

Water Resources

Among the concerns for the impact on water resources were the water quality and changes in flow of nearby rivers and streams, the impact that mining will have on the water table, and that there maybe an impact on the availability of potable water for the community.

Relocation and Security of Land Tenure

Among the concerns for the impact on communities were the relocation of persons living within the communities and security of tenure as a result of bauxite operations on their land.

Changes in Land Use

Among the concerns for land were the creation of a new disposal site, creation of haul roads and the impact on the regular traffic flow in and around the communities, and the removal of any type of vegetation

Dust Nuisance

Among the concerns for dust nuisance were the health impact it could have on persons within the community, the wetting of haul roads to mitigate dust pollution, and the contamination of water due to the spread of dust, especially to those who own water tanks.

Mining

Among the concerns for mining were that persons did not want any mining to take place within their community, concerns about mining done in the Pedro River, creation of a new mud lake nearby the communities, creation of sinkholes/pits, and concerns about bauxite companies exploring lands they do not own without permission.

Other concerns raised were the time in which the consultation took place, that bauxite companies do not listen, and that mining will have an impact on climate change.

The recommendations of the stakeholders from the voluntary consultation meetings are as follows:

- ✓ Windalco could partner with the community to alleviate issues that may arise pre, intra, and post-mining and conduct activities to stimulate the growth of the community. This would be a show of good faith and has an added public relations benefit.

- ✓ Windalco could partner with farmers to help purchase produce. Also, if farmlands are impacted and relocation occurs while the land is being rehabilitated, negotiations may be made with regards to compensation.
- ✓ In respect of potable water, a feasible water plan should be implemented to benefit the community from any negative impacts that may arise.
- ✓ The installation of a 20,000 gallon tank is recommended and would be a sign of good faith.
- ✓ A health insurance scheme should be provided for the communities within which mining will occur.
- ✓ A 25-year post mining rehabilitation plan should be developed.

7.0. Impact Identification & Assessment and Analysis of Potential Impacts

The following tables provide an assessment of potential environmental impacts which may be associated with this project, and include information on potential receptors, duration, magnitude, and mitigation measures. Since these are potential impacts, there is no certainty that they will materialize. However, Windalco will avoid or mitigate any adverse impacts should they arise during all phases of this project.

In general, the potential impacts arising from implementation of mining activities fundamentally involves a temporary change in land use. This change may be from grasslands or pastures to access bauxite ore for mining and through the creation of mining infrastructure such as haul roads. The total SEPL 524 6,839.9 hectares of which 496.7 hectares will be impacted, inclusive of haul roads. This amounts to approximately 8.2% of the total area that may be impacted over the lifetime of the project. The potential change in the configuration of the topography and the construction of haul roads may be irreversible.

The potential loss in grassland vegetation from the surface of the orebodies and haul roads is reversible or may be ameliorated through employing the use of ecological creative conservative strategies in support of natural recolonization. This could be done, for example, through temporary removal and relocation of protected, rare, threatened or endangered species of plants at different phases of project implementation (before mining, during mining and after the completion of mining).

The major positive impacts are contribution to macro-economic stability through foreign exchange earnings, GDP growth, purchase of goods and services in the domestic market and job creation. In addition, there are several indirect benefits such as improvements in agriculture and agro-processing and the use of improved agricultural practices with training and skills development, education and improved sporting and recreational activities. Other potential impacts are as follows:

- Change in the drainage regime
- Increase run-off rate and erosion
- Sedimentation of natural drainage system and potential for flooding

- Impact on flora and fauna
- Habitat loss
- Dust
- Noise
- Relocation of households
- Temporary loss of income for subsistence farmers

In assessing the significance of potential impacts, various measures are used. These include the use of checklists, matrices, expert knowledge and a keen assessment of the project plans and details. Each parameter is evaluated according to the following:

- **Activity** –action taking place during a phase of the development
- **Environmental receptor** - sensitive component of the ecosystem that reacts to or is influenced by environmental stressors
- **Potential impact** - any potential change to the environment, whether adverse or beneficial, wholly or partially resulting from the proposed activities, products or services
- **Magnitude** - A measure of how adverse or beneficial an impact may be
    - **Low**: negligible effect occurs when a component is slightly altered. For human population, the effect is negligible when it slightly affects a component or its use or valuation by the community.
    - **Moderate**: moderate effect occurs when a component is altered to a lesser extent but doesn't compromise its presence in the new environment. For human population, the effect is less intense when it partially limits the use of the component or its valuation by the community.
    - **Major**: major effect occurs when a component is completely destroyed or is altered significantly. For human population, the effect is when it compromises or alters significantly the component or its use or valuation by the community.
- **Duration** - the length of time needed to complete an activity
    - **Short-term impacts**: when component will be affected for a limited period such as the pre-construction and construction phases of the project.

- **Intermittent impacts**: when component will have difficulty to adjust at first to the new environmental conditions but will eventually return to pre-project levels and the population will be able to use it eventually as before or even better.
- **Long-term impacts**: when component will be affected for the lifetime of the project enough to compromise the survival of a local species or use of a component by the population.

- **Extent/Location –** The spatial extent or zone of impact influence can be predicted for site-specific versus regional occurrences. Depending on the type of impact, where necessary, the variation in magnitude will be estimated.
    - **Limited**: When impact occurs in relatively restricted areas such as the construction site facilities
    - **Local**: Limited area when component is well represented in region (<1 km radius)
    - **Regional**: When an impact exceeds local boundary and has the potential to affect a wide radius of communities such as a nearby town (1-10 km radius)
    - **National**: When an impact has the potential to affect the entire island
    - **International**: Impacts that may be considered as affecting the global population such as contributions to global warming
- **Significance** - A measure of importance of an effect
    - **Minor**: An impact of low significance is one that is short term and will have no long term cumulative effect on the environment and/or will affect a negligible portion of an environmental component.
    - **Moderate**: An impact may be considered to be of moderate significance when the change is medium to long term and/or will result in changes that affect a considerable portion of the environmental component.
    - **Major**: An impact of high significance will cause long term changes and/or will result in changes that affect a major percentage of the environmental component.
- **Likelihood** - probability, uncertainty or confidence in the prediction

- **Mitigation** - Measures taken to reduce adverse impacts on the environment
    - **Prevent:** The most effective approach will be to prevent the creation of adverse environmental effects at source rather than trying to counteract their effects through specific mitigation measures.
    - **Reduce** - If the adverse effects cannot be prevented steps will be taken to reduce them.
- **Reversibility/irreversibility**
    - **Reversible:** the system and its environment will return to their original conditions
    - **Irreversible:** Irreversibility (of environmental damage) refers to the permanent loss of environmental assets or environmental quality, requiring preventive action rather than restoration or clean-up
- **Residual** - The residual environmental impacts refer to the net environmental impacts after mitigation, taking into account the background environmental conditions and the impacts from existing, committed and planned projects. See Table 7-1.

Table 7-1: Key for Level of Impact after Mitigation Measures

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
Major	Degradation to the quality or availability of habitats and/or fauna with recovery taking more than 2 years	Change to commercial activity leading to a loss of income or opportunity beyond normal business variability/risk Potential short-term effect upon public health / well-being, real risk of injury	Concern leading to active campaigning locally or wider a field	Introduce measures to avoid these impacts wherever possible, closely monitor and control areas of residual impact
Moderate	Change in habitats or species beyond natural variability with recovery potential within 2 years	Change to commercial activity leading to a loss of income or opportunity within	Widespread concern, some press coverage, no campaigning	Actively work to minimize scale of impacts

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
		normal business variability/risk Possible but unlikely effect upon public health/well-being. Remote risk of injury		
Minor	Change in habitats or species which can be seen and measured but is at same scale as natural variability	Possible nuisance to other activities and some minor influence on income or opportunity. Nuisance but no harm to public	Specific concern within a limited group	Be aware of potential impacts, manage operations to minimize interactions
Negligible	Change in habitats or species within scope of existing variability and difficult to measure or observe	Noticed by but not a nuisance to other commercial activities. Noticed by but no effects upon the health and well-being of the public	An awareness but no concerns	No positive intervention needed but ensure they do not escalate in importance
Positive	An enhancement of ecosystem or popular parameter	Benefits to local community	Benefits to stakeholder issues and interests	Actively work to maximize specific benefits

Outlined below are the impacts on the various phases of the proposed development as they relate to key aspects of the project. Namely:

- Physical environment
- Biological environment
- Socio-economic environment

Cumulative impacts have also been assessed.

Mitigation measures are provided, where necessary, at the end of each subsection.

7.1. Impacts to Physical Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Project Design and Engineering							
Pre-operations	Natural Environment	***Item A1*** – The design and engineering of haul roads and mining of orebodies may result in erosion of pits and roadways. There could also be possible flooding of adjacent lands.	Low & Short Term	Local & Minor Negative	Low & Direct	All designs will be done in accordance with the approved regulatory standards taking into account best practices for storm water management, slope stability and materials specifications. All plans for mines development and designs must be submitted to the Mines & Geology Division for their approval.	Minor & Reversible
Aesthetics							
Pre-operations, operations, rehabilitation	Humans	***Item A1*** – The clearance and removal of vegetation from the haul road alignment and mining areas will result in a visually negative impact as it represents a change from what is customary.	Low & Long Term	Local & Minor Negative	High & Direct	Proper upkeep and maintenance of the site will be done. Epiphytes and any rare, threatened or endangered species will be removed and relocated to nearby areas that will be unaffected by mining operations or to a nursery managed and operated by WINDALCO. Land clearance will be limited to haul roads and orebodies. In addition, topsoil stripped during site clearance will be reused for the rehabilitation process. An Operations & Maintenance Plan will be developed and implemented so that the mining operations can be properly maintained. Effective monitoring of solid waste storage and disposal will be put in place so that the potential for environmental pollution at the project site and its environs be minimized. Haul roads will be developed along existing roads within the SEPL as much as possible	Minor & Reversible
		Item A2 – Where there are cuts, haul road construction will result in scarring of the terrain. The topography of the terrain and distance from human receptors naturally mitigates visual dis-amenity.	Low & Long Term	Local & Minor Negative	High & Direct	Cuts in the terrain will be made through benching, which is a soil conservation measure aimed at aiding in the prevention of soil erosion and landslides. It also aids in the management of storm water run-off. Selected haul roads will be removed and the land restored, as close as possible, to its original condition. Existing roadways and access paths will be exploited for haul road development as much as possible to reduce the use of virgin areas.	Minor & Reversible
Geological and Geotechnical							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	***Item GG1*** – Land movements. Within the orebodies and along the haul road, slope reinforcement and stabilization may be required to eliminate the potential for erosion.	Moderate & Long- term	Local & Minor Negative	Low & Indirect	Construction planning and monitoring should ensure that all agreed slope reinforcement and stabilization designs (if applicable) are properly implemented.	Minor & Irreversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						The limestone is hard and naturally mitigates against the requirement for slope reinforcement and stabilization. The overall width of the road will be kept at a standard of 11 m and within prescribed contour elevations to eliminate land movement. Where cuts exceed 6m, benching[29] will be implemented. The total SEPL 524 area is 6,839.9 hectares of which 496.7 hectares will be mined. This amounts to approximately 8.2% of the total area that may be impacted over the lifetime of the project.	
		Item GG2 – Potential Impact for change in the drainage regime, increased run-off rate, erosion and sedimentation of natural drainage system and potential for flooding. The inclusion of existing drainage features (which will be upgraded, where necessary) into the project's overall drainage design will allow for better control and management of storm water which will reduce or eliminate erosion.	Moderate & Long- term	Local & Major Negative	Low & Direct	Generally, the contour maps for SEPL 524 outline elevations and depressions and the depressions indicate the final destination of run-off within the landscape. WINDALCO , generally follows these contours in mining the specified areas to ensure that there are no significant disruptions to the natural drainage of the area. A properly designed drainage system will be a feature of the proposed development. Once implemented along with other protective measures, it will provide adequate protection for land stabilization. All effort will be made to ensure that this aspect of the project is implemented. The natural drainage will be maintained as far as practicable. Otherwise, all run-off will be directed to orebodies/depressions to eliminate adverse impacts. WINDALCO will not disturb any vegetated area outside the design footprint to reduce the risk of erosion. Stockpile material near drainage corridors must be bermed. Activities will not be implemented in the elevated areas of hillocks where caves are found. Depressions that are sinkholes will not contain bauxite. Hence, no mining activities will be carried out in these areas.	Minor & Irreversible
		Item GG3 – Potential impact of damage to sinkholes and caves within the SEPL 524:	None	Local & Negative	Low (Zero) & Direct	Sinkholes are at the bottom of a depression where mining will not be carried out because there are no bauxite deposits, neither will	Minor & Irreversible

[29] Benching: A ledge that, in open-pit mine and quarries, forms a single level of operation above which minerals or waste materials are excavated from a contiguous bank or bench face. The mineral or waste is removed in successive layers, each of which is a bench, several of which may be in operation simultaneously in different parts of, and at different elevations in, an open-pit mine or quarry. Source: *https://www.mindat.org/glossary/bench*

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						any haul roads be constructed which will traverse sinkholes and as such they will not be impacted. As is standard practice, during operations caves within SEPL 524 will be protected.	
Water Quality, Surface Water Hydrology and Groundwater							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	***Item WQ1*** –Contamination of water bodies by chemicals, waste streams or disposal activities associated with the development	Low & long -term	Local & Minor Negative	Low & Indirect	During haul road construction, allowances will be made for runoff to leave road sections at the earliest opportunity. The intention is to limit the accumulated volume of water on the road thereby reducing the opportunity for erosion and heavy silt loading. Generally, this will be done by appropriate super-elevation of the road and strategically placing breaks in berms to allow water to escape into adjoining company-controlled depressions. Within orebodies the general approach will be to confine runoff to the orebody by creating sumps at the bauxite/limestone contact, for collection and subsequent downward seepage of water through the limestone. Standard operating procedures for the control of runoff will be exercised where orebodies are located close to private lands or public roads, to ensure that there are adequate arrangements for collection of water and sediment within the orebody or in adjacent depressions away from the private lands/public road. Portable chemical toilets will be installed at the ore bodies. In most instances, the fueling of bauxite transport trucks and the service trucks are done on hard surfaces at the established contractors stations. As necessary, the transfer of fuel from the service trucks to the heavy equipment occurs at designated locations within the mining area. Service trucks as well as heavy equipment will be equipped with spill kits and spill containment apparatus.	Minor Reversible
Operations and rehabilitation	Humans	***Item WQ2*** –Water quality reduction to water collected from roofs and catchment that may have accumulated dust generated during the trucking of bauxite.	Moderate & Short-Term	Local & Minor Negative	Low & Direct	WINDALCO conducts assessments of complaints and provides compensation for fugitive dust fall and supply water to impacted households. The primary source of dust along the haul roads is from the road surface during dry periods. This is mitigated by increasing the frequency of wetting of the road surfaces from one to up to four times daily, as necessary, in addition, to the use of a dust suppressant.	Minor Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Air Quality							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	***Item AQ1*** – During site clearance and short term construction activities, there is a possibility that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring may dry out and result in fugitive dust formation which could be dispersed by the wind and affect air quality.	Moderate & Short -term	Local & Minor Negative	Low & Indirect	The physical and chemical characteristics of Jamaican bauxite are unique to the material, with relatively high natural moisture content (22 - 25%) and a very high angle of repose (>45 degrees). In addition, high cohesion of the material and shear strength of the soil makes it less likely to be spilled due to stress from vibration or wind. The primary source of dust along the haul roads is from the unwetted road surface during dry periods. This is mitigated by increasing the frequency of the wetting of the road surfaces from one to up to four times daily, as necessary, in addition, to the use of a dust suppressant. Bauxite therefore has a less likely potential for fugitive dust formation and it can be transported and stockpiled without wetting or covering. Further, there is no stockpiling proposed in SEPL 524 and the transportation time from ore body to disposal site is a maximum of 30 minutes. This time would be insufficient for the bauxite to dry out and generate fugitive dust. This potential impact will be avoided or mitigated by an effective dust suppression regime. Dust fall monitoring will be a feature of the environmental management programme. The dust suppression regime will include, at a minimum: • Wetting of roads with water • Trucks used in the transportation of bauxite will be covered. • Immediate removal of bauxite spillage from haul roads with the aim of reducing fugitive dusting. All stockpiled material will be vegetated if stockpiles are to be maintained for the medium to long term. Stockpiles will be removed in the shortest possible time. Storage of material with the potential for fugitive dust generation will be done far removed from sensitive receptors such as communities and commercial centers.	Minor Reversible
		Item AQ 2 – There is a potential for dust generation, especially during the dry seasons, as a	Low & Short-term	Local & Minor Negative	Low & Indirect	A dust suppression regime will be maintained for all active haul roads.	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
		result of movement of trucks along the haul roads. Some localized dust may also be generated in the immediate vicinity of the orebodies during mining activities. This may be assessed in terms of PM_{10} and TSP and may be the direct result of earthworks or the indirect result of operating earthworks machinery.					Reversible
		Item AQ3 – There is a potential for contamination of water tanks from fugitive dust	Low & Short-term	Local & Minor Negative	Low & Indirect	WINDALCO has developed specific methods to addressing these impacts. This include disconnection of water tanks from guttering and supply of fresh water to those citizens who may be impacted using tankers.	Minor Reversible
		Item AQ4 – Various mechanical equipment and vehicles are expected to be used at the project site. The heavy duty vehicles are expected to be primarily diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing a significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.	Low & Short-term	Local & Minor Negative	Low & Indirect	Heavy duty equipment and vehicles using diesel fuel must be properly maintained and inspected at regular intervals. As much as possible, all vehicular maintenance should be done at an approved off-site maintenance location such as a garage. Vehicles causing excessive emissions should be removed from service.	Minor Reversible
		Item AQ5 – The removal of vegetation from the site during site clearance activities may increase the potential for particulate matter to get into the atmosphere.	Low & Short-term	Local & Minor Negative	Low & Indirect	During site clearance activities, the area must be monitored and dust suppression techniques put in place as needed.	Minor Reversible
Noise							
Pre-operations, operations, rehabilitation	Humans and Fauna	***Item N1*** –Vehicles and site activities, and various mechanical equipment, can generate noise that may exceed acceptable levels.	Low & Long-term	Local & Minor Negative	Medium & Direct	Silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact the receptors.	Minor Reversible

7.2. Impacts to Biological Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Terrestrial Wildlife Resources							
Pre-operations, operations, rehabilitation	Fauna	***Item WR1*** – There exists a potential migration of wildlife resources within the immediate area of mining activities and haul road construction.	Low & Long-term	Local & Minor Negative	High & Direct	This migration is temporary. Any resident wildlife will temporarily migrate to nearby surrounding areas that are not affected. If identified during removal and relocation of vegetation, fauna will be carefully managed and returned to the wild or temporarily maintained in their habitats. The footprints of the operations will be strictly maintained to that which is unavoidable.	Minor Reversible
Terrestrial Vegetative Resources							
Pre-operations, operations, rehabilitation	Flora	***Item VR1*** –Removal of vegetation cover is unavoidable. This presents a potential loss of biodiversity within the immediate area. Established ecosystems will be disturbed. During the EIA, epiphytes, Wild Pine, Bromeliad and God Okra were identified.	Major & Long term	Local & Major Negative	High & Direct	The removal of vegetation and habitats is unavoidable and is the main trade-off to be made against the benefits to be derived from project implementation. Vegetation should only be removed within the design and operating footprints. Existing roadways and degraded areas will be utilized for use as haul roads. Protected, rare, threatened or endangered species of plants will be identified will be removed and relocated to areas that will not be affected by the operations or at WINDALCO 's greenhouses. Native trees should be used for rehabilitation.	Minor Reversible
		Item VR2: Fires as a result of accidents can damage vegetative cover within the hillocks.	Major & Long Term	Local & Major Negative	Low & Direct	No open flames policy for all operations within the development. Availability of firefighting facilities Training of staff to reduce potential of accidents and accidental fires.	

