For submission to:

Noranda Jamaica Bauxite Partners II (NJBP II)
Port Rhoades
Discovery Bay P.O.
St. Ann
Jamaica, W.I.

Environmental Impact Assessment

for proposed

MINING OPERATIONS

in the

SPECIAL MINING LEASE 173 (SML 173) AREA

located in the Parishes of

St. Ann and Trelawny, Jamaica

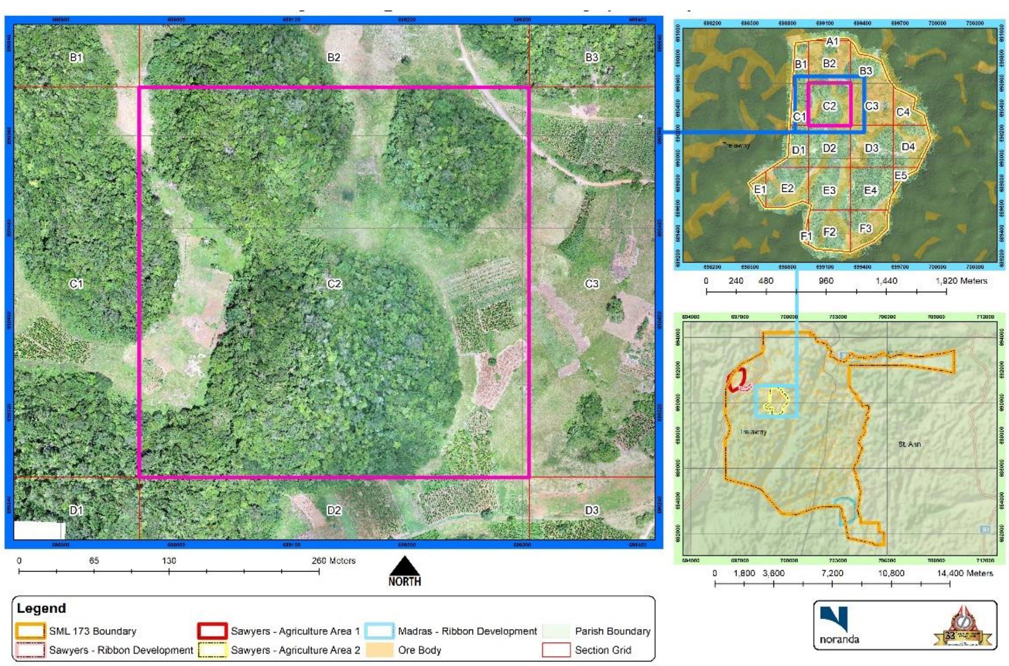
by

Noranda Jamaica Bauxite Partners II (NJBP II)

VOLUME I

DRAFT FINAL

November 6, 2020



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COVER CREDITS

From Aerial Surveys conducted by Conrad Douglas & Associates Limited in SML 173 area.

This shows mode of occurrence of bauxite deposit within SML 173 area. Elevated limestone hillocks with high biodiversity and low-lying deposits of bauxite supporting sparse grassland/shrub vegetation and agricultural activities.

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TABLE OF CONTENTS

Page Number

List of Figures

Page Number

List of Tables

Page Number

LIST OF APPENDICES

Page Number

List of Acronyms

ALCOA	Aluminum Company of America
ALPART	Alumina Partners of Jamaica
AQMS	Air Quality Monitoring Stations
ASTM	American Society for Testing and Materials
ADO	Automotive Diesel Oil
BC	Building Code
BOD	Biochemical Oxygen Demand
^oC	Degrees Celsius
CC	Cockpit Country – *The contiguous areas of Trelawny, St. James and St. Elizabeth generally showing a lowland or 'cockpit' and hillock formation.*
CCPA	Proposed Cockpit Country Protected Area
CCSG	Cockpit Country Stakeholder Group
CD&A	Conrad Douglas & Associates Limited
cm	Centimeter
dBA	Decibels (A-weighted decibels)
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
ft	Feet
GDP	Gross Domestic Product
GIS	Geographical Information System
gpm	Gallons per Minute
GoJ	Government of Jamaica
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
JNHT	Jamaica National Heritage Trust
JPS	Jamaica Public Service

JPSCo	Jamaica Public Service Company
kg/m	Kilogram per meter
Km	Kilometer
LAT	Latitude
LMO	Living Modified Organism
LONG	Longitude
m	Meter
mg/L	Milligram per litre
mm	Millimeter
MCM/yr	Million Cubic Metres per Year
MDMT	Million Dry Metric Tonnes
MIGD	Million Imperial Gallons per Day
NDAJL	New Day Aluminum (Jamaica) Limited
NEPA	National Environment and Planning Agency
NIC	National Irrigation Commission
NIR	Net International Reserves
NJBP II	Noranda Jamaica Bauxite Partners II
NPK	Nitrogen, Phosphorus, Potassium
NQMS	Noise Quality Monitoring Stations
NRCA	National Resources Conservation Authority
NS	North-South
NSWMA	National Solid Waste Management Authority
NWC	National Water Commission
pH	Potential of Hydrogen
PPE	Personal Protective Equipment
PM_{10}	Particulate Matter of size 10 microns or less
RH	Relative Humidity
SAJB	St. Ann Jamaica Bauxite
SML	Special Mining Lease
SML 173	Special Mining Lease Area
SDC	Social Development Commission
SPAW	Special Protected Areas and Wildlife
STATIN	Statistical Institute of Jamaica
STEA	South Trelawny Environmental Agency
TOR	Terms of Reference
TSP	Total Suspended Particulates
µg	Microgram
UNCED	United Nations Conference for Environmental and Development
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organization
WPT	Waypoint
WRA	Water Resources Authority

1.0. Executive Summary

1.1. Background

New Day Aluminum (Jamaica) Limited (NDAJL) is a limited liability company engaged in the business of the winning and exporting of bauxite pursuant to a suite of agreements with the Government of Jamaica (GoJ). Noranda Jamaica Bauxite Partners II (NJBP II) performs mining operations on behalf of New Day. NJBP II is a partnership between NDAJL, holding 49%, with Jamaica Bauxite Mining Limited (JBML) holding 51% on behalf of the GoJ.

The project proposes to exploit bauxite reserves in Special Mining Lease 173 (SML 173) Area, which is in proximity to the area proposed as the Cockpit Country Protected Area (CCPA) by the Most Honourable Prime Minister Andrew Holness in Parliament on November 21, 2017. The statement by the Most Honourable Prime Minister's presentation is presented in Appendix IV. Upon approval, the project will result in the mining of orebodies and transportation of high-quality bauxite to existing loading areas for stockpiling, railing, drying and shipping. The mined-out areas will be rehabilitated in keeping with the requirements of the Mining Act.

In accordance with the regulations, an Environmental Permit application was submitted to the National Environment and Planning Agency (NEPA). Subsequently, in keeping with the Natural Resources Conservation Authority Act of 1991 and its regulations of 1996, the NEPA requested Noranda Jamaica Bauxite Partners II (NJBP II) to carry out an Environmental Impact Assessment (EIA) on Special Mining Lease 173 (SML 173) Area. It is proposed to conduct bauxite mining operations in SML 173 for a period of about twenty-five (25) years. The area granted under SML 173 includes both the areas depicted as SML 173 and SML 172 (see Figure 1-1) of this summary. All references to 'the SML 173 area' in this report pertain to only that area shown as SML 173 in Figure 1-1. SML 173 has an area of 8,335 hectares, of which 15% are orebodies proposed for bauxite mining, inclusive of the haul roads to gain access to and transport the bauxite.

The mining activities proposed for 15% of the total area of SML 173, represents a temporary change in land use from predominantly agriculture and a few residential structures to bauxite extraction. This will be followed by activities to rehabilitate the mined-out areas and dedicate them to uses such as grassland (its natural state), housing, agriculture, greenhouses and water storage.

In this regard NJBP II has engaged the services of the multi-disciplinary environmental management consultancy firm, Conrad Douglas & Associates Limited to carry out the EIA.

This draft EIA is presented in four (4) Volumes, as follows:

- ✓ Volume I: Environmental Impact Assessment
- ✓ Volume II: Reports on Voluntary Stakeholder Consultations
- ✓ Volume III: Archaeological Impact Assessment
- ✓ Volume IV: Air Dispersion Modelling Report

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

On 28 August 2018, the GOJ granted SML 173 to New Day Aluminum (Jamaica) Limited (NDAJL). This is subject to the permits and/or approvals required to be issued by the NRCA, NEPA, other governmental agencies, and the provisions of the Mining Act.

SML 173 straddles the boundaries of the parishes of St. Ann and Trelawny and is in proximity to important natural resources (ground water and biodiversity), historical heritage resources, human settlements and agricultural activities. NJBP II is keenly aware of these resources and the need for their protection.

SML 173 borders the proposed Cockpit Country Protected Area (CCPA). The boundary of the proposed CCPA was arrived at after several studies and public consultations over a number of years. The boundary proposed for declaration was announced by the Most Honourable Andrew Holness, Prime Minister, in Parliament on November 21, 2017 (See Appendix IV).

There are important bauxite deposits in the SML 173 area which are required for providing bauxite feedstock for NJBP II's mining, railroading, drying, storage and shipping operations from Port Rhoades in Discovery Bay St Ann, to export markets overseas. NJBP II's export earnings from bauxite are variable. However, based on the volume of bauxite it can be as high as, or in excess of US$150,000,000 per year. This is a major contribution to maintaining NJBP II's operations and a critically important contribution to Jamaica's economy overall, and more specifically foreign exchange earnings, 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 which recently concluded a Standby Agreement with the International Monetary Fund (IMF) in November 2019, has shown steady, though small positive growth in recent times. Jamaica's debt to GDP ratio is now delicately balanced at 96%.

The country has only recently achieved nineteen (19) consecutive quarters of positive GDP growth. Growth in the third quarter of 2019 was registered at lower than the second quarter of 0.3%. 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.*"

The Jamaican economy is still at a very sensitive juncture and could be subject to exogenous and endogenous shocks. The former could take the form of natural hazards such as hurricanes and earthquakes, and pandemics. The latter refers to the potential collapse of major economic sectors including bauxite production. Changes in trade agreements 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.

Maintaining the mining sector, in general and bauxite mining, in particular, is more important than ever before for sustaining macro-economic performance and stability, and to continue the support and micro-economic development at the community level. There is no other sector of the Jamaican economy which can in the immediate and short term, provide the necessary level of export income to support the economy.

In proposing the Cockpit Country Protected Area (CCPA), the government has given up valuable bauxite resources located within the proposed CCPA in order to protect valuable renewable resources, such as biodiversity and water resources. The value of the bauxite that has been given up (sequestered) by the GOJ has been estimated to range from approximately US$1.44 billion to US$1.85 billion.

In essence, the objective of the scientific investigations 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. This agreed draft TOR was developed through a series of multi-agency stakeholder consultations inclusive of joint visits to the field and a presentation. This was followed by intensive correspondence between the consultants, NGOs and the regulators. The main headings covered by the TOR are provided below:

- ✓ Executive Summary
- ✓ 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 2018 and continued up to December 2019. 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 covering 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 SML 173 in the parishes of St. Ann and Trelawny (See Figure 1-1 below) and is aimed at providing bauxite feedstock for NJBP II's mining, railroading, drying, storage and shipping operations from Port Rhoades in Discovery Bay St Ann, to export markets. NJBP II's operations do not involve the processing of bauxite to alumina.

The rate of dry bauxite production may be as high as 6 million dry metric tonnes of bauxite per annum. This has the potential to earn about US$150,000,000 per year which is a major and critically important contribution to the Jamaican economy. NJBP II will continue to use standard international best practices in compliance with its internal corporate responsibility policies and Jamaica's regulatory framework.

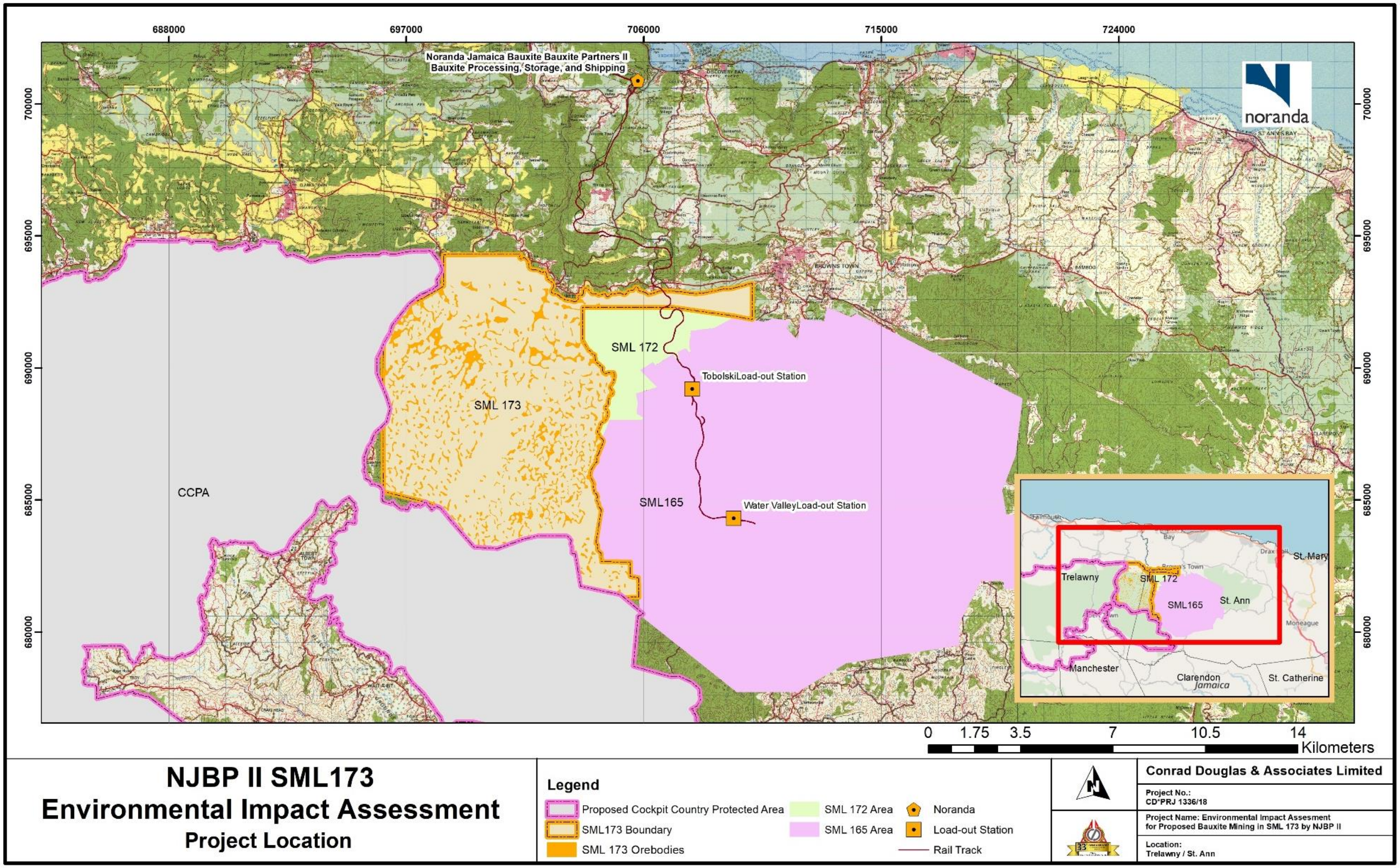


Figure 1-1: Project Location Map

1.4.1. Legislation and Regulatory Consideration

The 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 SML 173 area is contiguous to the eastern boundary of the proposed Cockpit Country Protected Area (CCPA). The environmental management study and EIA report focuses on the mineral, bio-physical, socio-cultural, economic and archaeological heritage resources within the SML 173 area.

It has been clearly stated by the Most Honourable Prime Minister that no mining will be permitted within the boundaries of the proposed Cockpit Country Protected Area (CCPA). Other restrictions and activities that cannot take place in the proposed CCPA have also been identified.

Bauxite (non-renewable resource) mining will only commence in SML 173 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 SML 173 area.

1.4.2. 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 SML 173 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 and agricultural practices.

1.4.2.1. <u>Geology and Geomorphology</u>

The SML 173 area displays karstic features typical of the high purity White Limestone formations which host bauxite deposits. Areas of high vegetation cover and biodiversity are located on the elevated hillocks. This type of karstic geomorphology is not uncommon in Jamaica and the most significant work was first carried out on the formations in Lluidas Vale, St. Catherine[1]. The bauxite deposits are located in the

[1] Cockpit Country, Jamaica Boundaries, Geological Significance, and Mining Impacts: A Report to the Jamaica Bauxite Institute, Prof. Edward Robinson

depressions between the hillocks. Caves and sinkholes observed in SML 173, were either elevated in the hillocks or in depressions that do not contain bauxite. There are ten (10) known caves identified within the boundaries of SML 173 (Please see Table 5-1). Please see Figure 5-10, which also shows thirty (30) additional caves within 5km of the boundaries of SML 173.

Within the SML 173 area bauxite deposits account for less than 15% of the total area (8,335Ha). Some of these areas are inaccessible, or not economically feasible to mine bauxite.

1.4.2.2. Hydrology

Our investigations have determined that there are no surface water features within the SML 173 area and that ground water resources are at significant depths (more than 100m) below the surface of SML 173 area. There are caves and sinkholes that form a part of the drainage system that convey water to these ground water resources. Most of the caves identified are elevated above the deposits and areas containing sinkholes will not be mined.

Nationally, the baseline associated with ground water quality and quantity in proximity to bauxite mining operations, for over 60 years, have shown that there has been no pollution of ground water caused by bauxite mining. It is highly improbable that the water resources will be impacted by the mining of bauxite in areas of similar karstic geomorphology. This is supported by evidence gathered from monitoring wells in St. Elizabeth, Manchester, St. Ann and Clarendon.

Our investigations of the environmental baseline have identified degraded water quality of high nitrate and sulphate concentrations in the Ulster Spring area, which is located just outside SML 173. The sources of these contaminants are likely from the use of nitrate, phosphate, and potassium (NPK) fertilizer and untreated sewage from nearby settlements.

1.4.2.3. 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. Thirty-five (35) species of trees were identified within SML 173 of which five (5) are endemic. Six (6) species of Bromeliads were identified of which two (2) are endemic. Three (3) species of aroids and three (3) species of orchid were identified with one (1) species of orchid being endemic. Four (4) species of ferns were identified as well as fourteen (14) species of herbs and sixteen (16) species of vines. Four (4) of the species of vines are endemic. Twenty-one (21) species of shrubs were observed within SML 173 with five (5) being endemic. Three (3) species of grasses were observed. In addition, thirteen (13) species of plants were observed to be cultivated within SML 173.

Forty-Six (46) species of birds were observed during the study. Nineteen (19) of the twenty-eight (28) endemic birds of Jamaica were observed within SML 173. All the birds observed were on the periphery of the grassland or within the highly vegetated hillocks. 55% are insectivorous, 17% herbivorous and 19% omnivorous. Eight (8) species of anole and three (3) species of amphibians were observed during the study. Notably, nine (9) species of bats were identified in three (3) caves studied within SML 173. These caves were all on elevated hillocks, removed from the orebodies to be accessed for bauxite.

There were no sightings of the endangered and protected Giant Swallowtail Butterfly (*Pterourus homerus,* formerly called *Papilio homerus)* nor the Water Mahoe (*Hernandia catalpelofia)*, which is crucial for supporting its existence after intensive and extensive searches.

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.

From a study of the rehabilitated area in an adjoining SML (See Section 8.3.3), the observation was made that rehabilitation of mined out areas to grasslands results in the restoration of the flora and fauna, which supports pre-mining communities.

1.4.2.4. Socio-Economic Environment

Comprehensive socio-economic and land use surveys were undertaken in SML 173 and surrounding areas. The socio-economic survey was undertaken using a pre-tested, pre-coded questionnaire, which was approved by NEPA prior to administration. The SML 173 area, while sparsely populated, is subject to intense anthropogenic stresses, mainly related to agricultural activities (yam, corn, sweet potato and other crops cultivation).

Some of the communities surrounding and within the SML 173 area were found to have a high incidence of poverty. While there is a high level of electrification, there is poor access and reliability of piped water. There is also sub-standard sanitation. This extends to where there are established institutions.

The communities which were aware of bauxite mining were found to be more receptive to bauxite mining (56%), while those that were not familiar with bauxite mining displayed some degree of reservation. The communities receptive to the proposed project anticipated employment opportunities and by extension an improvement in their quality of life. This is consistent with the mining of bauxite in Jamaica which has resulted in improvements in economic performance nationally and the provision of social amenities at the community level.

1.4.2.1. Archaeological Heritage

The archaeological heritage of SML 173 has been investigated in detail by the Jamaica National Heritage Trust (JNHT). This was a request of NEPA. The Archaeological Impact Assessment (AIA) was submitted to NEPA and CD&A by the JNHT. CD&A has also submitted the AIA as a companion document to this Draft EIA Report as Volume III: Archaeological Impact Assessment. The main objective of the AIA was to ascertain the presence of significant archaeological assets, describe and appraise their worth in the context of the proposed development (SML 173). For a summary of the AIA, please see the section titled Non-Technical Summary in the AIA (AIA pages x- lxxxviii).

1.4.3. Public Participation

In keeping with international best practices, Agenda 21 and the National Environment and Planning Agency guidelines, CD&A conducted four (4) Voluntary Public Stakeholder Consultations in the townships of Madras, Retreat, Sawyers and Ulster Spring over the period May 13 – 27, 2019. The meetings recorded attendance ranging from 67 – 134 persons. Details, including the provision of Attendance Registers are contained in Volume II of this EIA Report: "*Reports on Voluntary Stakeholder Consultations*".

In addition, stakeholder consultations were also held with the Jamaica Environment Trust, Windsor Research Centre, Southern Trelawny Environmental Protection Agency (STEPA). The last named being inclusive of members of the Cockpit Country Warriors.

There was a high level of agreement between the findings of the contact socio-economic survey and the public meetings.

1.4.4. Impact Identification and Assessment and Analysis of Potential Impacts

The potential impacts identified in the study are the predicted changes in the topography and land use resulting from the proposed bauxite mining operations from the orebodies. In order to gain access and transport the mined bauxite, it will be necessary to create haul roads. There will be at least 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. This can be mitigated with both local and international best practices from the planning stage, such as dust suppression through irrigation, as presently practiced by NJBP II. In most instances there are no human impact receptors for neither dust nor noise owing to the sparsely populated nature of the area.

It should be noted that the Air Dispersion Model commissioned by NJBP II (see Volume IV: Air Dispersion Modelling Report) has shown the following under an assumed worst-case scenario for the emission sources during mining and haulage:

- ✓ No receptor in ambient air showed concentrations in excess of the Jamaican AAQS for Total Suspended Particulates (TSP) or Particulate Matter of Size 10 microns and less (PM_{10}) within SML 173.
- ✓ The proposed activities at the ore body mining sites in SML 173 could cause localized high concentrations for TSP and PM_{10} that declined by at least 80% within 100 meters, of the active orebody.
- ✓ The proposed mining and hauling activities within SML 173 would result in ambient concentrations for TSP and PM_{10} at a maximum of 50-60% of the ambient air standards, including background concentrations, at locations outside of the ore body mining sites.

There were also concerns about the potential for the loss of biodiversity and destruction of heritage sites within the SML 173 area. The studies which were undertaken by leading experts in their respective fields, showed that the likelihood of there being an impact on these resources is low.

1.4.5. 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 SML 173. The general progression is from East to West. Five-year mining plans will be developed for each zone with mining at specified orebodies generally occurring for a period of 3-months to 6-months and a maximum of 1-year. 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 NJBP II 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; Sensitive species of plants identified will be removed and relocated to areas that will not be affected by the operations or at NJBP II's greenhouses; NJBP II's Environmental Health and Safety policies and procedures will be implemented; In the event that settlements will be impacted, NJBP II will employ its relocation and/or compensation plans; In the event that there is an archaeological find, NJBP II 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 SML 173 will not be impacted from mining activities. Most haul road construction will be confined to the transition zones. Only 15 %, or less (i.e. ~1,300 hectares), of the land area within SML 173 will be impacted over the estimated 25-years life of the project.

In keeping with the policies of NJBP II, Community Councils will be established to inform communities of activities and get feedback. As customary, these Councils will assist in community development as practiced in other mining areas with the objective of minimizing negative impacts and maximizing positive potential impacts.

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, NJBP II will be guided by best practices, precedence and the directives of the relevant regulatory agency in establishing appropriate setbacks.

1.4.6. Analysis of Alternatives

Five (5) alternatives were analysed during the preparation of the EIA. These include: (1) No Action Alternative, (2) The Proposed Mining Activity, (3) Modified Project Proposal, (4) Location and (5) Technology. The proposed mining activity and the modified '*clawed back*' area are viable. However, the modified '*clawed back*' SML 173 area (See Table 1-1 and Figure 10-3 below) is the preferred option of the alternatives assessed because it affords NJBP II access to bauxite reserves while reducing the magnitude, extent and duration of the impacts of mining in SML 173. This results from protection of the natural biological resources associated with the forest reserves. In addition, the livelihood of the yam and other farmers and export agriculture arising from farming would not be impacted in the '*clawed back area*'. This would also contribute to supporting national food security.

Table 1-1: Comparison of Entire SML 173 Area and Modified ('*clawed back*') SML 173 area – Rationale & Justification

Parameter	Entire SML 173 area	Modified ('*clawed back*') SML 173
Area (hectares)	**The entire SML 173 area** is 8,335 ha	**The area of the modified SML 173** is 6,226 ha -reduction of 25%
Exclusions	All Forest Reserves within the SML 173 area	1. All Forest Reserves within the SML 173 area, and 2. A section located north west within the SML 173 area **The aerial photographs and maps for sections of the '*clawed back area*' are shown in Appendix XXIII.**
Potential Impacts on Communities	Communities located north west within SML 173 may be impacted.	The likelihood that there will be any impact on communities located to the north west within SML 173 will be minimal to non-existent.
Potential impacts on Agriculture	The livelihoods of yam and other farmers located to the north-west within SML 173 may be impacted	The likelihood that there will be any impact on the livelihoods of yam and other farmers located in the north west areas will be minimal to non-existent.

1.4.7. Environmental Monitoring and Management

State-of-the-art environmental monitoring, evaluation and management methods will be used by NJBP II 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 NJBP II 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 and Recommendations

Based on the findings of the scientific investigations reported in this EIA using internationally accepted approaches, methodologies and best practices, the impacts identified and the mitigations proposed, we recommend that NJBP II be granted an environmental permit to implement mining operations in the SML 173 area, in compliance with all the relevant regulations, standards and guidelines and where applicable, its own internal standards. However, it is recommended that the modified 'clawed back' area be considered as the preferred option.

Jamaica's immediate to medium social, economic and sustainable development future is highly dependent on providing NJBP II with the permits to mine these bauxite resources. There are no other feasible immediate or short-term economic alternatives that have been identified that can be considered as a substitute to bring equal or greater macro and micro-economic benefits to Jamaica, at this time.

As stated by the Most Honourable Prime Minister and recognized by NJBP II, no mining will be carried out within the proposed Cockpit Country Protected Area (CCPA).

2.0. Introduction

2.1. Purpose of the Project

An application is hereby being made to the Natural Resources Conservation Authority (NRCA) of the National Environment and Planning Agency (NEPA) by Noranda Jamaica Bauxite Partners II (NJBP II), the proponent, for environmental permits which will be subsequently associated therewith for the establishment of mining operations and its associated activities.

The purpose of this project is to gain access to orebodies for the winning of bauxite in order to sustain NJBP II for the next twenty-five (25) to thirty (30) years. The bauxite will be railed and dried at NJBP II's facilities for export. A Special Mining Lease (SML 173) has been granted to New Day Aluminum (Jamaica) Limited for this purpose, subject to obtaining all relevant permits.

This draft EIA is presented in four (4) Volumes:

- ✓ Volume I: Environmental Impact Assessment
- ✓ Volume II: Reports on Voluntary Stakeholder Consultations
- ✓ Volume III: Archaeological Impact Assessment
- ✓ Volume IV: Air Dispersion Modelling Report

2.2. Project Proponent

The proponent of this project, Noranda Jamaica Bauxite Partners II (NJBP II) is a partnership between the Government of Jamaica (GOJ), holding 51% ownership through its wholly owned Jamaica Bauxite Mining Limited (JBML), and New Day Aluminum (Jamaica) Limited, (NDAJL) a company registered under the laws of Jamaica holding 49%. A suite of agreements governs the relationship between NDAJL, the GOJ, JBML and the Commissioner of Lands.

Pursuant to the management agreement, NDAJL has been appointed the managing partner for the entity. NJBP II carries out mining operations under the partnership.

2.3. Brief Description of the Project

The mining operations will be sited in an area referenced as SML 173, with a total area of 8,335 hectares. It is located in eastern Trelawny and western St. Ann, abutting the north-eastern edge of the proposed boundary of the newly formulated Cockpit Country Protected Area.

The area granted under Special Mining Lease 173 includes both the areas depicted as SML 173 and SML 172 in Figure 1-4. All references to 'SML 173 area' in this report, pertain to only that area shown as SML 173 in Figure 1-1 above.

The purpose of this project is to gain access to orebodies for the winning of bauxite in order to sustain NJBP II for the next twenty-five (25) to thirty (30) years. The bauxite will be railed and dried at NJBP II's facilities for export. A Special Mining Lease (SML 173) has been granted to New Day Aluminum (Jamaica) Limited for this purpose, subject to obtaining all relevant permits.

The total orebodies to be accessed over the twenty-five (25) year life of the lease is distributed within the SML 173 area and amounts to about 1,300 hectares. The new mining area will supply bauxite to the existing facilities for export at the existing Port Rhoades in Discovery Bay, St. Ann. The total orebodies to be exploited in the initial five (5) year plan amounts to 97.24 hectares.

The approximately 150 million tonnes of bauxite in the SML 173 area is a non-renewable resource, diminishing asset or finite resource which is of enormous value in maintaining NJBP II's operations and also to sustain Jamaica's economic growth, social development and macro-economic stability. Development of this resource will also contribute substantially to local community, regional and national economic development.

The GoJ Fiscal Policy Paper 2019-2020 indicates that maintaining the mining sector, in general and bauxite mining in particular, is more important now than 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[2].

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	TiO_2

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

Chemical		**Mineralogical**
	Rutile	
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 Ennis. 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 II.

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*".[3]

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

The Daily Gleaner

LARGEST CIRCULATION Price: TWOPENCE-HALFPENNY

KINGSTON, JAMAICA, WEDNESDAY, MAY 28, 1952. TWELVE PAGES

‘RED GOLD’ GOING FOR FIRST TIME

Bauxite ore loading starts at Ocho Rios

Figure 2-1: 1st Export of Bauxite - 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 SML 173 area comprises private and government holdings of which, approximately, 70% is titled. Noranda holds 55% of the total land areas (for and behalf of the Commissioner of Lands) and the remainder is privately held. The untitled lands are privately owned. The subject lands identified as SML 173 comprises several hundred parcels of land. This has been included as Appendix V of this EIA report. Their spatial distribution in the SML 173 is illustrated in Figure 2-2 below.

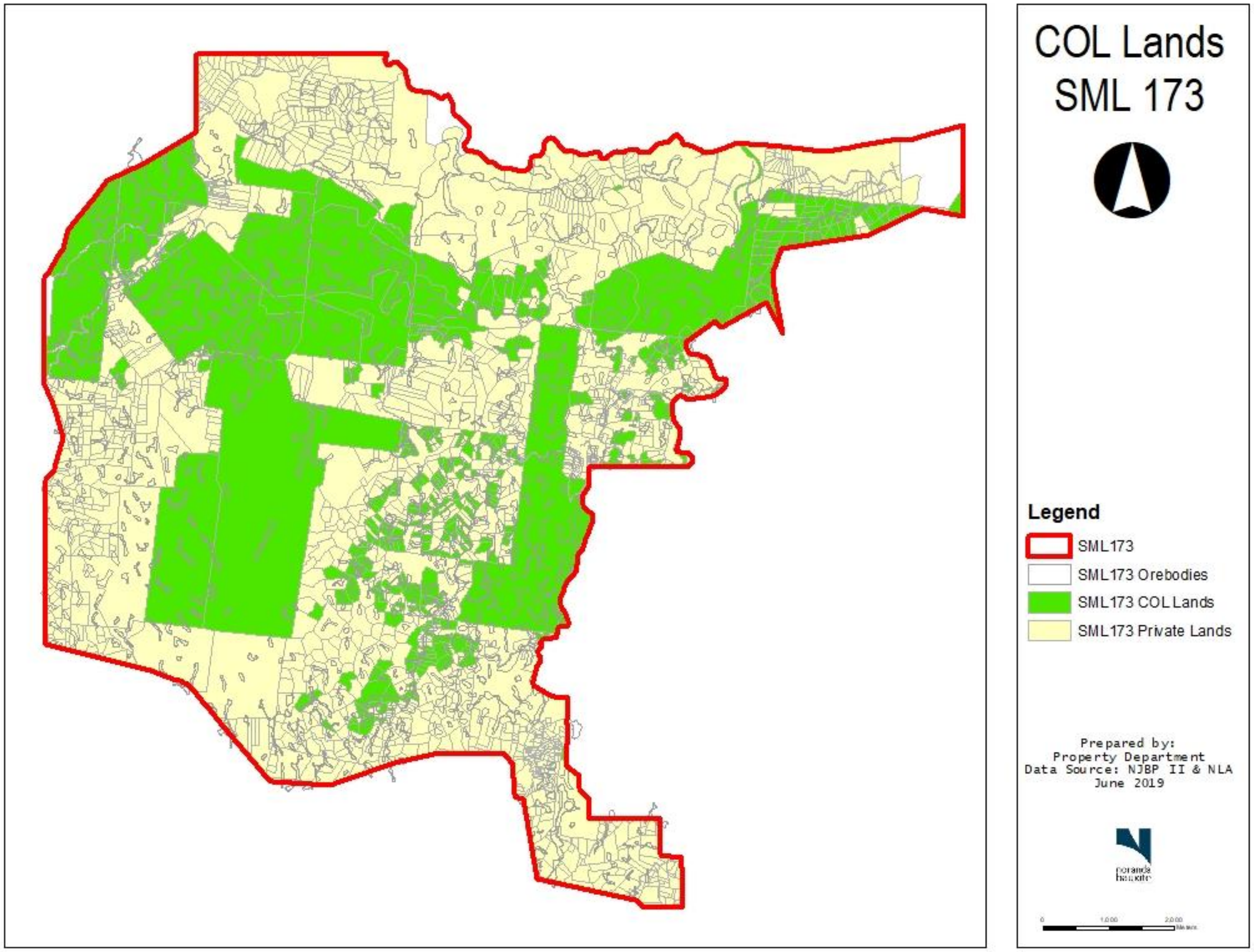


Figure 2-2: Land Title Status within SML 173 Area

2.6. Profile of the Project Proponent

The proponent of this project, Noranda Jamaica Bauxite Partners II (NJBP II) is a partnership between the Government of Jamaica (GOJ), holding 51% ownership through its wholly owned Jamaica Bauxite Mining Limited (JBML), and New Day Aluminum (Jamaica) Limited, (NDAJL) a company registered under the laws of Jamaica holding 49%. A suite of agreements governs the relationship between NDAJL, the GOJ, JBML and the Commissioner of Lands.

Pursuant to the management agreement, NDAJL has been appointed the managing partner for the entity. NJBP II carries out mining operations under the partnership.

NJBP II's bauxite mining assets consist of:

1. a concession from the Government of Jamaica (GoJ) to mine bauxite in Jamaica through 2030 and
2. a 49% interest in Noranda Jamaica Bauxite Partnership II, or NJBP II, which holds the physical mining assets and conducts the mining and related operations pursuant to the concession.

The GoJ Jamaica owns the remaining 51% of NJBP II.

Annual bauxite production is currently approximately 3.8 million dry metric tonnes (DMT) of ore. The St. Ann bauxite mine is operated through NJBP II and has an annual production capacity of 5.2 million DMT.

The proposed project will involve:

1. Land clearing for ore access and road construction
2. The mining of bauxite from the ore bodies
3. The transportation of bauxite to existing loading areas
4. The reclamation of the mined-out lands

As stated in 3 above, mined ore will be transported to already permitted facilities in active mining and processing areas located in areas under established leases.

The project will be executed over the lifetime of lease with all three (3) activities outlined above occurring to varying levels within each year of operation.

Name: Noranda Jamaica Bauxite Partners II (NJBP II)
Contact Address: Port Rhoades, Discovery Bay, St. Ann, Jamaica
E-mail: delroy.dell@norandabauxite.com
Implementing organization: Noranda Jamaica Bauxite Partners II (NJBP II)
Project Consultants: Conrad Douglas & Associates Limited

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

NJBP II 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.

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 at Special Mining Lease 173 (SML 173).

3.2. Applicable National Legislation, Standards and Policies

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

3.2.1. Proposed Cockpit Country Protected Area

On November 21, 2017 the Government of Jamaica (GoJ) announced the proposal to declare in Parliament that 74,726 hectares of lands spanning the parishes of St. James, Trelawny, St. Ann and Manchester, will be protected as the CCPA. The notes and details of the Most Honourable Prime Minister's presentation are presented in Appendix IV, *inter alia*, "*the Parris Lyew-Ayee Jr. (2005)* [4] *boundary is being recognized as the boundary of the Cockpit Country by the State…*".

The responsibility to establish the survey monuments of the boundary, on the ground, has been entrusted to the Forestry Department and the process is ongoing.

3.2.2. 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 that are declared under the NRCA Act.

[4] Parris Lyew Ayee Jr., *Redrawing the Boundaries of the Cockpit Country*, Jamaica, 2005

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.

3.2.2.1. <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 II 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 µg/m³)
Total Suspended Particulates Matter (TSP)	Annual	60
	24-hour	150
PM_{10}	Annual	50
	24-hour	150
Lead	Calendar Quarter	2
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

3.2.2.2. 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.

3.2.2.3. Noise Standards

Noise Standards for Jamaica have been recommended based on the World Bank standards. The guideline for daytime perimeter noise is 75 decibels and 70 decibels for night-time noise.

3.2.3. 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 specified rare or endemic 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. The Wild life Protection (Amendment of the second and third schedules) Regulations, 2016 is provided in Appendix VI.

3.2.4. 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. Appendix VII provides the Jamaica Gazettes for the estates in SML 173, supplied by the Forestry Department, which illustrates the boundaries of the Forest Reserves as printed between 1950 and 1964. There will be no bauxite mining in these areas.

3.2.5. 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.

3.2.6. 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. SML 173 falls within the Rio Bueno White River Watershed Management Unit.

3.2.7. 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.

NJBP II intends to abide by all regulations regarding air quality and intends to put in place best management practices.

3.2.8. The Town and Country Planning Act, 1958

This Act governs the development and use of land. Under this law the Town Planning Department 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.

3.2.9. Town and Country Planning Development Order (Trelawny Parish) Confirmed Development Order, 2015

This Development Order designates the Parish of Trelawny as a development order area and makes detailed provisions and policies to govern the orderly and planned development of Trelawny for the next ten to fifteen years.

The Order (particularly in the Third Schedule) sets out "*Permitted Development*" and "*Development Not Permitted*". It requires extensive consultation with a number of relevant agencies before permission is granted for development. The agencies or bodies to be consulted depend, mainly, on the type of development for which permission is being sought.

With specific reference to the mining of bauxite in the Cockpit Country, the Fifth Schedule to the Order states, inter alia:

> "*Proposed development of this resource has generated interest among environmentalists and residents of the area who are concerned about the implications such action could have on the fragile Cockpit Country environment. However, the National Minerals Policy states that where mineral resources are deemed to be of significant national importance efforts will be made to exploit them after assessment to determine the feasibility of doing so.*
>
> *Since it will be challenging to mine the area the required management practices necessary to protect its biodiversity and that for other areas will have to be put in place by the authorities".*

The Order speaks to the development of a policy with the objective to:

> "*ensure that mineral extraction minimizes adverse effects on communities, the landscape, wildlife and habitats.*"

A further policy is to:

> "*ensure that mineral extraction and waste disposal operations maintain high standards of site operation and restoration and provide for beneficial post mining activities…to safeguard mineral resources by identifying areas for minerals workings and extraction."*

The Order also states that:

> "*there will be a presumption against development likely to be damaging to the scientific or wildlife interest within or adjacent to the Cockpit Country.*" (Fifth Schedule – SP C4)

And that:

"*There will be a strong presumption against development changes or use or management which would be harmful to officially notified sites of scientific importance. Applications for substantial mineral workings and the exploration for and appraisal and production will be subject to the most rigorous examination because of their possible impact on the importance of these sites.*" (Fifth Schedule – SP C6)

The Order prohibits mining in any land being used for forestry.

3.2.10. 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.

3.2.11. 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.

3.2.12. 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.

3.2.13. 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*.

NJBP II will conduct ambient air quality monitoring in the project area during pre-construction, construction, and operation phases.

3.2.14. 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.

3.2.15. 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

3.2.16. 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).

3.2.17. 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.

3.2.18. 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.

3.2.19. 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.

3.2.20. 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 3-1 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 2019 are shown in Figure 3-2 and Figure 3-3, 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.

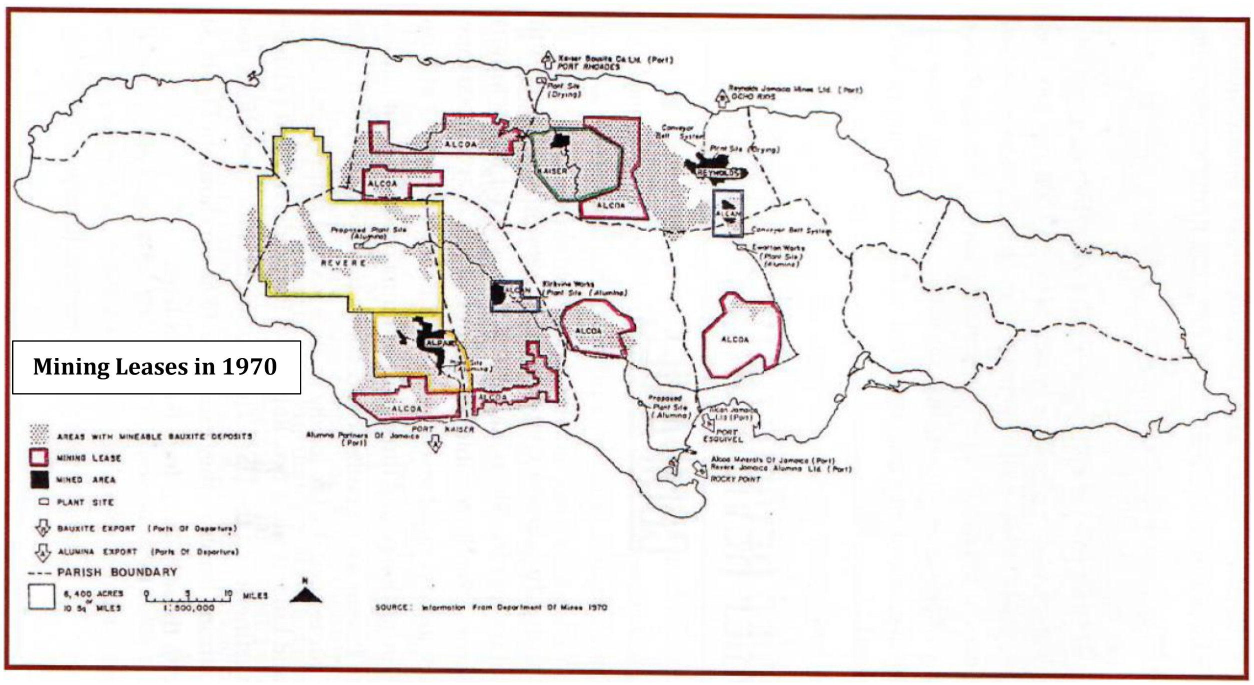


Figure 3-1: Mining Leases in 1970 ***(Source: Jamaican Bauxite: A Retrospective, ARD Porter, 2017)***

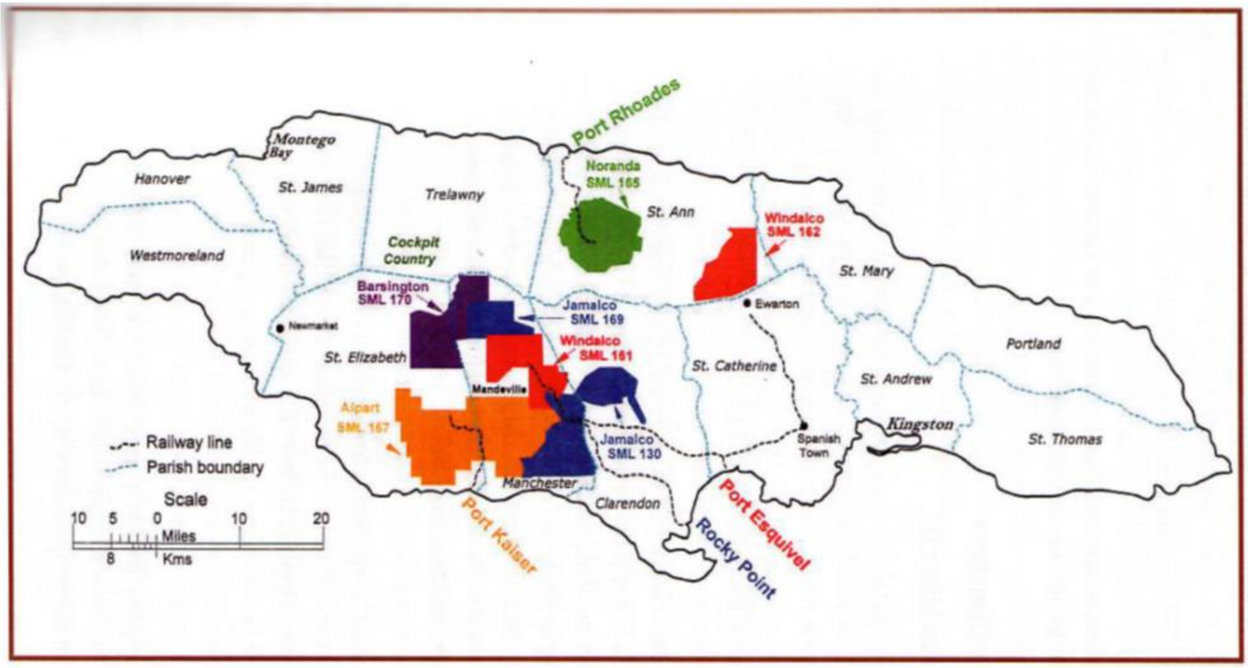


Figure 3-2: Mining Leases in 2015 ***(Source: Jamaican Bauxite: A Retrospective, ARD Porter, 2017)***

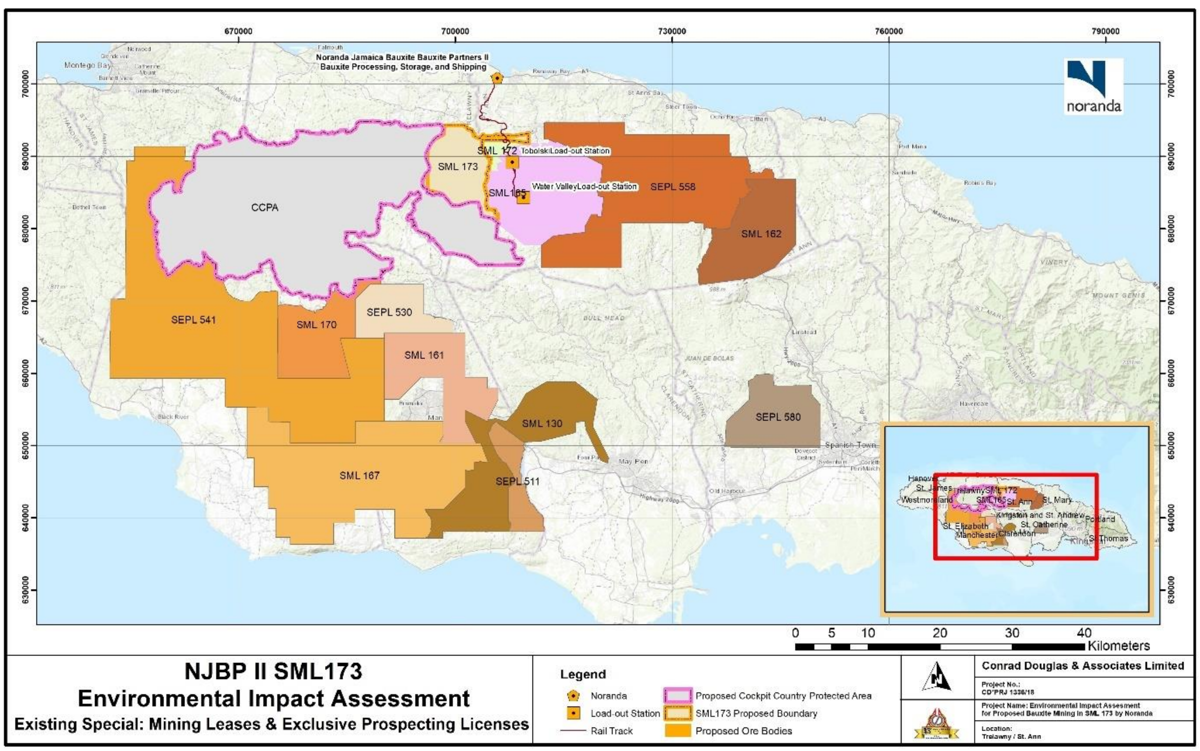


Figure 3-3: Mining Leases in 2019 ***(Source: Jamaica Bauxite Institute)***

The Mining Act: - 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 ***owner or occupier*** 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:

As of 2012, NJBP II placed reliance 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.

Special Mining Lease 173

The area granted under Special Mining Lease 173 includes both the areas depicted as SML 173 and SML 172 in the Figure 1-4. All references to 'SML 173 area' in this report, pertain to only that area shown as SML 173 in Figure 1-1 above.

3.2.21. 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 to be exempt from the liability to lodge 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.

3.2.22. 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.

3.2.23. 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 in the

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.

3.2.24. The Bauxite (Production Levy) Act

This act provides for the establishment of the Capital Development Fund where all sums received as payment of production levy under the Act and all other income from the assets 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.

3.2.25. 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.

3.2.26. 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.

3.2.27. 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 four schedules are as follows for the Endangered Species (Protection, Conservation and Regulation of Trade Act):

1. *"**First Schedule:** Endangered Species threatened with extinction which may be affected by trade therein*
2. ***Second Schedule:** Species which could become extinct or which have to be effectively controlled*
3. ***Third Schedule:** Species which any contracting party within its own jurisdiction for the purpose of preventing or restricting over-exploitation and require the cooperation of other parties for the control of trade in such species*
4. ***Fourth Schedule:** Species in Jamaica the trade of which is to be controlled to prevent or restrict exploitation and which require the cooperation of other Parties in the control of trade in such species"*

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 II)
3. Natural Landmark/ National Monument (Equivalent to IUCN Category III)
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)

In recognition that the value of ecosystem services is essential to human well-being, this policy was expanded by the preparation of the Protected Areas System Master Plan (PASMP), (2013 to 2017) to develop a comprehensive and representative system of protected areas. As a result, Jamaica has declared several marine and terrestrial 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).

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 is 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 in to 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).

The 1962 Constitution protects property rights and establishes principles on the ownership of property in Jamaica. The legal status of owned property applies to the ownership of flora and fauna in Jamaica. The proprietor owns all flora on his/her property and if he/she catches wildlife on his/her property (subject to the Wild Life Protection Act) then he/she owns these wild animals, subject to the Wild Life Protection Act.

In 2011, the Constitution of Jamaica was amended to provide for a Charter of Fundamental Rights and Freedoms. Section 13 (3) (l) of the Constitution now recognizes, inter alia, "*the right to enjoy a healthy and productive environment free from the threat of injury or damage from environmental abuse and degradation of the ecological heritage.*"

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 United Nations Framework Convention on Climate Change (UNFCCC) 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. Description of the Proposed Project

4.1. Project Concept and Description

The planning for the development of the Special Mining Lease 173 (SML 173) area will be done in five-year cycles. The plan for the five years, starting 2020 and ending 2024, is described in detail. The plan for 2025 to 2044 is also provided. The general development within the 8,335 hectares of SML 173 is the scope for the permits being sought. The location of SML 173, in relation to existing mining activities in SML 165, SML 172 and associated infrastructure, is presented in Figure 4-1 below. NJPB II will use their own existing facilities in the operations. Public roads will not be used. The permitting of SML 173 is to enable the sustained operations of NJBP II for the next 25 – 30 years. This, in essence, represents a spatial expansion of NJBP II's mining operations.

The layout for the orebodies to be mined over the next five (5) years and the haul roads for the distribution network for mined ore in this section of the SML 173 area are illustrated in Figure 4-2 below.

The topography of the area is gently undulating with the typical karstic limestone formation (See Section 5.1.2). The area is sparsely populated. Farming is the main economic activity within the SML 173 area, however, according to the 2012 Living Standard Report the communities in the SML 173 area have some of the highest levels of poverty in the country. (See sections 5.5 and 10.2).

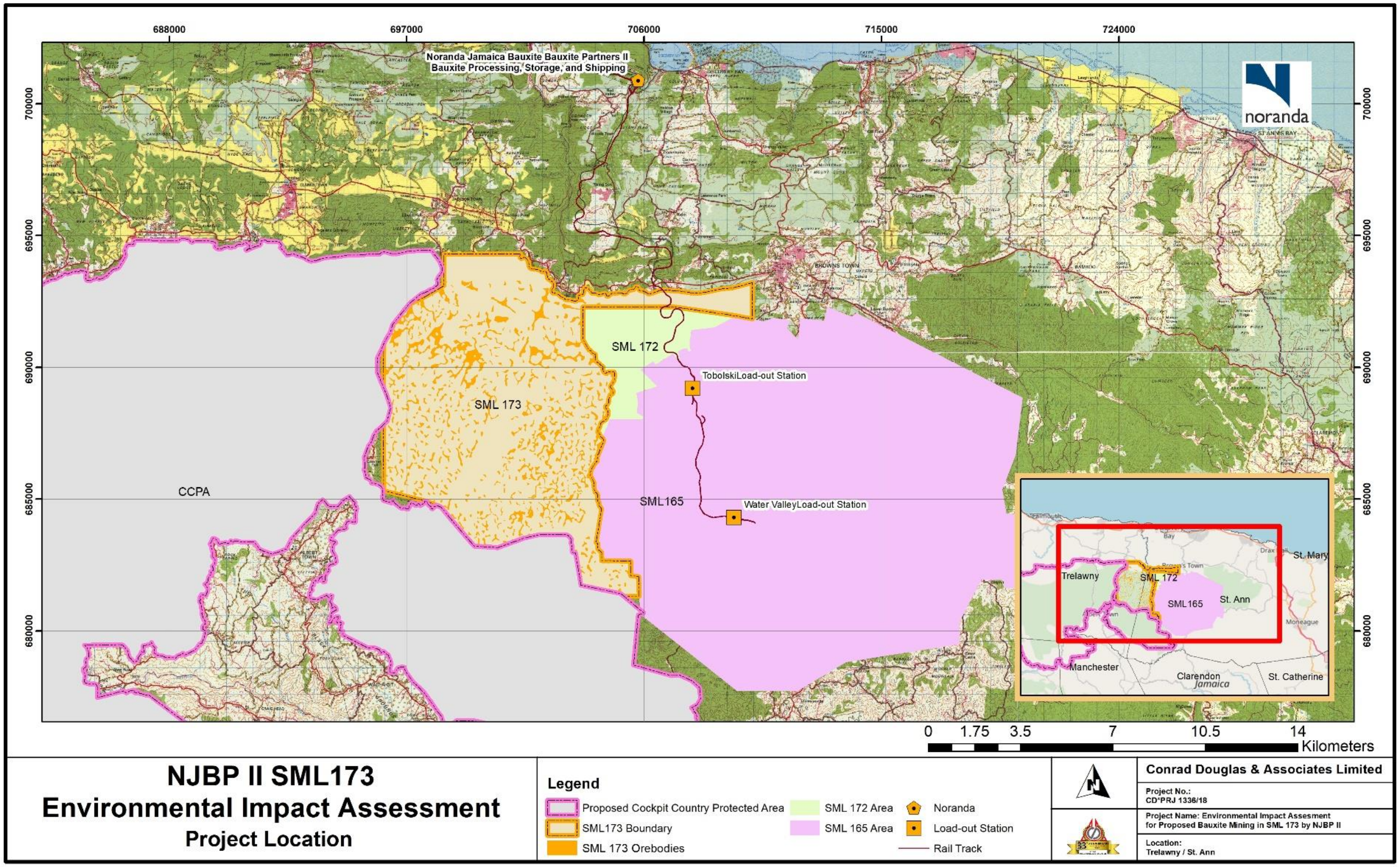


Figure 4-1: Project Location and Major Supporting Infrastructure

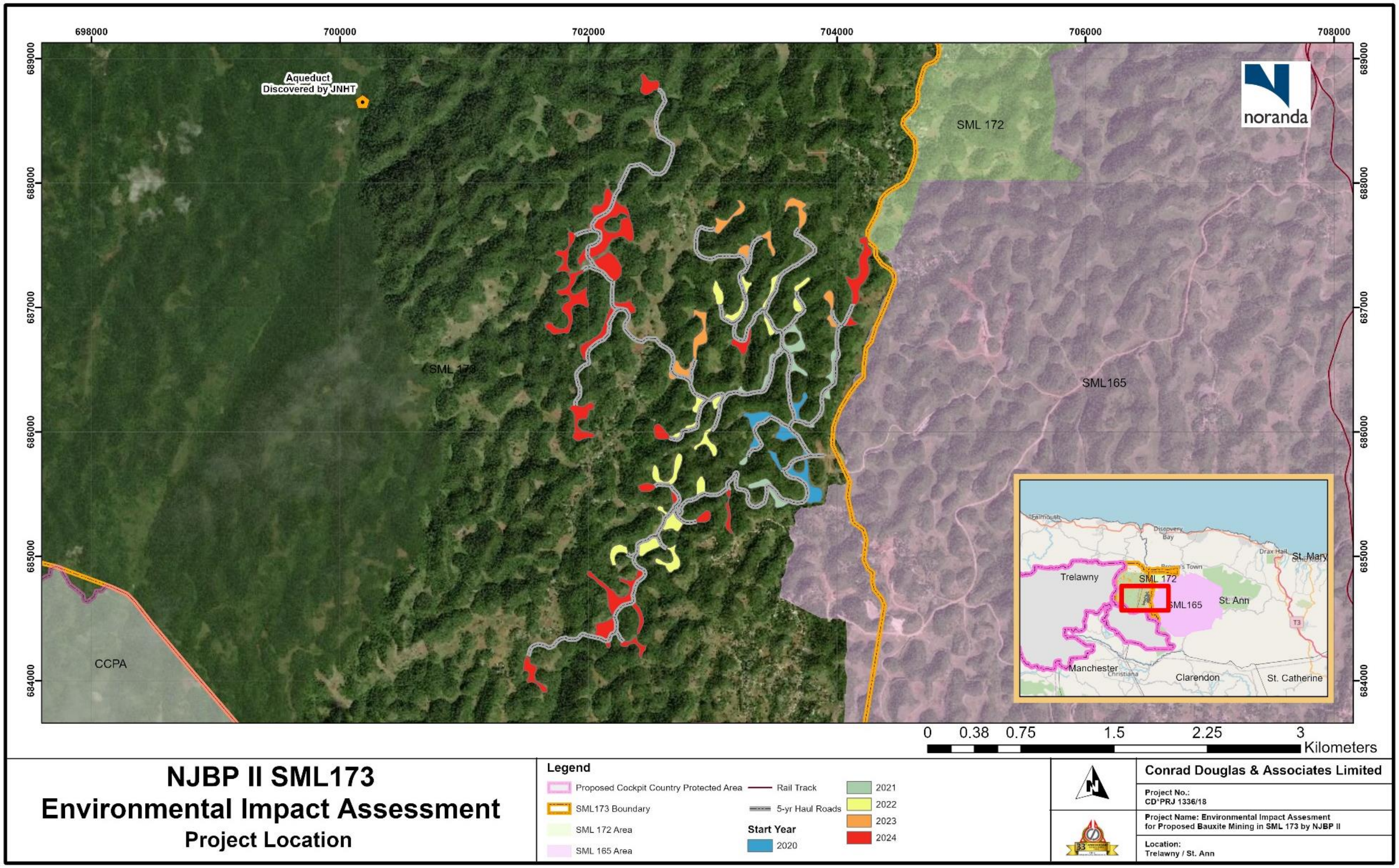


Figure 4-2: Proposed project location showing Ore Bodies for SML 173 Five Year Plan

4.2. Pre-operations

Initial exploration activities were done as a part of the SEPL 578 activities. Subsequent explorations will be done by drilling and ground penetration radar on a phased basis in accordance with the mining requirements. It is intended that the bauxite extracted will be transported to existing stockpile locations within SML 165. Haul roads will be constructed for the purpose of accessing orebodies on an as needed basis. There will be no new site facilities established within SML 173 for the pre-operations phase. NJBP II's existing site, administrative offices and services will be utilized. Pre-operation activities will also include the removal and relocation of sensitive species such as epiphytes to NJBP II's existing greenhouses. This will be done in accordance with NEPA's permit requirements.