7.3. Impacts on Socio-Economic and Socio-Cultural Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Employment & Worker Health & Safety							
Pre-operations, operations, rehabilitation	Humans	***Item E&HS1*** – This project will provide employment opportunities during all phases of project implementation, which will include residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and operations there.	Major & Long-term	Regional & Major Positive	High & Direct	No mitigation required, though training may be essential for certain class of operations	Positive Irreversible
		Item E&HS2 – There are risks associated with any working condition. This is primarily important where workers interact with moving and heavy equipment.	Moderate & Long-term	Local & Minor Negative	Low & Indirect	WINDALCO 's Environmental Health and Safety policies and procedures will be implemented. Proper personal protective equipment (PPE) should be issued to workers. This should include boots, safety glasses, hard hats and reflective vest at a minimum. Job specific PPE will be administered based on job tasks such as Gloves, and Ear muffs as is necessary. Management should institute a standard annual health and safety retraining exercise for all categories of workers. Compliance audits and incident/injury records must be done on a periodic basis.	Positive Irreversible
Pre-operations, operations, decommissioning, rehabilitation	Humans	***Item E&HS3*** – Risk may arise where communities are in close proximity to mined out pits.	Major & Short Term	Local & Major Negative	Low & Direct	Where necessary, prior to the rehabilitation activities, effective barriers and proper signage will be installed at the mined out pits near to settlement areas to prevent unauthorized access and safeguard the public.	Positive & Reversible
Dislocation and Compensation							
Pre-operations, operations, rehabilitation	Humans	***Item H1***- There are defined settlement areas in the SEPL 524 area. These are mainly Tydixon, Grierfield, Harmony Vale, Ballimony, Drumily Fort George, Concorde and Pedro River. These areas will not be impacted by dislocation of households. There are also sparse settlements in the immediate area. There will be dislocation of some households in the sparse distributed settlements in the SEPL 524 area.	Minor & Short-term	Local & Minor Negative	Low & Direct	There will be minimal displacement of residential plots. As a result any perceived dislocation will be negligible at best. Dislocation will be mainly for farm lands and these will be relocated to areas that are not being mined at the time. Farmers presently travel as much as 5 km to their farms. Relocations will ensure that these distances are not exceeded. Further, mining progresses in a consecutive series of five (5) year Mining Plans. Every four (4) years a Mining Plan must be developed and submitted to the Commissioner of Mines for their review and approval prior to expiry of the previous (5) years Mining Plan. In each instance, before mining commences, the communities are advised far in advance	Positive & Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						and are provided with alternative lands (and other resources, as the case may require) to continue their farming activities. In the event that settlements will be impacted, WINDALCO will employ its relocation and/or compensation plans, as necessary. As far as practicable, the household(s) to be dislocated will be accommodated in the same community or as close as possible to the original community. Better quality amenities, facilities, physical infrastructure and utilities are provided to improve the standard of living and quality of life.	
Operations	Humans	***Item H2 –*** Relocation of graves in mining areas	Low & Short Term	Local & Minor Negative	High & Direct	If necessary, a policy and plan will be developed and implemented in consultation with and approval by the relevant authority.	Negligible & Irreversible
Heritage Sites							
Operations	Humans	***Item CH1*** – There are various Archaeological heritage sites in SEPL 524. There is the potential that some may be disturbed.	Major & Long-term	Regional & Minor Positive	Medium & Indirect	No declared heritage site facilities will be affected by this development. It is expected that a protocol will be agreed by the Regulatory Authority in consultation with WINDALCO for the minimization of potential impacts. As a part of this protocol, declared historical sites will be delineated. In the event that there is an archaeological find, WINDALCO's is obliged to act in keeping with the JNHT's Act.	Positive & Irreversible
Traffic							
Pre-operations, operations, rehabilitation	Humans	***Item T1*** – The potential for increased traffic and heavy equipment traversing Parish Council and main roads. Hauls roads constructed and operated by WINDALCO will be traversed in the delivery and removal of any materials, and equipment to and from the proposed site locations. Safety issue from public using haul roads.	Moderate & Long-term	Regional & Minor Negative	Medium & Direct	Impact on traffic will be negligible. The project does not propose to add significantly to the existing traffic volumes to the public roads. Intersections will be actively monitored and signs installed, where necessary. WINDALCO will officially close the road as required by law.	Minor & Reversible
Pre-operations, operations, rehabilitation	Flora	***Item T2*** – There exists the potential of deforestation as a result of increased access to the forested areas.	High & Long Term	Regional & Major Negative	Medium & Direct	Effective measures will be implemented to minimize access to haul roads. This will include, for example, community engagement, posting of signs and closing of the haul road when not in use.	Minor & Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Solid Waste							
Pre-operations, operations, rehabilitation	Humans	***Item SW1*** – Solid waste may be generated during site activities. If these waste streams are not properly managed then the potential exists for negative impacts.	Low & Short-term	Limited & Minor Negative	Low & Indirect	All solid waste generated during all phases will be collected, managed and disposed of appropriately. All heavy equipment operators will store solid waste generated and remove them to WINDALCO 's approved solid waste disposal site. WINDALCO waste management policy will be fully implemented.	Minor & Reversible
Sewage Waste							
Pre-operations, operations, rehabilitation	Humans and Fauna	***Item SeW1*** – Contamination of land and water by sewage waste pollution during site activities.	Low & Short-term	Limited & Minor Negative	Low & Indirect	The use of regularly serviced portable chemical toilets will negate this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans.	Minor & Reversible
Oil Spill Contingency							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	***Item OSC1*** – There is the potential for oil spill during site activities which can cause contamination of land and water resources.	Low & Long-term	Regional & Major Negative	High & Direct	Repairs and maintenance of vehicles and equipment will be done at designated sites, which consists of paved surfaces to prevent contamination and a drainage system. There will be no oil or lubricant storage in SEPL 524. Neither will there be any major maintenance of equipment or machinery in SEPL 524.	Minor & Reversible
Natural Hazards							
Pre-operations, operations, decommissioning, rehabilitation	Humans, Flora and Fauna	***Item NH1*** – WINDALCO 's staff, machinery and equipment may be impacted by natural hazards such as hurricanes, earthquakes, landslides, flooding and forest fires.	High & Long-term	Regional & Major Negative	High & Direct	The operations will be subjected to an approved Emergency Response Plan. In the event of a natural hazards the emergency response measures will be implemented. Training of all staff in the principles of the Emergency Response Plan	Negligible & Reversible

7.4. Cumulative Impacts to Communities in SEPL 524

Activity	Environmental Receptor	Potential Cumulative Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Community Health & Safety							
Rehabilitation in adjacent mining areas	Humans	***Item AQ1*** – Reduced air quality may result from the use of heavy equipment to shape mined out pits	Minor & Short-term	Local & Minor Negative	Low & Indirect	No mining will be done in SML 162 while mining is occurring in SEPL 524. A dust suppression regime is proposed. The dust suppression regime will include, at a minimum: • Wetting of roads with water • Immediate removal of bauxite spillage from haul roads with the aim of reducing fugitive dust. All stockpiled material will be vegetated if stockpiles are to be maintained for the medium to long term. Stockpiles will be removed in the shortest possible time. Storage of material with the potential for fugitive dust generation will be done far removed from sensitive receptors such as communities and commercial centers. Health centres in the communities will continue to operate to provide health care for the potential impacted residents.	Negligible Reversible
		Item AQ2 – Reduced air quality may result from movement of material within the rehabilitation zone	Minor & Short-term	Local & Minor Negative	Low & Indirect		
		Item AQ3 – Reduced air quality as a result of dispersion of dust from the surface of haul roads during the movement of trucks and heavy equipment	Minor & Short-term	Local & Minor Negative	Low & Indirect		
		Item HS1 – Risk may arise where communities are in close proximity to mined out pits and could contribute to air quality related illnesses.	Major & Long Term	Local & Major Negative	Low & indirect		Positive & Reversible
Terrestrial Vegetative Resources							
Pre-operations, operations, rehabilitation	Flora	Potential temporary loss of additional vegetative cover in an ecologically sensitive area contiguous to both SEPL 524 and SML 162	Low & Short-term impacts	Local & Major Negative	Low & indirect	No mining will be done in SML 162 while mining is occurring in SEPL 524. Vegetation should only be removed within the design and operating footprints. Existing roadways and degraded areas will be utilized for use as haul roads. Protected, rare, threatened or endangered species of plants identified will be removed and relocated to areas that will not be affected by the operations or at WINDALCO 's greenhouses. Native trees should be used for rehabilitation. Rehabilitation will be done to the standards, and within the time frame, stipulated by the Commissioner of Mines in compliance with the requirements of the Mining Act.	Minor Reversible

Activity	Environmental Receptor	Potential Cumulative Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Terrestrial Wildlife Resources							
Pre-operations, operations, rehabilitation	Fauna	The potential migration of wildlife resources from the region due to mining in SEPL 524 and that already conducted in SML 162.	Low & Long-term	Local & Minor Negative	High & Direct	No mining will be done in SML 162 while mining is occurring in SEPL 524. This migration is temporary. Any resident wildlife will temporarily migrate to nearby surrounding areas that are not affected. If identified during the removal and relocation of vegetation, fauna will be carefully managed and returned to the wild or temporarily maintained in their habitats, in agreement with NEPA. The footprints of the operations will be strictly maintained to that which is unavoidable.	Minor Reversible
Employment & Worker Health & Safety							
Pre-operations, operations, rehabilitation	Humans	***Item E&HS1*** – Mining in the SEPL 524 will provide employment opportunities during all phases of project implementation. This will include residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and operations there. Additionally, the rehabilitation of mined our orebodies in SEPL 524 will also provide employment opportunities.	Major & Long-term	Regional & Major Positive	High & Direct	No mitigation required, though training may be essential for certain class of operations	Positive Irreversible
Dislocation and Compensation							
Pre-operations, operations, rehabilitation	Humans	***Item H1***- The potential exists for dislocation when mining occurs in SEPL 524. If there was dislocation in SML 162, then any additional dislocation in SEPL 524 would increase within the region.	Minor & Short-term	Local & Minor Negative	Low & Direct	There will be minimal displacement of residential plots. As a result any perceived dislocation will be negligible at best. Dislocation will be mainly for farm lands and these will be relocated to areas that are not being mined at the time. Farmers presently travel as much as 5 km to their farms. Relocations will ensure that these distances are not exceeded. Further, mining progresses in a consecutive series of five (5) year Mining Plans. Every four (4) years a Mining Plan must be developed and submitted to the Commissioner of Mines for their review and approval prior to expiry of the previous (5) years Mining Plan. In each instance, before mining commences, the communities are advised far in advance and are provided with alternative lands (and other resources, as the case may require) to continue their farming activities.	Positive & Reversible

Activity	Environmental Receptor	Potential Cumulative Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						In the event that settlements will be impacted, WINDALCO will employ its relocation and/or compensation plans, as necessary. As far as practicable, the household(s) to be dislocated will be accommodated in the same community or as close as possible to the original community. Better quality amenities, facilities, physical infrastructure and utilities are provided to improve the standard of living and quality of life.	

7.5. Impact of Bauxite Mining on Water Resources

The water resources of Jamaica is of critical important to health, sanitation and national development. The association of Jamaica's bauxite deposits with the major limestone aquifer unit in the island, the White Limestone Group, makes impacts, if any, on water resources most crucial to avoid.

In Jamaica, despite mining bauxite for over 50 years there has not been any report of any negative impact on water resources, surface and ground waters, in terms of quality and quantity.

Mining of bauxite has been done in the watersheds and recharge areas of the Dunn's River, Cave River, White River and Laughlands Great and Little Rivers along the north coast. None of these rivers have shown any change in quality and or quantity. Along the south coast mining has taken place in the watershed and recharge areas of the Milk River, The Black River, the Alligator Hole River and St. Jago/St. Toolies Springs and to date despite mining continuing in these areas there has not been any change in water quantity and quality.

The clearing of forested land for mining is not a part of this project. Clearing of forested areas will be minimal and will expose the land surface to direct sunlight and will increase evaporation and modify micro-climate of the mining area. This clearing is not wide spread as only the deep deposits will be mined and the areas associated with these deposits will be cleared and there will be no clear cutting of large areas.

Sinkholes and caves typical of karst terrain will become more exposed and there will be a need to create buffer zones around these before mining to reduce possible blockage and infiltration of particulate material that may discolor water.

Cleared mining areas with loose soil may increase turbidity levels in the rainfall runoff from mining sites and could lead to increased turbidity of rivers and streams. In the SEPL 524 area there is no significant surface water resources to be contaminated. The small streams in the western section of the SEPL 524 near Bensonton needs to be buffered to ensure that rainfall overland flow does not enter the water sources.

It is not expected that mining sites will generate any liquid or solid waste that will affect water quality. In addition, fuel is not stored at mining sites so hydrocarbon spills affecting water resources is not anticipated.

The monitoring of groundwater resources using the twelve (12) Moneague Monitor wells drilled in the 1991-1993 period, to assess contamination of the White River Sub-basin by caustic leachate from Mt Rosser red Mud Lake, has accumulated nearly 30 years of water level and water quality data that can be analyzed prior to mining and with continued monitoring any changes can be detected.

7.6. Impact Matrices

Table 7-2: Impact Identification of the WINDALCO 's Mining Operation within SEPL 524

	Activities													
	Site Preparation				Construction					Operations (Mining)				
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Haul Road Construction	Solid Waste Disposal	Sewage Management	Surfacing	Landscaping	Material Sourcing	Materials Transport	Materials Storage	Traffic	Solid Waste Disposal
Physical Parameters														
TOPOGRAPHY														
GEOLOGY & GEOTECHNICAL														
AMBIENT NOISE & VIBRATION														
WINDS														
RAINFALL														
NOISE AND DUST														
DRAINAGE														
WATER QUALITY														
TEMPERATURE														
NATURAL HAZARD VULNERABILITY														
Ecological Parameters:-														
TERRESTRIAL ECOSYSTEMS														
TERRESTRIAL VEGETATION														
AVIFAUNA														
OTHER FAUNA														
SENSITIVE HABITATS														
Socio-Economic Parameters: -														
AESTHETICS														
LAND USE COMPATIBILITY														
EMPLOYMENT														
STRUCTURES/ROADS														
WASTE MANAGEMENT														
TRAFFIC														
HAZARD VULNERABILITY														

	Activities													
	Site Preparation				Construction					Operations (Mining)				
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Haul Road Construction	Solid Waste Disposal	Sewage Management	Surfacing	Landscaping	Material Sourcing	Materials Transport	Materials Storage	Traffic	Solid Waste Disposal
SEWAGE DISPOSAL														
OCCUPATIONAL HEALTH & SAFETY														

KEY

No Impact	
Minor Negative	
Major Negative	
Minor Positive	
Major Positive	

7.7. Risk Analysis and Risk Assessment

7.7.1. Introduction

This environmental risk assessment seeks to predict the likely impacts of the development of and operation of the mining area on the natural and built environment in relation to the consequences, which would occur in the event of a hazardous spill through impacts on the following receptors:

- ✓ human settlements,
- ✓ in the vicinity of caves,
- ✓ sinkholes

The hazards addressed in this report are associated with the accidental release of

1. Automotive Diesel Oil
2. Oils used for lubricants and hydraulic fluids in mining equipment and transportation

Hazards in this report are identified in relation to the hazardous materials mentioned above. The occurrence of at least one of these events is referred to as an incidence, and the likelihood of an event that can directly cause a spill is referred to as a potential incident.

The potential risks associated with the formation and dispersion of fugitive dust was also considered in this EIA. Dust from the industry arises from the transportation of bauxite on haul roads and the surfaces of dried out bauxite stockpiles. Dried bauxite is an inert, innocuous material and any potential risk associated with it is classified as a nuisance. There are standard methods and protocols, which have been used for several decades to mitigate this potential impact[30].

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[30] United Nations Environment Programme Industry and Environment Office prepared by Douglas, Conrad 1982; Environmental Aspects of Alumina Production: Guidelines for the Environmental Management of the World's Bauxite Alumina Industry

7.7.2. Hazard Identification

The following two (2) petroleum hazardous chemical to be used on the project are considered to be environmental hazards:

- Automotive Diesel Oil
- Motor oil

7.7.2.1. Petroleum

The two compounds have the potential hazards:

- ADO is flammable or explosive
- ADO can cause illness if inhaled or if contact is made with the skin or eyes or if smoke from flames is inhaled
- ADO and motor oil are toxic to aquatic life
- ADO and motor oil has the potential to impact negatively on various natural resources

Table 7-3: Physico-chemical characteristics of hazards identified, Oil

Physiochemical Characteristic	Automotive Diesel Oil	Motor Oil
Chemical Name	Petroleum	
Structural Formula	Hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C9 to C25 range	$C_{15} – C_{30}$
Molecular Weight	Variable because it consists of a wide range of substances of different molecular weight	Variable because it consists of a wide range of substances of different molecular weight
Aspect	Sticky, black liquid similar in appearance and smell to asphalt sealing compounds	Viscous liquid
Solubility in water	6.26 mg/L at 22°C	Insoluble in water
Concentration (%)	May have a composition of: 88% wt Carbon	

	10% wt Hydrogen 1% wt Sulphur 0.5% wt Water 0.1% wt ash	
Density	820-860 kg/m^3	886 - 898 kg/m^3

7.7.2.2. Determination of Risk to the Environment:

The risk of negative environmental impact resulting from accidental spillage of a hazardous material is pronounced where:

1. the accidental spillage occurs or result in consequences beyond the boundaries of the facility, and;
2. environmental factors, such as wind, ground infiltration, facilitate transport to resources or populations that are vulnerable.

The natural resources which could be affected by an incident at orebodies or along the transport route are:

- groundwater,
- surface ponds;
- vegetation, if fuel is ignited

7.7.2.3. Other Potential Risks

7.7.2.3.1. Structural Damage

There is the potential for damage to structures in close proximity in mining areas as a result of the vibration that may be caused by heavy equipment operations during mining.

In addition, community members have complained about loaded trucks having an impact on the integrity of housing structures in areas close to roads traversed by heavy duty vehicles.

Structural surveys are normally carried out prior to mining to determine their condition. After mining is completed, surveys are again carried out and if damage is done to the structures, there is appropriate compensation.

7.7.2.3.2. Air Quality

There is the potential for bauxite mining operations to negatively impact on air quality. For example, there is the potential for dust to be generated from unpaved haul road surfaces, especially during the dry season. As illustrated by data collected from the monitoring of SML 162, the risk is very low, as the data shows very good compliance with the air quality standards (See section 5.1.7.3 above). The breaches of the air quality standards for specific periods of time within SML 162 correlates with the Sub-Saharan Dust Plume. Fires, whether from spontaneous combustion of fire climax communities or manmade within the area also have the potential to impact negatively on air quality.

7.7.3. Impact Identification

The potential direct, indirect and cumulative impacts as a result of the mining operations to terrestrial and socio-cultural environments were assessed and described below.

The indirect or secondary impacts are changes that are usually less obvious, occurring later in time or further away from the impact source.

Cumulative effects, typically, result from the incremental impact of an action when combined with impacts from projects and actions that have been undertaken recently or will be carried out in the near or foreseeable future. These impacts may be individually minor but collectively significant because of their spatial concentration or frequency in time. Cumulative effects can accumulate either incrementally (or additively) or interactively (synergistically), such that the overall effect is larger than the sum of the parts. In conducting the cumulative assessment it has been noted that the surrounding economic zone comprises:

- Existing mining by WINDALCO - *producers of alumina*
- various land-based commercial shops, and
- farming

In the event of a spill, WINDALCO 's spill prevention plan involves initiating the immediate steps necessary to contain or divert releases away from surface water bodies and other sensitive receptors.

The indirect impacts of spillage of oil are the loss of habitat, loss of feeding ground, disruptions in natural life cycles.

7.7.4. Risk Analysis

The major consequence to the natural and built environment in respect of ADO and motor oil is identified on the basis of the minimum quantities of the substances that in the event that a spill should occur, require reporting to NEPA. In that regard, the risk evaluation reflects how any aspect of their operation may be assessed in relation to having to make a report to NEPA in the event of a spill. By extension, it also represents NEPA's a major safeguard to ensure compliance with NEPA's standards for the operation in relation to the potential of a spill event.

Table 7-4: Derived Hazard List Risk Analysis

	Hazard Identification			Consequences
Hazardous compound	**Hazard**	**Environmental Receptor**	**Activity**	
Automotive Diesel Oil and Motor Oil	Fire and Explosion	Humans	Spillage of oil during mining activities	✓ Health impartment – ○ air pollution, plume from fire dispersed to settlements in the air shed. ○ Skin damage due to contact with ADO on water and land ✓ Flora and fauna smothered – death to organisms ✓ Damage to houses and property from fires and explosion ✓ Loss of life in fires and explosion
		Terrestrial –Flora and Fauna		
	Environmental Damage	Built Environment	Spillage of oil during its transport via road	
		Terrestrial – Flora and Fauna	Spillage of oil during its storage	
		Ground water	Spillage of oil during its transport via road Spillage of oil during its storage	
	Health impairment	Humans	Spillage of oil during its transport via road Spillage of oil during its storage	

7.7.5. Risk to Water Resources

In an island state such as Jamaica with a high reliance on groundwater stored in karstic and highly permeable limestone aquifers which are very susceptible to contamination, the risk to water resources will be always be present. The issue is how great is the risk and how is the risk ameliorated or managed to minimize impacts.

Several potential risks to water resources associated with bauxite mining in the Rio Bueno - White River Watershed Management Unit have been set out by various stakeholders. These are:

1. Turbidity from erosion of cleared and excavated land and the use of unsealed roads and tracks
2. Hydrocarbon contamination through fuel spills from vehicles and machinery
3. Pathogen contamination due to increased human activity in the area
4. Pollution of the aquifer
5. Blockage of conduits
6. Erosion of the limestone leading to collapse of the limestone blocking caves and conduits and affecting flows.