4.3. Operations

The activities involved in the operations phase include the following four (4) main components:

1. Acquisition of mining rights to land
2. Site Clearance
3. Transportation
    a. Road Preparation
    b. Haulage of material (ore and waste)
4. Mining

The scope of work for each aspect is described in separate sections below.

4.3.1. Acquisition of mining rights to land

The partnership 'NJBP II' currently owns 49% of lands within SML 173. Additional rights will be secured on a phased basis in accordance with the Mining Plan, as provided by in the Mining Act.

4.3.2. Site Clearance Process Description

Site clearance will be required for:

1. Roadway construction
2. Orebody preparation

The following activities will be involved:

1. Design of site layout and road network
2. Vegetation removal
    a. Sensitive species relocation
    b. De-bushing
    c. Topsoil removal (40cm – 60cm) – Sustainable management of topsoil
    d. Carting of topsoil to storage (for use in rehabilitation on completion of mining the specific orebody)

The detailed process is described below:

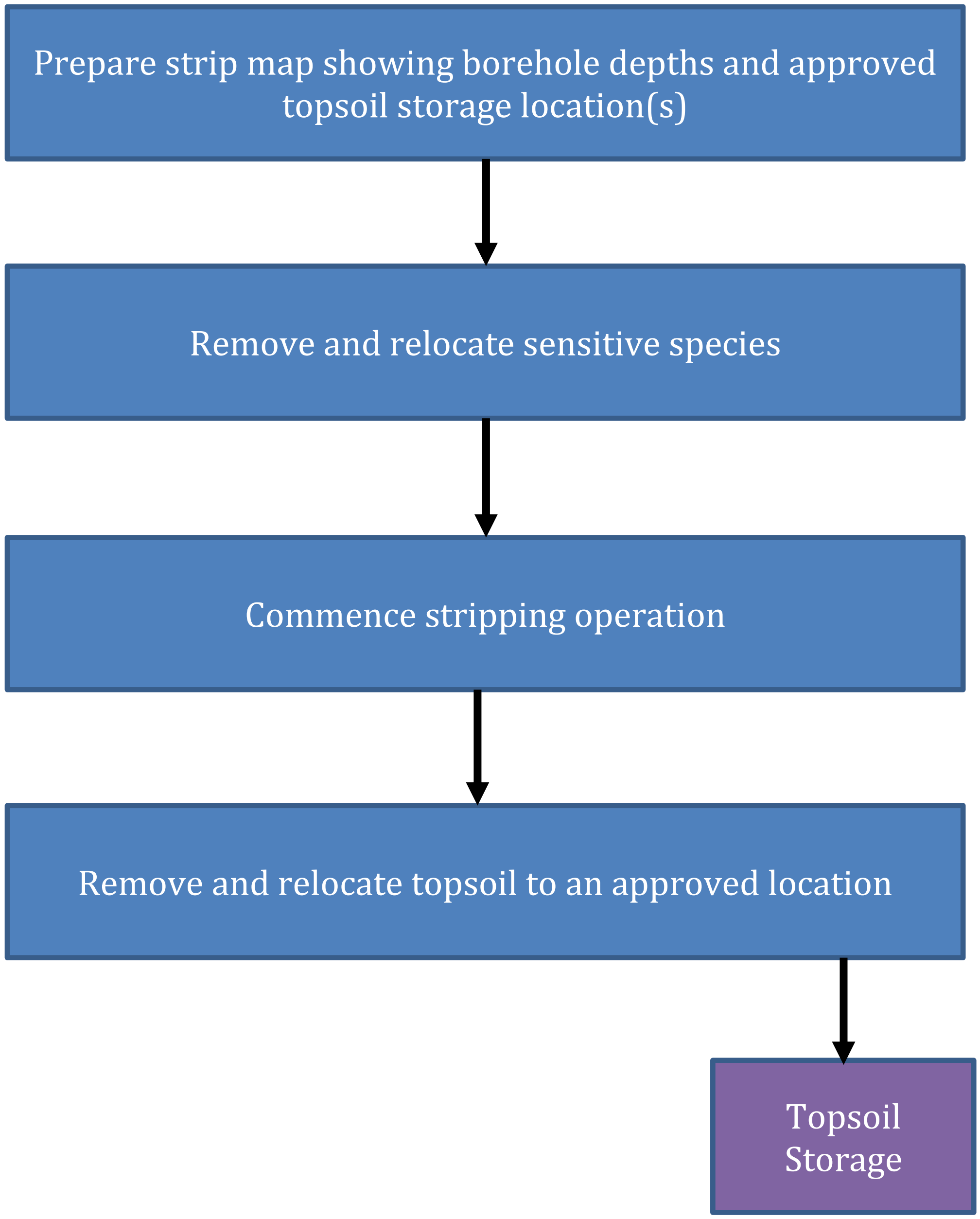


Figure 4-3: Process flowchart for Site Clearance for each orebody

4.3.3. Transportation

In order to facilitate the transportation of mined ore, NJBP II will construct roads to new orebodies in SML 173. The construction of roads will involve:

1. Design approval
    a. Drainage approval

2. Excavation for optimal gradient and base laying
3. Transportation of fill material
4. Compaction of fill
5. Grading and rolling
6. Waste management
    a. excess excavated material,
    b. site waste,
    c. domestic waste.

Haul trucks and excavators will be maintained at existing maintenance facilities. Routine road maintenance will be undertaken. Road maintenance will involve:

1. resurfacing and grading
2. drainage cleaning
3. water wetting and/or application of Dustreat (a binding agent) for dust suppression. The MSDS is attached in Appendix VIII.

Repair and maintenance facilities within SML 165, will be used during this project phase. The potential impacts and mitigation measure resulting from access to the sites are described in sections 7.0 and 8.0, respectively.

4.3.4. Bauxite Mining Process Description

Prior to mining, orebodies are drilled to bedrock on a horizontal grid of 15.24 meters (50-feet) spacing. Drill samples are taken at 3.048 meters (10 ft) intervals and analyzed for chemical content. The derived analyses form the basis for long-term (5 years), medium-term (annual) and short-term (daily) mine plans.

In preparation for mining, vegetation is removed and an average of 40cm (18 inches) of topsoil is stripped and stored (for use in reclamation after mining).

The typical maximum depth excavated for bauxite in NJBP II's operation is 20 meters (65.61 ft) and the average depth is 10 meters (32.80 ft).

4.3.4.1. Orebody Development and Mining Specifications

The orebodies distributed in SML 173 to be exploited in the first five (5) years are as shown in Figure 4-2. The surface areas for the orebodies to be mined on a yearly basis for the next five years and by five years increments, thereafter, are presented in Table 4-1 below.

Table 4-1: Size of areas to be disturbed over the next five years and five year increments thereafter

Year	2020	2021	2022	2023	2024	TOTAL (2020 – 2024)	2025-2029	2030-2034	2035-2039	2040-2044	Total
Disturbed Area (ha)	10.2	9.94	18.89	10.75	47.47	**97.24**	**175**	**257**	**274**	**197**	**1,000**

4.3.4.2. Access Development Description

To facilitate bauxite transportation, 11m (36 feet) wide roads are constructed from the existing haul road network to designated orebodies.

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

Year	Length (m)	Road Construction (m^2)	Road Construction (hectares)
2020	1,124	11,995	1.20
2021	2,411	25,716	2.57
2022	5,493	58,595	5.86
2023	3,341	35,644	3.56
2024	7,385	78,780	7.88
Total (2020-2024)	**19,755**	**210,730**	**21.07**
2025-2029			54
2030-2034			67
2035-2039			59
2040-2044			49

All the bauxite mined in the SML 173 area will be transported to the Tobolski load station within SML 165. Tobolski has a capacity of 5.5 million tonnes of bauxite/year. The maximum projected haul distance from SML 173 to the Tobolski load station in the first five years is 14.8 kilometers.

Truck and excavator operators will be instructed to store solid waste within their operating equipment for disposal at their respective site offices, workshops or truck parks. Portable chemical toilets will be installed within operating areas. Staff and contractors will be equipped with adequate personal protective equipment (PPE), including but not limited to items, such as safety boots, gloves, safety glasses, reflective vests, safety hats/helmets, air plugs/muffs and N95 respirators for voluntary users. Prominent safety and caution signs will be erected throughout the property at critical traffic nodes.

NJBP II will ensure that excavated topsoil is stored at elevated locations and not subjected to accelerated water flow and ponding. Surface water drained from active mining pits will be conveyed to in-pit sumps within the limits of the pits. Haul roads will be bermed to also assist in directing rain run-off into in-pit sumps. These sumps will be maintained. Dry gullies will not be modified.

Mining will be carried out by contractors, using excavators and 25 tonne road trucks. Typically, eight to twelve orebodies are mined concurrently in order to achieve the requisite tonnage and grade. Most of the material delivered by road trucks is deposited on the main stockpiles at each load station (Water Valley and Tobolski). If the grade from a particular orebody cannot be included in the daily blend, the bauxite is deposited on a designated satellite stockpile. Bauxite from the main stockpile is loaded daily onto trains by means of bulldozers and loaders. On occasion this input is supplemented by bauxite reclaimed from the satellite stockpiles. The existing capacity of these two loading areas is 5.5 DMT and is able to accommodate the increase in production without significantly upgrading existing infrastructure. The mining process is outlined in Figure 4-4 to Figure 4-5 below.

Figure 4-4: Overview of NJBP II's Operations

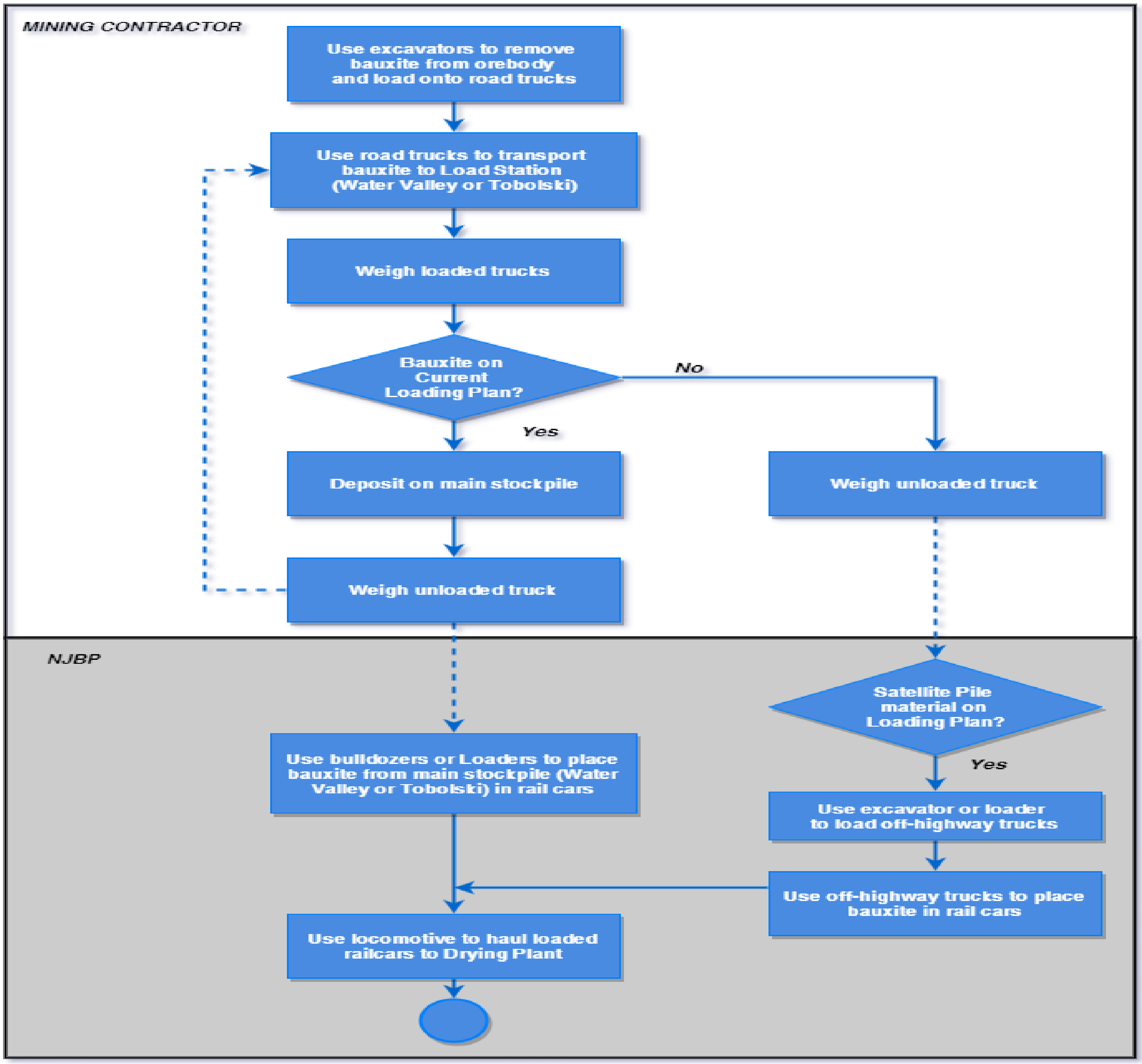


Figure 4-5: Flowchart of mining process

4.4. Decommissioning

Mined out bauxite pits will be decommissioned and rehabilitated in accordance with the regulatory requirements. Upon completion of the project, existing facilities, including arterial haul roads, will be closed and decommissioned in accordance with the approved Closure Plan. This includes:

- ✓ Mapping of the disturbed landscape
- ✓ Detailed mapping of current land use and ownership
- ✓ Completion of reclamation with consideration given to required end uses
- ✓ Complete inventory check of all waste, contaminants and hazardous materials and outlined planned disposal, storage methods and locations. It is not expected that the operations will result in any contamination during the pre-operations and operations phases. In the event of any contamination, a soil remediation plan will be prepared and submitted to the NEPA.
- ✓ Prepare a plan for the mothballing and disposal or redeployment of physical assets
- ✓ Conduct a detailed hydrological assessment of the specified area
- ✓ Completion of outstanding land transactions/obligations prior to closure
- ✓ Completion of land use plans based on discussions with stakeholders on end use considerations
- ✓ Preparation of schedule of completion and budget
- ✓ Measurement of the performance of these activities from the start to end

There will be no construction of buildings and permanent structures within SML 173. Hence decommissioning will not be necessary.

Only mobile machinery and equipment will be used in all phases of the project, including portable systems for wastewater management. The decommissioning operations will not result in environmental pollution.

4.5. Rehabilitation

Rehabilitation activities will involve:

1. Design and approval of a Rehabilitation Plan for designated use based on best practices.
2. Mobilization of heavy equipment
3. Reshaping of mined out pit

4. Transportation and spreading of stored topsoil
5. Replanting of vegetative cover

After mining is completed in an orebody and it is certified as such, by the Government's Mines Inspectorate, rehabilitation of the mined-out orebody is done. Flow diagrams depicting the various stages of the rehabilitation process is presented in Figure 4-6 below.

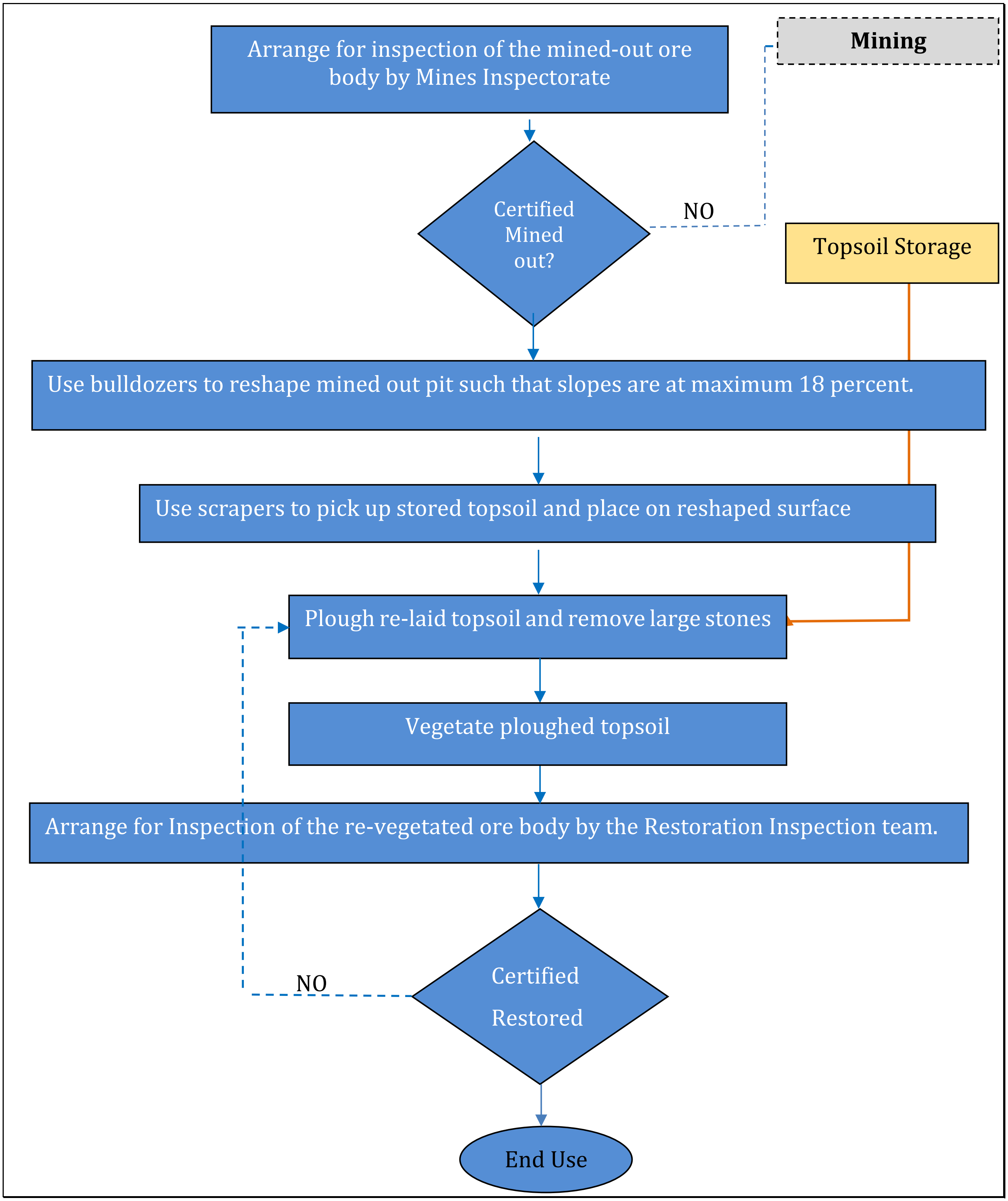


Figure 4-6: Process Flow for Rehabilitation of mined out areas

NJBP II has rehabilitated 2,889 hectares of land over the time of its operations (approximately 91% of all lands impacted – the remaining 9% is within the timelines planned for their reclamation). NJBP II will also use creative methods for the reclamation of the mined-out bauxite orebody beyond standard regulatory requirements in keeping with its own policy for Corporate Social Responsibility. Figure 4-7 to Figure 4-8 below show examples of rehabilitated areas and their existing land uses. The possible end uses are listed below:

- Agricultural and agro-processing activities
- Installation of greenhouses,
- Aquaponics
- Water storage for irrigation purposes
- Housing sub-divisions
- Recreational playfields

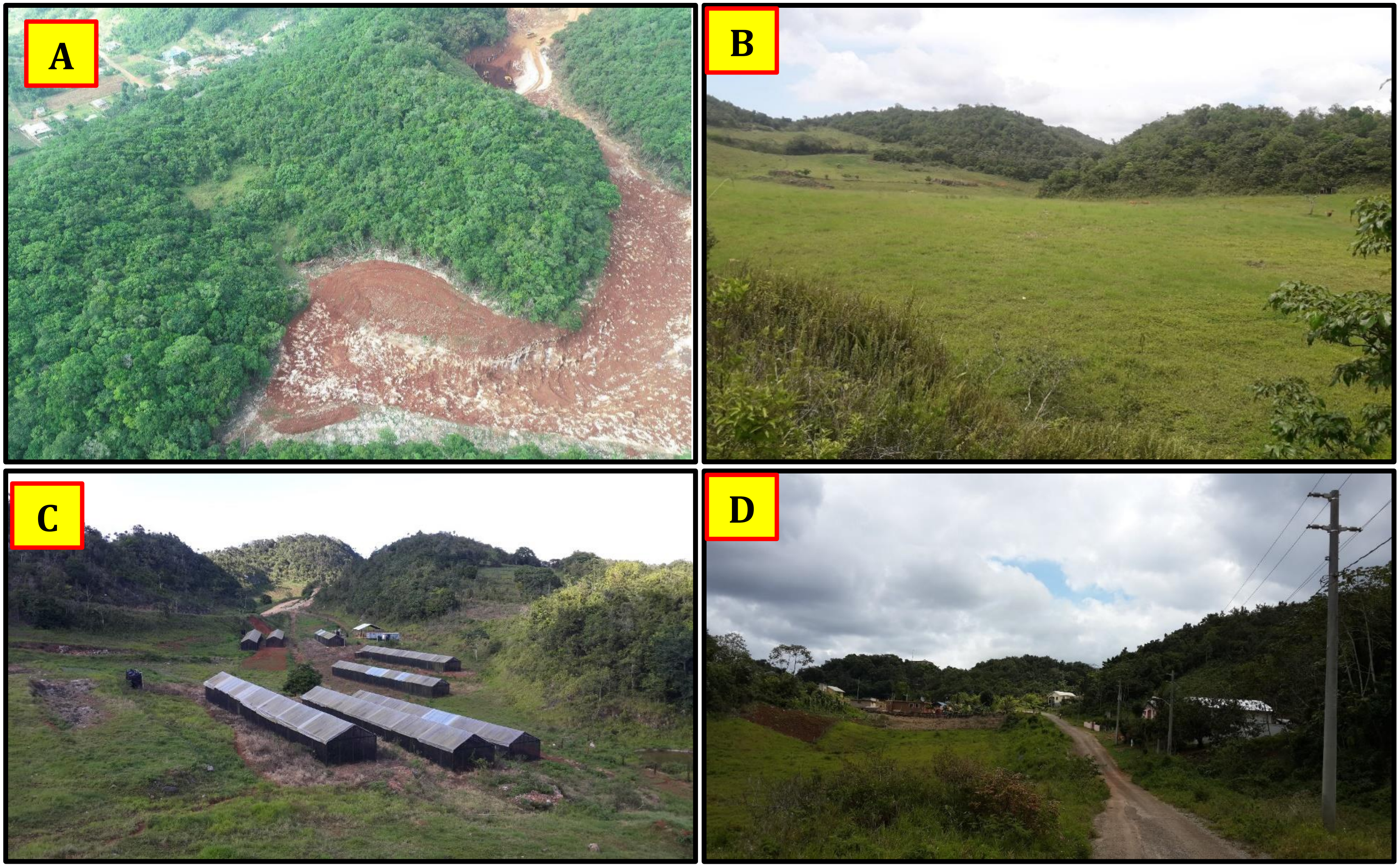


Figure 4-7: [A] Typical Mined Out Pit | [B] Rehabilitated land under pasture | [C] Watt Town Greenhouse cluster on rehabilitated lands | [D] Hyde Park Subdivision developed on rehabilitated land

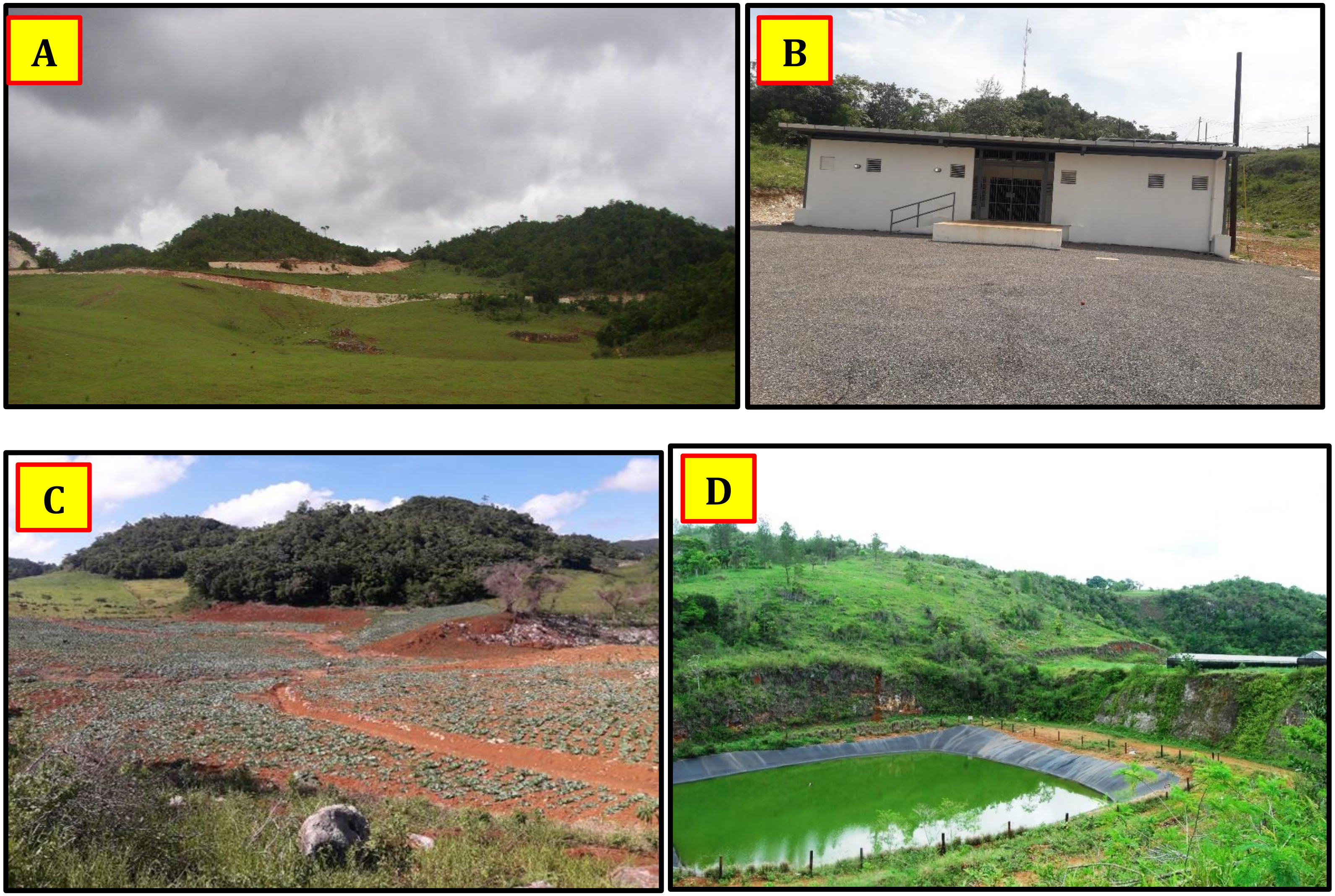


Figure 4-8: [A] Rehabilitated land under pasture | [B] Cold Storage facility built on restored lands at Water Valley for use in Noranda Bauxite Farmers Agricultural programme | [C] Cabbage Growing on restored lands at Higgins Land | [D] Pond established on Rehabilitated land

4.6. NJBP II Environment, Health & Safety and Security Policies & Practices

NJBP II operations are executed within a framework of internal policies that are aligned with local and international laws and best practices. The vision and mission of the organization are presented here specifically as it regards environment, health and safety.