7.7.5.1. Addressing the potential risks

- ✓ The wholesale clearance of land for bauxite mining is not done. Selective areas are cleared and no strip mining takes place only proven deep deposits are mined. There is always bauxite left atop the limestone that can filter out particulate material. The roads are compacted, hard and of low permeability to withstand the large trucks and with their heavy bauxite load traversing the roads. This may result in increased surface runoff but the volume will be small and can easily be absorbed by the highly permeable limestone.
- ✓ Refuelling of vehicles (tippers and Bowers) for bauxite transport and for transport of fuel to heavy equipment in the mines respectively, take place at a central area and not at the mine pit; the fuel/lubricant tanks at the central area have bunds around them that are at least twice the volume stored (NEPA's requirement). Emergency response plans in case of fuel spills have to be developed and will be approved by Office of

Disaster, Preparedness and Emergency Management (ODPEM). ***Hydrocarbon contamination of groundwater resources from bauxite mining operations has not been recorded in over 50 years of bauxite mining***

- ✓ The number of persons working at a mine pit is very small and consist primarily of heavy duty machinery operators. The vadose zone (above the water table) is so thick and devoid of oxygen (anaerobic conditions) that pathogens would not survive the travel time it takes to get to the groundwater table.
- ✓ There is no doubt that sinkholes in the limestone facilitate rapid drainage to the underground and may transport fine grained particulate material in suspension to the water table discoloring water and increasing turbidity. This has been noted in the Lluidas Vale NWC's well in St Catherine. However, it is very easy to identity sinkholes prior to mining and ensure buffer zones are created to prevent any infiltration of material. This was done during the construction of the NS highway link. In the over 50 years of bauxite mining along the south and north coasts there has not been any report of bauxite contamination of water from mining as seen in spring flows, well discharges and river systems. It is highly unlikely that this will occur in the Rio Bueno –White River WaterShed Management Unit if the ore bodies within the southeast area (SEPL 524 area) is mined.
- ✓ Blockage of conduits by infiltrating material has never been reported. The deposition of fine sediment within conduits have been reported in the limestone of Southern Clarendon to the point where an American student diving in a bluehole (Gods well) along the Canoe Valley area disturbed the sediments, lost her way in the turbid water and maze of conduits, ran out of air and drowned. However, the conduits were for all purposes 100% open and transmitting water.
- ✓ Flow in conduits do not obey Darcy's Law of laminar flow (smooth flow) but is known to be turbulent (high velocity) and compartmentalized. This flow does not allow for deposition of material which can only take place where the gradient is low (smooth, gentle flow) as seen in the geomorphology of streams where the deposition of fine material takes place where the flow is very gentle and smooth. The mining of bauxite will not introduce any greater concentration of particulate material that is of such coarseness to block conduits in the subsurface. The highest producing well in Jamaica

is located at Spring Plain at 1090 cubic metres per hour (4,000igpm ---imperial gallons per minute) and just south of Jamalco's mining area of St Jago-South Manchester. This well has been in existence for over 50 years and taps a conduit hence the high yield. A recent yield test of the well in 2015 by the National Irrigation Commission (NIC) indicate that the yield has not declined despite it being down gradient of the mining area. The bauxite in the South Manchester and Plateau area occurs atop a very high permeable limestone that has undergone significant karst development and its aquifer characteristics such as transmissivity, permeability and productivity far exceeds that of the north coast limestones which are finer grained and were deposited in a deepwater environment

- ✓ The dissolution of limestone is a very slow process that takes a long time (geologic time) to occur. There are instances of collapse of caves but these have been after many years of dissolution. These include Gods Well close to the Southern Clarendon/Manchester border along the Canoe Valley road and the one at Kellits in Northern Clarendon exposing the Piece River which flows from the remnants of the cave and disappears down a sinkhole. A review of the geology literature for Jamaica does not indicate any recent collapse feature and any resulting from bauxite mining.

The reasons not to mine bauxite in the Rio Bueno White River Water managemnet Unit is neither based on scientific information nor on the experience of bauxite mining in Jamaica and indicates a clear misunderstanding of bauxite-limestone relationship and limestone geology and processes.

7.7.6. Risk Associated with Excavation

The risk associated with excavation is potential slip and fall hazard. This risk is deemed as very low and is adequately mitigated with well trained staff and restriction of public access to these areas. In addition, appropriate signage is installed, and active orebodies and mined-out orebodies pending certification are patrolled by security personnel. The rehabilitation of orebodies that are located in close proximity to communities, are prioritized and accelerated by WINDALCO.

7.7.7. Risk of Deforestation

The risk of deforestation is insignificant to very low as there are no forested areas to be mined. No mining will be carried out in the Forest Reserves.

The vast majority of the hillocks within SEPL 524 will not be impacted from mining activities. Most haul road construction will be confined to the transition zones. Orebodies are located under grasslands that are rehabilitated according to the requirements of the Mines & Geology Division. Only 8.2%, or less (496.7 hectares), of the land area within SEPL 524 will be impacted over the estimated 25-years life of the project.

WINDALCO 's standard operating procedures ensure the protection and sustainability of these resources.

7.7.8. Risk to Changes in Landscape

Presently, the majority of the orebodies have been modified for anthropogenic activities including farming and commercial activities.

The risk to changes in landscape is therefore low. The removal of bauxite from the orebody will result in depressions being deeper. However, the rehabilitation activity will substantially return the landscape to its original characteristics.

The main risk to change in landscape is potentially due to the construction of the haul roads. However, haul roads will be constructed on existing pathways to minimize the extent of these landscape changes. These haul roads will be demolished and allowed to naturally recolonize, with the exception of those instances where the regulatory authority recommends the retention of any haul road to facilitate the socio-cultural and economic development of the surrounding communities.

7.7.9. Risk to Houses and Communities

In analyzing risks to houses and communities within the SEPL 524, the potential negative impacts that could lead to risks have been identified. These potentially are:

1. Vibration from heavy equipment use in orebodies and loaded trucks on the community roads
2. Elevated concentrations of air pollutants mainly suspended particulates as haulage tracks traverse haul roads.
3. Deposition of bauxite into artificial water catchment infrastructures (roofs, storage tanks, reservoirs with catchment)
4. Injury from accidents caused by haulage trucks
5. Potential injury from slip and fall into excavated areas.

The possibility of these potential negative impacts being encountered are very low. Anecdotal information exists for the complaints of communities relating to suspended particulates and water quality.

In the case of potential injury from slip and fall into excavated areas, Windalco secures active mining sites by installation of security personnel and appropriate signage at the mining area, thereby significantly reducing the risk of this occurrence.

Windalco should implement its community engagement programme to ensure that community issues are addressed in a timely manner. This includes the establishment of Community Councils and complaints register at the site.

8.0. Impact Mitigation

In the process of conducting this Environmental Impact Assessment (EIA), several potential impacts of the proposed project were identified and evaluated in section 7.0 above. The mitigative measures necessary to avoid, minimize or eliminate the potential impacts are described below.

8.1. Mitigation Methods

Some impacts identified have been deemed unavoidable and therefore no mitigative measures can be provided at this time. Although these are unavoidable during the operational life of the project, it must be emphasized that these are reversible once operations cease. These include:

- Change in land use from pasture land and farm land to mine area (will revert once rehabilitated),
- Displacement of biodiversity (can be replaced upon completion of rehabilitation)
- Loss of vegetation (easily replaced once operations cease),
- Temporary visual intrusion
- Increase in traffic

8.1.1. Aesthetics

In order to maintain the aesthetics of the project area, proper upkeep and maintenance of the site will be done. Epiphytes and any rare, threatened or endangered species will be removed and relocated to nearby areas that will be unaffected by mining operations or to a nursery managed and operated by WINDALCO . Land clearance will be limited to haul roads and orebodies. In addition, topsoil stripped during site clearance will be reused during rehabilitation of mined orebodies.

An Operations & Maintenance Plan will be developed and implemented so that the mining operations can be properly maintained.

Effective monitoring of solid waste storage and disposal will be put in place so that the potential for environmental pollution at the project site and its environs be minimized.

Cuts in the terrain will be made through benching. Selected haul roads will be removed and the land restored, as close as possible, to its original condition.

8.1.2. Geological and Geotechnical

Construction planning and monitoring should ensure that all agreed slope reinforcement and stabilization designs (if applicable) are properly implemented.

The limestone is hard and naturally mitigates against the requirement for slope reinforcement and stabilization.

The overall width of the road will be kept at a standard of 11 m and within prescribed contour elevations to eliminate land movement.

Where cuts exceed 6m, benching will be implemented.

The total SEPL 524 area of 6,839.9 hectares of which 496.7 hectares will be mined. This amounts to approximately 8.2% of the total area that may be impacted over the lifetime of the project.

Sinkholes are typically found at the bottom of a depression where mining will not be carried out. A sinkhole indicates exposed limestone fissures and indicates that the soil cover for this depression is non-existent. Therefore, it is highly unlikely to contain viable bauxite deposits. Since there is no bauxite, neither will any haul roads be constructed which will traverse sinkholes and as such they will not be impacted.

As is standard practice, during operations caves within SEPL 524 will be protected.

8.1.3. Water Quality, Surface Water Hydrology and Groundwater

During haul road construction, allowances will be made for runoff to leave road sections at the earliest opportunity. The intention is to limit the accumulated volume of water on the road thereby reducing the opportunity for erosion and heavy silt loading. Generally, this will be done by appropriate super-elevation of the road and strategically placing breaks in berms to allow water to escape into adjoining company-controlled depressions.

Within orebodies the general approach will be to confine runoff to the orebody by creating sumps at the bauxite/limestone contact, for collection and subsequent downward seepage of water through the limestone. Standard operating procedures for the control of runoff will be exercised where orebodies are located close to private lands or public roads, to ensure that there are adequate arrangements for collection of water and sediment within the orebody or in adjacent depressions away from the private lands/public road.

Portable chemical toilets will be installed at the ore bodies.

8.1.4. Air Quality

The physical and chemical characteristics of bauxite are unique to the material, with relatively high natural moisture content (25%) and a very high angle of repose (>45 degrees).

Bauxite therefore has a less likely potential for fugitive dust formation and it can be transported and stockpiled without wetting or covering. Further, there is no stockpiling proposed in SEPL 524 and the transportation time from ore body to disposal site is a maximum of 30 minutes. This time would be insufficient for the bauxite to dry out and generate fugitive dust.

As a result of movement of trucks, there is the potential for dust to be generated from unpaved haul road surfaces, especially during the dry seasons. However, this will not significantly impact ambient air quality. Trucks used in the transportation of bauxite will be covered. A dust suppression regime will be maintained for all active haul roads. In addition, dust fall monitoring will be a feature of the environmental management programme.

8.1.5. Climate Change

There will be a net positive increase in climate change mitigation over the lifetime of the project, as the carbon sequestration capacity of the rehabilitated mined out areas will be increased. This will take place through an increase in the size of the grasslands plus the planting of several trees in the vicinity. Furthermore, WINDALCO will establish greenhouses to store vegetation, epiphytes removed from the area for replanting later, and to produce crops on the rehabilitated lands.

In addition, water catchment and storage facilities will be created in some mined out bauxite pits using appropriate technology. This represents climate change adaptation. Safety measures will also be taken into account in these water storage facilities.

8.1.6. Noise

It should be noted that a significant majority of the SEPL is uninhabited. As a result sensitive receptors are not widespread within the mining areas.

However, silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact the receptors.

8.1.7. Terrestrial Wildlife Resources

This migration is temporary. Any resident wildlife will temporarily migrate to surrounding areas that are not affected.

If identified during removal and relocation of vegetation, fauna will be carefully managed and returned to the wild or temporarily maintained in their habitats.

The footprints of the operations will be strictly maintained to that which is unavoidable.

Further, mining is proposed for the orebodies and not the limestone hillocks, which hosts the highest level of biodiversity. The area to be impacted by mining activities and associated infrastructure, represents 8.2% of the land area containing orebodies. The 8.2% also includes the haul roads that must be constructed in order to gain access to and transport the bauxite ore.

8.1.8. Terrestrial Vegetative Resources

The removal of vegetation and habitats is unavoidable and is the main trade-off to be made against the benefits to be derived from project implementation.

Vegetation should only be removed within the design and operating footprints. Protected, rare, threatened or endangered species of plants identified will be removed and relocated to areas that will not be affected by the operations or at Windalco 's greenhouses. Native trees should be used for rehabilitation.

Windalco will plant suitable orchard crops or other trees along the alignment of the haul roads. These will provide an improvement in aesthetics, as well as a sound barrier to mobile equipment traversing these corridors.

Additionally the community stakeholders will be employed to assist with the planting of and maintenance of the trees, beginning with the creation of a nursery to support this programme.

8.1.9. Employment & Worker Health & Safety

No mitigation required, though training may be essential for certain class of operations

WINDALCO 's Environmental Health and Safety policies and procedures will be implemented.

Proper personal protective equipment (PPE) should be issued to workers. This should include boots, safety glasses, hard hats and reflective vest at a minimum.

Job specific PPE will be administered based on job tasks such as Gloves, and Earmuffs as is necessary.

Management should institute a standard annual health and safety retraining exercise for all categories of workers.

Compliance audits and incident/injury records must be done on a periodic basis.

Where necessary, prior to the rehabilitation activities, effective barriers and proper signage will be installed at the mined-out pits near to settlement areas to prevent unauthorized access and safeguard the public.

8.1.10. Dislocation and Compensation

There will be minimal displacement of residential plots because mainly farming occurs on the orebodies, presently. As a result, dislocation will be mainly for farm lands and these will be relocated to areas that are not being mined at the time. Farmers presently travel as much as 5 km to their farms. Relocations will ensure that these distances are not exceeded.

Further, mining progresses in a consecutive series of five (5) year Mining Plans. Every four (4) years a Mining Plan must be developed and submitted to the Commissioner of Mines for their review and approval prior to expiry of the previous (5) years Mining Plan. In each instance, before mining commences, the communities are advised far in advance and are provided with alternative lands (and other resources, as the case may require) to continue their farming activities.

In the event that settlements will be impacted, WINDALCO will employ its relocation and/or compensation plans, as necessary.

As far as practicable, the household(s) to be dislocated will be accommodated in the same community or as close as possible to the original community.

Better quality amenities, facilities, physical infrastructure and utilities are provided to improve the standard of living and quality of life.

In the event that there is a need for the relocation of graves in mining areas, a policy and plan will be developed and implemented in consultation with and approval by the relevant authority.

8.1.11. Heritage Sites

No declared heritage site facilities will be affected by this development. It is expected that a protocol will be agreed by the Regulatory Authority and WINDALCO for the minimization of potential impacts. As a part of this protocol, declared historical sites will be delineated.

In the event that there is an archaeological find, WINDALCO is obliged to act in keeping with the JNHT's Act.

8.1.12. Traffic

Impact on traffic will be negligible. The project does not propose to add significantly to the existing traffic volumes to the public roads.

Intersections will be actively monitored and signs installed, where necessary.

8.1.13. Establishment of Buffer Zones

This EIA is concerned with the area delineated within the boundaries of SEPL 524. In this regard, investigations were carried out to identify sensitive geomorphological features such as caves and sinkholes and historical heritage features, which have the potential of being impacted during mining activities. In order to protect these features, the following is being proposed:

8.1.13.1. Caves

Caves are features of the limestone bedrock and are found at high elevations within the hillocks. These play important roles as habitats in the ecology of the SEPL 524 area. Caves are not found within the orebodies.

To ensure the protection of caves during the construction and traversing of access roads, these roads will be constructed at least five (5) meters from the entrance of all caves identified within SEPL 524.

8.1.13.2. Sinkholes

Sinkholes are features of the karst limestone topography of the SEPL 524 area They may be present as exposed openings leading to caverns between the hillocks or may be unexposed since they covered by bauxite deposits. The mining of orebodies will not impact unexposed sinkholes as there is always bauxite left atop the limestone that may host the sinkholes. This layer of ore will filter out particulate material protecting water quality entering the groundwater infiltration network. However, the construction and operation of the access roads may pose potential threats for negatively impacting on sinkholes.

During our investigations, we did not observe any sinkholes in bauxite orebodies. Haul roads will be constructed at least 5 meters from the edge of any depression containing a sinkhole. The requisite engineering designs to protect the sinkholes from being conduits for sediment transport and potential blockage as a result of siltation must be implemented for all sinkholes that have the potential for being impacted by road construction.

8.1.13.3. Historical Heritage Sites of Significance

Heritage sites have been identified within the SEPL 524 area. The significance of these have been assessed by the JNHT and ranked in respect of protection or preservation, or permission to proceed with mining unhindered. WINDALCO will ensure that all heritage sites deemed significant by the JNHT are protected in compliance with the requirements of the JNHT Act.

There are no internationally stipulated buffers associated with the mining industry. However, we are recommending that any significant sites within SEPL 524 area be demarcated and a no mining buffer zone of no less than five (5) meters be established around each site.

8.1.13.4. Public and Private Infrastructure

Where road construction activity is being done close to sensitive areas such as public roads, private lands or occupied pasture on private land adjoining the construction site berms will be erected on the downslope side. This will be done to ensure that debris generated by the construction activity, does not roll onto these sensitive areas.

In the case of orebodies, boundaries will be established at the requisite 150 feet from the center line of public roads to ensure compliance with the statutory limits. Where bauxite extends from the target orebody onto adjoining private lands, limits will also be placed on the proximity of mining to ensure the integrity of private lands. At a minimum, mining boundaries will be placed 50 feet from private land boundaries where bauxite depth is shallow (<10 feet), with increasing offsets for increasing bauxite depth.

8.2. Restoration and Rehabilitation Plan

Rehabilitation will be done to the standards, and within the time frame, stipulated by the Commissioner of Mines in compliance with the requirements of the Mining Act. Orebodies will be rehabilitated within three years of them being certified mined out by the Commissioner of Mines representatives. All rehabilitated orebodies must be certified by the Commissioner of Mines. There are three main processes involved:

1. Backfilling/shaping
2. Topsoiling
3. Rehabilitation/planting

As required by the regulations of the Mining Act, the 1st 24 inch of topsoil is removed and placed in storage for later use in rehabilitation activities, after mining is completed. It should be noted that this layer of topsoil is rich in organics (humus) and soil moisture.

No mining will take place in the Forest Reserves.

Figure 8-1 to Figure 8-19 below show rehabilitation activities carried out by Windalco.

Figure 8-1: Mined out pit being leveled for reclamation and restoration

Figure 8-2: Reclamation Process – Contouring and Landscaping (Manchester)

Figure 8-3: Top soil hauled for use in the reclamation process

Figure 8-4: Restoration process – top soil placed (Manchester)

Figure 8-5: Restoration process – grass planted (Manchester)

Figure 8-6: Casava planted on restored land (Manchester)

Figure 8-7: Restored land used for farming and playfield – Moneague

Figure 8-8: Tenant farming on restored land (St. Ann)

Figure 8-9: Farming on restored land – Faith's Pen, St. Ann

Figure 8-10: Farming on restored land

Figure 8-11: Yam farming on restored land using environmentally friendly stake-free method

Figure 8-12: Housing development on restored land – Russell Place, Manchester

Figure 8-13: Houses on restored land

Figure 8-14: Housing development on restored land – Happy Content

Figure 8-15: Water catchment at greenhouse project site – Clapham, St. Ann

Figure 8-16: Greenhouse in Clapham, St. Ann

Figure 8-17: Inside greenhouse at Clapham, St. Ann

Figure 8-18: Water catchment at greenhouse site – Blue Mountain, Manchester

Figure 8-19: Greenhouses in Blue Mountain, Manchester

8.3. Residual Impacts

Any potential residual impacts ranked as moderate or major will be discussed in more detail in the subsequent text in the section addressed. The residual environmental impacts refer to the net environmental impacts after mitigation, taking into account the background environmental conditions and the impacts from existing, committed and planned projects.

The following table outlines the criteria used to assess environmental impacts in terms of minor, moderate, or major impact subsequent to mitigation measures being incorporated.