Vision: *Everyday the safety and health of all workers, contractors, and visitors at Noranda Jamaica Bauxite Partners II shall be accomplished by setting standards, enforcing policies, providing training, coaching and education; establishing partnerships and facilitating continuous improvement in workplace safety and health practices.*

Mission: Noranda Jamaica Bauxite Partners II will achieve this vision by:

- *Facilitating a process of 100% employee involvement and participation.*
- *Documenting and communicating written **rules** and **regulations**.*
- *Focusing on **systems** instead of **symptoms**.*
- *Acting **fast** on **facts** without **fear** or **favoritism**.*

Principles:

1. *All employees and contractors are responsible for their own safety and a commitment to safety must be highly visible in their behaviour*
2. *No job is so important that it would require our employees to risk their lives or compromise their value on safety*
3. *All employees and contractors are empowered to stop any job that is deemed to be life threatening*
4. *Safety is equal to production, cost, engineering, quality, environmental and all other business concerns*
5. *All occupational injuries, illnesses, accidents and significant incidents are preventable*
6. *Programs, rules and procedures shall be developed and enforced to prevent injuries, illnesses and accidents*
7. *All employees and contractors must be indoctrinated in safety prior to employment and further trained in safety programs, rules and procedures to work safely*
8. *Safety audits shall be conducted to identify deficiencies and their root causes. Corrective actions will be planned and timely implemented*

9. *Tracking and trending of deficiencies and their corrective actions will be done to drive continuous improvement*
10. *The highest safety performance coupled with the highest productivity is an integral element of all employees appraised.*

4.6.1.1. NJBP II's Roles & Responsibilities

Environmental, Health & Safety is managed and enforced by NJBP II's team of dedicated, qualified and experienced staff. The Environmental, Health & Safety (EHS) Manager is responsible for enforcing the management and monitoring of measures described. The EHS Manager is supported by Officers, Technicians and an Administrative Assistant in order to ensure that all activities are carried out effectively and efficiently. In addition, all staff members and contractors are trained on the EHS procedures and protocols. The EHS organogram is shown in Figure 4-9 below and the roles and responsibilities for NJBP II staff is described in Table 4-2 below:

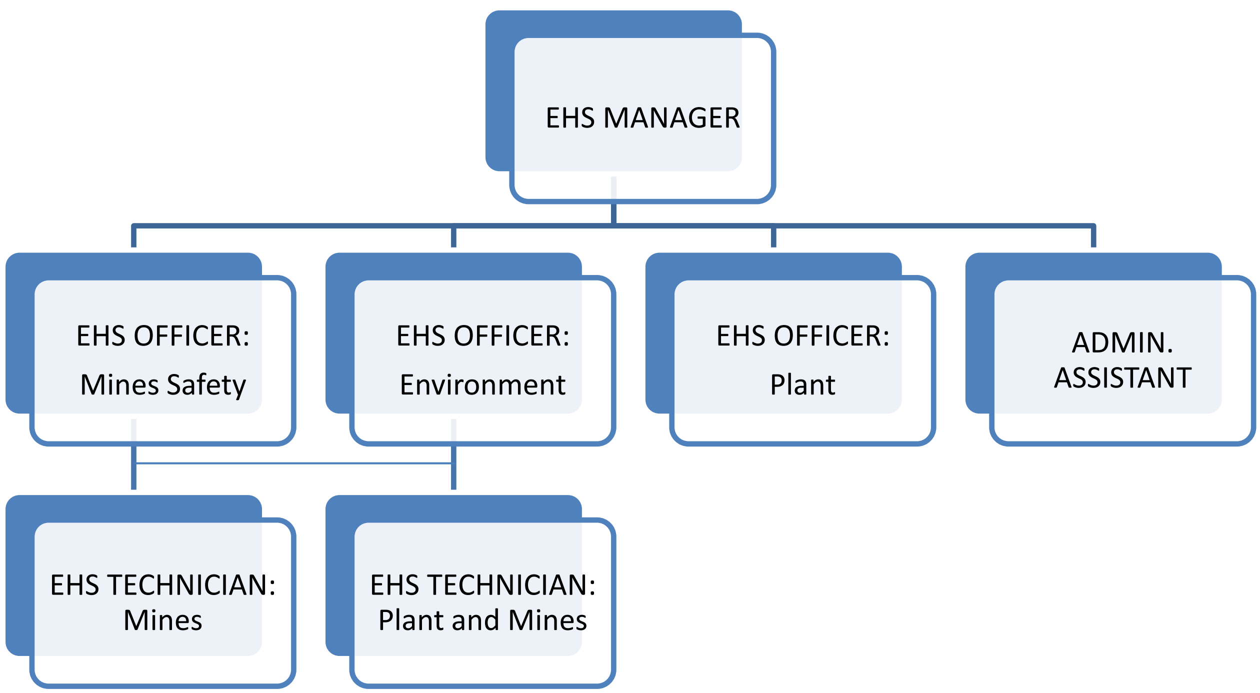


Figure 4-9: Environmental, Health & Safety Organogram

Table 4-2: Personnel and their respective Roles & Responsibilities

Responsible Personnel	Roles & Responsibilities
Project Manager (General Manager/VP)	Responsible for assuring that the Environmental, Health & Safety Manager has the required resources, information and authority to implement the management and monitoring measures.
EHS Manager	Responsible for assuring that the Environmental, Health & Safety Team has the required resources and information authority to implement the management and monitoring measures. Responsible for also enforcing the management and monitoring measures.
EHS Officers	Provides support to the EHS Manager in enforcing the management and monitoring measures.
	Responsible for the provision of training to staff and contractors.
Public Relation Officers	Responsible for consultations with community and institutional stakeholders.
Land Agents	Responsible for land acquisition for bauxite ore consolidation & haul road construction.
Agricultural Extension Officer	Responsible for farm relocation and compensation (lease holders).
Property Officers	Responsible for permission and compensation to mine within 300 feet of bauxite deposit Mining nuisance compensation of residence within 1,000 feet of mining operations.
Mines Manager	Responsible for monitoring stripping and mining practice Also responsible for monitoring the relocation of graves to cemetery. To ensure compliance with environmental terms and conditions of permits.
Reclamation and Surveying Superintendent	Responsible for vetting road design and post construction sign-off to ensure that appropriate measures are put in place
Contractors	Responsible for following the procedures and protocols.

4.7. Economic Profile

The bauxite mining, drying and shipping operations date back to January 17, 1967, when Kaiser Aluminum & Chemical Corporation (Kaiser Jamaica Bauxite Company) commenced shipping bauxite from the newly constructed Port Rhoades pier in Discovery Bay to Baton Rouge in Louisiana. Kaiser, one of the pioneers of bauxite mining in Jamaica (dating back to 1953 when it commenced local operations on the south coast), maintained steady production in St. Ann and were good corporate citizens. Kaiser continued to operate in Jamaica until 2004 when it decided to sell its bauxite mining operations in St. Ann and alumina production businesses in St. Elizabeth at Nain and Port Kaiser (Alpart).

In October 2004 Century Aluminum and Noranda Aluminum Holdings jointly purchased Kaiser's 49% ownership of the Kaiser Jamaica Bauxite Company. The remaining 51% had been acquired by the government of Jamaica in 1977 when it entered into a partnership with Kaiser Aluminum & Chemical Corporation. The company was renamed St. Ann Jamaica Bauxite Partners (SAJB).

The worldwide recession began to affect SAJB in 2008. Global aluminum prices fell during 2008 – 2009 and negatively impacted the bauxite industry in Jamaica. On August 3, 2009 an agreement was reached for Noranda Aluminum to fully acquire SAJB and Gramercy Aluminum from Century Aluminum. Noranda's 'leap of faith in Jamaica' took off officially on September 1, 2009 with the completion of the agreement[5].

NJBP II's return to full production was like a shot in the arm for the local and national economy. Commerce, trade, service and manufacturing activities were bolstered by the effects of NJBP's local purchases and employment.

On February 8, 2016 Noranda Holdings Inc. and its subsidiaries voluntarily applied for a court supervised restructuring under Chapter 11 of the USA Bankruptcy Code. Noranda's

[5] Jamaica Observer, Noranda praised for 'leap of faith' in Jamaica, October 27, 2011

assets in Gramercy Louisiana and at St. Ann Jamaica, were purchased by New Day Aluminum (Jamaica) Limited. On 24 October 2016, a partnership between New Day Aluminum (Jamaica) Limited (NDAJL) and the Government of Jamaica was established as Noranda Jamaica Bauxite Partners II and operates as such presently.

There are important bauxite deposits in the SML 173 area which are required for providing bauxite feedstock for NJBP II's mining, railroading, drying, storage and shipping operations from Port Rhoades in Discovery Bay St Ann, to export markets overseas. NJBP II's export earnings from bauxite is variable. However, based on the volume of bauxite it can be as high as, or in excess of US$150,000,000 per year. This is a major contribution in maintaining NJBP II's operations and 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 4-10 below). Jamaica’s debt to GDP ratio is now delicately balanced at 96%.

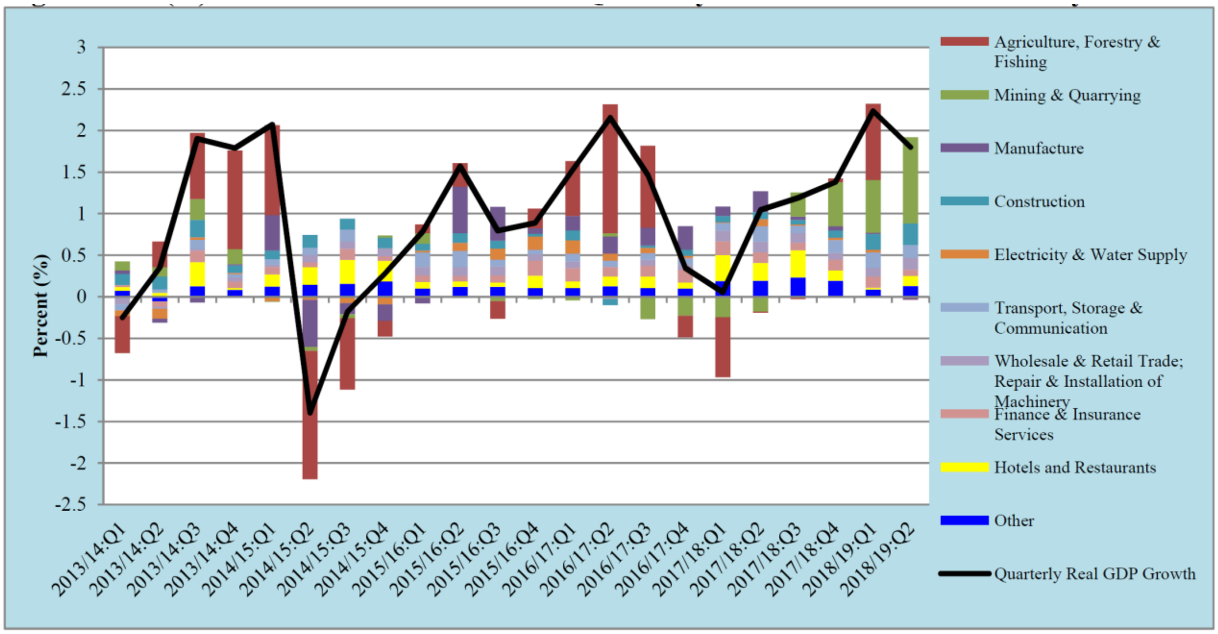
Source: STATIN

Figure 4-10: Quarterly year over year % change in Goods and Services components of real GDP (Original Source: STATIN)

The country has only 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 is directly linked to the recent closure of JISCO-ALPART bauxite processing plant. Figure 4-11 below shows that the mining & quarrying sector is a major contributor to economic growth.

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

The Jamaican economy is still at a very sensitive juncture and could be subject to exogenous and endogenous shocks. The former could take the form of natural hazards such as hurricanes and earthquakes or a pandemic. The latter refers to the potential collapse of major economic sectors including bauxite 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 4-11: Contribution to Quarterly GDP Growth by Industry

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

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

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.

In proposing the Cockpit Country Protected Area (CCPA), the government would be giving up substantial quantities of valuable bauxite resources located within the CCPA. This is supported by the following extract from the Ministry of Mining & Transport:

i. *"The Jamaica Bauxite Institute (JBI) estimates that at least **272 million dry metric tonnes** (MDMT) of bauxite exist within Trelawny. If processed into alumina, the 90.75 MDMT of bauxite in the northern section would be worth approximately US$11.643 billion at an alumina price of US$325.00 per tonne.*
ii. *The loss of income to the Government of Jamaica (GOJ) through local expenditure, income taxes, royalties and bauxite levy associated with the mining and processing of the 90.75 MDMT of bauxite in the north and north-eastern segments of the proposed Cockpit Country is estimated to be in the region of approximately **US$1.44 billion to US$1.85 billion**.*
iii. *Significantly, the JBI's intention **was** that mining companies would have access to these resources to facilitate a 'blending' regime with bauxite of lower quality so as to increase the quantities of processable reserves, improve the value of our bauxite resources, extend the size of our bauxite reserves, allow the bauxite mining companies to provide their alumina plants and clients with bauxite of acceptable quality for processing, and help to improve the sector's competitiveness.*

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).

4.7.1. 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 has declined since then to approximately 5% presently. The production numbers for the country between 1952 and 2015 are shown in Figure 4-12 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.

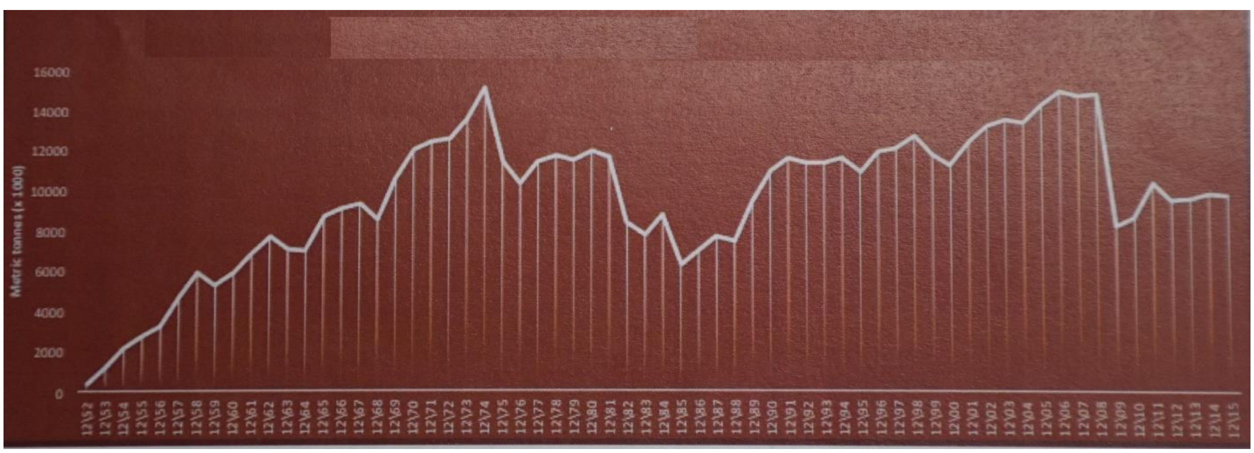


Figure 4-12: Bauxite Production for Jamaica 1952 to 2015[9]

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

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

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

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.

This proposed mining operation will contribute 60% of total company revenue to the national economy. This is in excess of USD $60 million per annum. The operation will contribute 17% of the mining (bauxite and alumina) GDP, and represent 8.4% of the total domestic exports.

4.7.2. Micro-economic

The local economy will benefit from the mining operation within SML 173 and its environs. Jobs will be created, and local goods and services will be required by the NJBP II and its employees. Living standards of local communities (and Jamaica, in general) will improve through increased employment and earning.

NJBP II's ongoing corporate social initiatives have resulted in tremendous benefits to thousands of individuals who have achieved upward mobility. Some of these Corporate Social Initiatives include:

1. Expansion of Green House Programme at Tobolski, Water Valley, Watt Town and Nine Mile
2. Commencement of aquaponics project on restored lands
3. Expansion of School Green House Project at:
    a. St Hilda's High School
    b. York Castle High School
    c. Aboukir Institute
    d. Aabuthnott Gallimore High School
    e. St. Christopher's School for the Deaf, and
    f. Browns Town High School
4. Presentation of Community Council Awards, recognizing contributions of citizens of local communities

5. Mechanical and Welding Training continued at Water Valley and Discovery Bay Training Centers
6. Tertiary Education Assistance Programme for over 100 college students receiving financial assistance each year
7. Seventy-six (76) GSAT students receiving NJBP II Scholarships
8. Construction of recreational facilities in various communities
9. Execution of NJBP II annual Summer Sports Programme with 800 community residents participating
10. Sponsors of the St. Ann Parish Cricket League
11. Sponsors and organizers of Community Concert Series at Sports Club each year (Produced Rising Star winner)
12. Host Social Development Commission (SDC) National 20/20 Cricket Finals at the Sports Club
13. Financed over 100 small business projects (GetStart Programme)
14. Active Community Councils at Mines and Plant
15. Sponsors of Community Football League.
16. Sponsors of Parish Primary School Athletics Championship
17. Sponsors of St Ann Parish Netball League
18. Sponsors of North Central Athletics Championship (Clubs and Schools)
19. Provide Farming Assistance to farmers across communities
20. Provide potable water to communities
21. Distribution of care packages during the COVID-19 pandemic

4.7.3. Production and Competitiveness

Mining in close proximity to the existing product delivery infrastructure will ensure that production cost for bauxite for export is kept in close range to the cost of producing at the existing locations. This will ensure continued production guarantee and cost competitiveness of the bauxite that NJBP II supplies to the export market.

5.0. Description of the Environment

5.1. Physical Environment

5.1.1. Introduction

The Special Mining License 173 (SML 173) area is located in the south-western area of the parish of St Ann and the south-eastern area of the parish of Trelawny. The SML 173 area straddles the parish boundary of Trelawny and St. Ann with the northern boundary of the SML 173 approximately 10 kilometers south of the north coast of the island. Most of the SML 173 area is located within the south eastern area of Trelawny. SML 173 falls wholly outside the proposed Cockpit Country Protected Area (CCPA). The total area of SML 173 is approximately 8,335 hectares (ha). Mining activity will be restricted to less than 15% (~1300 ha) of this area. The location of SML 173 is provided in Figure 5-1.

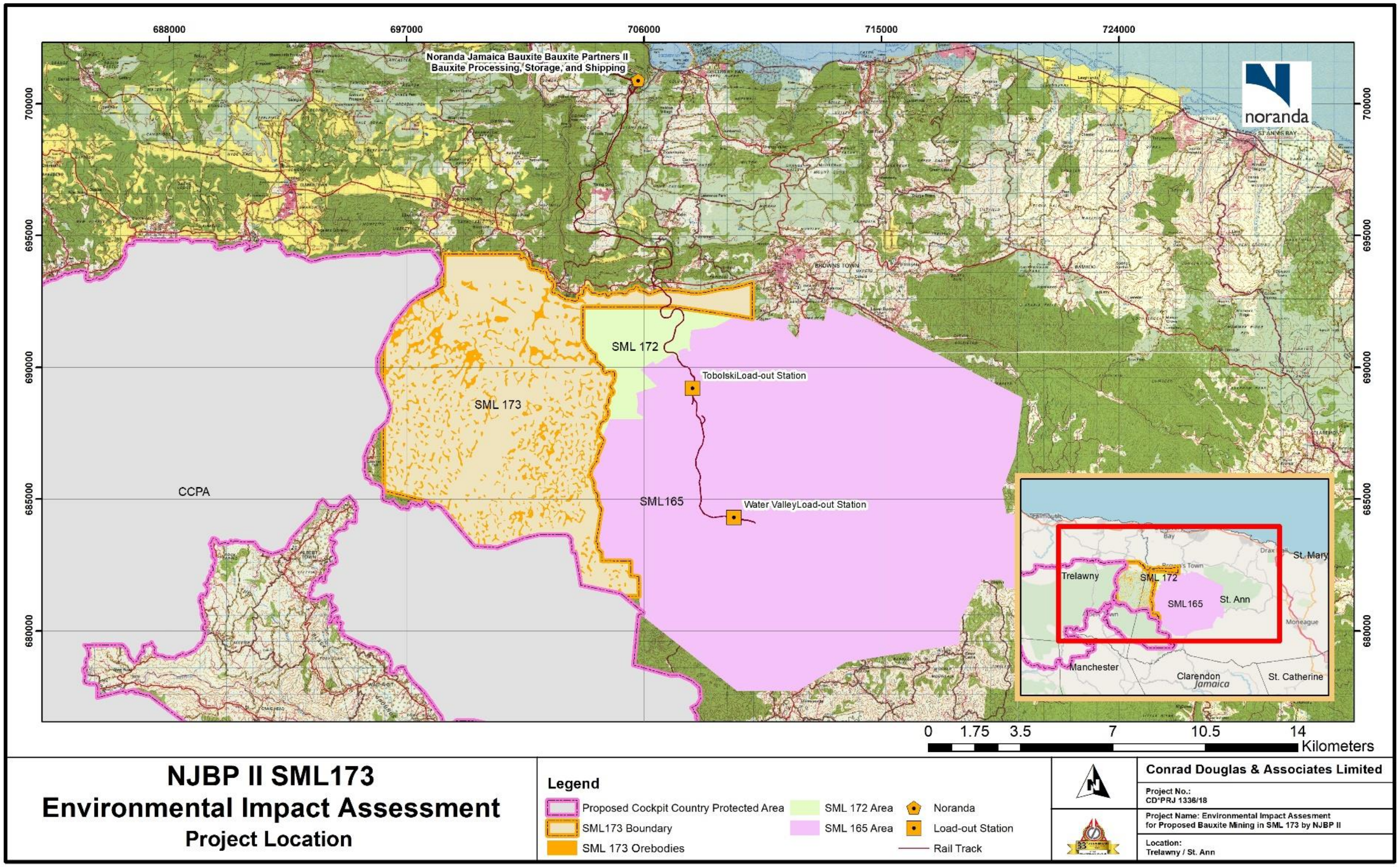


Figure 5-1: Location of SML 173

5.1.2. Topography

The topographical features of the SML 173 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[10], where there are classic examples. The 1:50,000 topography map of the area is shown in Figure 5-2 below.

[10] Cockpit Country, Jamaica Boundaries, Geological Significance, and Mining Impacts: A Report to the Jamaica Bauxite Institute, Prof. Edward Robinson

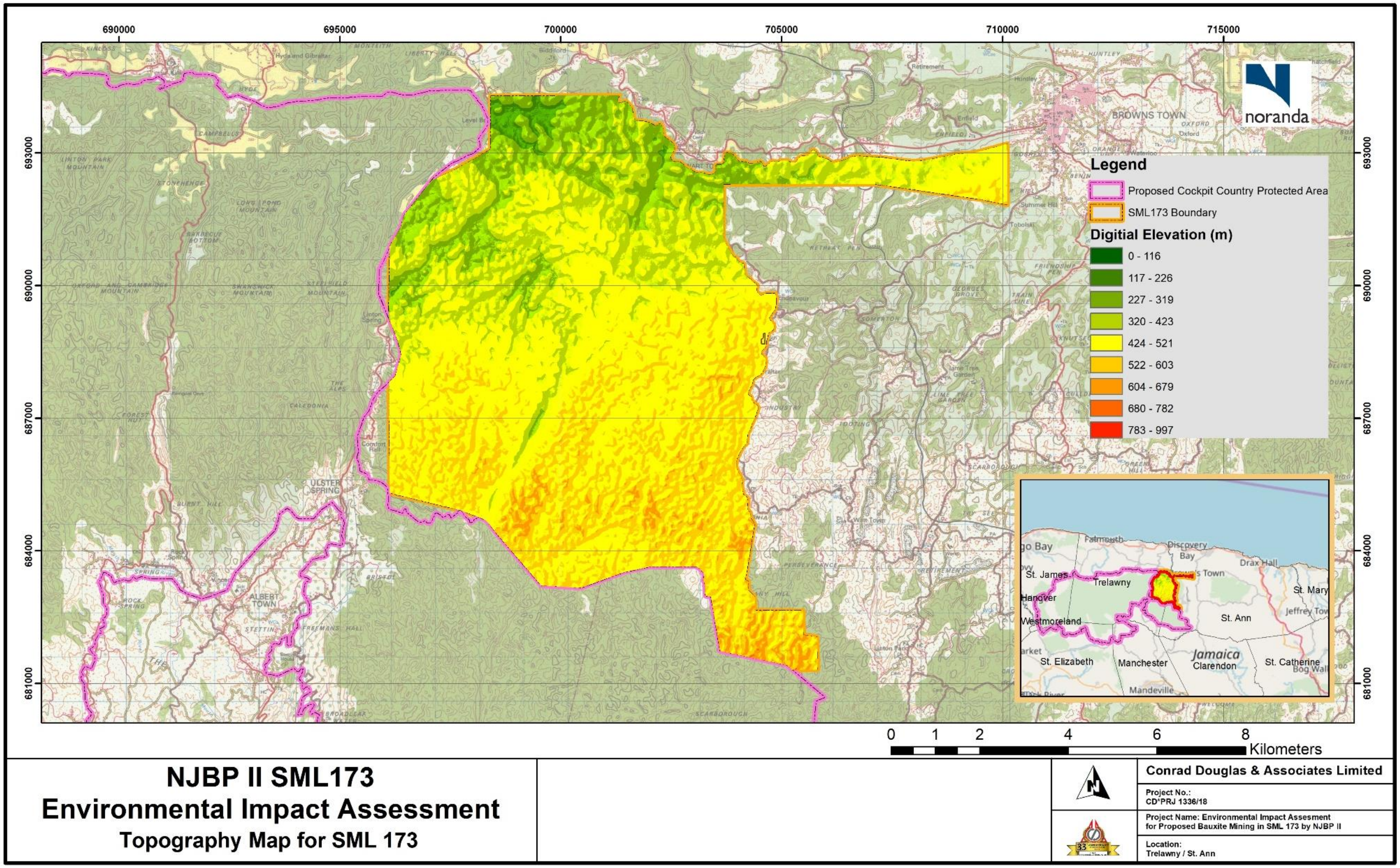


Figure 5-2:Topography Map of SML 173

5.1.3. Soils

The soils in the area of the SML 173 can be classified as upland plateau soils. SML 173 is contained on the fringes of the Dry Harbour Mountains of the central region of the island.

The specific soil textures and their distribution in SML 173 are shown in Figure 5-3 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[11].

The soils in the area are of two types[11]:

1. Well drained, moderately deep to deep, highly weathered red to dark red clayey soils (*terra rossa*).
2. Excessively drained, predominantly shallow, strong brown to reddish brown loamy and clayey soils, as well as stony in areas with many rock outcrops.

The soil types encountered in the SML 173 area are shown in Figure 5-4. The Bonnygate soil type is the predominant soil type in the SML 173 area. This soil type is described as being a thin mantle covering hard white limestone. This soil type dominates the limestone hills of the SML 173 area.

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

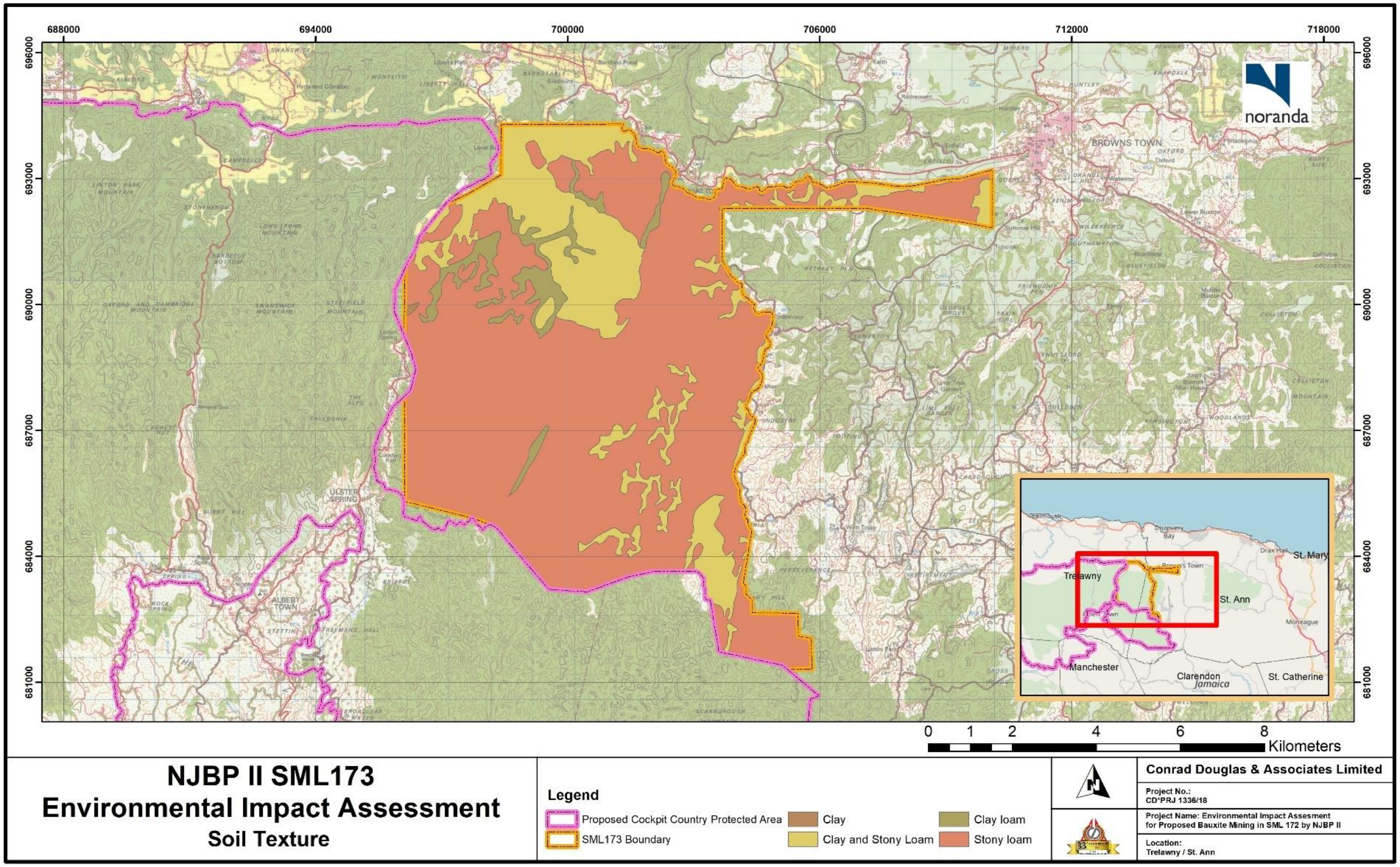


Figure 5-3: Soil texture distribution in SML 173 (Source data: *Agricultural Land Management Division, MICAF*)

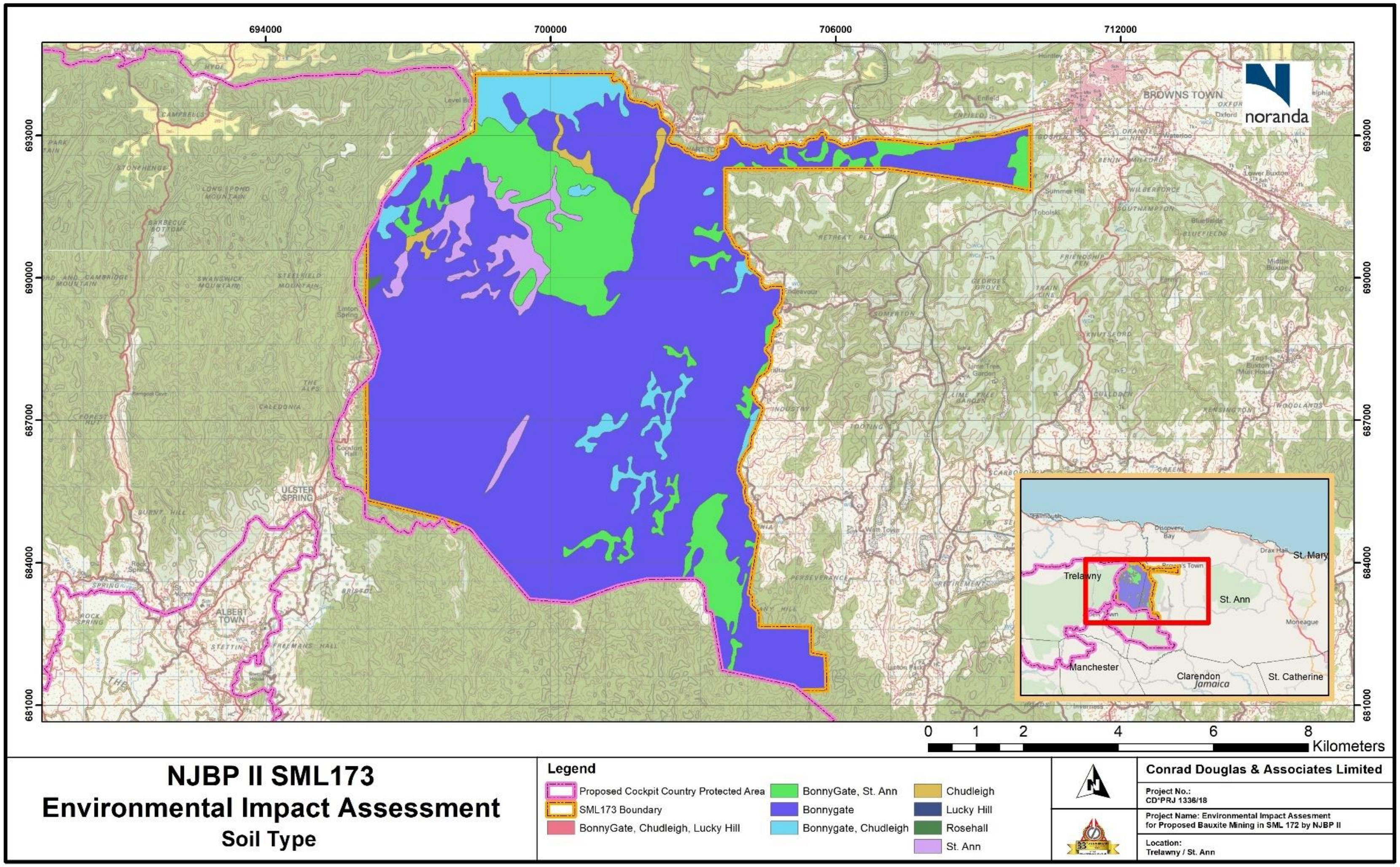


Figure 5-4: Soil types in SML 173 (Source data: *Agricultural Land Management Division, MICAF*)

5.1.4. Geology

5.1.4.1. Limestone Geology

The geology of south-eastern Trelawny and south-western St. Ann areas consists mainly of the members of the White Limestone Group. They form a sequence of moderately compacted, well bedded, partially crystallized bioclastic and micritic limestones that rest directly on the underlying basement volcanic formation. Group thickness exceeds 1500 metres.

The Walderston-Browns Town Limestone Formation underlies the entire south-eastern area of Trelawny and the western area of St. Ann with small outcrops of the Somerset Limestone Formation thinly developed to the south and east of Browns Town. The Montpelier Limestone Formation lies to the north and outcrops in an east-west belt parallel to and fringing the coast across the parishes of Trelawny and St. Ann. The Coastal Limestone occurs as a discontinuous belt up to a maximum of 0.6 kilometers from the coast. The basal unit of the White Limestone Group, the Troy Limestone Formation, is located to the south and outcrops in the south-eastern corner of the SML 173 area. The Chapelton Formation of the Yellow Limestone Group also outcrops along the western margin but outside the SML 173 area.

The Troy and Claremont Limestones are grouped together since they are effectively distinguishable only on the intense recrystallization and partial dolomitization of the Troy Limestone. Recent mapping within the proposed Cockpit Country Protected Area (CCPA) in Trelawny, west of the SML 173, has not allowed satisfactory separation of these two members hence they are considered together.

The Troy Limestone Formation is the oldest and the basal unit of the White Limestone Group. The Troy Limestone is varied in colour (brown, yellow, pink or white) is completely recrystallized and extremely tough and compact. It is devoid of organic remains (fossils).

The Claremont Limestone Formation is a soft limestone, evenly bedded bioclastic molluscan rich limestone and for the most part poor in foraminifera (fossil). The Troy and Claremont Limestones are platform interior facies.

The Walderston Limestone Formation is comparatively soft largely made up of milliolids while the Browns Town Limestone is loose and nodular with large amount of interstitial calcareous powder but otherwise lacking in sedimentary structure.

The Walderston Formation is a lateral (shallow water) equivalent of the Browns Town Formation. The Walderston is the platform interior facies and the Browns Town the platform edge facies. Wright and Robinson (in Wright, 1974 p.50) considered that the Walderston and Browns Town Limestones "*may be considered as distinct facies within the same formation.*"

The Montpelier Limestone Formation, which runs parallel to the coast, consists of pure, hard chalks with flint which may inter-digitize with the Browns Town Limestone. The Montpelier Limestone was deposited on a deep water, open sea platform with fringing reefs in the shallower parts.

The Coastal Group consists mainly of chalks and rubbly limestone with some reefs in the higher parts. The Coastal deposits are characterized by a series of terraces indicating several periods of uplift. These are seen along the coast between Discovery Bay and Rio Bueno.

The Walderston-Browns Town Limestone occupies the greater portion of the SML 173 area with the small outcrop of Troy-Claremont Limestone in the south-eastern corner of the SML 173 area (See Figure 5-5).

Two sets of faults crisscross the area. One trends east-west in the Hampshire Lane – Stewart Town- Browns Town area and represents the eastward extension of the Duanvale Fault system. The second set trends south-north with one such fault passing through the SML 173 area from Elgin in the south to Stewart Town in the north. Another south-north trending fault literally forms the eastern boundary of the SML 173 area. The primary downthrow of the east-west fault is to the north (See Figure 5-5 above).

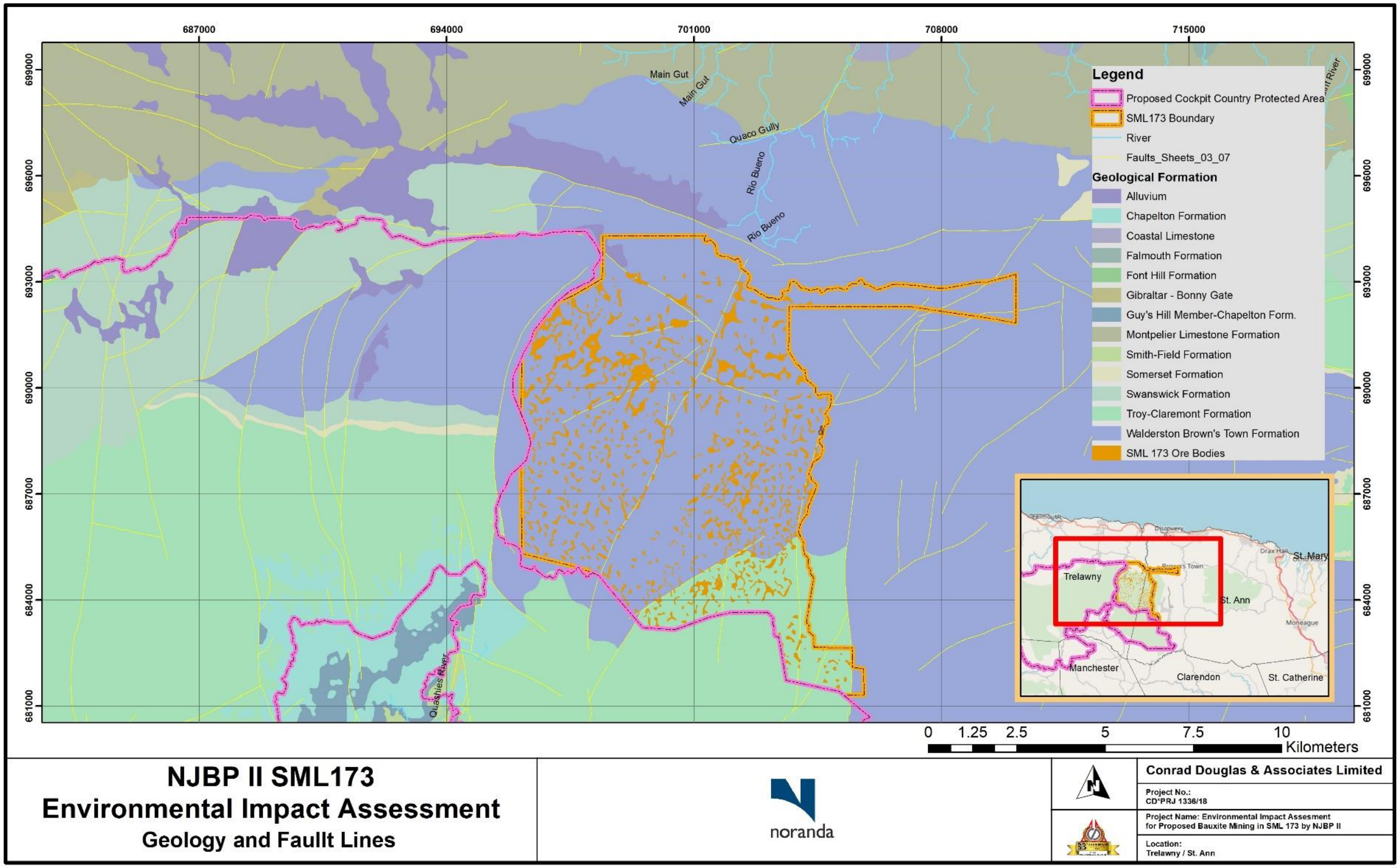


Figure 5-5: Geology and Fault Map of Eastern Trelawny/Western St. Ann with Location of SML 173

5.1.4.2. 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.

SML 173 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 was also damage and rock fall in some lowlands west of SML 173.

There have been reported landslides in the SML 173. Landslides have, however, been reported in the areas on the fringe of the SML 173 where towns and communities have developed. The lack of reports does not mean landslides do not occur.

See description in Natural Hazards Section 5.2.6.

5.1.5. Geomorphology

The formation of sinkholes, caves and other solution features are typical of limestone which have undergone karstification. The evolution of features within the SML 173 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 and Figure 5-8 represents potential sinkholes that have been identified based on depressions obtained from geospatial information provided by the WRA. Figure 5-6 below shows a sinkhole that was identified in SML 173 in proximity to Stewart Town. Other sinkholes or caves identified in SML 173 are shown in Figure 5-9. The potential sinkholes represent depressions which do not overlap orebodies and have been categorized based on their proximity to SML 173 orebodies. Known caves identified in and within 5 km of SML 173 are shown in Table 5-1 and Figure 5-10. The sinkholes identified in SML 173 are massive openings in the ground, which form cliffs at the edges. The opening in the sinkhole identified in Figure 5-6 below is about 50 meters across.

Figure 5-6: Sinkhole identified in SML 173

Table 5-1: Known caves identified within the boundaries of SML 173

Name	Parish	Area of Proximity	Latitude	Longitude	Source
Arcadia Cave	Trelawny	Belmont Area	18.35441	-77.4626	WRA
Ashley Hall Cave	Trelawny	Sawyers Area	18.37245	-77.4721	WRA
Belmont Cave	Trelawny	Stewart Town Area	18.36527	-77.4522	WRA
Drip Cave	Trelawny	Stewart Town Area	18.36256	-77.455	WRA
Dunn's Hole	St Ann	Stewart Town Area	18.36206	-77.4474	WRA
Manchester Pen Hole	Trelawny	Stewart Town	18.38425	-77.4522	WRA

Name	Parish	Area of Proximity	Latitude	Longitude	Source
Marsh Hill Cave	St Ann	Endeavour	18.35447	-77.4342	WRA
Old Man Cave	Trelawny	Stewart Town	18.38153	-77.4532	WRA
Undefined Sinkhole 1	Trelawny	Stewart Town	18.38285	-77.4494	CD&A
Undefined Cave 1	St. Ann	Gibraltar	18.35046	-77.4296	CD&A

All caves were identified through remote sensing. However, during ground truthing not all caves identified were visited. It is important to note that the caves are protected by the heavy vegetation (See Figure 5-7) 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. As a result, three (3) caves were visited based on the knowledge of community members.

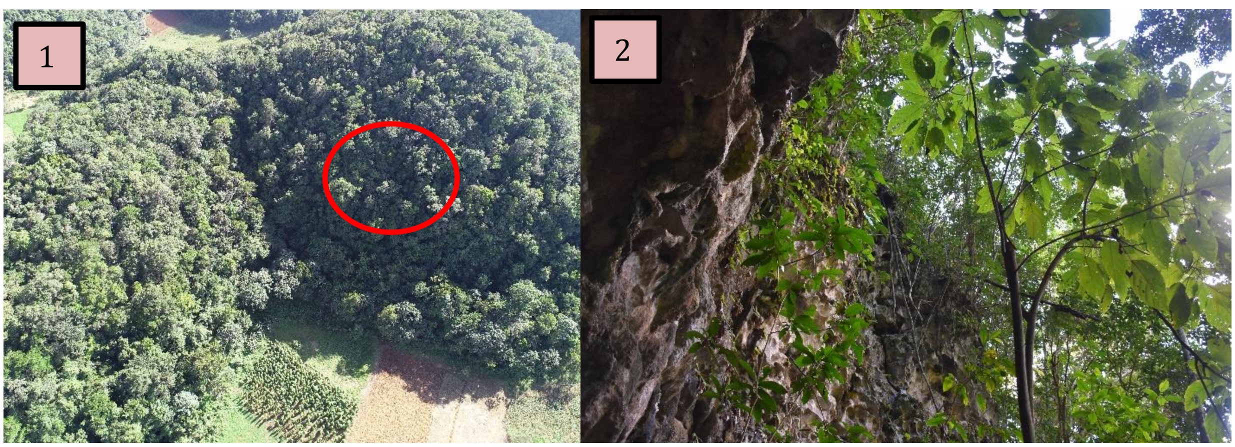


Figure 5-7: Location of Drip Cave | 1: Showing location within hillocks and 2: showing view from inside Drip Cave

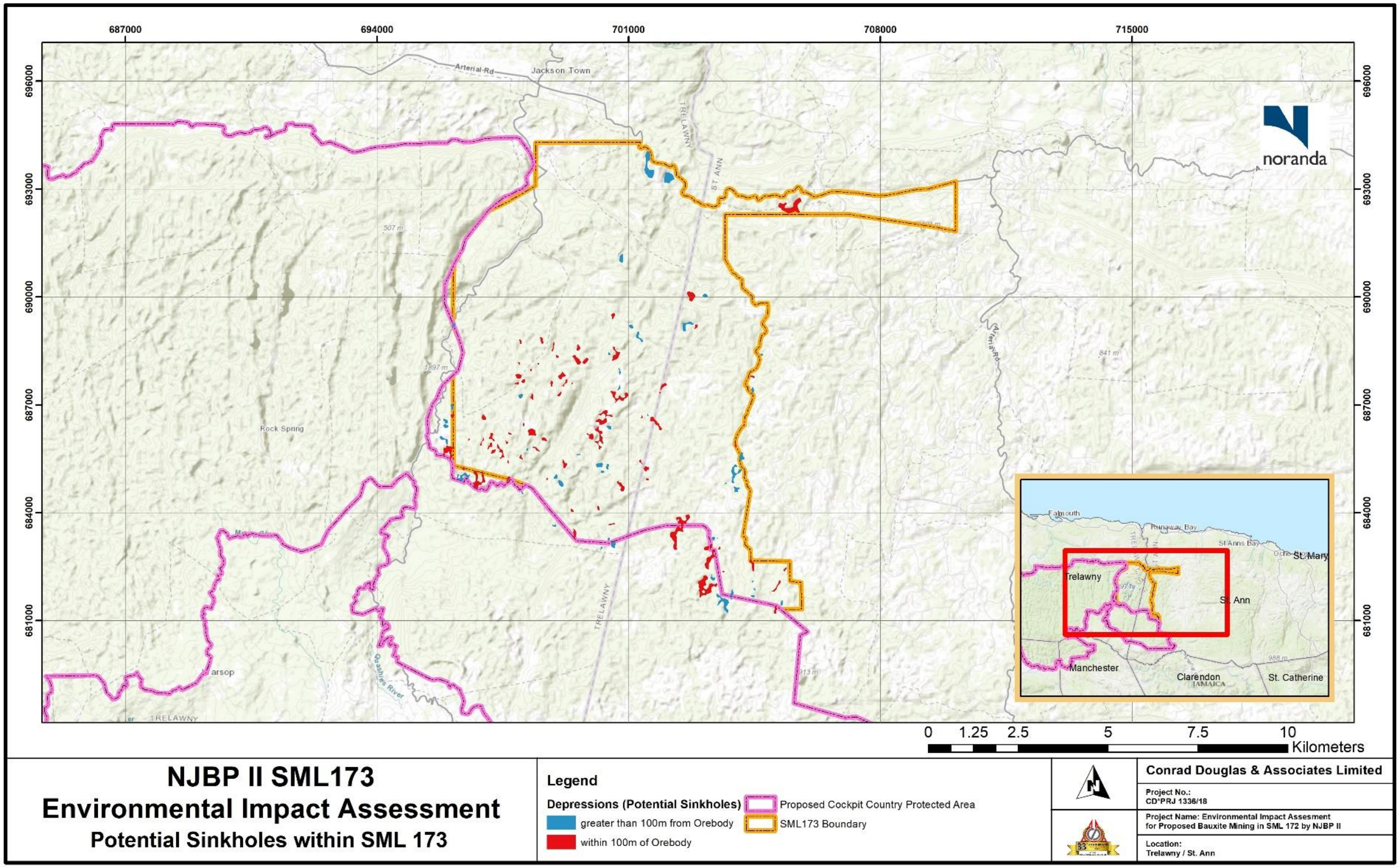


Figure 5-8: Potential Sinkholes within SML 173

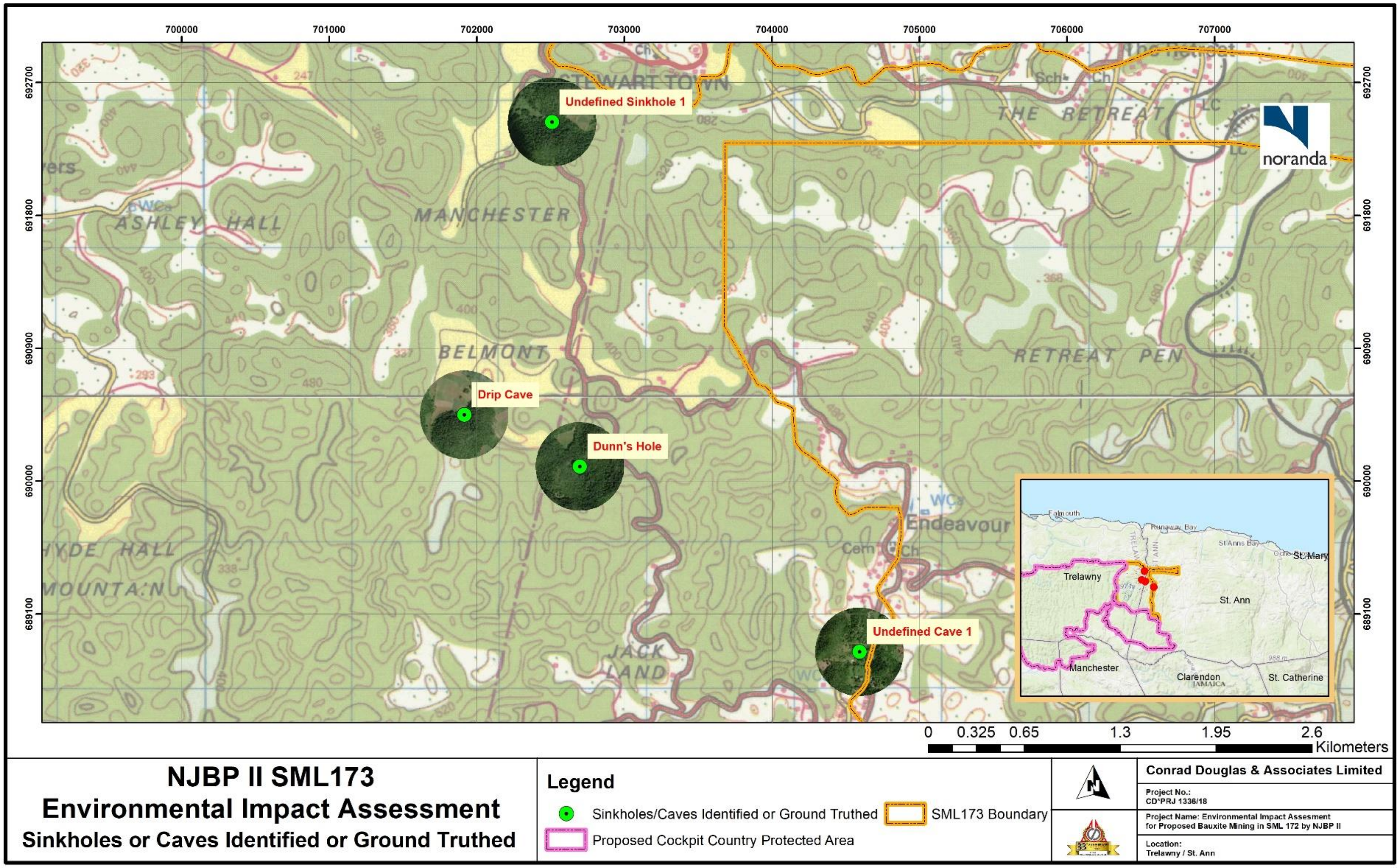


Figure 5-9: Sinkholes or caves identified or ground-truthed in SML 173

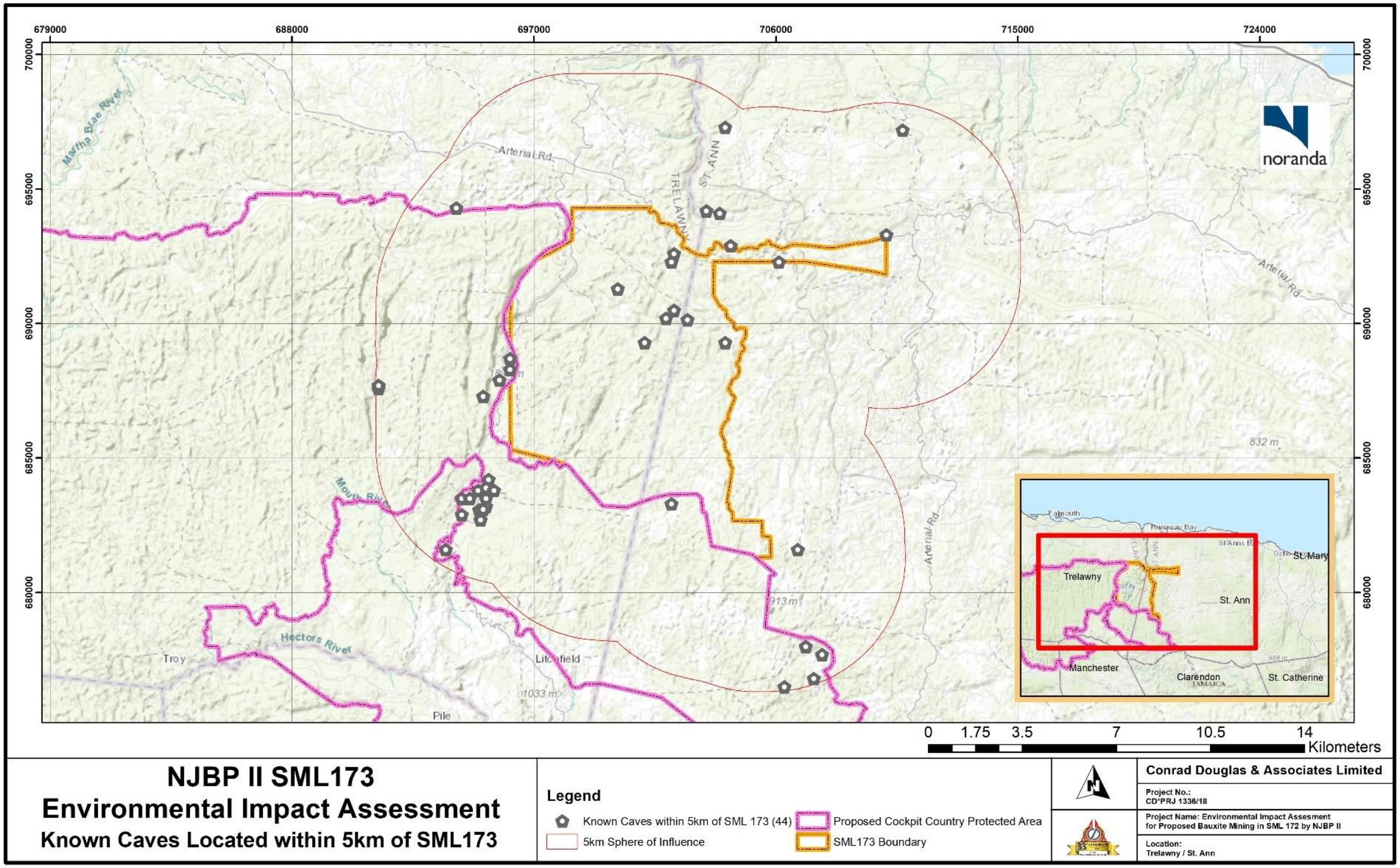


Figure 5-10: Known Caves Located in and within 5km of SML 173

5.1.6. Hydrology/Hydrogeology

5.1.6.1. Hydrologic Basin/Sub-basins

The SML 173 area is located entirely within the Dry Harbour Mountains Hydrologic Basin. The Dry Harbour Mountains Hydrologic Basin is basin number nine (IX) of the 10 (X) basins across Jamaica. The area of the Dry Harbour Mountains Basin constitutes 13% of the total land area of Jamaica.