Table 8-1: Level of Impact after Mitigation Measures

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
Major	Degradation to the quality or availability of habitats and/or fauna with recovery taking more than 2 years	Change to commercial activity leading to a loss of income or opportunity beyond normal business variability/risk Potential short-term effect upon public health / well-being, real risk of injury	Concern leading to active campaigning locally or wider a field	Introduce measures to avoid these impacts wherever possible, closely monitor and control areas of residual impact
Moderate	Change in habitats or species beyond natural variability with recovery potential within 2 years	Change to commercial activity leading to a loss of income or opportunity within normal business variability/risk Possible but unlikely effect upon public health/well-being. Remote risk of injury	Widespread concern, some press coverage, no campaigning	Actively work to minimize scale of impacts
Minor	Change in habitats or species which can be seen and measured but is at same scale as natural variability	Possible nuisance to other activities and some minor influence on income or opportunity. Nuisance but no harm to public	Specific concern within a limited group	Be aware of potential impacts, manage operations to minimize interactions

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
Negligible	Change in habitats or species within scope of existing variability and difficult to measure or observe	Noticed by but not a nuisance to other commercial activities. Noticed by but no effects upon the health and well-being of the public	An awareness but no concerns	No positive intervention needed but ensure they do not escalate in importance
Positive	An enhancement of ecosystem or popular parameter	Benefits to local community	Benefits to stakeholder issues and interests	Actively work to maximize specific benefits

Ecological Effects

The residual impacts on the ecology are minor.

The rehabilitation of mined out areas is a requirement of which Windalco must comply. Therefore the residual impact on flora is minor and in some case positive. In one such positive case, the activities of Windalco will not increase access to the forested hillocks within SEPL 524 but improve the roadways because all these areas already have access routes.

The haul roads will improve access for all stakeholders, which will increase the potential of monitoring and enforcement by the regulators and security forces. This should reduce the potential for forest loss. Windalco will also be responsible for the management of access to the haul roads to be constructed. The areas will be actively monitored by Windalco.

The residual impact on the fauna is minor as the forested hillocks, which contains the highest levels of biodiversity will not be impacted by mining operations within SEPL 524.

Socio-economic Effects

The residual impact on employment & worker health & safety is positive. Skilled and unskilled workers will be engaged by Windalco who will also benefit from training provided by Windalco. It is expected that the workforce in the area will be improved.

Windalco typically establishes or upgrades health clinics within their mining areas. The residual impact will be positive as the members of the community will benefit from this development associated with the project.

As a result of the rehabilitation of the mining areas and handing over of roadways to the relevant authority for management, there will be no significant residual impacts on air and noise quality in the area.

The residual positive impact on development potential is also expected as a result of the improved access within the area.

Stakeholders

The establishment of community councils within the areas will foster more integration and harmony within the communities. This will be a positive residual impact.

Landscape

The cuts in landscape to facilitate haul roads will result in an irreversible change to the landscape in the area. This is a major residual impact.

The rehabilitation process and obligations are well established, actively and efficiently regulated, monitored and enforced by the Mines & Geology Division, NEPA and the Portfolio Ministry. The Mines & Geology Division certifies the rehabilitation of mined-out pits by a process of approval of Mining Plans, site inspections, approvals and certification. Windalco is required to comply with the requirements of all Mining laws.

9.0. Analysis of Alternatives

The following alternatives have been analyzed for the project:

- No Action Alternative
- The Proposed Mining Activity
- Location
- Technology

9.1. No Action Alternative

The 'No Action' or 'Do Nothing' alternative means that nothing will be done. This implies that the existing land use will remain in place. These are mixed land uses of floral grassland cover and its associated fauna, agriculture, commercial activities and a few residential structures. By doing nothing the environmental baseline and its setting and the attributes of the built and natural environment contained within SEPL 524 will also remain unchanged. Furthermore, Windalco will not have a supply of bauxite to support its mining and production operations.

9.2. The Proposed Mining Activity

The proposed mining of SEPL 524 will ensure the continued viability of Windalco's operations and bring the following benefits:

- Continued operations of the company for at least 20 years, thereby sustaining the current employment for both the mining and alumina productions processes.
- Windalco has the opportunity to expand its operations and generate further micro and macro benefits to Jamaica's Economic Growth & Job Creation policies, while at the same time making a significant contribution to environmental quality through the rehabilitation of lands and restoration of research plots for conservation best practices.
- Improved standard of living for residents that will be disturbed.

9.3. Location

The proposed activity at SEPL 524 is located adjacent to the existing SML 162. A change in location would therefore require additional economic considerations as all the supporting infrastructure for product delivery are in place at the present location. A new location would involve extension or reconstruction of all support services and infrastructure resulting in a much larger footprint for the project.

9.4. Technology

The only alternative to getting additional reserves of high gibbsite content bauxite is to upgrade the technology at the refinery. The upgrade would allow the refinery to utilize lower grades of bauxites, similar to what will remain in the SML 162 after 2021. The cost of completing this upgrade far outweighs the cost of construction related to mining within the SEPL 524. In addition, the time to complete the selected upgrade option of the refinery is also much longer than the 2-3 years duration envisaged with the completion of this project.

10.0. Environmental Monitoring and Management

The Monitoring Plan to be developed for the project should be implemented during site clearance and all operational aspects of the project. Monitoring involves the observation, review and assessment of onsite activities to ensure adherence to regulatory standards and the recommendations made to reduce negative impacts. The Plan must be comprehensive and address relevant issues, with a reporting component that will be made available to the regulatory agencies based on a mutually agreed frequency. It is recommended that a minimum monthly monitoring report be prepared and submitted to NEPA, if required.

The monitoring report will include at a minimum:

- Raw data collected
- Tables/graphs (where appropriate)
- Discussion of results with respect to the development in progress, highlighting parameters which exceed standards
- Recommendations
- Appendices with photos/data, etc.

At a minimum, the following basic activities will be monitored during specified phases of the project:

10.1. Site Clearance Phase Monitoring

- Where identified, endemic and rare species should be preserved in place or collected for transplanting.
- Stockpiles of soil and vegetative debris generated during site clearing activities should be monitored and maintained to eliminate generation of fugitive dust.
- If any cultural heritage resources are unearthed during construction, activities should be stopped and an Archaeological Retrieval Plan implemented.
- If any unexploded ordinance or other military materials are unearthed, work should be stopped immediately, the site vacated and professionals brought in to determine how to proceed.

- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding permitted standards.

10.2. Operations Phase Monitoring

- Sewage - Monitor the management of portable chemical toilets.
- Solid Waste - Monitor solid waste skips/dumpsters and removal contractor to ensure proper waste handling and disposal.
- Drainage - Regular inspections of drainage systems should be performed to ensure that the drains remain clear of blockages to safeguard against flooding or damage.
- Equipment staging and parking areas must be monitored for releases and potential impacts.
- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards.

10.3. Outline Environmental Monitoring Plan

The development of appropriate environmental management and monitoring programmes and methodologies are a vital part of the environmental management and monitoring controls of the Project. This section outlines the main environmental parameters to be monitored, timing of the monitoring work and the recommended frequency of monitoring.

The main objectives of the proposed management and monitoring protocols are:

1. to clarify and identify sources of pollution, impact and nuisance arising from the proposed works;
2. to provide an early warning system for impact prevention;
3. to provide a database of environmental parameters against which to determine any short-term or long-term environmental impacts;
4. to propose timely, cost-effective and viable solutions to actual or potential environmental issues;
5. to monitor performance of the mitigation measures;
6. to verify the EIA predicted impacts;

7. to collate information and evidence for use in public, NEPA, and any other required regulatory consultation; and
8. to audit environmental performance.

The proposed environmental monitoring will take the form of site inspection and supervision. The two main phases of the Project for which the proposed monitoring will cover are the baseline and operations phase.

Environmental monitoring for dust and noise during the short-term construction (haul roads), mining and other aspects of the project and operation phases is recommended in order to ensure all proposed mitigation measures are effectively implemented.

Obtaining a suitable and representative baseline data set will be critical to the whole monitoring and audit process because it forms the standard against which environmental impacts will be assessed.

The proposed parameters for monitoring at the project site are listed in Table 10-1 below.

Table 10-1: Framework for Environmental Monitoring Plan

Monitoring	Period	Parameters	Monitoring Frequency
Noise	Baseline	Leq (30 mins) GPS location	Measurements at selected locations (within and surrounding project site) to generate representative data
	Operations Phase	Leq (30 mins) GPS location	Measurements between 0700-1900 hours on normal weekdays once per week.
Air Quality	Baseline	PM_{10}, wind speed/ direction GPS location	Measurement (24-hour sampling) at selected locations once every six (6) days to generate representative data [31].

[31] Claude Davis & Associates, *NRCA Ambient Air Quality Guideline Document*, NEPA, p 4-13, November 2016

Monitoring	Period	Parameters	Monitoring Frequency
	Operations Phase	PM_{10}, wind speed/ direction GPS location	Measurements (24-hour sampling) at selected locations once every six (6) days to generate representative data. [32].
Water	Baseline	BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	Measurements to generate representative data
	Impact (during Operations)	Visual Survey of watercourses in area of active mining works and other areas with stockpiled materials on exposed ground surface BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	Bi- monthly during operations.
Waste	Baseline	Visual Survey of area around proposed sites	Prior to commencement of operations
	Operations Phase	Routine supervision of mining works	As per site inspection schedule
Landscape/ Visual Resources	Baseline	Remove and relocate protected, rare, threatened or endangered species of plants	Prior to commencement of operations
Chemical Waste & Control of Spills	Operations	Materials and chemicals that will be used during operations	Once per week during mining operations

Note (1): Should the operations schedule require works in restricted hours, monitoring in the form of 3 consecutive $L_{eq\ (5mins)}$ readings should be taken.

The following parameters will be monitored using internationally accepted standard practices:

- Noise
- Air Quality
- Water Quality
- Waste
- Landscape and Visual

[32] Claude Davis & Associates, *NRCA Ambient Air Quality Guideline Document*, NEPA, p 4-13, November 2016

- Soil Conservation
- Chemical Waste & Control of Spills
- Traffic and Access
- Environmental Management & Monitoring Responsibilities, and;
- Reporting

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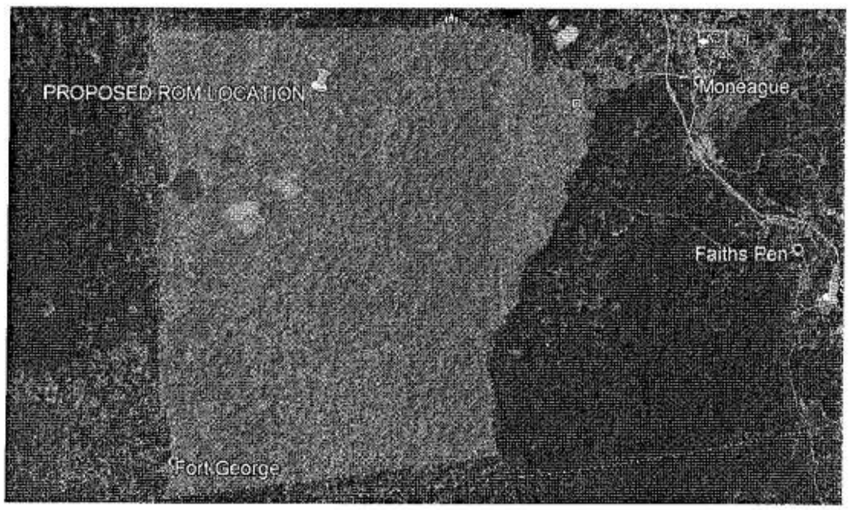
APPENDIX

DRAFT TERMS OF REFERENCE
FOR AN
ENVIRONMENTAL IMPACT ASSESSMENT

FOR THE

PROPOSED MINING AT SEPL 524
BY UC RUSAL JAMAICA LIMITED (WINDALCO)



PREPARED BY PETER WILSON-KELLY & ASSOCIATES ON BEHALF OF
RUSAL WINDALCO LTD.
DECEMBER 2019

APPLICATION SECRETARIAT BRANCH
DEC 09 2019
NEPA

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Foreword

The Terms of Reference (TOR) outlined below for an Environmental Impact Assessment (EIA) have been prepared upon the premise that, though the entire SEPL 524 will ultimately be explored and feasible areas exploited, the process in obtaining the detailed data for the **ecological services and biological environment specifically** will progress according to the areas where:

1. Ore bodies are located on Government and WINDACLO owned lands,
2. Haulage roads for bauxite transportation are to be constructed
3. Ore bodies on Private Lands and associated haulage and mining roads.

All other sections within the table of contents will be analysed in detail for the purposes of the EIA

Figure 1 below shows a site location diagram of the SEPL boundary in relation to known communities.

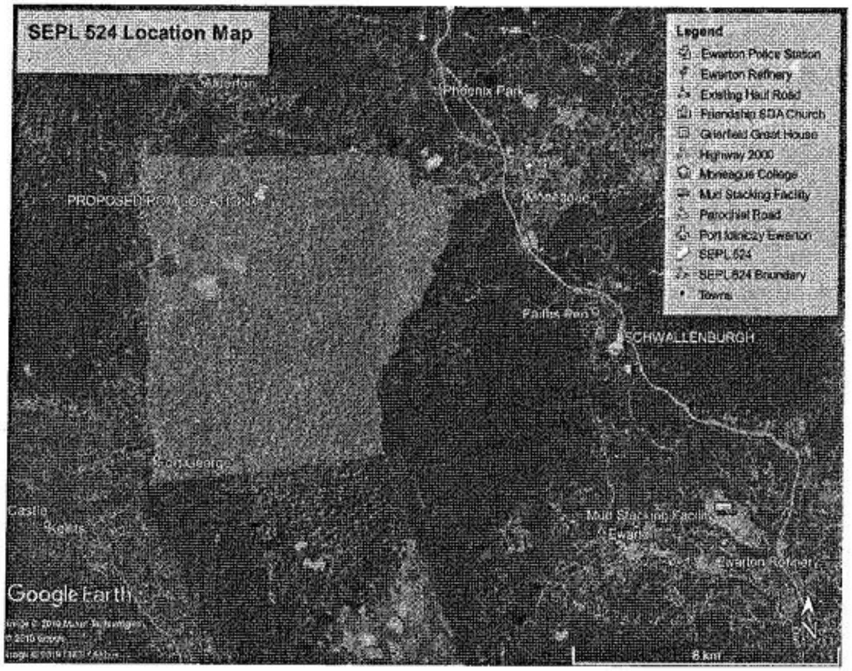

Figure 1: Site location Diagram of the SEPL Boundary In Relation To Known Communities

Figure 2 shows a land use/land ownership and ore body presence map of the SEPL boundary area. The SEPL is approximately 6837 hectares in size. The areas highlighted in purple and blue represent lands immediately available to WINDALCO for access and totals approximately 2729 hectares, or 40% of the overall SEPL area. Within this area, proving works have been conducted for ore presence and value. Approximately 24 million tonnes of ore have been proven to date, which would be enough to support operations for the next 12 years, at an extraction rate of 2 million tonnes per annum.

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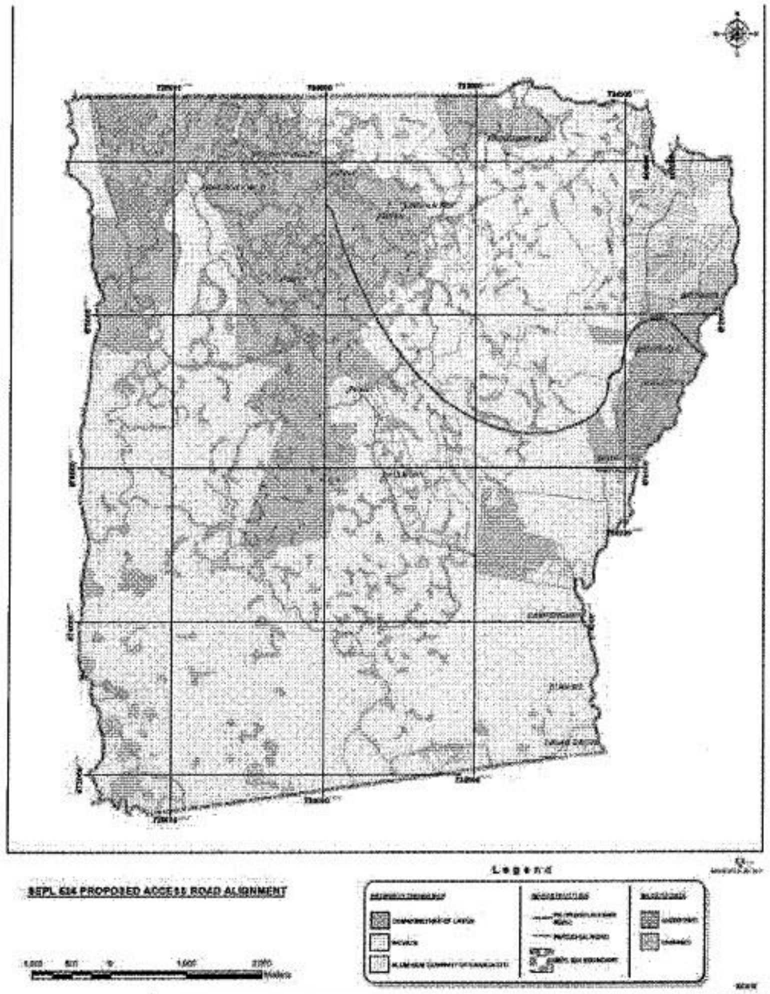

Figure 2: SEPL 524 Property Ownership and Proposed Haul Road Alignment

It would be the objective of WINDALCO to prepare a detailed EIA description within the areas owned by the Commissioner of Lands and Windalco shaded purple and blue respectively, which will be referred to as **Phase 1** of the project development. The footprint of the haul road depicted on Figure 2 will also be included in this phase. The remaining areas in yellow on Figure 2 are privately owned and obtaining access to these areas to prove the resources will require a long lead time and heavy capital investment, which will not be achieved in the short term. As we have a buffer of 12 years, we are proposing that these areas and their associated mining and haulage roads be regarded as **Phase 2** of the project development.

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Resources within the adjoining SML 162 are now at a critical stage of depletion and it is imperative that we advance the process of transfer to SEPL 524 to ensure the continued viability of our company. This further solidifies or proposal that our effort at generating environmental data to support our permitting process be generated in a phased basis, to coincide with the phased manner in which mining will be executed at the proposed location and in accordance with the undermentioned steps.

Phase 1 –

Step 1 – Baseline literature reviews and remote sensing based geological, climatic, topographical, demographic and floral characterizations for the entire SEPL and a 1 km buffer area stipulated in the Draft TORs submitted by NEPA, supported by preliminary ground truthing. The end result would be the generation of spatial characterization maps of the physical, environmental, land ownership, 5 year mining boundaries and socio-economic resources present within the area.

Step 2 – Execution of detailed flora and fauna evaluations in accordance with the area of the SEPL 524 that has been proven (purple lined areas on Figure 2).

Step 3 – The preparation and presentation of foreseeable impacts, mitigations and restoration plans specific to the proven areas within the SEPL 524.

Step 4 – Monitoring of restoration and evaluation of whether or not there are impacts emanating from mining areas within the first 5 year mining plan boundary to unmined areas within the Phase 1 development area and the generation of mitigations.

It is hoped that the current EIA requirements can encompass these steps, with the caveat that conditions be placed to establish and refine environmental evaluations, under a detailed pre/during/post mining monitoring plan for the proven area.

A permit would then be sought for the proven areas under Phase 1 of the development, based on the findings of the EIA. Upon establishment of proving for the unproven locations within the SEPL 524, it is hoped that a second phase of EIA requirements will then be implemented for the yellow-lined areas within the SEPL 524. This would be submitted as an addendum to the submitted EIA.

Phase 2 –

The following steps would pertain (compare with Phase 1):

Step 2 – Execution of detailed flora and fauna evaluations in accordance with the area of the SEPL 524 that will be proven outside of the Phase 1 boundary (Private properties)

Step 3 – The preparation and presentation of foreseeable impacts, mitigations and restoration plans specific to the proven areas within Phase 2 - SEPL 524.

Step 4 – Monitoring of restoration and evaluation of whether or not there are impacts emanating from mining areas within the first 5 year mining plan boundary to unmined areas within the Phase 2 development area and the generation of mitigations.

It is hoped that after the addendum to the EIA has been reviewed, an addendum to the permit can be obtained upon completion of the detail EIA requirements under phase 2 of the project development.

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The Terms of Reference to conduct the Environmental Impact Assessment are as follows:

1. Executive Summary

The Executive Summary will provide a brief statement on the content of the EIA report and will provide a comprehensive overview and objectives for the project proposal, natural resources and justifications for the project. It will also include relevant background information and provide a summary of the main findings, including main impacts and mitigation measures, analyses and conclusions in the report.

2. Introduction

The introduction will provide the context of the project and the EIA, the delineation and justification of the boundary of the study area, general methodologies being used as well as any assumptions and constraints of the study.

The study area will include the boundary of the SEPL 524 as well as an area within 1km radius of the boundaries of the proposed site. The EIA will also include:

- The purpose of the project, project proponent, brief description of the project – name, nature, size, location of the project, its importance to the country and the region
- Land description – land parcel (volume and folio/valuation number) street/scheme address, parish and total acreage of the land
- Profile of the project proponent, name and contact address with e-mail, implementing organization and project consultants, among others
- Windalco will confirm that the project meets the approved Terms of Reference and environmental and planning standards applicable for the project
- Windalco will declare any litigation pending against the proposed project and/or any direction or order passed by any court of law against the project, if so, details thereof will be provided.