The Dry Harbour Mountains Basin is subdivided into two units or sub-basins as follows:

1. The Rio Bueno Sub-basin within which the SML 173 area is located and
2. The White River sub-basin to the east.

The Rio Bueno sub-basin is twice the area of the White River sub-basin and abuts unto the boundary with the Martha Brae River Hydrologic Basin in the region of the Cockpit Country. The SML 173 area is partially located within the boundary of the Rio Bueno surface water catchment. The location of the SML 173 area in relation to the Rio Bueno surface water catchment boundary and WRA stream gauges within 5km of SML 173 is shown in Figure 5-11 below.

The Rio Bueno-White River Watershed Management Unit is graded as *least degraded (*State of the Environment Report, 2013) (See Figure 5-12). The designation of the status is based on The National Watershed Classification and Monitoring Programme, NRCA/CAD Inc., using the following parameters: 1) geology; 2) soils (susceptible to erosion); 3) land use and vegetative cover; 4) slope; 5) rainfall; 6) landslide potential; 7) stream density; 8) road density; 9) WMU boundaries (upper watersheds). The report also stated that "*Bauxite mining which requires the removal of forest before the ore can be extracted*". This indicates that there is a general misconception that bauxite occurs under forested areas and hence the belief that bauxite mining impacts watershed quality. Figure 5-89 shows the natural occurrence of bauxite orebodies in SML 173 and should dispel the misconception. The mode of occurrence of bauxite, which is predominantly grassland cover and is common throughout Jamaica to the extent that it facilitates the use of aerial surveys to identify the location of bauxite deposits[12]. Figure 5-12 illustrates that the most degraded watersheds are located in Clarendon, Kingston & St. Andrew and St. Mary in which bauxite mining is not carried out.

[12] Lee, J.W., Exploration & Development Drilling for Bauxite in Jamaica, The Journal of the Geological Society of Jamaica Bauxite/Alumina Symposium, 1971

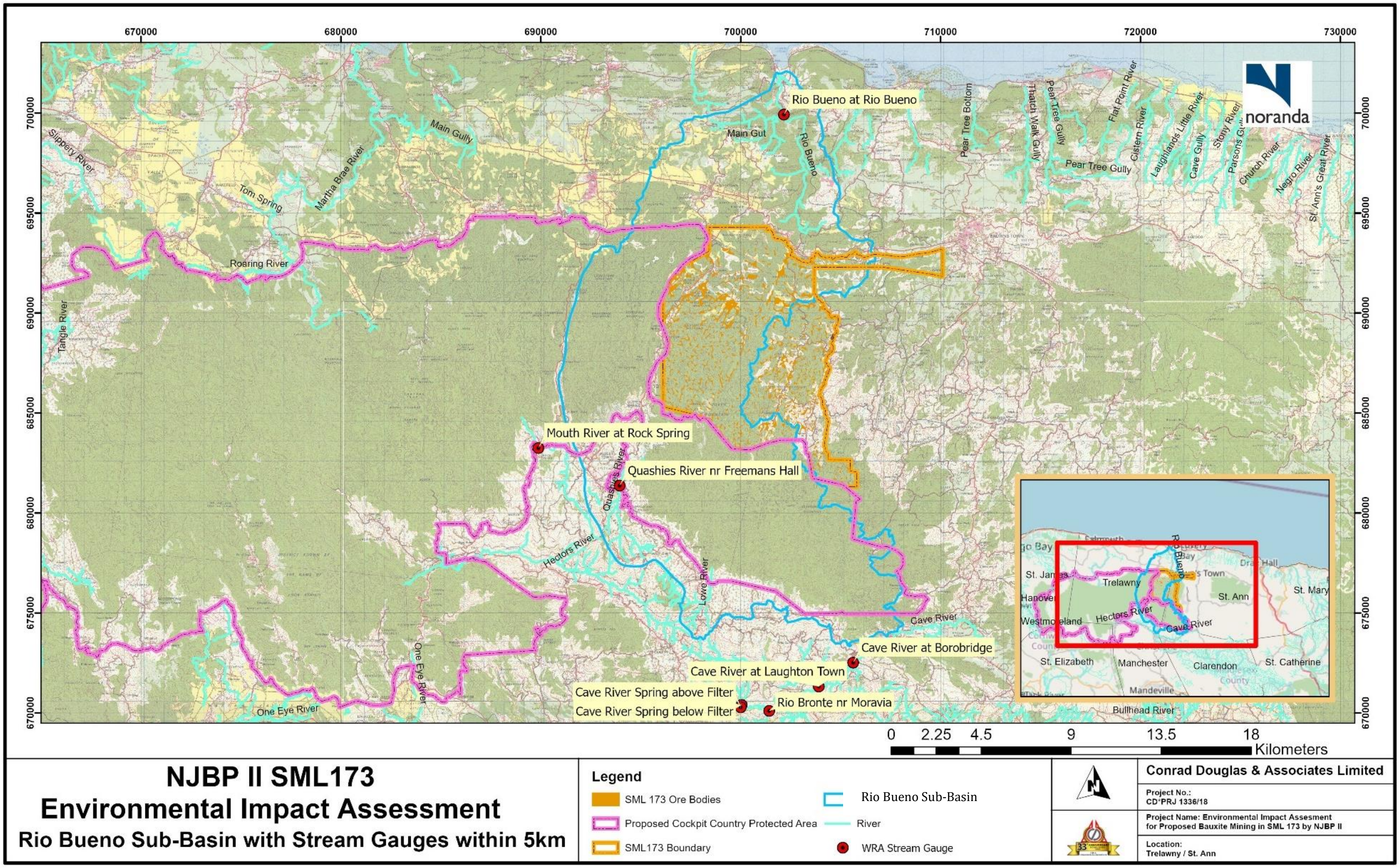


Figure 5-11: Location of proposed CCPA Boundary, Rio Bueno Surface Water Catchment Boundary, SML 173 showing ore bodies for licensing and mining, surface drainage north and south of the SML 173 and WRA Stream Gauges (**Source**: Water Resources Authority website: (http://webmapjam.dyndns.pro/webmap/app/db/code/container_SVG.php?viewquery=0&viewraster=1)

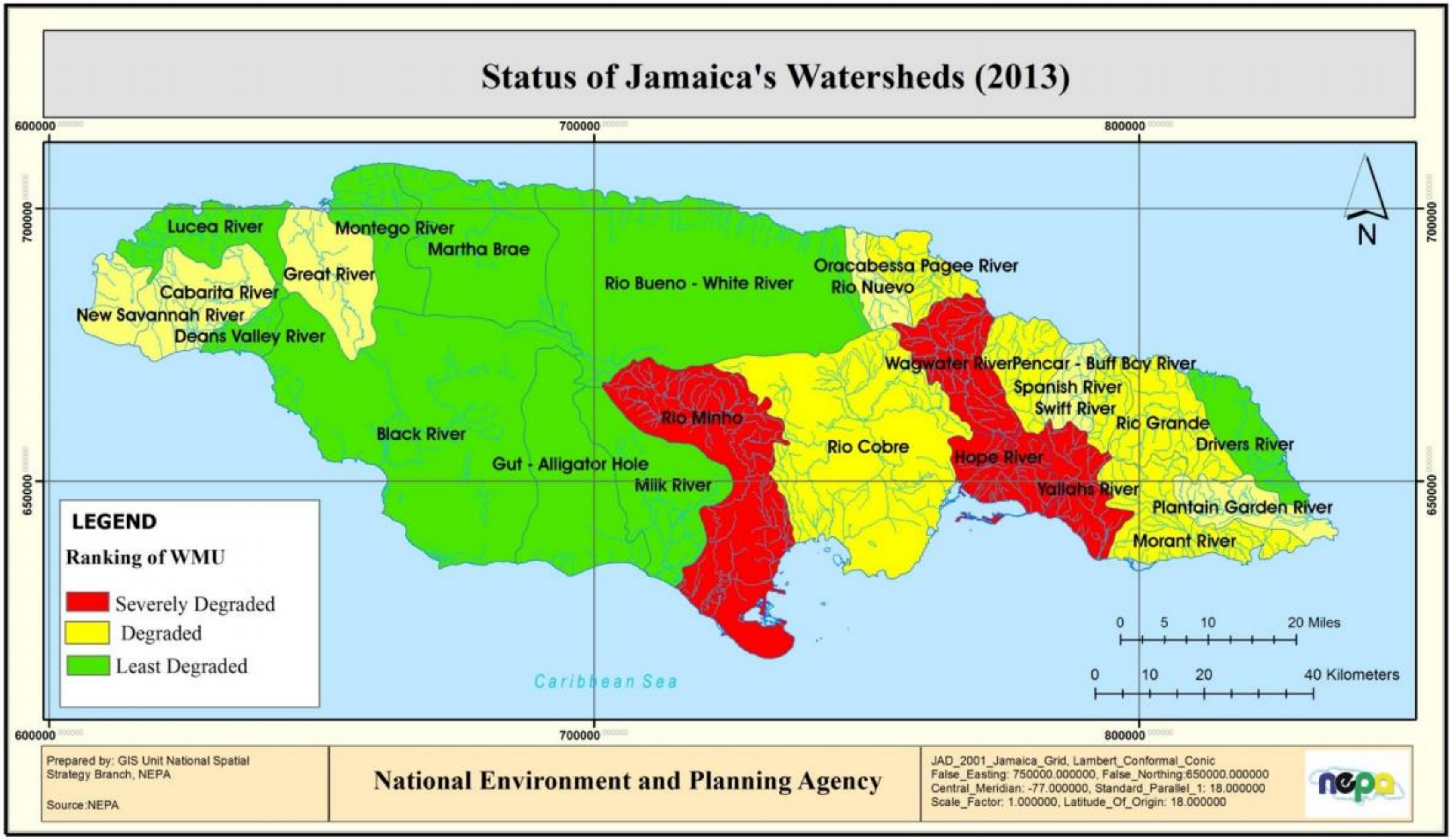


Figure 5-12: Status of Jamaica's Watersheds, 2013 (State of the Environment, 2013)

5.1.6.2. Hydrologic Sub-divisions (Hydrostratigraphy)

A hydrostratigraphic unit is a geologic formation or series of formations that have a distinct hydrologic character. The hydrostratigraphic units are classified as aquifers or aquicludes based on their permeability and potential to support perennial well and/or spring yields. Groundwater is the main water type of aquifers and surface water the main water type of the aquicludes. This is illustrated in Figure 5-13 below.

The Dry Harbour Mountains Basin has five (5) hydrostratigraphic units. These are the basal aquiclude (impermeable basement rocks), the limestone aquifer, the limestone aquiclude (Montpelier Limestone Formation) the coastal aquifer and the alluvium aquiclude. The SML 173 area is located in its entirety atop the limestone aquifer hydrostratigraphic unit, Rio Bueno Sub-basin, Dry Harbour Mountains Basin (See Figure 5-14 below).

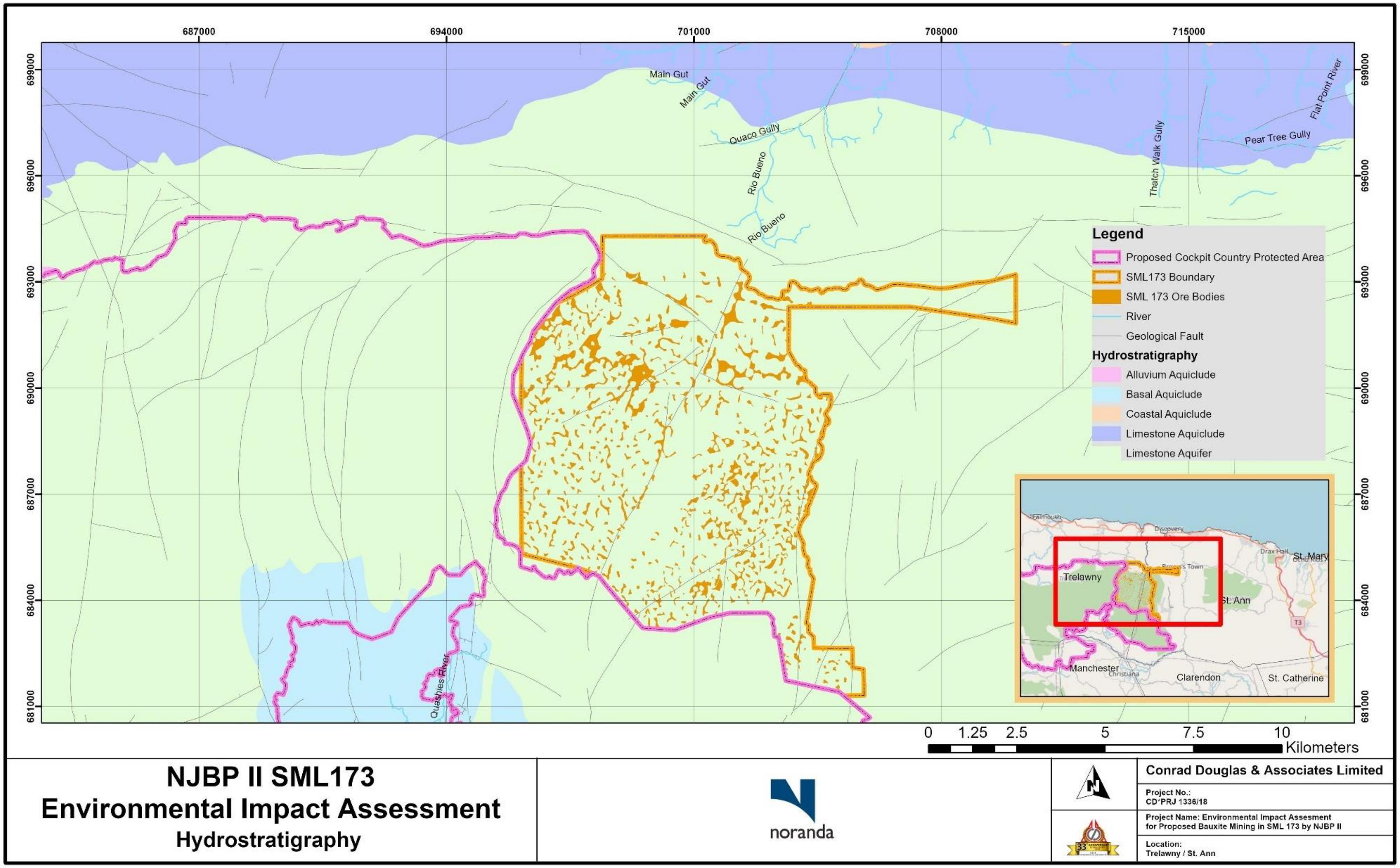


Figure 5-13: Hydrostratigraphy Map

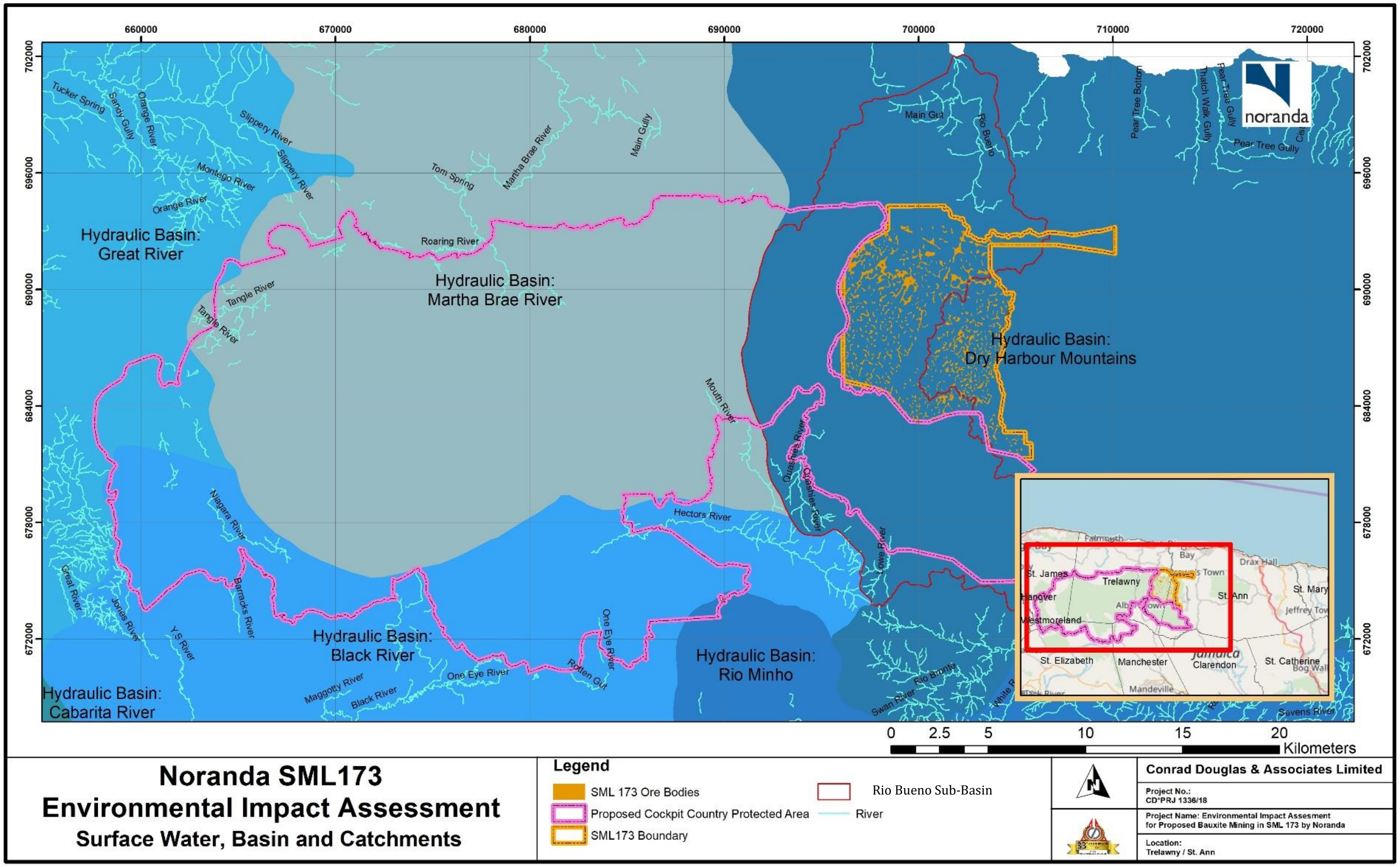


Figure 5-14: Surface Water, Basin and Catchments with Location of SML 173

5.1.6.3. Water Resources

5.1.6.3.1. Rainwater

Rainfall across the Dry Harbour Mountains Basin show an elevation related increase varying from 1,200mm on the coast to 2,200mm at elevation 750 metres. The highest rainfall occurs in the southwestern corner of the basin. The SML 173 area is close to the high rainfall area. Across the basin rainfall averages 1800mm/year, approximating a source potential of 2,450 million cubic metres per year (MCM/yr). Harvesting of rainwater is done in the southern area of the basin to partially meet domestic water demands, as no municipal supply from the National Water Commission (NWC) exists.

5.1.6.3.2. Surface Water

Rainwater is the basis for surface water draining from the basement aquiclude of the southwestern corner of the basin and provides flow to the Cave, Quashies and Lowe Rivers. These are outside the area of the SML 173. The Quashies and Lowe Rivers lose all their flow to the limestone aquifer atop of which SML 173 is located. Dye tracing studies done by the University of Bristol in the 1970s have proven the linkage between the flows from the Quashies and Cave to the Limestone aquifer and unto the Rio Bueno River. (See Figure 5-15 below). Dye tracing by the WRA in 2018 proved the Lowe River connection. No linkage with the Martha Brae River or any other surface system in either the Martha Brae River or Dry Harbour Mountain Hydrologic Basins has been proven.

South of the SML 173 area is the Hectors River that originates on the Basement Aquiclude and flows westward sinking into the limestone of the Upper Black River hydrologic basin; supporting flows in the Black River. There is also the Yankee River, which is a tributary to the Cave River, which flows towards the Rio Bueno (Source: WRA).

North of the SML 173 area, within a 50-kilometer-long and 5-kilometer-wide coastal strip, are the Limestone aquiclude and the Coastal aquiclude. Several streams draining this catchment to the sea were estimated to have a mean annual surface water yield of 268.8MCM/yr. (*WRA 1985*).

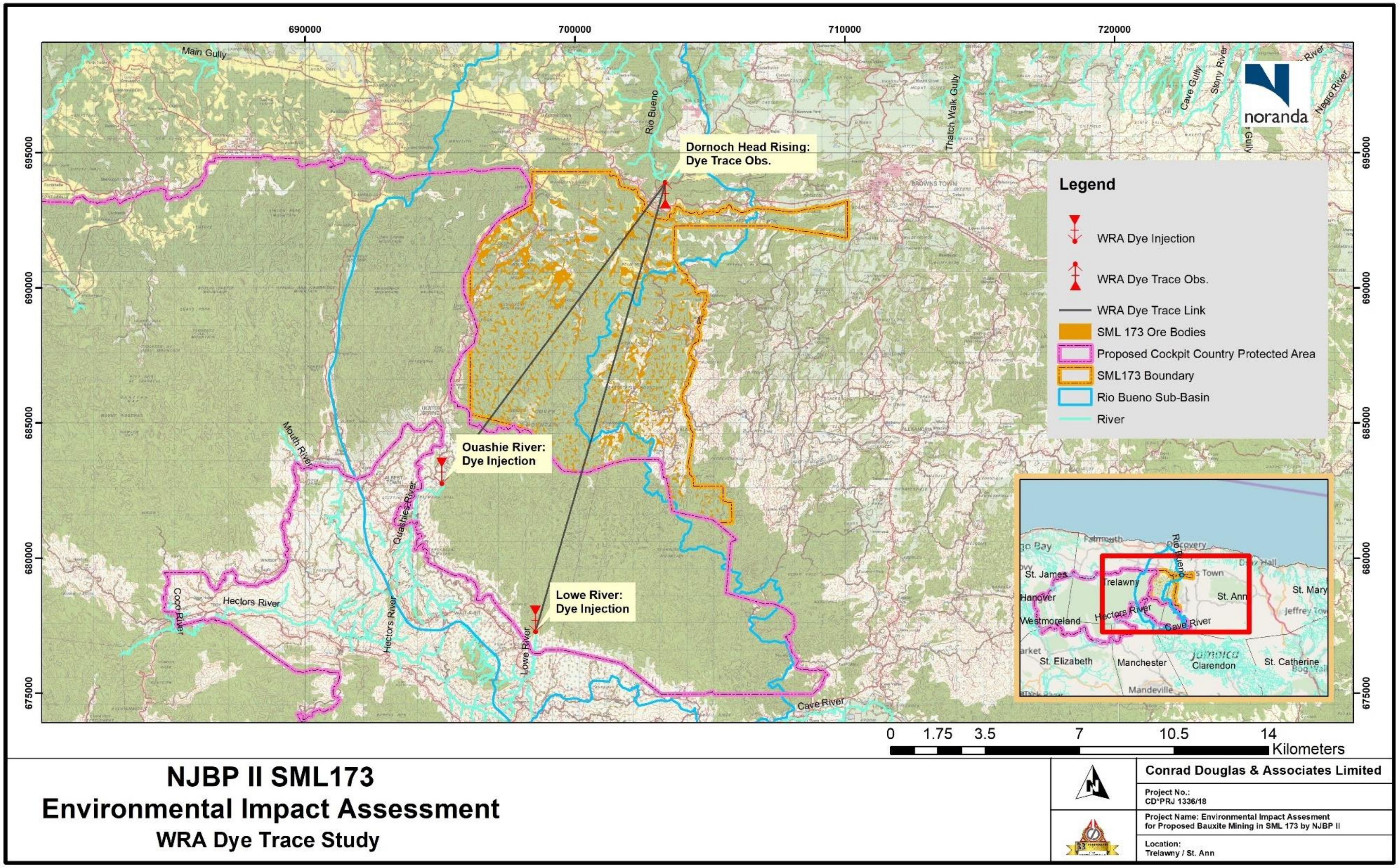


Figure 5-15: WRA Dye Trace Study (Source: *WRA*)

Perennial streams draining the basin to the sea are sustained by the drainage of water from Limestone aquifer storage. The Rio Bueno River is the largest perennial stream located within the Rio Bueno sub-basin.

Use of surface water in the Rio Bueno sub-basin includes:

- hydropower generation by the Jamaica Public Service Company Limited (JPSCO),
- domestic supply by the National Water Commission (NWC),
- irrigation use at Braco by the National Irrigation Commission (NIC) and
- private domestic water supply by the Bengal Water Company

All extraction is taken directly from the Rio Bueno River.

Hydropower generation is a non-consumptive use and the water is available for use downstream of the tail race of the hydropower plants.

Across the basin the potential surface water yield has been approximated at 26MCM/yr of which 80% is located within the Rio Bueno Sub-Basin in the south western corner around the Cave, Quashies and Lowe Rivers. An announcement in 2016 by the government stated that water from the Quashies River at Freemans Hall, Trelawny will be diverted for use for domestic purposes[13] [14]. The NWC has harnessed the Cave River flow for water supply to Christiana and environs. Increased utilization of these sources could lead to a decline in the flow of the perennial streams, especially the Rio Bueno River.

5.1.6.3.3. Groundwater

The groundwater resources of the Dry Harbour Mountains Hydrologic Basin are contained within the Limestone Aquifer south of the Coastal Aquiclude that fringes the coast for the

[13] https://jis.gov.jm/262-7m-earmarked-improving-trelawny-communities-water-supply/

[14] http://www.jamaicaobserver.com/westernnews/-No-more-drought--_89682?profile=1434

entire length of the basin. The Limestone aquifer is recharged mainly by rainfall though runoff from the basement aquiclude also contributes to aquifer storage. Recharge to the Limestone aquifer of the Rio Bueno sub-basin was determined to be 436.5MCM/yr[15]. (WRA 1985)

The Limestone aquifer has undergone significant karstification with the development of conduits, caves and fractures that enhance groundwater flow. Groundwater flow is turbulent, high velocity and generally to the north via the underground conduits and caves. Groundwater is discharged from the aquifer via the Dornoch Bluehole, which is the head of the Rio Bueno River, and a number of fault-controlled springs within the Limestone aquiclude. The discharges from the Limestone aquifer take place at the juncture/boundary of the Limestone aquifer and the Limestone aquiclude. The Limestone aquiclude that fringes the entire coastline of the basin is of very low permeability and ponds water, as a subsurface barrier, behind it in the Limestone aquifer. Once groundwater storage reaches an elevation where it can flow over the subsurface barrier, discharge occurs. The Limestone and Coastal aquicludes also keep saline water from the sea from entering the aquifer.

The SML 173 area is located upgradient of the Dornoch Bluehole and groundwater flow towards Dornoch passes subsurface and through the area of the SML 173. Rainfall over the SML 173 area contributes to recharge of the Limestone aquifer.

The major unutilized potential of water resources within the basin is groundwater amounting to 658MCM/yr or 92% of the available storage. In the Rio Bueno sub-basin, the unused potential has been determined to be 408MCM/yr or 62% of the total basin potential (WRA 1985). This resource has been earmarked for development by the NWC (The North Coast Water Supply Project).

The Rio Bueno River has an average flow of over 277,184 cubic metres per day or 101MCM/yr. (>60migd) which has remained sustainable since 1951 when flow records were

[15]Underground Water Authority December 1985; Water Resources Development Master Plan, Jamaica, Report #1 Water Resources Inventory. An Underground Water Authority publication

started. The plot below shows the two-day minimum flow for the Rio Bueno River for the period 1951 to 2015. The trend line indicates a slight increase in flow despite the diversion of the Cave River and the mining of bauxite within the Rio Bueno Sub Basin by Kaiser Bauxite, and successive companies over the past 50 years.