3. Legislation and Regulatory Consideration

The study will outline all relevant 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 will include the Natural Resources Conservation Authority Act; the Mining Act; the Public Health Act; the Town and Country Planning Act; Building Act, Codes and Standards; the Wildlife Protection Act, the Watersheds Protection Act, the Water Resources Act, the Jamaica National Heritage Trust Act, The Forest Act, The National Solid Waste Management Act and any Regulations promulgated under any of the previously mentioned Acts; Development Orders and Plans and all appropriate international conventions /protocols/treaties where applicable.

4. Project Description

The project description will 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 will be addressed, including:

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- Description of the project site, level of existing land development, slope, transport and connectivity, demographic aspects, socio, cultural and economic aspects, communities and settlements
- Name and address of the owner of the land and the Title Deed Description of the land, as well as land tenure and use of immediately adjacent lands. A list of names and addresses of these owners will be provided, where available.
- Estimated life of the projected and planned production rate.
- A drainage assessment. This assessment will take into consideration existing natural drainage channels, proposed man-made drainage and water features or any proposed changes in topography. Potential issues of increased surface runoff and sediment loading must also be addressed. Special emphasis will also be placed on the storm water run-off, drainage patterns, characteristics of the aquifer, including the level and status of the groundwater.
- List of equipment and machinery to be used, how these will be mobilized and areas to be used for storage of machinery and material will be clearly indicated.
- **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 mining site, estimated mining rates, mining method, material transportation processes, required 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 mining areas, methods for rehabilitation, storage area locations (mining material, spoils, overburden/topsoil), zones requiring blasting, expected 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 ore body rehabilitation, 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.

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, including the exact location of the proposed development and will clearly identify the areas which will be used for mining, storage and stockpiling and haulage of material to the processing facility.

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- 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.
- Buffers and areas to be preserved in their natural state.
- Schematic plans, diagrams and drawings where relevant.
- Details of proposed access(es) to the site to be used for pre-development, development, operational and post operational phases
- Details on infrastructure development including design plans for all components of the development including road cuts, ROM, man-made drainages and water features, wastewater/sewage treatment systems and disposal of any treated effluent.
- Plans for the provision of utilities (potable water, electricity generation, roads and other services).
- Waste management for all aspects of waste generated during the execution of the mining process, to include earth works for road construction, maintenance wastes and disposal measures.
- 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 if necessary.
- Details of implementation time schedules, phased maps, diagrams and appropriate visual aids.

5. Description of the Environment

This section will involve the generation of baseline data which is used to describe the study area as follows:

i. Physical Environment
ii. Biological Environment
iii. socio-economic environment
iv. cultural and historical/archaeological environment
v. land ownership

The methodologies employed to obtain baseline and other data will be clearly detailed in the EIA and will 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 data collection process will be initiated with the collation of detailed literature reviews to be used as a basis for comparison with field-collected data. For field-collected data, 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.
d) **meteorology** - inclusive of wind speed and direction, precipitation, relative humidity and ambient temperatures.
e) **topography**

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f) soil

ii. Air quality in the area of influence including air emissions (e.g. TSP, PM10, NOx, SOx) from stationary or mobile sources. These descriptions will be informed by a review of the Natural Resources Conservation Authority Air Quality Regulations. The implications of the regulations on the proposed project will be ascertained.

iii. Water quality of any existing wells, rivers or ponds within the SEPL boundary area in general and in the mining areas specifically, will be ascertained, with water quality parameters to be evaluated being nitrates, phosphates, faecal coliform, biochemical oxygen demand, suspended solids, dissolved solids, turbidity and oil/grease.

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 mining.

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

A detailed description of the flora and fauna of the area will be made, with special emphasis on rare, endemic, protected or endangered species. In this section the emphasis will be 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 will include:

- A detailed quantitative assessment of floral assemblages in and around the proposed project sites and the areas of impact, to include the presentation of vegetation profiles trending from proposed ore bodies to adjoining hill areas.
- A detailed quantitative assessment of fauna associated with and around the floral assemblages present within the study area. This will include both diurnal and nocturnal assessments for relevant fauna.
- The identification of rare, endemic, protected or endangered flora and fauna species, as may be highlighted by initial literature reviews.
- Species dependence, relative abundance and measures of species diversity will be evaluated.
- The utilization of the bullet points above to define representative habitat maps of the area to outline relationships between floral characteristics and supported fauna.
- The presentation of species lists for both flora and fauna, representing relative abundance and numbers observed.
- The field data collected should include but not be limited to vegetation profile and a habitat map of the area.

5.5 Heritage

- The historical importance of the area should also be examined including identification of culturally significant features e.g. archaeological finds. An identification and mapping of the locations of artifacts, archaeological, geological and paleontological features for the site will be conducted.

5.6 Socio-economic Environment

Demography, regional setting, location assessment and current land-use patterns within; description of existing infrastructure such as transportation, electricity, water and telecommunications, public health safety; residences, shops, schools, cultural peculiarities, aspirations and attitudes will be explored; and other material assets of the area should also be examined. This will be gleaned from existing government-based census information as well as ground-truthed information.

The description will also include a socio-economic survey to determine public perception of the project, the direct and indirect economic sphere of influence of the current mining activities and a determination of public opinion on potential impacts on social, aesthetic and historical/ cultural values. This assessment will take the form of administered questionnaires.

The determination of whether or not any prescriptive rights including public access rights exist within the area will be conducted.

Finally, the existing economic land use and land tenure will be analyzed and discussed in relation to existing legislation, policies and development orders using a combination of secondary and primary data sources

5.6 Comparative Baselines – SML 162

Specifically chosen areas (mining, rehabilitated and undeveloped areas) within the adjoining SML 162 will be identified for the establishment of baselines examined for components identified under sections 5.1, 5.2 and 5.4. This data will serve to facilitate comparisons with areas within which the intended developments are already underway.

6. Public Participation

Public participation meetings for the presentation of EIA findings will be held in accordance with the National Environment and Planning Agency (NEPA) Guidelines for Conducting Public Presentation once NEPA and its supporting Agencies have conducted their internal reviews of the EIA and NEPA has agreed that such meetings can be held. The locations and times for such meetings will be determined with the input of NEPA. Additionally, all relevant documents, plans and maps etc. will be made available to the public at known and agreed on public spaces, such as churches, schools, libraries etc.

Any material change to the design of the project that may occur as a consequence of the review of the EIA will be presented at further public meetings and all changes made to the document should be clearly outlined to the public.

Verbatim minutes, lists of attendees, target groups etc. of every meeting conducted will be tabulated and presented as addenda to the EIA review process. Further, any issues identified during the public participation process will be summarized and incorporated or addressed in the EIA.

7. Impact Identification and Assessment/ Analysis of Potential Impacts

A detailed analysis of the project components will 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.

An evaluation of cumulative impacts (considering the proximity of the proposed development to similar developments being conducted in the adjoining SML 162) will be evaluated. Any identified cumulative impacts will be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental and public health issues will be noted and their relative importance to the design of the project and the intended activities will be indicated.
The extent and quality of the available data will be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts.

Project activities and impacts will be ranked as major, moderate and minor and presented in evaluation matrices within the EIA for all the phases of the project). NOTE. Impacts can either be POSITIVE or NEGATIVE and each will be evaluated where relevant.

The impacts to be assessed will be evaluated according to the following:

7.1 Physical Impacts

Impacts to be assessed will include impacts on:

1. Soil, hydrology and geology (site clearance, storm water runoff, loss of topsoil, potential erosion/slippage, change in drainage patterns, flooding risks (as it pertains to the site and the surrounding environs/communities), and ground water contamination.
2. Air (particularly in the context of the potential impact that the proposed development may have on communities through the generation of dust from mining, haulage and stockpiling).
3. Noise (exploratory drilling, blasting, haulage vehicular noise impacts).
4. Pollution (possible contamination of surface and subsurface resources from improper waste disposal, storm water runoff, sewage contamination, fuel, oil and lubricants);
5. The landscape (loss of character of the area, impact of excavation on aesthetics).
6. Major geological formations, such as sinkholes and caves
7. Water quality (pollution of potable, surface and ground waters)
8. Related to the creation of vibrations
9. Related to changes in drainage patterns
10. Carrying capacity of the proposed site
11. Impacts/demands/requirements of the following:

- Water supply

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- Drainage
- Sewage treatment and disposal
- Wastewater disposal
- Solid waste disposal
- Communications and other utility requirements
- Transport systems, traffic management and supporting infrastructure required
- Operation and maintenance – waste disposal, site drainage, sewage treatment and disposal solutions and air quality

7.2 Natural Hazard

The impact that natural hazards, namely, hurricanes, earthquakes, landslides and flooding can have on the development process will be evaluated.

7.3 Biological

The direct impact of haul road and mining activities on both flora and fauna resources will be assessed, with emphasis being placed on any rare, endemic, protected or endangered species that might be displaced within or adjoining the footprint of the mining area disturbance. Additionally, the indirect impact of any relevant physical impacts (listed under section 7.1 above) on biological resources found within the areas of those impacts will also be assessed.

7.4 Heritage

The potential for loss of and damage to artifacts, archaeological, geological and paleontological features within the footprint of any mining area, haul or mining road areas will be assessed.

7.5 Human/Social/Cultural

The effect of mining area development, mining activity and post mining rehabilitation works on the socio-economic status of the area will be assessed. Here is an example of where both negative and positive impacts may feature, with impacts ranging from those concentrated within the sphere of influence of the SEPL/SML boundary to that of the parish and national economy.

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 will be described as well as public perception as it relates to loss/gain of property value, loss/gain of aesthetic enjoyment and loss/gain of employment and other revenue earning potentials will 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) will be examined, in terms of what is the identified impact and proposed mitigation.

7.7 Risk Assessment

An analysis of any risks to the safety of persons within the sphere of influence related to the projected impacts identified during the studies will be conducted in order to:

1. Identify hazards
2. Assess the potential consequences
3. Assess the probability of the consequences
4. Present steps for risk mitigation.

8. Impact Mitigation

The mitigation measures will endeavour to avoid, reduce and remedy identified potential negative effects while at the same time enhancing the positive impacts projected. Mitigation and abatement measures will be developed for each potential negative impact identified. This will include recommendations for the enhancement of beneficial impacts (if identified), and quantify and assign financial and economic values to mitigating methods.

A statement is to be made on strategies that will be used to conserve energy and water in relation to this project. Additionally, international and local best practices, which have been accepted for the protection of sinkholes and caves in the past, will be employed to develop and delineate buffer zones for the protection of sensitive features such as caves, sinkholes and heritage sites as applicable.

A Site Rehabilitation and Restoration Plan will be required, which will indicate the extent and quantitative coverage, plant species and timeframe for implementation.

9. Residual Impacts

Any foreseeable residual negative impacts that potentially have no solution for mitigation (for example, changes in aesthetics, habitat loss, etc.) will be evaluated.

10. Analysis of Alternatives

Alternatives to the proposed development/project should be examined and these will be assessed according to the physical, ecological and socio-economic parameters of the site. The alternatives will be based around:

1. A no-action alternative, which would basically evaluate all of the impacts associated with not conducting the development of SEPL/SML 542.
2. A limited implementation option, which would be based on a rationalized implementation criteria set by WINDALCO, including 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.

11. Environmental Monitoring and Management

An environmental monitoring and management plan will be developed which will detail the requirements for exploration, operational, rehabilitation and decommissioning/closure phases of the project. A draft environmental monitoring programme will be included in the EIA for simultaneous review along with the EIA.

The monitoring programme will include:

- Introduction outlining the need for a monitoring programme
- The activity(ies) being monitored and the parameters for monitoring and reference standards.
- The locations of the areas being monitored, supported by similar monitoring data to be collected from established control sites for unmined and historically rehabilitated areas, the methodology and frequency of monitoring recommended.
- Raw data collected, supported by tables, graphs and maps will be used for the presentation process.

- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s) as well as presentations of recommendations for the management of any exceedances.
- Appendices of data and photographs if necessary.
- The name and qualifications of the person(s) proposed to undertake the monitoring programme
- Frequency of reporting to NEPA
- The proposed format that the monitoring reports will take

12. List of References

13. Appendices

The appendices will include 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. All findings will be presented in the EIA report and will reflect the headings in the body of the TORs, as well as, references. GIS references will be provided where applicable. One hard copy and an electronic copy will be submitted to NEPA for review after which ten (10) hard copies and an electronic copy of the report will be submitted. One copy of the document will be perfect bound.

The report will 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 will be properly sourced and credited.

Appendix II: Team Composition

The project team that carried out this Environmental Impact Assessment are as follows:

- **Dr. Conrad G.C. Douglas**, C.D., B.Sc., Ph.D. (Natural Sciences, Applied Chemistry & Process Engineering), MJIM, MJIE, *Project Director, Environmental Management*
- **Mr. Basil Fernandez,** C.D., BSc. (Geology & Hydrology) **-** *Team Leader, Hydrogeology and Hydrology*
- **Dr. Mark Richards, B.Sc., PhD –** Environmental Management, Air Quality
- **Mr. Vance Johnson**, B.Sc. (Pure & Applied Chemistry), M.Sc., (Environmental Engineering), P.E., Snr. Environmental Engineer –*Geographic Information System (GIS), Risk Assessment, Air Quality, Water Quality and Noise Quality Assessment*
- **Mr. Doran Beckford,** B. Eng. (Chemical Engineering), MBA, Dip. Bus. Admin., MJIEP, Snr. Process & Environmental Engineer – *Air Quality, Water Quality and Noise Quality Assessment, Economics*
- **Mr. Peter Wilson-Kelly,** BSc. (Hons), MPhil. - *Team Leader, Ecology*
- **Mr. Patrick Lewis**, BSc., MPhil (Botany), Botanist, Ecology
- **Ms. Leanne Green**, B.Sc. (Experimental Biology), Botany, Ecology Assistant
- **Mr. Justin Saunders,** BSc., Avi-fauna, Ecology
- **Mr. Gavin Campbell,** BSc. (Environmental Biology), M.Phil (pending), Arthropods, Ecology
- **Mr. George Waugh**, BSc. Environmental Biology, Ecology
- **Ms. Jha'neal James**, B.Sc., Biology & Science Education, Ecology
- **Mr. Delford Morgan**, BSc., MSc. (Physical Planning) – *Team Leader, Socio-Economic Baseline and Land Use Survey*
- **Ms. Melissa Douglas**, B.A. (UWI), LL.B. (Lond.), A.K.C. (Lond.), L.E.C. - *Policy and Regulatory Framework*
- **Ms. Ruth-Ann Lacey**, B.Sc. (Urban & Regional Planning), Environmental Management
- **Mr. Reece Adams**, B.Eng. (Chemical Engineering), Process & Environmental Engineer, *Air Quality, Water Quality and Noise Quality Assessment*
- **Mrs. Jheanelle James,** B.Sc. (Geography), *Socio-economic and Public Consultation Meetings*
- **Jamaica National Heritage Trust –** Historical Heritage Resources
- **Environmental Technicians, Socio-economic interviewers, scientific laboratories**

Appendix III: Approved Socio-Economic and Cultural Surveys

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SOCIO-ECONOMIC AND CULTURAL IMPACT ASSESSMENT SURVEY

West Indies Alumina Company are the applicant for environmental permit to mine bauxite in the Special Exclusive Prospecting License (SEPL 524). The SEPL 524 is approximately 6837 hectares of land located in southern St. Ann. It is bounded to the north by the community of Alderton in the north-west and Moneague in the northeast and by the parish boundary with St. Catherine and Clarendon to the south. Other towns such as Kellits, Fort George, Faith's Pen and Phoenix Park are all in close proximity to the boundaries of the SEPL 524.

Definition of SEPL: A Special Exclusive Prospecting License (SEPL) is license granted by the Government of Jamaica (GoJ) to grant access an area in which land has potential for mining. This license gives the holder all the rights, privilege and powers conferred by the Act. (Source: Mining Act 1947)

Community Name ______________________ Community Code ☐☐☐☐☐

Section 1: Respondent Characteristics

1) Sex: **Male** ☐ **Female** ☐
2) Age Range: **Under 20** ☐ **20-39** ☐ **40-49** ☐ **50-59** ☐ **60 & over** ☐
3) What is your level of educational attainment (at what level did you finish school)?
   Primary ☐ **Secondary/Junior High** ☐ **Vocational/Skills** ☐ **Tertiary** ☐ **None** ☐
4) Are you the head of your household? **Yes** ☐ **No** ☐
5) What is the size of your household? **1-2** ☐ **3-4** ☐ **5-6** ☐ **7-8** ☐ **9+** ☐
6) Where do you live? ____

Section 2: Knowledge/Views of WINDALCO and Proposed Bauxite Mining Operations

7) Were you aware of proposed plans by Windalco to mine bauxite in SEPL 524? **Yes** **No** ☐
8) If yes, how did you hear about it?
   Media **Government** **Consultant** ☐ **Community Member** ☐
   This Survey ☐ **Windalco Representative** **Other** ☐ ______________
9) What are your views on the mining of bauxite in the proposed SEPL area?
   ____
   ____
   ____
10) Which of the following **negative impacts** do you associate with the proposed SEPL and Bauxite Mining?
   Dust Pollution ☐ **Health Issues** ☐ **Loss of Land Resources** ☐
   Noise Pollution ☐ **Loss of Income** ☐ **Reduced Land Value** ☐
   Water Pollution ☐ **Destruction of Farms** ☐ **Damaged landscape/aesthetics** ☐
   Other ☐ ______________________________________

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11) What effect do you think the proposed activities will have on the following?

(Answer in terms of positive, negative, no change, doesn't know. ASK and WAIT)

i. Income/Economic value of the community

Positive ☐ **Negative** ☐ **No Change** ☐ **Don't Know** ☐

ii. Job Opportunities

Positive ☐ **Negative** ☐ **No Change** ☐ **Don't Know** ☐

iii. Pollution

Positive ☐ **Negative** ☐ **No Change** ☐ **Don't Know** ☐

iv. Health

Positive ☐ **Negative** **No Change** ☐ **Don't Know**

12) Which of the following **positive impacts** do you associate with the proposed SEPL and Bauxite Mining?

Employment ☐ **Improved Economy** ☐ **Increased Land Value** ☐
Support for Community Businesses ☐ **Increased Government Revenue** ☐
Funding for Community Projects ☐ **Other** ☐ ____________________

13) On a scale of 1-4 **(1 being not important and 4 being very important)**, how important do you think this project is to …national development? ____ community development? ____
Give reasons for your answer

____

____

____

14) Do you think the bauxite mining activities will affect you personally?
Yes ☐ **No** **Not Sure**
How? (explain nature of effect)

____

____

____

15) Do you think bauxite mining in the proposed SEPL area can potentially affect the community?
Yes ☐ **No** ☐ **Not Sure** ☐

How? (explain nature of effect)

____

____

____

16) What threats have you or your community faced from the past operations of Windalco?

____

____

17) How were the issues/concerns handled by Windalco?

____

____

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18) Does Windalco provide any support to the community?
Yes ☐ **No** ☐ **Not Sure** ☐

Explain____

<u>Section 3: Housing, Economic & Community Attributes</u>

19) What is your current employment status?
Full-Time ☐ **Part-Time** ☐ **Self-Employed** ☐ **Other** ☐

20) What is your occupation? ____

21) What is your **<u>monthly</u>** income?
Less than $50,000 ☐ **$50,001 - $100,000** **$100,001 - $200,000**
$200,001 - $400,000 ☐ **More than $400,000** ☐ **No Response** ☐

22) What is your main source of drinking water?
Indoor tap/pipe ☐ **Outdoor private tap/pipe** ☐ **Public standpipe** ☐
Spring/river ☐ **Rainwater (tank/drum)** ☐ **Trucked water (NWC)** ☐
Other ☐ **(specify)** ____________________

23) On a scale of 1-5 (***1 being very poor and 5 being excellent***), how would you rate the water supply in your community in terms of:

1. Quality __________ Give reason for rating ______________________________
2. Reliability __________ Give reason for rating ______________________________

24) What is the main source of lighting for your home?
Electricity ☐ Candles ☐ Kerosene Lamp ☐ Other ☐ ____________________

25) Do you currently **Own** ☐ **Lease** ☐ **Rent** ☐ the property on which you live?

26) Do you rely on the areas within or in close proximity to the proposed SEPL area for your livelihood? **Yes** ☐ **No** ☐

27) If yes, explain:

What?____

Where?____

How?____

When?____

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28) Do you currently **Own** ☐ **Lease** ☐ **Rent** ☐ any land within the proposed SEPL area?