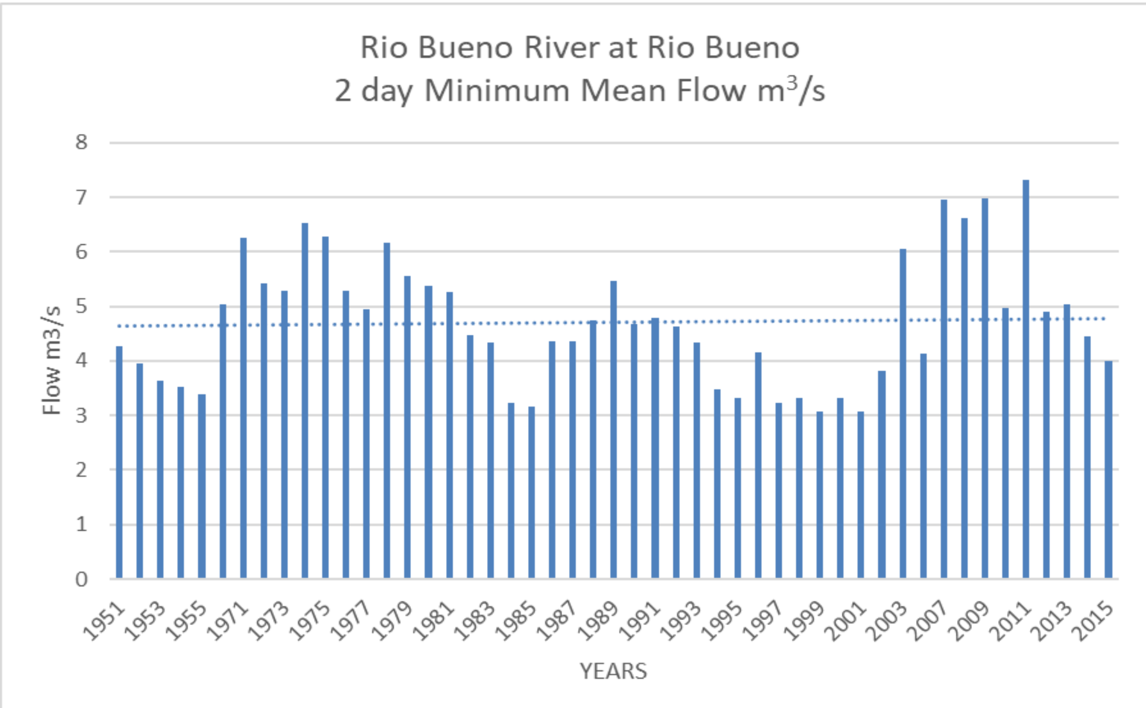


Figure 5-16: Hydrograph of 2-day Mean Minimum Flow Rio Bueno River 1951 to 2015

5.1.7. Drainage

As stated above the surface water resources are associated with the basement aquiclude in the south western corner of the basin and the Limestone and Coastal aquicludes along the coast. The perennial streams, such as the Rio Bueno River, are sustained by water draining from Limestone aquifer storage.

There are no surface streams across the St. Ann Plateau, which is above the limestone aquifer. Rainfall infiltrates into the Limestone rock formation which functions as the Limestone aquifer and flows by subsurface channels towards the coast where it is ponded in the aquifer by the Limestone Aquiclude before discharging to sea as the Rio Bueno River.

Within the SML 173 area ground water resources are at significant depths (more than 100m) below SML 173.

Surface drainage from the basement Aquiclude to the south of the SML 173 area feeds the Yankee River, Manchester and Hectors River that flow westward to the Black River basin and the Black River.

The mining of the bauxite orebodies will not result in the wholescale stripping of the land, exposing the limestone surfaces. Mining is restricted to less than 15 % (i.e. ~1,300 hectares) of the SML 173 (8,335 hectares). The bauxite ore to be mined is that located within the depressions of the erosional limestone (wavy) surface.

The mining of bauxite will not result in any increase in surface runoff but may increase infiltration to the limestone aquifer. Hard top road surfaces that are constructed for the haulage of the bauxite to storage/blending areas can generate increased surface run-off but this should be minimal and can easily be absorbed by the limestone formation/aquifer.

5.1.7.1. Bauxite Mining and Water Resources

Jamaica's bauxite deposits are associated with the White Limestone Group as a blanket deposit. Bauxite mining has been carried out in the upper watershed areas of five (5) of the ten (10) hydrologic basins across the island viz. Rio Cobre (St Catherine Parish), Rio Minho (Clarendon Parish), Black River (St Elizabeth Parish), Martha Brae (Trelawny Parish) and Dry Harbour Mountains (St Ann Parish) basins.

The protocols and procedures involved in the management of bauxite mining involves the temporary removal and the storage of the topsoil. The subsequent removal of bauxite temporarily exposes the highly karstic and very permeable limestone rock. The base of each mined out pit may have sinkholes that will drain the rainfall runoff that temporarily accumulate within the mined-out orebody. This may increase recharge to the aquifer and could entrain particulate material that could lead to a temporary increase in turbidity and discoloration of the water resources.

The SML 173 area is for the most part located within the surface water catchment of the Rio Bueno River and is directly upgradient of the Dornoch Bluehole (~1 km north of the SML 173 boundary). Mining in the SML 173 area may present a risk to the water resources of the Rio Bueno sub-basin and the Rio Bueno River. See Figure 5-17 below-showing the Rio Bueno Catchment Area, the location of the SML 173 area and bauxite deposits atop the Limestone aquifer within the proposed Cockpit Country Protected Area and the SML 173 area. The ore bodies to be mined are shown on Figure 5-11.

In the upper watershed areas where the SML 173 area is located, the depth to groundwater is greater than 100 metres.

The Risk to water resources are discussed in section 7.5.5.

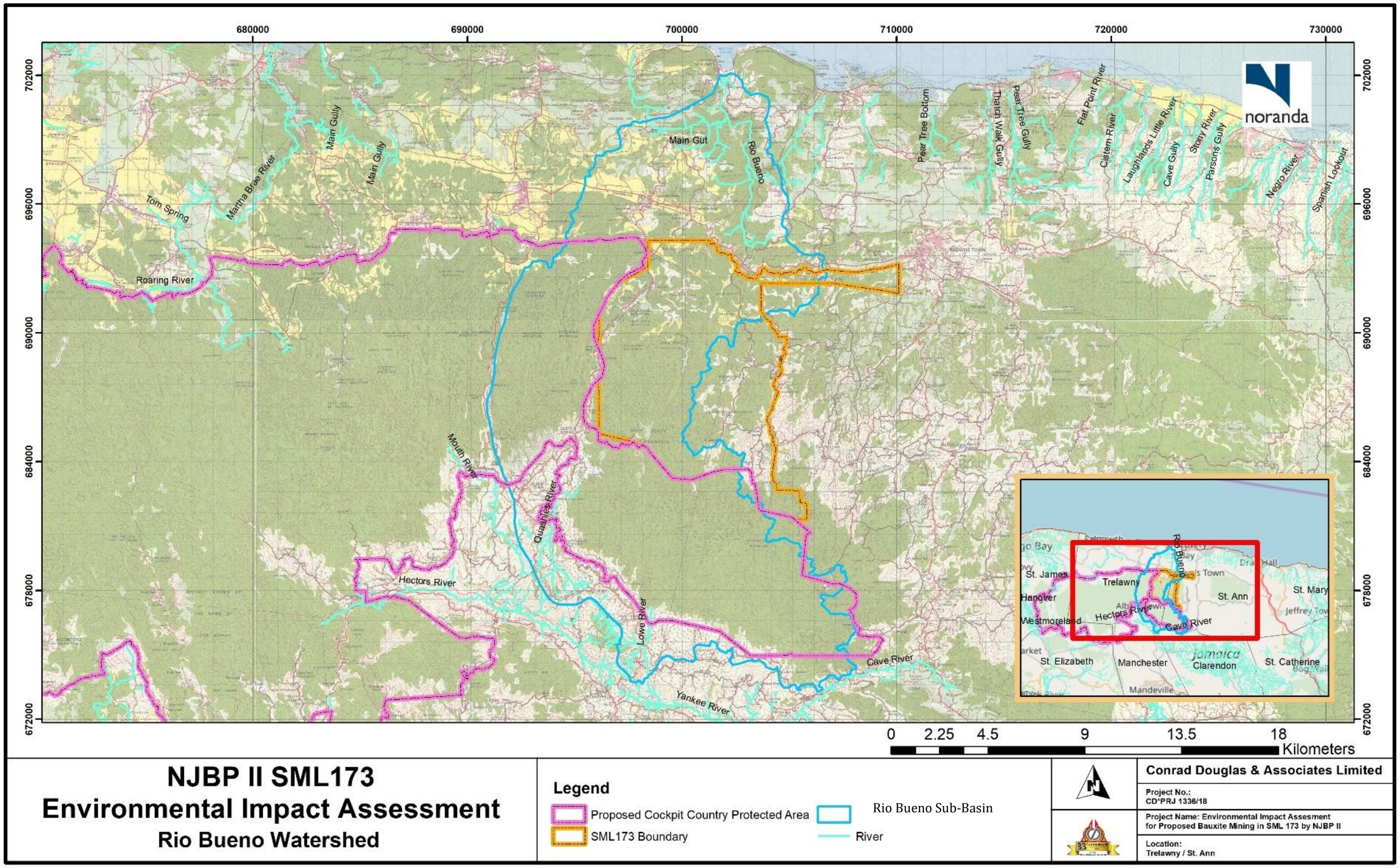


Figure 5-17: Map of Catchment of Rio Bueno River with Location of SML 173

5.1.8. 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 NJBP II Special Mining Lease 173 (SML 173) area was sourced from the National Meteorological Service and supplemented with secondary information from NJBP II databases. These Meteorological Office and NJBP II's databases include information from the following close collection points:

- Bamboo
- Llandovery
- Moneague
- Lowe River
- Ulster Spring
- Sawyers
- Watt Town Community Centre
- Tobolski
- Water Valley

The locations of the weather collection points are shown in **Figure 5-18** below.

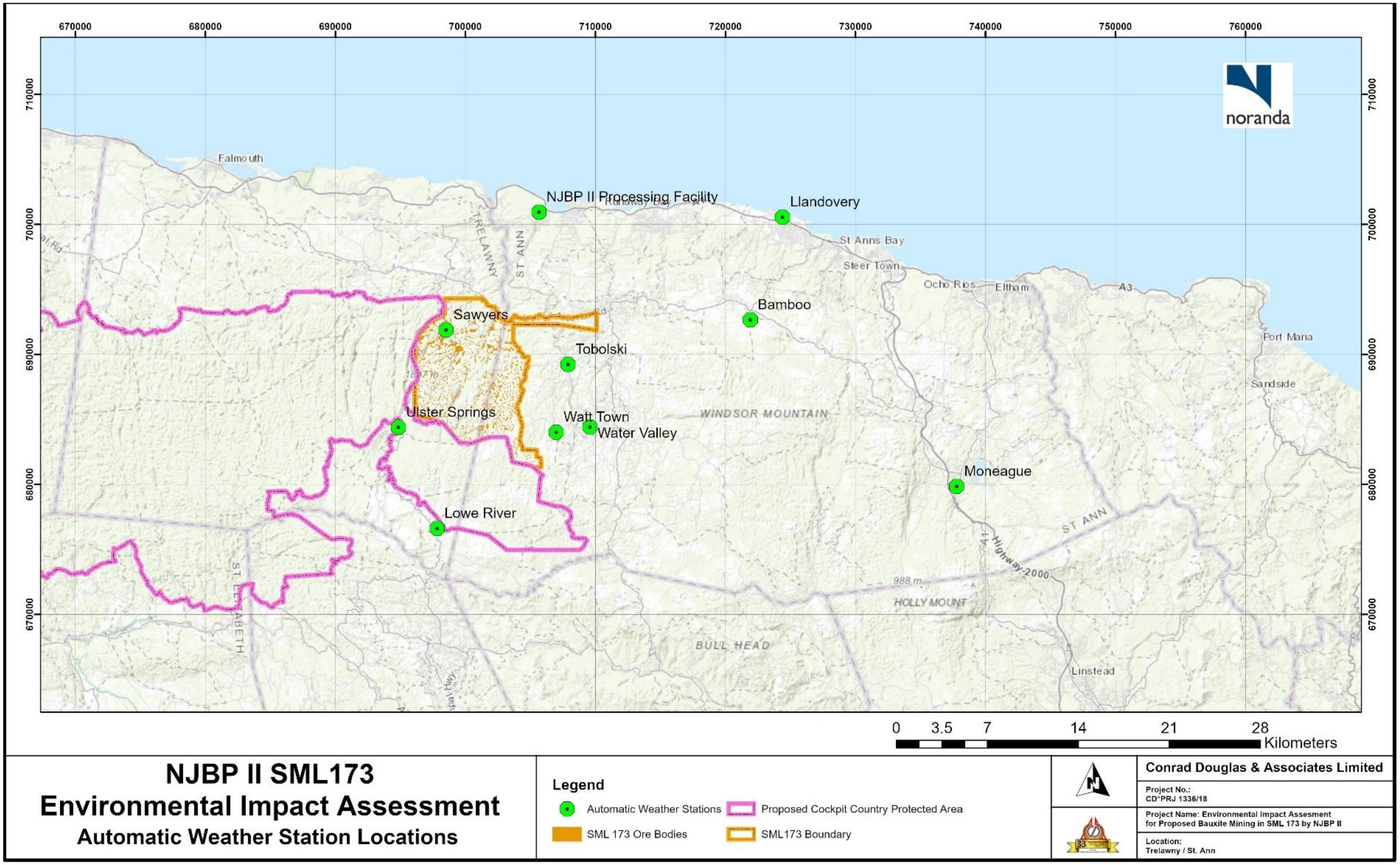


Figure 5-18: Locations of Weather Stations

5.1.8.1. 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 5-19** below). There is also a dry period between December to April, with February being the driest month.

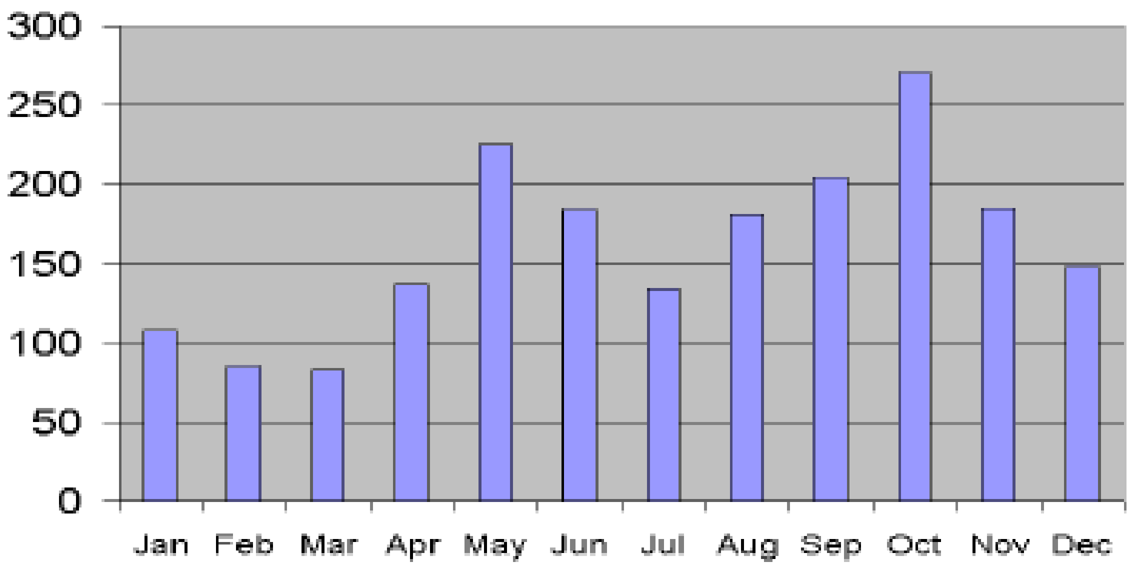


Figure 5-19: Rainfall Climatology in mm for Jamaica. Averaging period is 1951-1980 Source: National Meteorological Service of Jamaica and (Climate Studies Group, Mona, 2016)

Jamaica's 30-year rainfall average for the period 1951-1980 is shown in Figure 5-20 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 5-20**). In combination with sea breezes this result in the high levels of precipitation recorded (Climate Studies Group, Mona, 2016).

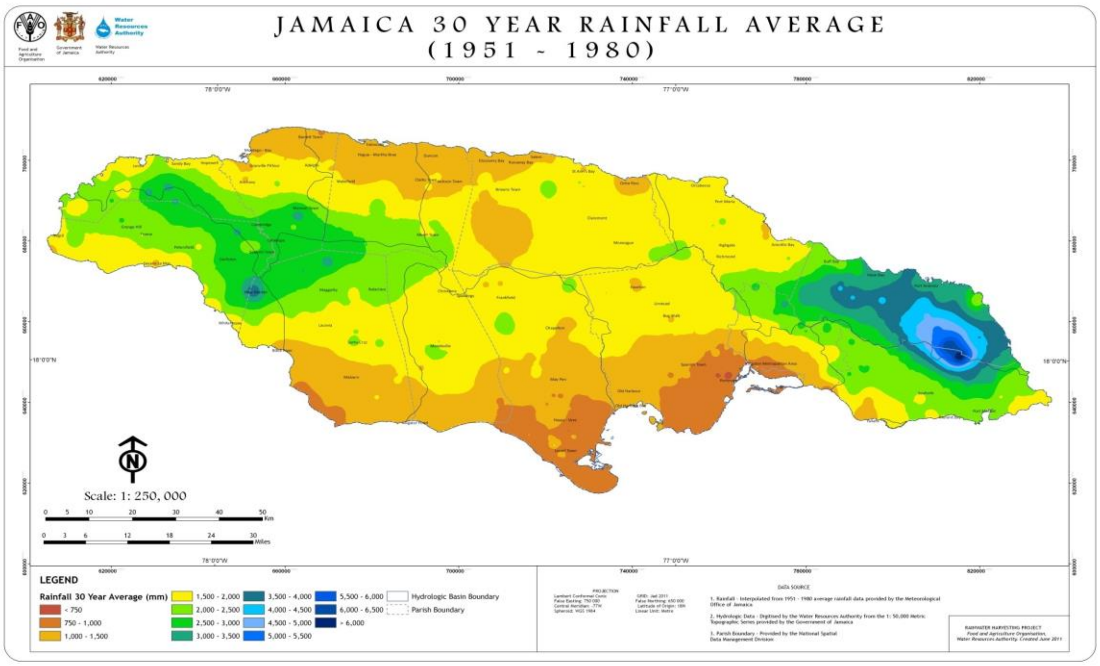


Figure 5-20: Jamaica 30 Year Rainfall Average (1951-1980) (Water Resources Authority, 2015)

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 5-21** shows the mean long-term mean rainfall for the parish of St. Ann for 1971-2000.

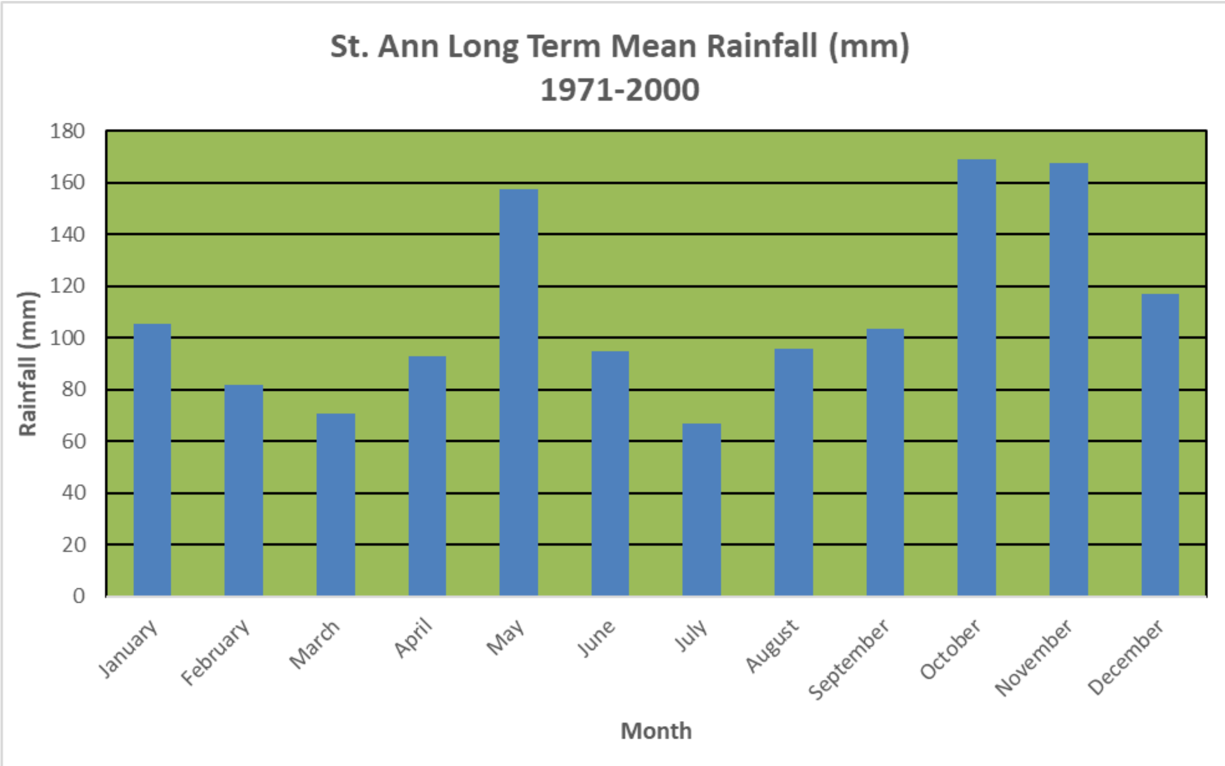


Figure 5-21: St. Ann Long-Term Mean Rainfall (mm) 1971-2000[16]

Other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

The parish of St. Ann receives an annual average of 1323.67 mm of rainfall per year mainly during the month of May and the period of October to January. The driest period occurs in the months of March and July, with less than 72 mm per month as seen in **Figure 5-21**.

Figure 5-22 to **Figure 5-27** below shows the total annual rainfall for Bamboo, Llandovery, Moneague, Lowe River, Sawyers and Ulster Spring the closest available rainfall monitoring sites in the area.