29) Have you or any member of your household ever worked for Windalco or in the bauxite-mining industry? **Yes** ☐ **No** ☐ **Not Sure** ☐

30) Are you aware of any programs or activities initiated by the Windalco in your community?
Yes ☐ **No** ☐ **Not Sure** ☐

31) If yes, explain:
____
____
____

32) What do you like most about the community? ***(ASK & WAIT FOR RESPONSE)***
No crime/Violence ☐ **Clean Environment** ☐ **Availability of Farmland** ☐
Friendly People ☐ **Quiet** ☐ **Other** ☐ ____________

33) What don't you like about the community? ***(ASK & WAIT FOR RESPONSE)***
Poor Roads ☐ **Lack of Utilities** ☐ **Crime/Violence** ☐ **Unemployment** ☐
Dirty Environment ☐ **Not stated** ☐ **Other** ☐ ____________

34) On a scale of 1-5, how would you describe the traffic on the roads in your community? ___
(1 meaning low as in little to no traffic and 5 the highest as in very heavy vehicular traffic)

35) When is traffic the heaviest? **Morning** ☐ **Afternoon** ☐ **Night** ☐

36) What type of improvements do you think are needed in your community?
____
____
____
____

END OF QUESTIONNAIRE

Name of interviewer: ________________________

Signature of interviewer: ________________________

Date of interview: ________________________

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Appendix IV: The Wild Life Protection Act (Amendment of the Second and Third Schedules) Regulations, 2016

THE WILD LIFE PROTECTION ACT

The Wild Life Protection (Amendment of Second and Third Schedules) Regulations, 2016

In exercise of the power conferred upon the Authority by section 14 (2) of the Wild Life Protection Act, and of every other power hereunto enabling, the following Regulations are hereby made, with the approval of the Minister:-

1. These Regulations may be cited as the Wild Life Protection (Amendment of Second and Third Schedules) Regulations, 2016, and shall be read and construed as one with the Wild Life Protection Act (hereinafter referred to as the "principal Act") and all amendments thereto.

2. The Second and Third Schedules of the principal Act are repealed and the following substituted therefor –

"

SECOND SCHEDULE **(Section 2)**

Part I

Mourning Dove (Long-tailed Pea Dove)	*Zenaida macroura*
White-winged Dove	*Zenaida asiatica*
White-crowned Pigeon (Bald-pate)	*Patagioenas leucocephala*
Zenaida Dove (Pea Dove)	*Zenaida aurita*

Part II

Cattle Egret	*Bubulcus ibis*
Rock Dove (Pigeon)	*Columba livia*
Turtle-Doves (including Barble Doves and Collard-Doves)	*Streptopelia species*
European Starling	*Sturnus vulgaris*
Saffron Finch (Wild Canary)	*Sicalis flaveola*
House Sparrow	*Passer domesticus*
Yellow-crowned Bishop	*Euplectes afer*
Red Bishop	*Euplectes orix*
Nutmeg Mannikin	*Lonchura punctulata*
Tricolored Munia	*Lonchura malacca*
Chestnut Munia	*Lonchura atricapilla*
Great-tailed Grackle	*Quiscalus mexicanus*
Shiny Cowbird	*Molothrus bonariensis*
Chickens	*Gallus gallus*

Geese (excluding migratory species the genera Chen and Branta) *Anser spp.*	
Turkey	*Meleagris gallopavo*
Guinea fowl (all species in the family *Numididae*)	
Pheasants (all species in the Sub-family *Phasianinae*)	
Quails (all species of the Old World Quail in the Family Phasianidae and all species of New World Quail in the Family *Odontophoridae*)	
Pea fowl	*Pavo cristatus*
All species in the Order Psittaciformes excluding Black-billed Parrot (*Amazona agilis*), Yellow-billed Parrot (*Amazona collaria*), and Jamaican Parakeet (*Eupsittula nana*)	
Ducks excluding native and migratory species	
Swans (excluding migratory Tundra Swan *Cygnus columbianus*	
Toucans (all species in the Family *Ramphastidae*)	

THIRD SCHEDULE ***(Section 2)***

Mammals

Caribbean Monk Seal (Pedro Seal)	*Monachus tropicalis*
Baird's Beaked Whale	*Berardius bairdii*
Humpback Whale	*Megaptera novaeangliae*
Short-finned Pilot Whale	*Globicephala macrorhynchus*
Sperm Whale	*Physeter macrocephalus*
Bottlenose Dolphin	*Tursiops truncatus*
Pantropical Spotted Dolphin	*Stenella attenuata*
Jamaican Flower Bat	*Phyllonycteris aphylla*
Jamaican Red Bat	*Lasiurus degelidus*
West Indian Manatee	*Trichechus manatus manatus*
Jamaican Hutia (Coney)	*Geocapromys brownii*

Reptiles

American Crocodile	*Crocodylus acutus*
Atlantic Kemps Ridley	*Lepidochelys kempii*
Green Turtle	*Chelonia mydas*
Hawksbill Turtle	*Eretmochleys imbricata*
Loggerhead Turtle	*Caretta caretta*
Leatherback Turtle	*Dermochelys coriacea*
Jamaican Slider Turtle	*Trachemys terrapen*
Jamaican Iguana	*Cyclura collei*
Jamaican Skink	*Spondylurus fulgidus*
Yellow Snake / Jamaican Boa	*Epicrates subflavus*

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Amphibians	
Portland Ridge Frog	*Eleutherodactylus cavernicola*
Jamaican Earshot Frog	*Eleutherodactylus fuscus*
Cockpit Frog	*Eleutherodactylus griphus*
Rock Pocket Frog	*Eleutherodactylus junori*
Jamaican Stream Frog	*Eleutherodactylus orcutti*
Leaf Mimic Frog	*Eleutherodactylus sisyphodemus*
Insects	
Jamaican Kite Swallowtail	*Eurytides marcellinus*
Giant Swallowtail Butterfly	*Papilio homerus*
Clear-winged Butterfly	*Greta diaphana*
Fish	
Long-snout Seahorse/ Slender Seahorse	*Hippocampus reidi*
Corals	
Black Coral	*Antipathes species*
White Coral	*Scleractinia*
Wire Coral	*Cirrhipathes*
Sponge	
Sponge (*sclerosponge*)	*Ceratoporella nicholsoni* ".

Dated this 30th day of May, 2016.

Andrew Holness

Minister of Economic Growth and Job Creation

OFFICE OF THE PRIME MINISTER

3

Appendix V: Calibration Certificates (Air Quality Samplers)

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Conrad Douglas & Associates Limited
Kingston, Jamaica

Annual Instrument Service Report

April 2019

Report Date Of Issue : April 3, 2019

Report Prepared By : Alex Cooper & Nicholas Katapodis
Environmental Instrumentation Specialist

INTRODUCTION:

American Ecotech LC. was retained by Vance Johnson at Conrad Douglas & Associates Limited to perform annual instrumentation servicing/repairs on March 29, 2019. The purpose of the visit was to evaluate, repair and calibrate 7 Ecotech MicroVol 1100 air samplers, and one HiVol 3000 sampler. Conrad Douglas & Associates Limited maintains 7 MicroVol 1100 air samplers and one HiVol 3000 sampler. Alex Cooper & Nicholas Katapodis from American Ecotech were tasked with completing service and calibration on all air samplers maintained by Conrad Douglas and Associates Limited, during their visit.

This service was executed in accordance with American Ecotech's internal maintenance requirements manufacturer's recommendations.

The calibration records appear in Appendix A of this report.

1. Calibration Equipment

Calibration equipment used during the course of the service is regularly certified against NIST traceable standards and was current at the time of review (see table 1.1).

Table 1.1 Calibration Equipment

Parameter	Instrument	ID	Last Calibrated	Calibration Expiration
Pressure	Meriam M100	1129000081	02/18/19	02/18/20
Temperature	Vaisala HM34C	H4530001	02/19/19	02/19/20
Flow	Omega A2308	9274	08/08/18	08/08/19
Flow	Omega A2308	19676	05/18/18	05/18/19

2. Calibration Procedures

The annual service was performed using specific procedures and guidelines in accordance with the manufacturer's instructions for calibration and regular maintenance of the instrumentation. Detailed procedures used for specific calibrations can be obtained from the instrument manuals or from the manufacturer by request. Instrument performance was appraised with respect to the manufacturer's recommendations.

3. Monitoring Equipment Assessment

Unit #1
Ecotech MicroVol: 1100 sn: [06-0290]
Unit #2
Ecotech MicroVol: 1100 sn: [07-0396]
Unit #3
Ecotech MicroVol: 1100 sn: [07-0397]
Unit #4
Ecotech MicroVol: 1100 sn: [07-0816]
Unit #5
Ecotech MicroVol: 1100 sn: [07-0817]
Unit #6
Ecotech MicroVol: 1100 sn: [06-0289]
Unit #7
Ecotech MicroVol: 1100 sn: [14-0766]
Unit #8
Ecotech HiVol: 3000 sn: [10-0247]

3.1 Service Items Completed:

- Performed temperature checks on all equipment
  - Performed necessary adjustments
- Performed pressure checks on all equipment
  - Performed necessary adjustments
- Performed 3 point flow checks on all equipment
  - Performed necessary adjustments with 3 point calibrations

Summary:

MicroVol [06-0290]: Upon initial inspection, the Microvol was found in acceptable condition. The temperature sensor was checked, requiring calibration to remain aligned with the temperature reference standard. The pressure sensor was checked and required no adjustment. The flow sensor was checked and required adjustment to remain aligned to flow reference standard. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [07-0396]: Upon initial inspection, the sample inlet tubing was found to have considerable degradation due to weathering. Sample inlet tubing was replaced. The temperature sensor was checked and required no adjustment. The pressure sensor was checked and required no adjustment. The flow sensor was checked and required no adjustment. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [07-0397]: Upon initial inspection, the sample inlet tubing was found to have considerable degradation due to weathering. Sample inlet tubing was replaced. The flow sensor was found in an unresponsive state, and deemed defective. The flow sensor was replaced. The temperature sensor was checked and required no adjustment. The pressure sensor was checked and required no adjustment. The new flow sensor was checked, and required calibration to be aligned with the reference standard. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [07-0816]: Upon initial inspection, the Microvol was found in acceptable condition. The temperature sensor was checked and required no adjustment. The pressure sensor was checked and required no adjustment. The flow sensor was checked and required adjustment to remain aligned with the reference standard. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [07-0817]: Upon initial inspection, the Microvol was found in acceptable condition. The temperature sensor was checked and required no adjustment. The pressure sensor was checked and required no adjustment. The flow sensor was checked and required adjustment to remain aligned with the reference standard. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [06-0289]: Upon initial inspection, the Microvol was found in acceptable condition. The temperature sensor was checked and required no adjustment. The pressure sensor was checked and required no adjustment. The flow sensor was checked and required no adjustment. After calibration checks were completed, the Microvol was found to be in alignment with all reference standards.

MicroVol [14-0076]: Upon initial inspection, the sample inlet tubing was found to have considerable degradation due to weathering. Sample inlet tubing was replaced. The temperature sensor was checked and required no adjustment. The pressure sensor was checked, and required no adjustment. The flow sensor was checked, and required adjustment to keep it aligned with the flow reference standard. After calibrations were completed, the Microvol was found to be in alignment with all reference standards.

HiVol [10-0247]: The Hivol was in an acceptable condition with the calibration plate available for calibration. The temperature sensor was checked and required no adjustment. The pressure sensor was checked, and required no adjustment. The flow sensor was checked and required adjustment to remain aligned with the reference standard. After calibration checks were completed, the Microvol was found to be in alignment with all reference standards.

RECOMMENDATIONS:

Recommended parts for replacement in customer stock are as follows:

- Flow sensor – ZRU-10003312, (Customers last spare used to repair MicroVol [07-0397])
- Silicone Tubing – Microvol-TUB, (Customers has only enough for 1 more inlet replacement on site)
- Inlet Tubing Clip/Holders (x6) parts available upon request (to replace missing or corroded clips as needed)

Recommended preventative maintenance for the Ecotech Microvol 1100 Units are as follows:

- Monthly – cleaning of inlet head of dirt and dust
- Monthly – cleaning of impactor plate
- Monthly – replacement of silicon grease on impactor plate

A water U tube manometer should be utilized to verify flow rate on the HiVol before installing each filter for sampling.

APPENDIX A: CALIBRATION REPORTS

AMERICAN ECOTECH
Air Pollution Monitoring Systems

High Volume Air Sampler 3000 Volumetric Calibration Report

Customer	Conrad Douglas
Instrument	Ecotech HiVol 3000
ID No.	10-0247

Calibration Performed by	AC
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

Orifice Plate	464
Volumetric Orifice Const.	3.249

Digital Barometer	Vaisala HM34C
Digital Thermometer	Vaisala HM34C
Manometer	Meriam M100

Instrument Parameters - Pre Calibration

Flow Coeff 0		22.0510
Flow Coeff 1		-0.8520
Flow Coeff 2		5.8183
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	68.7
Press Coeff 1	168.7	168.7
WS Coeff 0		-
WS Coeff 1		-
WD Coeff 0		-
WD Coeff 1		-

Flow (m^3/hr)	67.7
Standard Temp (°C)	25.0

Standard Pressure (mmHg)	760.0
S/W Version	

Initial Audit

Displayed Temperature (°C)	Reference Sensor (°C)	Difference (°C)
29.864	29.1	0.8

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure (mmHg)	Reference Sensor (mmHg)	Difference (mmHg)
754.04	751	3.0

Must be less than 15 mmHg difference

PRESSURE	PASS

Displayed Flow (m^3/hr)	Manometer (kPa) 2	Calculated (m^3/hr)	Percent Error
67.7	98.5	72.7	7.3%

Must be within 10% of expected value

FLOW	PASS

Calculated Coefficients

	Coefficient 0	Coefficient 1	Coefficient 2
Temperature	0.3810	0.0178	0.0006
Pressure	71.7	168.7	

Flow Calibration

	Initial Pressure (kPa)	Initial Sensor (V)	Expected Press (kPa)	Final Press. (kPa)	Sensor (V)
Calibration Point 1 (60 m^3/hr)	98.90	2.56	99.02	99.00	2.4915
Calibration Point 2 (70 m^3/hr)	98.50	2.86	98.62	98.60	2.8141
Calibration Point 3 (80 m^3/hr)	98.10	3.18	98.15	98.20	3.0896

Final Audit

Displayed Temperature (°C)	Reference Sensor (°C)	Difference (°C)
29.82	29.2	0.6

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure (mmHg)	Reference Sensor (mmHg)	Difference (mmHg)
754.04	751	3.0

Must be less than 15 mmHg difference

PRESSURE	PASS

Displayed Flow (m^3/hr)	Manometer (kPa)	Calculated (m^3/hr)	Percent Error
67.7	98.7	68.0	0.5%

FLOW	PASS

Instrument Parameters - Post Calibration

Flow Coeff 0		14.4350
Flow Coeff 1		6.7232
Flow Coeff 2		4.6788
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	68.7
Press Coeff 1	168.7	168.7
WS Coeff 0		
WS Coeff 1		
WD Coeff 1		
WD Coeff 1		

Technicians Signature	Alex Cooper	Date	March 29, 2019

AMERICAN ECOTECH Air Pollution Monitoring Systems

Inlet Tubing Replaced

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	14-0076

Calibration Performed by	NK
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	19676	Yes	2
Temperature Reference Sensor	Vaisala HM40	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.399	1.3489	
Temperature	0.381	0.016	0.0007
Pressure	74.65	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
23.81	24.1	0.3

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
753.4	751	-2.4

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	2.04	2.09	4.1%
3	3	3	3.07	2.2%
4	4	4.01	4.10	2.5%

Must be less than 2% error.

FLOW	FAIL

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.25075	1.32428	
Temperature	0.38100	0.01581	0.00068
Pressure	72.25000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
24.22	24	-0.2

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
753.4	751	-2.4

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.95	1.99	-0.3%
3	3	2.92	2.99	-0.5%
4	4	3.96	4.05	1.2%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Nicholas Katapodis	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas		Calibration Performed by	AC
Model	Ecotech Microvol 1100		Date	3/29/2019
ID No.	07-0817		Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	9274	Yes	2
Temperature Reference Sensor	Vaisala HM34C	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.043	1.2174	
Temperature	0.381	0.0199	0.0008
Pressure	72.12	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
22.821	24.2	1.4

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
752.23	751	-1.2

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	2.02	2.07	3.2%
3	3	3.01	3.08	2.6%
4	4	4.05	4.14	3.5%

Must be less than 2% error.

FLOW	FAIL

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.01540	1.23294	
Temperature	0.38100	0.01877	0.00071
Pressure	70.89000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
22.531	23.9	1.4

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751.89	751	-0.9

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.94	1.98	-0.9%
3	3	2.93	2.99	-0.2%
4	4	3.96	4.05	1.2%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Alex Cooper	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	07-0816

Calibration Performed by	NK
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	19676	Yes	2
Temperature Reference Sensor	Vaisala HM40	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.419	1.3131	
Temperature	0.381	0.0196	0.0007
Pressure	67.66	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
25	25.8	0.8

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
752.2	751	-1.2

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	2.02	2.08	3.7%
3	3	3	3.09	2.8%
4	4	4	4.11	2.8%

Must be less than 2% error.

FLOW	FAIL

New Co-efficients			
	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.36855	1.32352	
Temperature	0.38100	0.01899	0.00066
Pressure	66.46000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
23.92	23.4	-0.5

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751.3	751	-0.3

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.96	2.00	0.0%
3	3	2.93	2.99	-0.4%
4	4	3.92	4.00	0.0%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Nicholas Kitapecka	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	07-0397

Calibration Performed by	AC
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	9274	Yes	2
Temperature Reference Sensor	Vaisala HM40	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.488	1.3578	
Temperature	0.381	0.0196	0.0008
Pressure	72.25	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
23.117	24.1	1.0

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
754.29	751	-3.3

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	2.17	2.22	9.9%
3	3	3.16	3.23	7.2%
4	4	4.19	4.28	6.6%

Must be less than 2% error.

FLOW	FAIL

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.31219	1.37467	
Temperature	0.38100	0.01880	0.00074
Pressure	68.96000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
23	24.8	1.8

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
754.29	751	-3.3

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.98	2.03	1.5%
3	3	2.92	2.99	-0.2%
4	4	3.96	4.06	1.5%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Alex Cooper	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	07-0396

Calibration Performed by	NK
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	19676	Yes	2
Temperature Reference Sensor	Vaisala HM40	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.274	1.2984	
Temperature	0.381	0.0193	0.0008
Pressure	68.89	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
24.472	24.4	-0.1

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751.19	751	-0.2

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	1.999	1.97	2.02	0.9%
3	3	2.92	2.99	-0.4%
4	4.006	3.92	4.01	0.2%

Must be less than 2% error.

FLOW	PASS

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.16316	1.26144	
Temperature	0.38100	0.01936	0.00080
Pressure	68.70000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
24.47	23.8	-0.7

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751.2	751	-0.2

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	1.999	1.94	1.98	-0.9%
3	3	2.92	2.98	-0.6%
4	4	3.91	3.99	-0.1%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Nicholas Katapodis	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	06-0290

Calibration Performed by	AC
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	9274	Yes	2
Temperature Reference Sensor	Vaisala HM34C	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.531	1.4078	
Temperature	0.381	0.0167	0.0007
Pressure	69.51	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
21.601	24.2	2.6

Must be less than 2°C difference

TEMPERATURE	FAIL

Displayed Pressure	Reference Sensor	Error
754.85	751	-3.9

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	2.02	2.07	3.2%
3	3	2.94	3.01	0.3%
4	4	3.93	4.02	0.5%

Must be less than 2% error.

FLOW	FAIL

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.25677	1.32496	
Temperature	0.38100	0.01491	0.00056
Pressure	65.66000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
24.08	23.5	-0.6

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
754.85	751	-3.9

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.97	2.01	0.5%
3	3	2.96	3.02	0.7%
4	4	3.97	4.05	1.3%

Must be less than 2% error.

FLOW	PASS

Technicians Signature	Allex Cooper	Date	March 29, 2019

AMERICAN ECOTECH
Air Pollution Monitoring Systems

Ecotech Microvol Calibration Report

Customer	Conrad Douglas
Model	Ecotech Microvol 1100
ID No.	06-0289

Calibration Performed by	NK
Date	3/29/2019
Location	Kingston, Jamaica

Calibration Equipment

	Model Number	ID Number	Standard Flow?	
Flow Calibrator	Omega FMA-A2308	19676	Yes	2
Temperature Reference Sensor	Vaisala HM40	H4530001	ST°C	21
Pressure Reference Sensor	Meriam M1	1129000081	SPtorr	760

Initial Displayed Instrument Parameters

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.28	1.2639	
Temperature	0.381	0.0188	0.0007
Pressure	68.96	168.7	

Initial Calibration

Displayed Temperature	Reference Sensor	Error
21.86	23.6	1.7

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751	751	0.0

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.97	2.01	0.6%
3	3	2.95	3.01	0.4%
4	4	3.96	4.04	1.1%

Must be less than 2% error.

FLOW	PASS

New Co-efficients

	Co-efficient 0	Co-efficient 1	Co-efficient 2
Flow	-1.27045	1.26455	
Temperature	0.38100	0.01741	0.00060
Pressure	68.96000		

Final Calibration

Displayed Temperature	Reference Sensor	Error
22.2	23.1	0.9

Must be less than 2°C difference

TEMPERATURE	PASS

Displayed Pressure	Reference Sensor	Error
751	751	0.0

Must be less than 15 mmHg difference

PRESSURE	PASS

Expected Lpm	Displayed Flow	Reference Flow	Actual flow	Error
2	2	1.96	2.00	-0.1%
3	3	2.97	3.03	0.9%
4	4	3.96	4.04	0.9%

Must be less than 2% error.

FLOW	PASS

Technicians Signature Nicholas Katapodis	Date	March 29, 2019

Appendix VI: Point Count data sheet

Observer:		Point Count #:	WayPoint #:	Start time:		
Date:		Site Name:		Wind (0-4):		
Weather (Circle one): Sunny Cloudy Rain Fog Other:						
	Period	Species	Detection?	New Record?	Distance Class	Notes
	1,2	TUVU (eg)	FO, H, S	Y/N	see below	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
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25						
26						
27						
28						
29						
30						

0 - Calm, smoke rises vertically
1 - Smoke indicates direction, still wind vanes
2 - Wind felt on face, leaves rustle
3 - Leaves/twigs constantly moving, light flags extended
4 - Dust, leaves, lifted, small tree branches move

Detection: FO = Fly Over
H = Heard
S = Seen

Distance Classes: 1 = 0-25 m, 2 = 26-50 m
3 = 51-100 m, 4 = >100 m

Created by J. Saunders
Last edit: 21-Aug-2019

Appendix VII: Flora Species List for SEPL 524 Area

Growth Habit	Species	Common Name	IUCN Listing	Abundance (DAFOR)	Average Height (m)	Average DBH (cm)
Trees	***Adenanthera pavonina***	Red Sandalwood	LC	F	5.1	25.0
	Alchornea latifolia	Dovewood, Lablab Tree	LC	O	6.2	21.0
	Bauhinia divaricata	Bull's Hoof	LC	F	5.5	15.0
	Bumelia nigra	Black Bullet	-	R	12.0	31.0
	Bursera simaruba	West Indian Birch, Copperwood	LC	R	8	29.0
	Calyptranthes sp.	-	-	A	2.3	4.0
	Cecropia peltata	Trumpet Tree	LC	A	11.5	30.0
	Ceiba pentandra	Silk Cotton Tree	LC	R	12	36.0
	Citrus sp.	-	-	O	4	17.0
	Clethra occidentales	-	-	F	4.1	21.0
	Coccoloba sp.	Maiden Plum	-	A	6.2	15.0
	Comocladia pinnatifolia	Angelica, Tree	-	A	4.3	6.1
	Dendropanax arboreus		-	F	5.7	10.5
	Erythrina corallodendron	Duppy Machete	LC	O	-	24.2
	Eugenia axillaris	Black Cherry	LC	F	2.4	3.1
	Eugenia sp.	-	-	A	2.4	-
	Ficus pertusa	-	LC	F	4.6	22.7
	Ficus sp.	-	-	O	-	-
	Hibiscus elatus	Blue Mahoe	LC	A	8	35.2
	Laetia thamnia	Scarlet Seed	-	O	-	14.6
	Lagetta lagetto	Lace Bark	-	O	7.1	20.4
	Mangifera indica	Mango	DD	R	6.2	32.1
	Metopium brownei	Burn Wood	LC	A	11.1	30.5
	Myrsine sp.	-	-	O	5.5	17.8
	Nectandra sp.	-	-	R	7.1	22.1
	Ocotea sp.	-	-	F	6.3	25.2
	Oreopanax capitatus	Woman Wood	LC	F	3.5	15.1
	Oxandra lanceolata	Black Lancewood	LC	O	6.7	17.2
	Phyllanthus montanus	-	NT	R	8.2	13.2
	Pimenta dioica	Pimento		O	3.2	14.1
	Pisonia aculeata	Wait-a-bit	LC	R	2.1	0.45
	Pithecellobium arboreum	Wild Tamarind	-	O	10.5	29.9
	Rauvolfia nitida	Glasswood	-	R	5.6	24.3
	Roystonea sp.	-	-	R	12.2	17.1
	Schefflera troyana	-	VU	R	8.7	21.2
	Sideroxylon foetidissimum		-	O	3.1	26.2

	Simarouba glauca	Bitter damsel	LC	F	8.1	23.0
	Spathelia sp.	Mountain Pride	-	F	11.2	20.1
	Spathodea campanulata	-	LC	O	-	-
	Terminalia latifolia	-	-	F	6.7	17.2
	Zanthoxylum martinicense	Prickly Yellow	-	D	6.9	21.2
Bromeliads	***Aechmea paniculigera***	**-**	-	O	0.8	-
	Guzmania lingulata	**-**	-	O	0.51	-
	Hohenbergia sp.	**-**	-	R	0.83	-
	Tillandsia fasciculata	**-**	LC	F	0.21	-
	Tillandsia bulbosa	**-**	-	R	0.15	-
	Tillandsia sp.	**-**	-	O	-	-
	Vriesea sp.	**-**	-	O	-	-
Aroids	***Anthurium grandifolium***	**Junction Root, Wild Coco**	-	O	0.7	-
	Philodendron lacerum	**-**	-	D	2.1	
	Syngonium auritum	**Five-Finger Jack**	-	D	2.1	-
						-
Orchids	***Campylocentrum jamaicensis***	-	-	O	0.14	-
	Tolumnia tetrapeltata	-	-	O	0.29	-
	Oeceoclades maculata	-	LC	O	0.25	-
	Epidendrum cochleatum	-	-	R	0.47	-
						-
Ferns	***Adiantum capillus- veneris***	**MaidenHair Fern**	LC	F	0.22	-
	Adiantum tenerum	**-**	-	R	0.13	-
	Blechnum occidentales	**-**	-	R	0.15	-
	Campyloneurum phyllitidis	**-**	-	D	0.61	-
	Nephrolepis sp.	**Cow Tongue Fern**	-	D	0.45	-
	Microgramma lycopodioides	**-**	-	R	0.07	-
	Polypodium polypoides	**-**		O	0.12	-
	Pteridium aquilinum var.	**Resurrection Fern**	-	R	0.62	-
	Caudatum	**Bracken Fern**	LC	O	-	-
	Pyrrosia sp.	**-**	-	R	0.31	-
	Tectaria sp.	**-**	-	R		
Herbs	***Asclepias curassavica***		-	F	0.50	0.31
	Bidens pilosa		-	F	0.21	0.22
	Bryophyllum pinnatum	**Leaf of Life**	-	O	0.32	0.42
	Clidemia sp.		-	R	0.25	0.21
	Desmodium incanum		-	F	0.16	-
	Desmodium triflorum		LC	F	0.17	-

	Eupatorium odoratum	**Jack in the Bush**	-	D	0.45	0.45
	Eupatorium villosum		-	O	0.43	0.33
	Dichondra sp.		-	R	-	-
	Hylocereus triangularis		LC	R	3.2	-
	Lantana camara	**White Sage**	-	D	0.45	0.33
	Leonitius nepetifolia	**Bald bush**	-	O	-	0.36
	Nicotiana tobacum	**Tobacco**	-	R	0.12	-
	Pseudorhipsalis ramulosa		LC	R	0.36	-
	Rhipsalis baccifera		LC	O	2.1	-
	Rhytidophyllum tomentosum	**Search Mi Heart**	-	A	1.2	0.89
	Sida acuta		-	O	0.31	0.23
	Stachytarpheta cayennensis	**Broomweed**	-	F	0.25	-
	Stachytarpheta jamaicensis		-	O	0.22	-
	Tradescantia spathacea		-	O	0.25	-
	Trimezia martinicensis	**Vervine**	-	R	0.29	0.14
	Varronia bullata		LC	R	0.35	0.22
	Wedelia gracilis	**Consumption Weed**	-	O	0.19	0.17
Vines	***Aristolochia sp.***		-	R	-	-
	Bidens reptans		-	O	-	-
	Cardiospermum grandiflorum		-	R	-	-
	Centrosema pubescens	Duppy Pumpkin	-	F	-	
	Cionosycios pomiformis	Velvet Leaf	LC	R	-	-
	Cissampelos pareira	Wild yam	-	R	-	-
	Dioscorea bulbifera		-	O	-	-
	Dioscorea polygonoides		-	F	-	-
	Galactica pendula		-	R	-	-
	Ipomoea triloba		LC	R	-	-
	Lisianthus longifolius		-	R	-	-
	Merremia umbellata		-	O	-	-
	Mikania sp		-	O	-	-
	Momordica charantia	Cerasee	-	R	-	-
	Passiflora foetida		-	R	-	-
	Passiflora rubra	Goat Hoof	-	F	-	-
	Passiflora suberosa		-	R	-	-
	Paullinia jamaicensis		-	A	-	-
	Rhynchosia phaseoloides		-	R	-	-
	Schlegelia parasitica		-	R	-	-
	Vitis tiliifolia		-	R		-
Shrubs	***Aciditon urens (E)***	Mountain Cowitch	-	F	0.70	0.34
	Ambrosia peruviana	Wild Tansy	-	D	0.62	0.41
	Bocconia frutescens	Johncrow Bush	-	O	0.33	1.10

	Cassia ligustrina	Piss a bed	-	O	1.3	1.23
	Cassia occidentalis	Dandelion	-	F	0.5	1.34
	Cestrum diurnum	Wild Jasmine	LC	O	2.1	4.5
	Clusia flava	Card Gum	LC	A	2.4	10.2
	Faramea occidentalis	Wild Coffee	-	R	2.3	5.5
	Hewittia scandens	-	-	R	1.3	-
	Miconia impetolaris	-	LC	R	1.6	0.91
	Miconia laevigata	White Wattle	-	A	0.8	0.25
	Mimosa pudica	Shame-mi-lady	LC	A	0.10	-
	Phyllanthus arbuscula	-	NT	R	1.7	-
	Piper amalago	Black Jointer	LC	D	2.1	3.2
	Piper umbellatum	-	-	R	0.45	-
	Pentalinon luteum	-	-	F	1.2	0.35
	Psidium guajava	Guava	LC	O	2.3	11.4
	Psychotria nervosa	-	LC	O	1.9	0.61
	Ricinus communis	Castor Oil	-	R	2.6	-
	Solanum capsicoides	Soda Apple	-	F	0.23	0.11
	Solanum erianthum	-	-	A	2.12	2.1
	Thrinax parviflora	Broom Thatch	-		0.7	-
Grass	***Bambusa vulgaris***	Bamboo	-	O	7.0	-
	Digitaria sanguinalis	-	-	F	0.03	-
	Lasciasis divaricata	-	-	A	0.40	-
	Panicum sp.	-	-	F	0.45	-
	Paspalum sp.	-	-	F	0.43	

Appendix VIII: Mammals Observed in the Study Area

Species	Common Name	IUCN Listing	Abundance (DAFOR)
Rattus norvegicus	Brown Rat	LC	-
Herpestes javanicus	mongooses	LC	-
Bats Detected by Audio Surveys in Study Area			
Pteronotus parnellii	Parnell's Mustached Bat	LC	A
Pteronotus macleayii	Macleay's Mustached Bat	LC	F
Noctilio leporinus	Greater Bulldog Bat	LC	F
Tadarida brasiliensis	Mexican Free-tailed Bat	LC	O
Molossus molossus	Velvety Free-tailed Bat	LC	O
Mormoops blainvillei	Antillean Ghost Faced Bat	LC	R
Eptesicus fuscus	Big Brown Bat	LC	R
Nyctinomops macrotis	Big Free-tailed Bat	LC	R

Appendix IX: Birds Observed During Day and Night Surveys Conducted at the Site

No.	Species List (endemic*)	Diet	4-Letter Code	DAFOR	IUCN
1	American Kestrel (*Falco sparverius*)	Insectivorous	AMKE	O	Least Concern
2	Antillean Palm Swift (*Tachornis phoenicobia*)	Insectivorous	ANPS	O	Least Concern
3	Arrow-headed Warbler (*Setophaga pharetra*)*	Insectivorous	ARRW	R	Least Concern
4	Bananaquit (*Coereba flaveola*)	Frugivorous	BANA	A	Least Concern
5	Black-Faced *Grassquit (Melanospiza bicolor*)	Herbivorous	BFGR	D	Least Concern
6	Black-necked Stilt (*Himantopus mexicanus*)	Insectivorous	BNST	R	Least Concern
7	Black-whiskered Vireo (*Vireo altiloquus*)	Insectivorous	BWVI	F	Least Concern
8	Cattle Egret (*Bubulcus ibis*)	Insectivorous	CAEG	O	Least Concern
9	Cave Swallow (*Petrochelidon fulva*)	Insectivorous	CASW	F	Least Concern
10	Chestnut-bellied Cuckoo (*Coccyzus pluvialis*)*	Insectivorous	CBCU	R	Least Concern
11	Common Ground Dove (*Columbina passerina*)	Herbivorous	COGD	R	Least Concern
12	Gray Kingbird(*Tyrannus dominicensis*)	Insectivorous	GRAK	R	Least Concern
13	Greater Antillean Bullfinch (*Loxigilla violacea*)	Herbivorous	GABU	A	Least Concern
14	Jamaican Crow(*Corvus jamaicensis*)*	Omnivorous	JACR	D	Least Concern
15	Jamaican Euphonia (*Euphonia Jamaica*)*	Frugivorous	JAEU	R	Least Concern
16	Jamaican Mango (*Anthracothorax mango*)*	Omnivorous	JAMA	R	Least Concern
17	Jamaican Oriole (*Icterus leucopteryx*)*	Omnivorous	JAOR	O	Least Concern
18	Jamaican Peewee (*Contopus pallidus*)*	Insectivorous	JAPE	R	Least Concern
19	Jamaican Spindalis (*Spindalis nigricephala*)*	Frugivorous	JASP	F	Least Concern
20	Jamaican Tody (*Todus todus*)*	Insectivorous	JATO	F	Least Concern
21	Jamaican Vireo (*Vireo modestus*)*	Insectivorous	JAVI	A	Least Concern
22	Jamaican Woodpecker (Melanerpes radiolatus)*	Insectivorous	JAWO	A	Least Concern
23	Killdeer (*Charadrius vociferous*)	Insectivorous	KILL	R	Least Concern

24	Loggerhead Kingbird (*Tyrannus caudifasciatus*)	Insectivorous	LOKI	D	Least Concern
25	Northern Mocking Bird (*Mimus polyglottos*)	Omnivorous	NOMO	F	Least Concern
26	Northern Potoo (*Nyctibius jamaicensis*)	Insectivorous	NORP	R	Least Concern
27	Olive-throated Parakeet (*Aratinga nana*)	Herbivorous/Frugivorous	OTPA	A	Least Concern
28	Orangequit (*Euneornis campestris*)*	Frugivorous	ORAN	F	Least Concern
29	Prairie Warbler(*Setophaga discolour*)	Insectivorous	PRAW	R	Least Concern
30	Red-Billed Streamertail (*Trochilus polytmus*)*	Omnivorous	RBST	F	Least Concern
31	Rufous-tailed Flycatcher (*Myiarchus validus*)*	Insectivorous	RFTF	O	Least Concern
32	Ruddy Quail Dove (*Geotrygon montana*)	Granivorous	RUQD	R	Least Concern
33	Saffron Finch (*Sicalis flaveola*)	Herbivorous	SAFI	R	Least Concern
34	Shiny Cowbird (*Molothrus bonariensis*)	Insectivorous	SHCO	R	Least Concern
35	Smooth-billed Ani (*Crotophaga ani*)	Insectivorous	SBAN	F	Least Concern
36	Stolid Flycathcer (*Myiarchus stolidus*)	Insectivorous	STOF	O	Least Concern
37	Turkey Vulture (*Cathartes aura*)	Omnivorous	TUVU	A	Least Concern
38	Vervain Hummingbird (*Mellisuga minima*)	Insectivorous	VEHU	R	Least Concern
39	White-chinned Thrush (*Turdus aurantius*)*	Omnivorous	WCTH	O	Least Concern
40	White-eyed Thrush (*Turdus jamaicensis*)*	Omnivorous	WETH	R	Least Concern
41	White-Crowned Pigeon (*Patagioenas leucocephala*)	Herbivorous	WCPI	F	Near-Threatened
42	White-winged Dove (*Zenaida asiatica*)	Granivorous	WWDO	O	Least Concern
43	Yellow-Billed Parrot (*Amazona collaria*)*	Omnivorous	YBPA	R	Vulnerable
44	Yellow-faced Grassquit (*Tiaris olivaceus*)	Herbivorous	YFGR	A	Least Concern
45	Yellow-shouldered Grassquit (*Loxipasser anoxanthus*)	Herbivorous	YSGR	A	Least Concern
46	Zeneida Dove (*Zenaida aurita*)	Herbivorous	ZEDO	F	Least Concern

Appendix X: Bird Species List per Transect Site

Study Site	1	2	3	4	5	6	7	8	9	10	11	12	13
Species per site, 4-Letter Alpha Codes	ANPS	BFGR	ARRW	BANA	ANPS	ANPS	CASW	BFGR	BANA	BFGR	JACR	BANA	BFGR
	BANA	JACR	BANA	BFGR	BFGR	BFGR	JACR	CASW	COGD	BWVI	JAMA	BFGR	CASW
	GABU	JAEU	BFGR	CAEG	COGD	COGD	JAVI	JACR	GABU	COGD	JASP	BWVI	GABU
	JACR	LOKI	GABU	GABU	GABU	GABU	LOKI	LOKI	JAVI	JACR	JAVI	JACR	JAVI
	JASP	OTPA	JACR	JACR	JACR	JACR	NOMO	NOMO	LOKI	JATO	LOKI	JATO	JAWO
	JATO	RBST	JAEU	JASP	JAOR	JAOR	SBAN	SBAN	SBAN	LOKI	NOMO	JAVI	LOKI
	JAVI	ZEDO	JAVI	JAWO	JAVI	JAVI	YSGR	WWDO	TUVU	NOMO	OTPA	JAWO	RBST
	JAWO		LOKI	LOKI	LOKI	LOKI			YFGR	ORAN	TUVU	LOKI	RUQD
	LOKI		RBST	OTPA	OTPA	OTPA			ZEDO	TUVU	YFGR	NOMO	SBAN
	ORAN		RTFL	RBST	RBST	RBST				WCPI		ORAN	TUVU
	RBST		VEHU	SBAN	TUVU	TUVU						RBST	
	TUVU		WCPI	TUVU	WCPI	WCPI						STOF	
	ZEDO		WCTH	TUVU	YFGR	YSGR						TUVU	
			WETH	WCPI	YSGR	ZEDO						WCPI	
			WWDO	YSGR	ZEDO	YFGR						YFGR	
Total	13	7	15	15	15	15	7	7	9	10	9	15	10

Bird Species List per Transect Site Cont'd

Study Site	14	15	16	17	18	19	21	21	23	25
Species per site, 4-Letter Alpha Codes	BANA BWVI CAEG JACR JAEU JAVI OTPA RBST STOF WCTH	BWVI JACR JAPE JAVI JAWO NOMO OTPA WCPI WWDO YFGR	BANA BFGR COGD YFGR JATO JAVI JAWO ORAN RBST YFGR	BANA BFGR BWVI CASW GABU JACR JAVI JAWO LOKI NOMO OTPA YFGR	BANA BFGR BWVI GRKI JASP JATO JAVI JAWO AMKE ORAN OTPA RBST TUVU YFGR YSGR	BANA BFGR JACR JASP LOKI OTPA PRAW RBST RTFL STOF WWDO YFGR	BANA BFGR GABU JACR JAEU JAWO LOKI SBAN WCPI YFGR	BFGR BNST CAEG CASW GABU KILL LOKI NOMO SHCO	AMKE GRKI NOMO	AMKE CASW GRKI NOMO
Total	10	10	10	12	15	12	10	9	3	4

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Email: bab78@cornell.edu
Postal Address: Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY, 14850.

Appendix XII: Amphibians and Reptiles Lists for Hillocks and Lowlands in Study Area

Species	Common Name	IUCN Listing	Abundance (DAFOR)
REPTILES			
Anolis garmani	Giant Anole	LC	O
Anolis grahami	Turquoise anole	LC	F
Anolis opalinus	Opal Anole	LC	D
Anolis lineatopus	Gray anole	LC	O
Anolis sagrei	Brown anole	-	F
Aristelliger praesignis	Croaking Lizard	LC	A
Celestus crusculus	Common Galliwasp	LC	R
AMPHIBIANS			
Eleutherodactylus johnstonei	-	LC	D
Eleutherodactylus gossei	-	LC	A
Eleutherodactylus luteolus	-	EN	R
Rhinella marina	Cane Toad	LC	O
Osteopilus crucialis	Snoring Frog	EN	R

Appendix XIII: Gastropods Observed in Hillocks in Study Area

Species	Common Name	IUCN Listing	Abundance (DAFOR)
Thelidomus cognata	-	-	O
Pleurodonte peracutissima	-	-	O
Sagda foremaniana	-	-	O
Achatina fulica	*Giant African Snail*	-	O
Pleurodonte amabilis	-	-	O
Orthalicus undatus	-	-	O
Pleurodonte candescens	-	-	O
Pleurodonte invalida	-	-	O
Pleurodonte sp	-	-	F

Appendix XIV: Arthropods for Hillocks and Lowlands in Study Area - Order Lepidoptera

Species	Common Name	IUCN Listing	Abundance (DAFOR)
Anartia jatrophae saturata	White Peacock	-	O
Atlantea pantoni	Jamaican Checkerspot	-	O
Eurema sp.	Grass Yellow	-	O
Glutophrissa drusilla castalia	Florida White	-	O
Agraulis vanillae	Gulf Fritillary	-	O
Heliconius charithonia simulator	Zebra Heliconian Longwing	-	O
Heraclides andraemon andraemon	Bahaman Swallowtail	-	O
Historis acheronta cadmus	Tailed Cecropian	-	O
Junonia zonalis	Tropical Buckeye	-	O
Mestra dorcas	Jamaican Mestra	-	O

Appendix XV: Jamaican Endemic Birds

LOCAL BIRD NAME	SCIENTIFIC NAME
Jamaican Poorwill or Jamaican Parauque	***Siphonorhis americanus***
Ring-tailed Pigeon	***Columba caribaea***
Crested Quail Dove	***Geotrygon versicolor***
Yellow-Billed Parrot	***Amazona collaria***
Black-billed Parrot	***Amazona agilis***
Lizard Cuckoo	***Saurothera vetula***
Chestnut-bellied Cuckoo	***Hyetornis pluvialis***
Jamaican Owl	***Pseudoscops grammicus***
Mango Hummingbird	***Anthracothorax mango***
Red-billed Streamertail Hummingbird	***Trochilus polytmus polytmus***
Black-billed Streamertail Hummingbird	***Trochilus polytmus sciatus***
Jamaican Tody	***Todus todus***
Jamaican Woodpecker	***Melanerpes radiolatus***
Jamaican Elaenia	***Myiopagus cotta***
Jamaican Pewee	***Contopus pallidus***
Sad flycatcher	***Myiarchus barbirostris***
Rufous-tailed Flycatcher	***Myiarchus validus***
Jamaican Becard	***Pachyramphus niger***
Jamaican Crow	***Corvus jamaicensis***
White-eyed Thrush	***Turdus jamaicensis***
White-chinned Thrush	***Turdus aurantius***
Jamaican Vireo	***Vireo modestus***
Blue Mountain Vireo	***Vireo osburni***
Jamaican Blackbird	***Nesopsar nigerrimus***
Arrow-headed Warbler	***Dendroica phareta***
Jamaican Euphonia	***Euphonia Jamaica***
Jamaican Stripe-headed Tanager	***Spindalis nigricephalus***
Yellow-shouldered Grassquit	***Loxipasser anoxanthus***
Orangequit	***Euneornis campestris***

Appendix XVI: Jamaican Endemic Herpetofauna

LOCAL NAME	SCIENTIFIC NAME
Jamaican Boa	***Epicrates subflavus***
Jamaican Racer	***Alsophis ater***
Jamaican Red Racerlet	***Arrhyton callilaemum***
Jamaican Black Racerlet	***Arrhyton funereum***
Jamaican Long-tailed Racerlet	***Arrhyton polylepis***
Jamaican Blindsnake	***Typhlops jamaicensis***
Limestone Forest Galliwasp	***Celestus barbouri***
Blue-tailed Galliwasp	***Celestus duquesneyi***
Bromeliad Galliwasp	***Celestus fowleri***
Red-spotted Galliwasp	***Celestus hewardi***
Small-eyed Galliwasp	***Celestus microblepharis***
Jamaican Giant Galliwasp	***Celestus occiduus***
Jamaican Collared Dwarf Gecko	***Sphaerodactylus gilvitorques***
Parker's Banded Dwarf Gecko	***Sphaerodactylus parkeri***
Montego Banded Dwarf Gecko	***Sphaerodactylus richardson***
Jamaican Giant Gecko	***Tarentola albertschwartzi***
Jamaican Iguana	***Cyclura collei***
Jamaican Gray Anole	***Norops lineatopus***
Bluefields Anole	***Norops opalinus***
Blue Mountain Anole	***Norops reconditus***
Jamaican Twig Anole	***Norops valencienni***
Jamaican Ameiva	***Ameiva dorsalis***

Appendix XVII: Jamaican Endemic Frogs

LOCAL NAME	SCIENTIFIC NAME
Jamaican Laughing Treefrog	***Osteopilus brunneus***
Jamaican Snoring Treefrog	***Osteopilus crucialis***
Yellow Bromeliad Treefrog	***Osteopilus marianae***
Green Bromeliad Treefrog	***Osteopilus wilderi***
Jamaican Peak Frog	***Eleutherodactylus alticola***
Jamaican Rumpspot Frog	***Eleutherodactylus andrewsi***
Portland Ridge Frog	***Eleutherodactylus caverinicola***
Jamaican Cave Frog	***Eleutherodactylus cundalli***
Jamaican Earspot Frog	***Eleutherodactylus fuscus***
Blue Mountain Rock Frog	***Eleutherodactylus glaucoreius***
Jamaican Forest Frog	***Eleutherodactylus gossei***
Jamaican Pallid Frog	***Eleutherodactylus grabhami***
Cockpit Frog	***Eleutherodactylus griphus***
Jamaican Bromeliad Frog	***Eleutherodactylus jamaicensis***
Rock Pocket Frog	***Eleutherodactylus junori***
Jamaican Masked Frog	***Eleutherodactylus luteolus***
Jamaican Red-eyed Frog	***Eleutherodactylus nubicola***
Jamaican Stream Frog	***Eleutherodactylus orcutti***
Western Yellow-bellied Frog	***Eleutherodactylus pantoni***
John Crow Yellow-bellied Frog	***Eleutherodactylus pentasyringos***
Leaf Mimic Frog	***Eleutherodactylus sisyphodemus***

Appendix XVIII: Jamaican Endemic Butterflies

LOCAL NAMES	SCIENTIFIC NAMES
Jamaican Satyr	***Calisto zangis***
Jamaican Patch	***Atlantea pantone***
Jamaican Hairstreak	***Calophrys crethona***
Burke's Hairstreak	***Heterosmaitia bourkei***
Panton's Hairstreak	***Electreostrymon pan***
Jamaican Blue	***Hemiargus dominica***
Miss Perkin's Blue	***Leptotes perkinsae***
Adam's Small Sulphur	***Eurema adamsi***
Hartonia	***Aphrissia hartonia***
Giant Swallowtail	***Papilio homerus***
Jamaican Kite Swallowtail	***Protographum marcellinus***
Thersites Swallowtail	***Papilio thersites***
Jamaican Swallowtail	***Papilio thoas melonius or***
Skinner's Jamaican Skipper	***Proteides mercurius jamaicensis***
Hewitson's Silver-spotted Skipper	***Epargureus antaeus***
Evan's Jamaican Skipper	***Polygonus leo hagar***
Asander	***Aguna asander jasper***

Appendix XIX: Jamaican Endemic Mammals

LOCAL NAMES	SCIENTIFIC NAMES
Jamaican Flower Bat	***Phyllonycteris aphlla***
Jamaican Fig-eating Bat	***Ariteus flavescens***
Jamaican Greater Funnel-eared Bat	***Natalus jamaicensis***
Jamaican Red Bat	***Lasiurus degelidus***
Jamaican Hutia	***Geocapromys brownie***
Jamaican Brown Bat	***Eptesicus lynni***

Appendix XX: General Information on Species of Bats Observed/Anticipated to be Present in Jamaica

SPECIES	COMMON NAME	RANGE	ROOST / NURSERY	OCCURS IN CC?
Noctilionidae (fisherman / bulldog bats)				
Noctilio leporinus	Fishing Bat	Neotropics	Cave, crevice,	Yes
			tree hollow	
Mormoopidae (mustached & ghost-faced bats)				
Moormops blainvillei	Antillean Ghost-faced Bat	Greater Antilles	Obligate cave	Yes
Pteronotus parnellii*	Parnell's Mustached Bat	Jamaica, (Cuba)*	Obligate cave	Yes
Pteronotus macleayii	MacLeay's Mustached Bat	Jamaica, Cuba	Obligate cave	Yes
Pteronotus quadridens	Sooty Mustached Bat	Greater Antilles	Obligate cave	Yes
Phyllostomidae (leaf-nosed whispering bats)				
Macrotus waterhousii	Big-eared Bat	Cuba, Jamaica, Hispaniola,	Cave, tunnel	Yes
	(link to anecdotal story	Bahama Isls, Cayman Isls, Beata Isls,	man-made structures	
	from Windsor House)	Mexico south to Guatemala		
Glossophaga soricina	Pallas' Long-tongued Bat	Neotropics	Cave,	Yes
			man-made structures	
Monophyllus redmani	Leach's Single Leaf Bat	Greater Antilles, S. Bahama Isls,	Obligate cave	Yes
		Turks and Caicos Isls		
Artibeus jamaicensis	Jamaican Fruit Bat	Neotropics	Cave, foliage	Yes
			man-made structures	
Ariteus flavescens	Jamaican Fig-eating Bat	Jamaica	Tree crown	Yes
Erophylla sezekorni	Brown Flower Bat	Cuba, Jamaica, Bahama Isls,	Obligate cave	Yes
		Cayman Isls, Turks and Caicos Isls		
Phyllonycteris aphylla	Jamaican Flower Bat	Jamaica	Obligate cave	Yes**
Natalidae (funnel-eared bats)				
Natalus jamaicensis	Jamaican Funnel-eared Bat	Jamaica	Obligate cave	
Chilonatalus micropus	Cuban Lesser Funnel-eared Bat	Cuba, Jamaica, Hispaniola,	Obligate cave	Yes
		Providencia Isl (Colombia).		
Vespertilionidae (verspertilionid bats)				
Eptesicus fuscus (lynni)	Big Brown Bat	New World (Jamaica***)	Obligate cave (?)	Yes
Lasiurus degelidus	Jamaican Red Bat	Jamaica	Foliage	?
Molossidae (free-tailed & mastiff bats)				
Tadarida brasiliensis	Free-tailed Bat	New World	Cave,	Yes
			man-made structures	
Nyctinomops macrotus	Big Free-tailed Bat	New World	Cave, crevices	
Eumops auripendulus	Black Bonneted Bat	Neotropics	Cave, loose tree bark,	
			man-made structures	
Eumops glaucinus	Wagner's Bonneted Bat	Neotropics and So. Florida	Cave,	
			man-made structures	
Molossus molossus	Pallas' Mastiff Bat	Neotropics and Florida Keys	Cave,	Yes
			man-made structures	

Notes

** Pending molecular analysis, P. parnell either will be endemic to Jamaica or restricted to Jamaica and Cuba [i.e., the subspecies P.p.parnel should be recognized as a distinct species (Clare et al 2013)].*

*** Last confirmed reliably in Cockpit Country in 1983 (Pregill et al. 1991); current status requires URGENT attention.*

**** Taxonomic classification remains unresolved as to whether this bat is an endemic subspecies or endemic species.*

Source: http://cockpitcountry.com/batsChecklist.html

Appendix XXI: Meeting Notes – Voluntary Stakeholder Consultation with the Forestry Department

Voluntary Stakeholder Consultation Meeting

with

Forestry Department

convened on

August 19, 2020 at 9:00 am

via

Online Microsoft Team Meetings Platform

Forestry Department (FD) representatives present were:

- Ms. Rainee Oliphant, Acting Chief Executive Officer & Conservator of Forest
- Ms. Donna Lowe, Senior Director, Forest Science & Technology Services Division

CD&A team members present:

- Ms. Ruth-Ann Lacey, Manager, Strategic Development
- Dr. Mark Richards, Technical Director
- Mr. Vance Johnson, Snr. Environmental Engineer
- Mr. Doran Beckford, Snr. Process & Environmental Engineer

Meeting Notes

Opening Remarks Forestry Department

Ms. Oliphant welcomed all the meeting participants and indicated that the Forestry Department was not fully appraised of the project so the discussion may not be as fruitful as the consultant would be hoping for.

Opening Remarks Conrad Douglas & Associates Limited

Dr. Richards thanked the FD for taking time to facilitate the meeting and indicated that the purpose of the meeting is to discuss the proposed EIA for SEPL 524 and obtain the views, opinions and comments of the Forestry Department.

He indicated that this is a voluntary stakeholder consultation, which, forms part of the EIA process recommended by the UN framework and it is the intention of CD&A to have Forestry review the project and obtain their concerns and these will be addressed in the EIA as best as possible, as the project is still in the planning phase as well as preliminary field data is being gathered.

Discussion

Ms. Oliphant noted that the Forestry Department was not a part of the Terms of Reference preparation and did not received a copy. She noted that this is something that FD will have to raise with NEPA.

Dr. Richards indicated that CD&A did not prepare the Final ToR and are guided by the directives of NEPA. It was indicated that a meeting was held with NEPA who further directed CD&A to meet with critical stakeholders which includes the FD.

Dr. Richards explained that the ToRs nor the details of the project are required at this stage of the EIA process as during this Voluntary Stakeholder engagement, the intention is to ascertain from the stakeholders, the impacts that they would like to taken into consideration and the mitigation measure that could be considered. He also reminded the FD that CD&A supplied the information requested by the FD subsequent to which the FD agreed to have the meeting.

Stakeholder Consultation Meeting

Ms. Lowe interjected, stating that the FD did not receive the shapefiles for the orebodies only the outline of the SEPL 524 was observed.

CD&A team verified that the shapefiles of the orebodies were sent as well as the existing roads and proposed haul roads. Ms. Lowe acknowledged that she would check with her team to ascertain why these files were omitted.

Ms. Oliphant reiterated that she would be writing to NEPA to request the ToR and the have discussions regarding the EIA process.

Dr. Richards agreed with the suggestion and stated that CD&A would have no issue but our best practice process requires that we consult and obtain as much information from the stakeholders of which the Forestry Department is a major one and all the concerns and issued raised in the discussion will be recorded and incorporated in the EIA for the regulators to make their decisions.

The Screen was shared for the discussion of the maps with orebodies, forestry reserves and property:

The Forestry Department indicated that the following are the Major Points to be incorporated from a forestry perspective based on Forest Policy, management plans, etc:

- No net loss of Forest Cover across the SEPL;
- No mining in the Forestry Department resources;
- Some of the areas fall within these descriptions and
- No mining in the Forestry Reserve.
- Important resources are not only in Camperdown but parts of Kellits-Camperdown and Barret's Pen to the North.
- There is a project in Stephany John's Vale that is being undertaken by the FD and this project in close proximity is also a concern.

CDA highlighted that Stephany John's Vale is outside of the SEPL 524.

Ms. Oliphant raised concerns with the proximity of the project to Stephany John's Vale Forest Reserves as it has the potential for indirect impacts on the reserves.

Kellits-Camperdown Forest Reserves (KCFR)

Ms. Lowe noted that the FD is currently executing budget support projects in the KCFR. There are presently disturbed broadleaf forests in these areas that these project are aiming to rehabilitate.

Ms. Oliphant informed the meeting that if private sector organizations are interested in partnership for rehabilitation or forestry projects, then the option exists but there are mechanisms that exists for the Forestry Department to participate.

Overall, FD wants no net loss of forested areas. In general, the entity engaged in reforestation must cover cost of establishment over a 3 year period.

The aim of the FD is not to lose Forest Cover. If (some) forest is taken taken out then it must be replaced and funded by the institution responsible for the removal.

FD will push back when it is broadleaf forest and ensure that there is no net loss

Ms. Oliphant indicated that the FD wants to ensure that where Forest is impacted that the company goes beyond what is presently done ie. grassing. **The FD wants the mining companies to go beyond**

Stakeholder Consultation Meeting

that and include mainly re-forestation. Even if it is at a significant cost – progressive mining should consider reforestation.

The FD would also like to see restoration being undertaken using native species that were in existence before mining – not only public lands but also private lands which have been mined. This reforestation should be done for both the haul roads and orebodies.

Dr. Richards brought to the meeting's attention that CD&A's visits to the areas shows that the orebodies are originally grasslands and some minimal number of fruit trees. The hillocks are where the Forest Cover exists. FD indicated that the EIA should show what is forest cover in the baseline so change can be estimated.

FD would like to do an assessment to see what forest cover exists. The FD knows that there is a level of disturbance that results from filling of the pits.

Access to orebodies is created by creating haul roads the FD recommends there be security established to ensure that there is no intrusion into the areas. The EIA must recognize that access developed within this area is also access to the Forest Estates.

CDA requested clarification on the terms being used and the FD indicated the following:

Forest Estate or Reserve? A Forest Reserve can be a part of Forest Estate. Forest Estates are not yet declared. Forest Estate represents all lands managed by FD including Forest Reserve.

CD&A requested information on Forest Estates. FD indicated that these are enshrined in the Forest Act of 1996, Forest Regulation of 2001 – Legislative mandate from legislation. The actual areas can be provided to CD&A if requested.

Ms. Oliphant wanted to get the timeline for completing the EIA. CD&A explained that a specific completion date could not be provided at this point as we are still in the planning and development phase of implementation. This set of feedback will impact sampling plan and other activities.

The meeting adjourned at 9:45 am.

Appendix XXII: Invitations - Meeting with Stakeholders

cdaestech@hotmail.com

From:	CDA ESTECH <cdaestech@hotmail.com>
Sent:	Tuesday, 21 July 2020 4:47 pm
To:	southeast.stann@gmail.com
Cc:	Douglas
Subject:	Meeting Request - Voluntary Consultation for the EIA for Proposed Mining in SEPL 524

Dear MP Hanna,

Conrad Douglas and Associates Limited are in the process of preparing the EIA for the proposed Mining of Bauxite in SEPL 524 on behalf of WINDALCO. We are currently in the phase of public consultation and are using the method of **Voluntary Public Consultation Meetings to gather feedback on the proposed project.**

As the Member of Parliament for the area, who represents the interests of all members of the constituency, you have been identified as a critical stakeholder, to be consulted in this phase of the EIA development.

We have attempted to contact your Constituency office by telephone on numerous occasions and have also visited the office without success. We would be grateful if you could accommodate us for a meeting to discuss the project with you. We are available Monday July 27, 2020 and any day next week at a time convenient to your team, preferably as early as possible next week. We are amenable to meet within St. Ann or Kingston.

This meeting is to inform you of the project and more importantly, to obtain the views of your constituents.

We urgently look forward to your reply.

With kindest regards.

Sincerely,

Dr. Conrad Douglas, CD,
Executive Chairman & Principal Consultant

CONRAD DOUGLAS & ASSOCIATES LIMITED
14 CARVALHO DRIVE
KINGSTON 10, JAMAICA W.I.

TELEPHONE: (876) 929-8824
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(876) 929-0025
FAX: (876) 960-2014
Website: www.cdaestech.com
E-MAIL: info@cdaestech.com, conraddouglasnassociatesltd@gmail.com

cdaestech@hotmail.com

From:	CDA ESTECH <cdaestech@hotmail.com>
Sent:	Tuesday, 21 July 2020 4:47 pm
To:	rsimpson@sesajlp.com
Cc:	Douglas
Subject:	Meeting Request - Voluntary Consultation for the EIA for Proposed Mining in SEPL 524

Dear Dr. Simpson,

Conrad Douglas and Associates Limited are in the process of preparing the EIA for the proposed Mining of Bauxite in SEPL 524 on behalf of WINDALCO. We are currently in the phase of public consultation and are using the method of **Voluntary Public Consultation Meetings to gather feedback on the proposed project.**

As the Opposition's Representative for the area you have been identified as a critical stakeholder, to be consulted in this phase of the EIA development.

We would be grateful if you could accommodate us for a meeting to discuss the project with you. We are available Monday July 27, 2020 and any day next week at a time convenient to your team, preferably as early as possible next week. We are amenable to meet within St. Ann or Kingston.

This meeting is to inform you of the project and more importantly, to obtain the views of the residents of South East St. Ann.

We urgently look forward to your reply.

With kindest regards.

Sincerely,

Dr. Conrad Douglas, CD,
Executive Chairman & Principal Consultant

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