[16] Jamaica Meteorological Service, Climatological Data

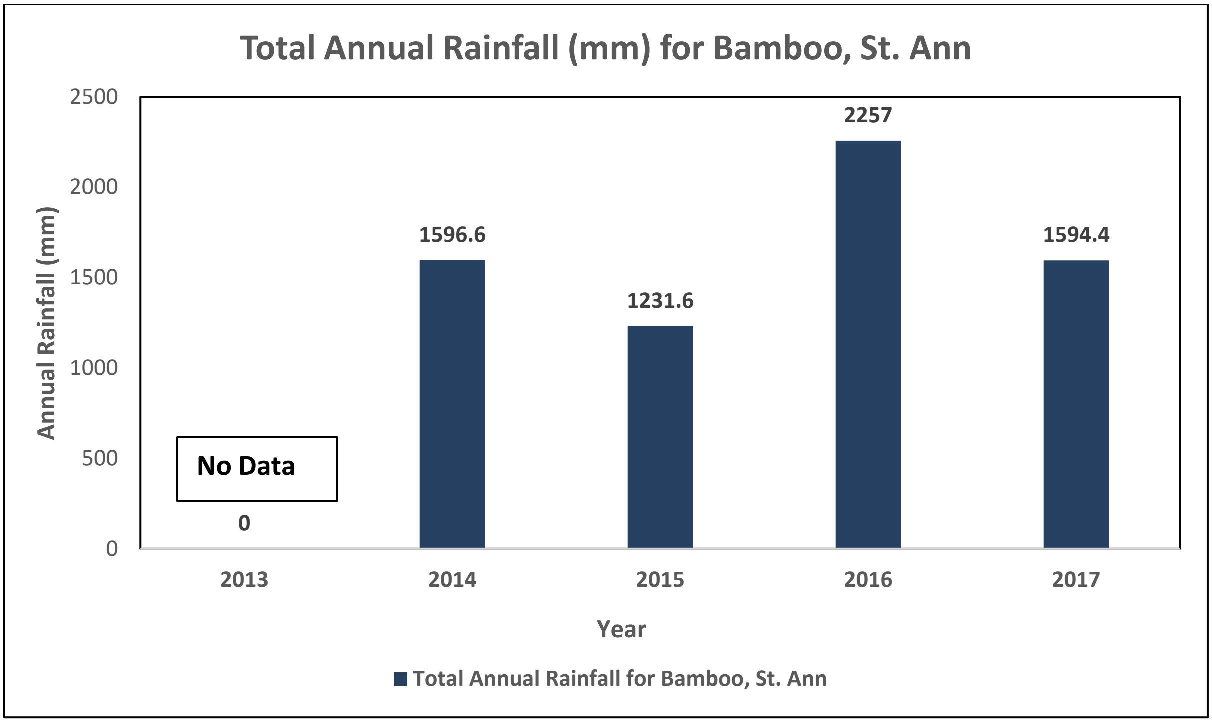


Figure 5-22: Total Annual Rainfall for Bamboo, St. Ann

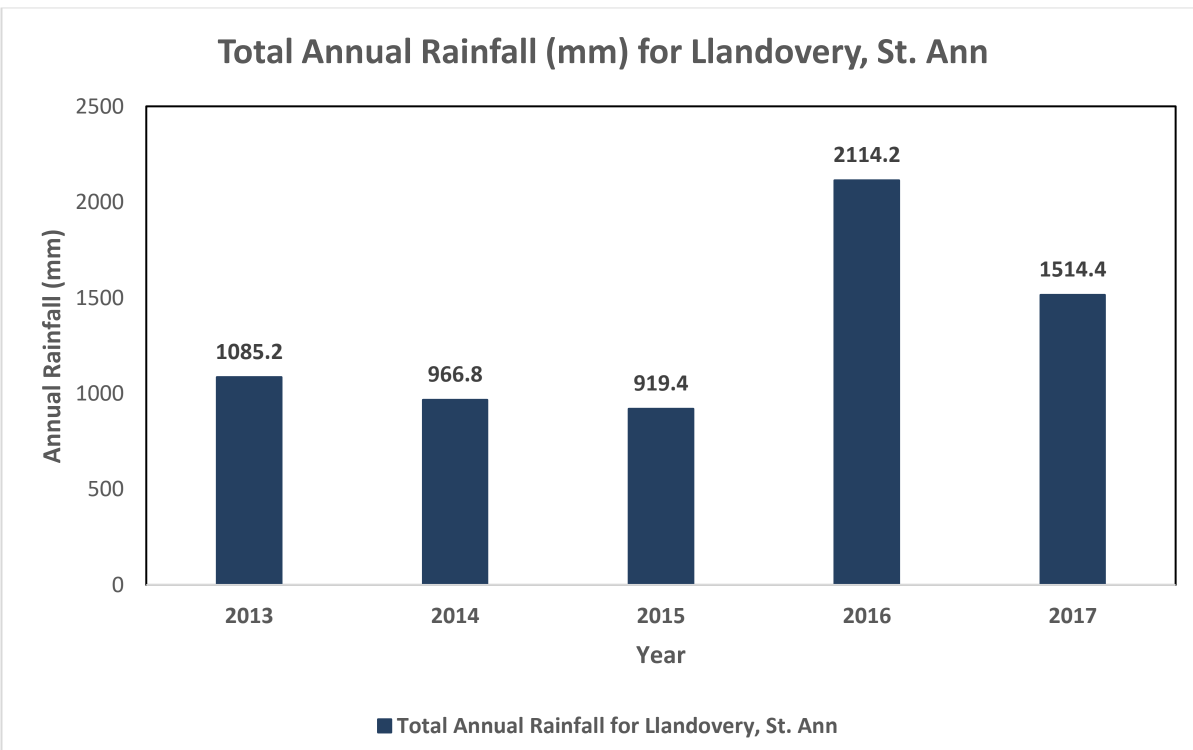


Figure 5-23: Total Annual Rainfall (mm) for Llandovery, St. Ann

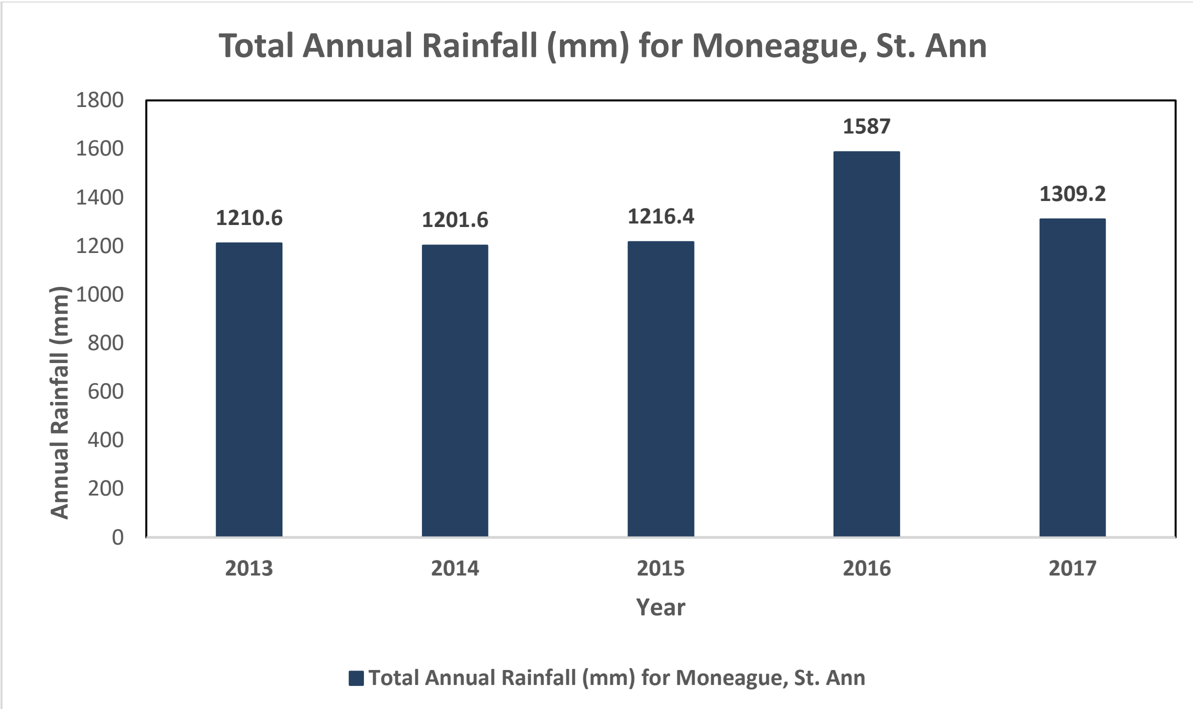


Figure 5-24: Total Annual Rainfall (mm) for Moneague, St. Ann

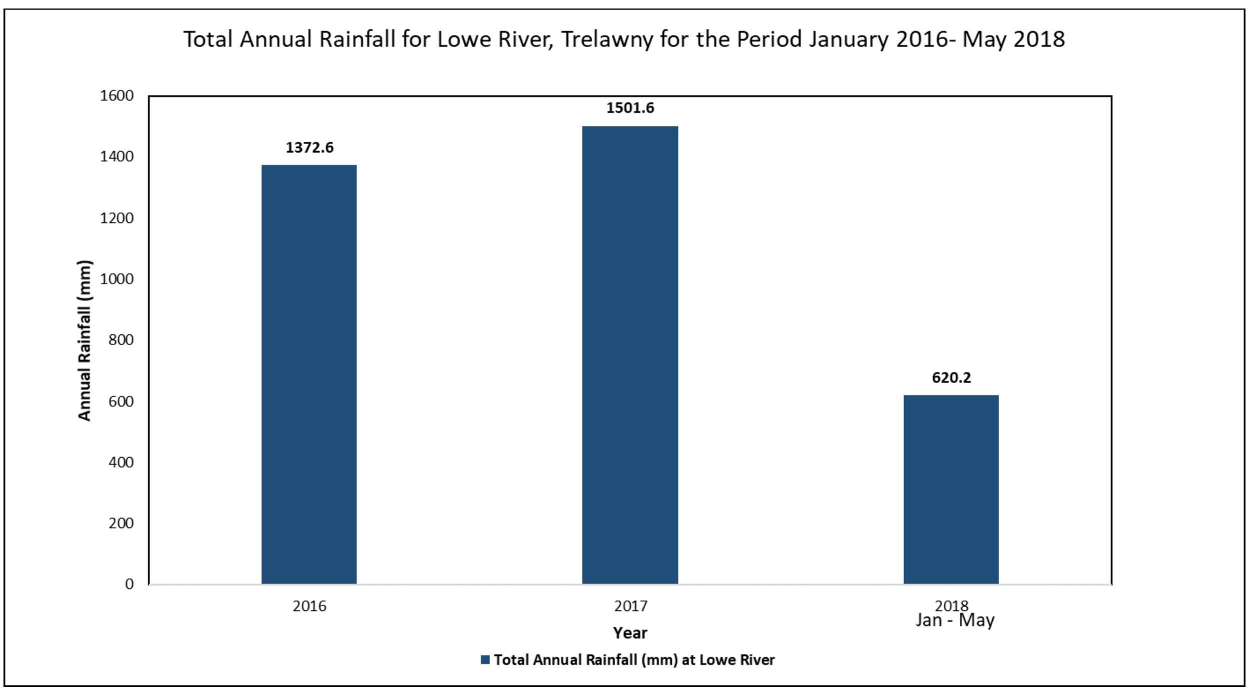


Figure 5-25: Total Annual Rainfall for Lowe River, Trelawny

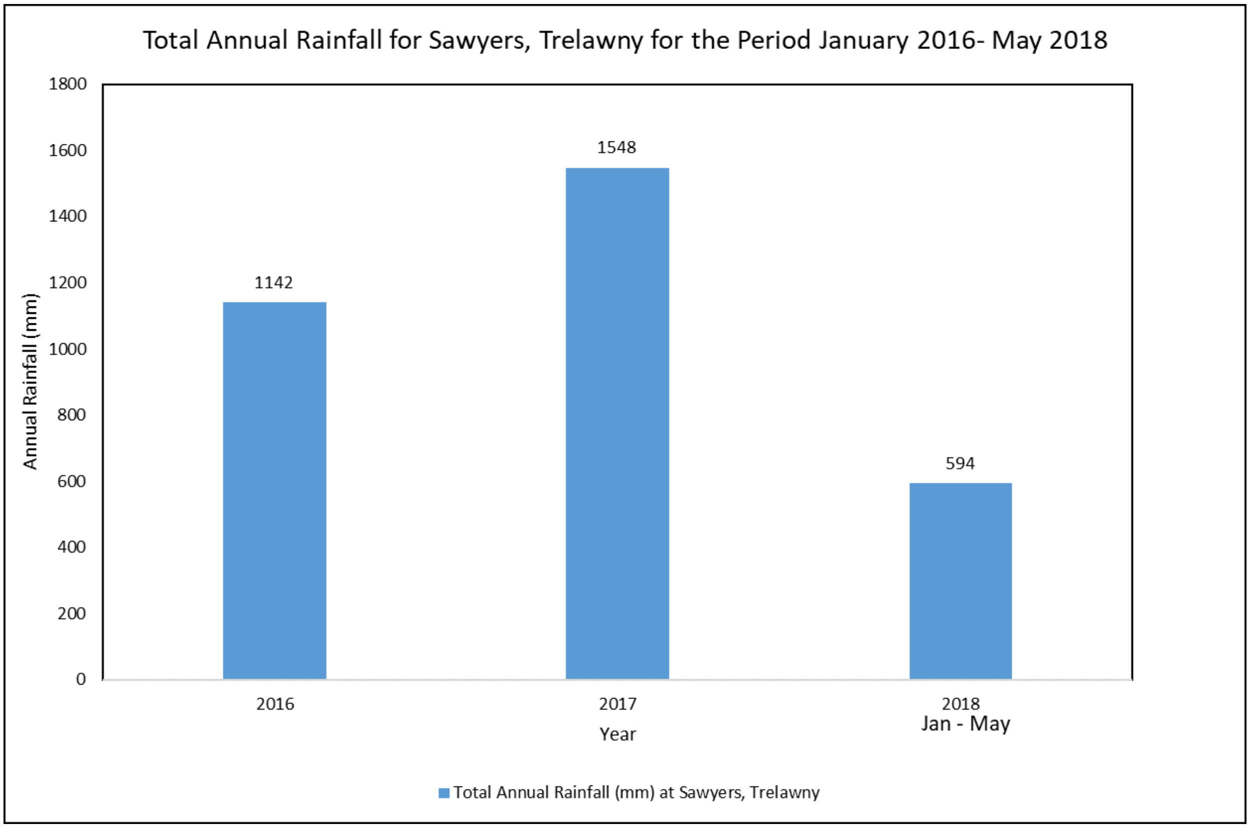


Figure 5-26: Total Annual Rainfall for Sawyers, Trelawny

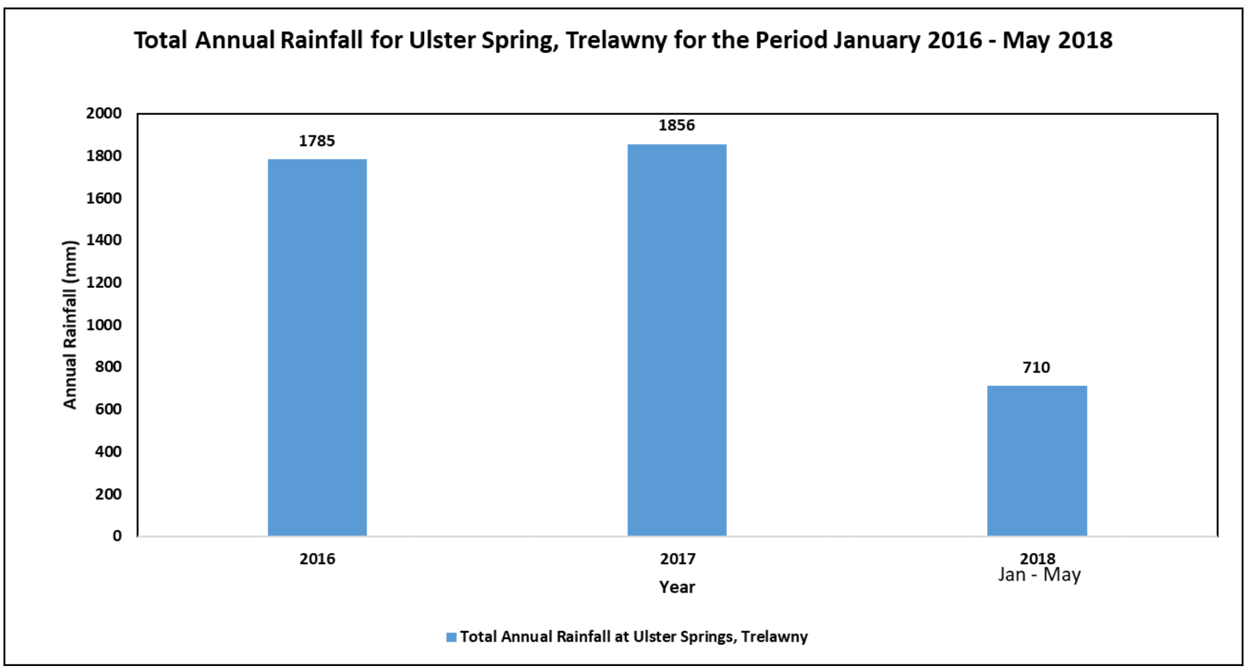


Figure 5-27: Total Annual Rainfall for Ulster Spring, Trelawny

5.1.8.2. 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.

5.1.8.3. Wind Pattern and Direction

Wind roses were also created from data supplied from the Meteorological Services of Jamaica and NJBP II. These were overlaid on google maps. The general wind direction and speed from the Bamboo, Llandovery, Moneague, Tobolski and Water Valley weather station are shown. The data shows that majority of the wind directions measured were blowing towards the west with the exception of Moneague where majority of the wind blows towards the south west. This suggests that any dust generated will generally blow in these directions.

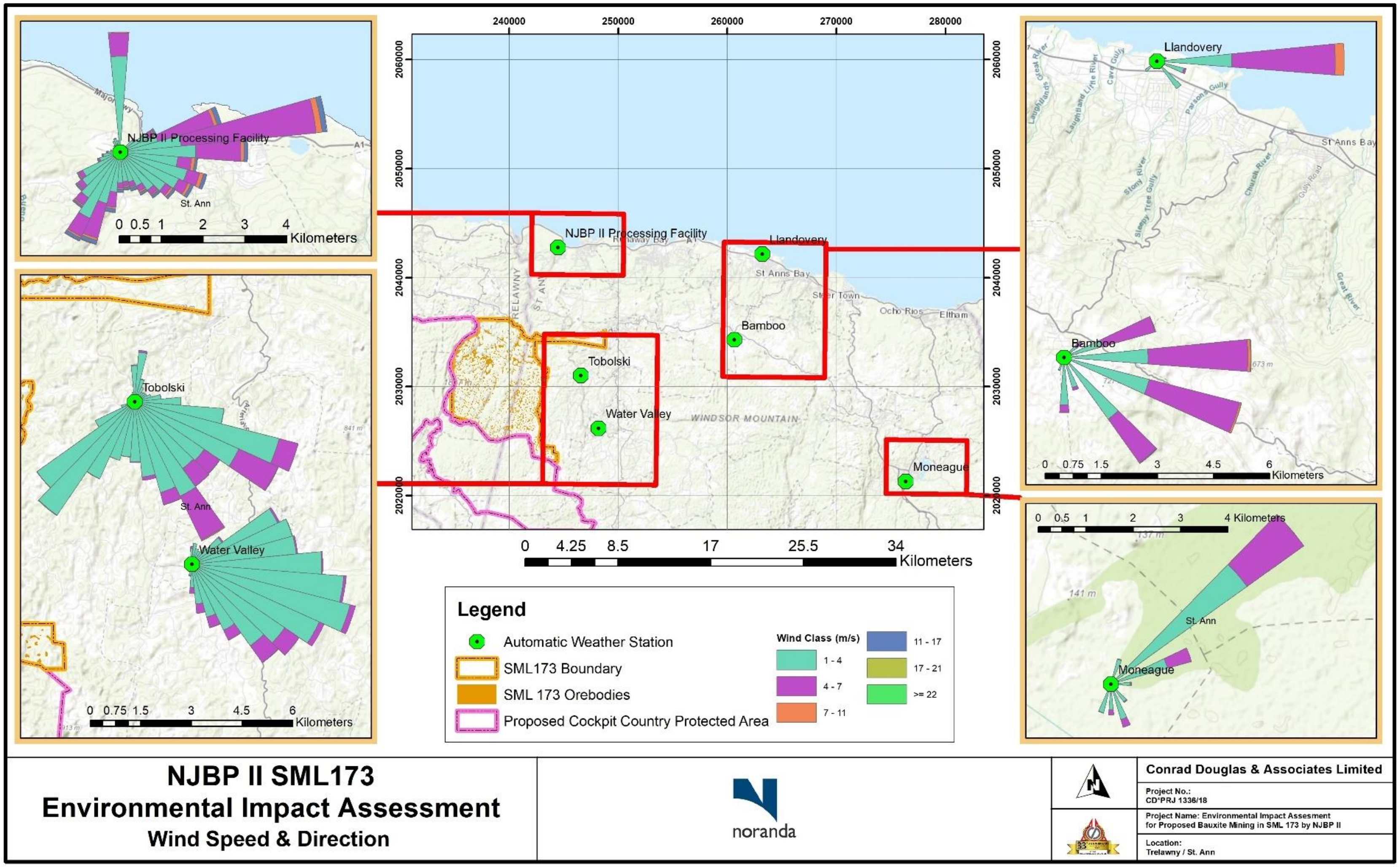


Figure 5-28: Wind Rose for Bamboo, Llandovery and Moneague Weather Station overlaid on Google Map

5.1.8.4. 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 % relative humidity (%RH) and temperature experienced on the North coast is given in Figure 5-29 below. These values are tempered by the usual afternoon showers experienced in the hilly interiors. The average annual temperature for this period was 24.33ºC.

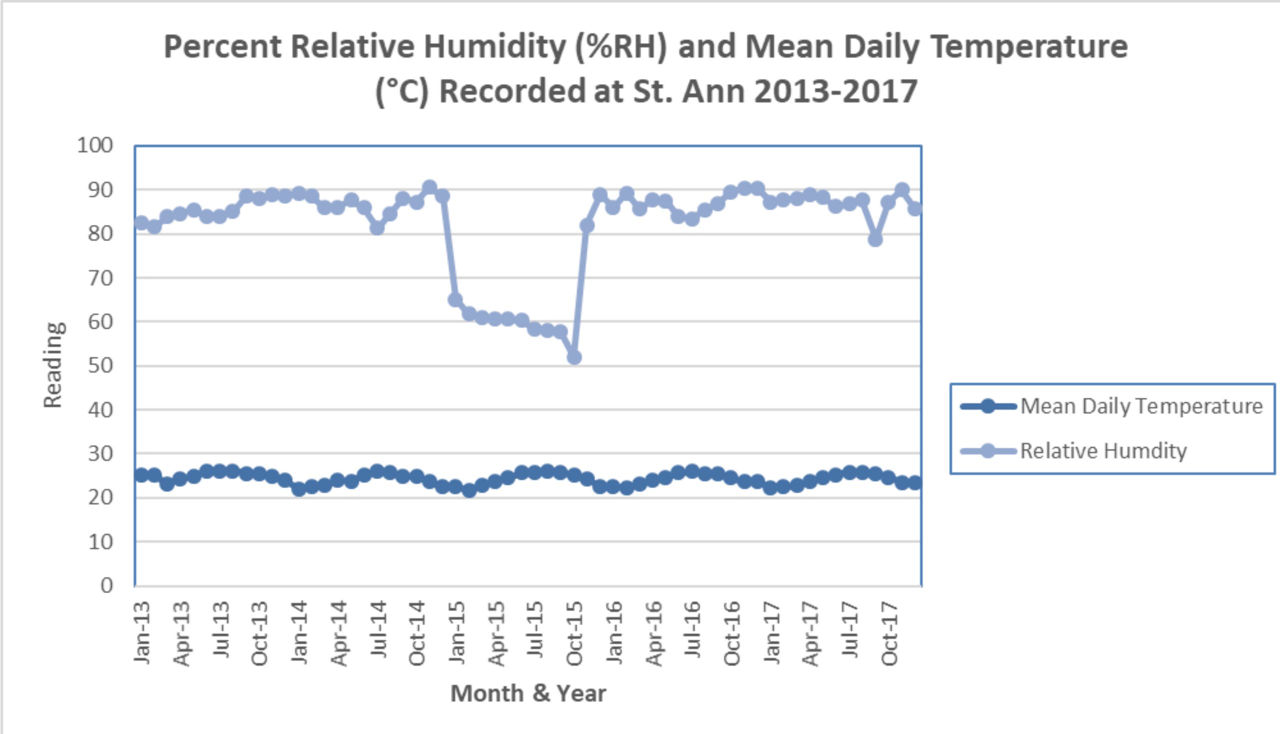


Figure 5-29: Averaged Percent Relative Humidity and Mean Daily Temperature Experienced at Bamboo, Llandovery and Moneague, St. Ann 2013- 2014

5.1.8.5. Barometric Pressure

Barometric pressure data was collected at the following two (2) sites. The sites are located outside the SML 173.

- NJBP II Drying Plant, Discovery Bay, St. Ann (See Figure 5-30)
- Water Valley, St. Ann (See Figure 5-31)

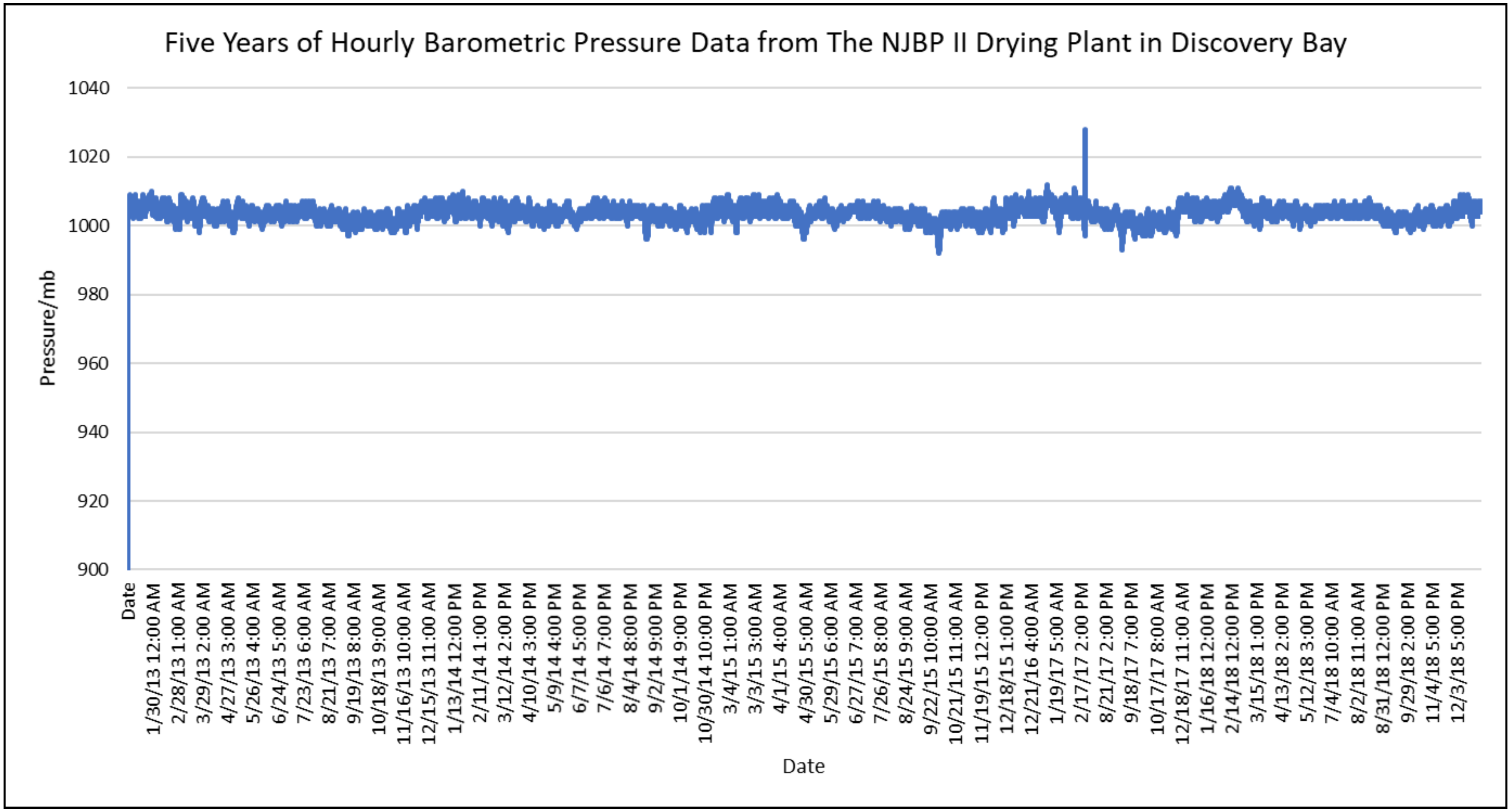


Figure 5-30: Five Years of Hourly Barometric Pressure Data from The NJBP II Drying Plant in Discovery Bay

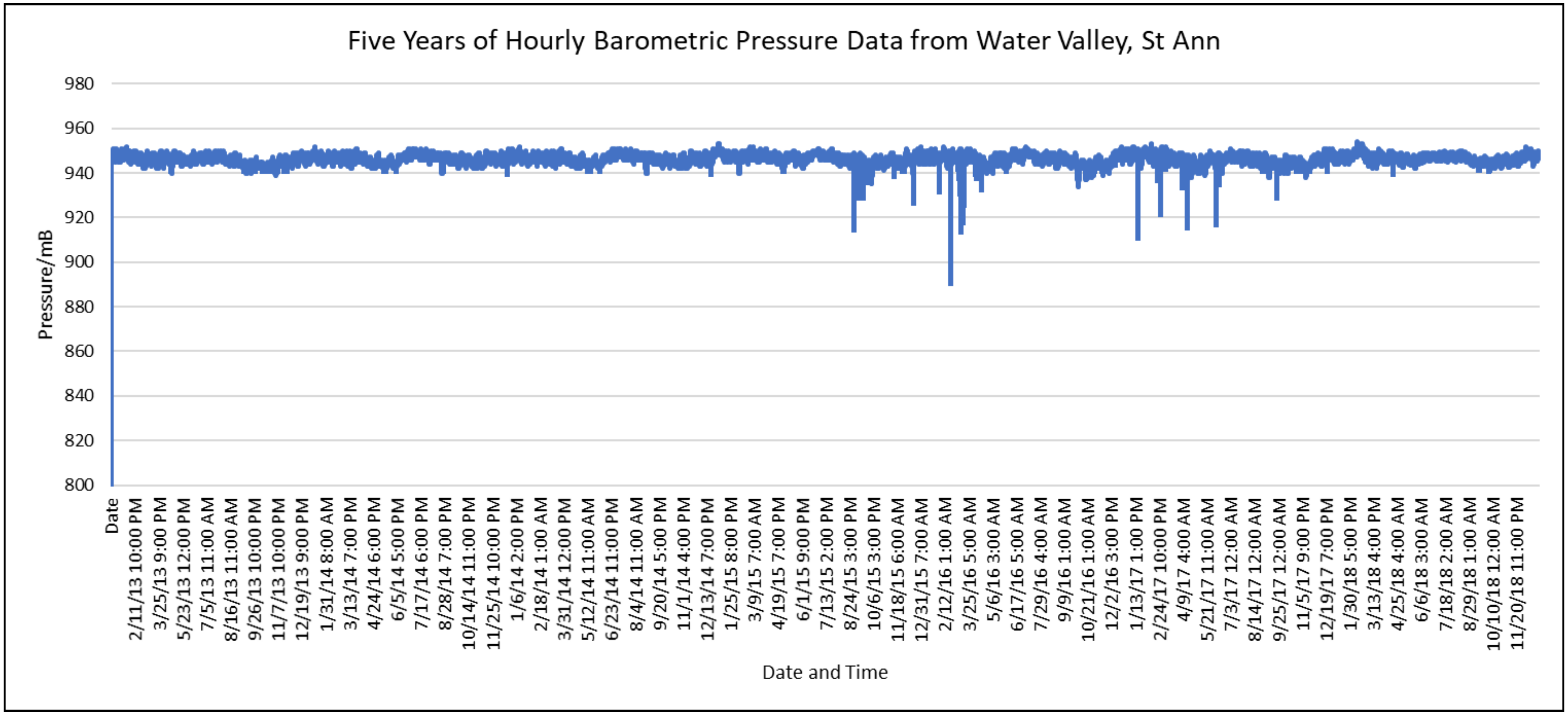


Figure 5-31: Five Years of Hourly Barometric Pressure Data from Water Valley, St Ann

5.1.9. Air Quality Assessment

A baseline assessment of ambient pollutant concentration was carried out in the SML 173 area. The objective was to determine the baseline for the criteria pollutants nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and 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 fraction (TSP) contains all particles with aerodynamic diameter up to 65 micrometers.

The existing major sources of pollutants in SML 173 include vehicular traffic, garbage burning, bush fires (natural and land clearing activities). The low traffic flow in the SML 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.

5.1.9.1. Approach and Methodology

CD&A implemented an air quality monitoring plan to assess the status of air quality within the proposed project area. The results were assessed in relation to the air quality standards set by the regulatory agency. The exercise employed active as well as passive methods for pollutant concentration measurements. Active sampling was done for the particulate matter concentration measurements while passive monitors were used for the measurement of atmospheric NO_2 and SO_2[17].

Active monitor measurements can be compared directly with the existing air quality standards as they are based on the same sampling time frame. Twenty-four-hour sampling was used carried out for PM_{10} concentrations.

Passive monitors collect pollutants based on the natural movement of these pollutants through air (See Appendix IX). The movement is dictated by diffusional forces in the case of

[17] Vieira, L.C., Korf, E.P., *Passive Samplers for Air Quality Monitoring in a Brazilian University*, International Journal Environment and Pollution, Vol 53, Nos. 1/2, 2013

gaseous pollutants and by gravitational forces in the case of particulates. As a result of these natural forces, there is no power demand during the collection process. The collection process therefore requires relatively long periods of time (to the order of days) to accumulate enough pollutant load that it can be detected by inexpensive analytical methods off site in a lab. This method is ideal for areas where formal electricity supply is unavailable or restricted.

Short-term variations in pollutant concentration are therefore not detected by these devises. Passive monitor results therefore cannot be compared with short-term standards such as hourly or daily standards but must be compared with long-term standards such as monthly or annual standards to be useful in accessing air quality. The SML is not anticipated to require details of short-term analysis based on the existing land uses and potential sources of pollutants.

The pollutants measured were NO_2 and SO_2. The passive monitors used were nitrogen dioxide and sulphur dioxide diffusive air monitors supplied and analyzed by Gradko Environmental UKAS accredited in-house method GLM 3. See Appendix IX to Appendix XI.

Monitors were exposed in duplicates at the seven sites during 2 exposure periods. Monitors were exposed in a vertical orientation as stipulated by the manufacturer and held in that position by clamps attached to available support by tie strap. Exposure was from May 8, 2018 to June 28, 2018. The locations of the Air Pollutant Measurement Stations (APMS) are shown in Table 5-2 and Figure 5-32 below.

The exposed monitors were collected, stored and subsequently shipped to England for analysis by ion chromatography. Figure 5-33 shows the exposure setup at one site in the SML. Four passive samplers were kept unexposed to be used as field blanks on return to the overseas lab.

Table 5-2. Monitoring Site Locations

Site Name	Landuse in at Sample Site	Latitude	Longitude
APMS 1	Residence	N 18.31794°	W 077.43820°
APMS 2	Residence	N 18.34590°	W 077.42893°
APMS-3	West Wood High School	N 18.39040°	W 077.45621°
APMS-4	Sawyers Primary	N 18.37866°	W 077.48598°
APMS-5	Field/Farm and Forest	N 18.36584°	W 077.47972°
APMS-6	Residence	N 18.33094°	W 077.44946°
APMS-7	Residence	N 18.32922°	W 077.45043°

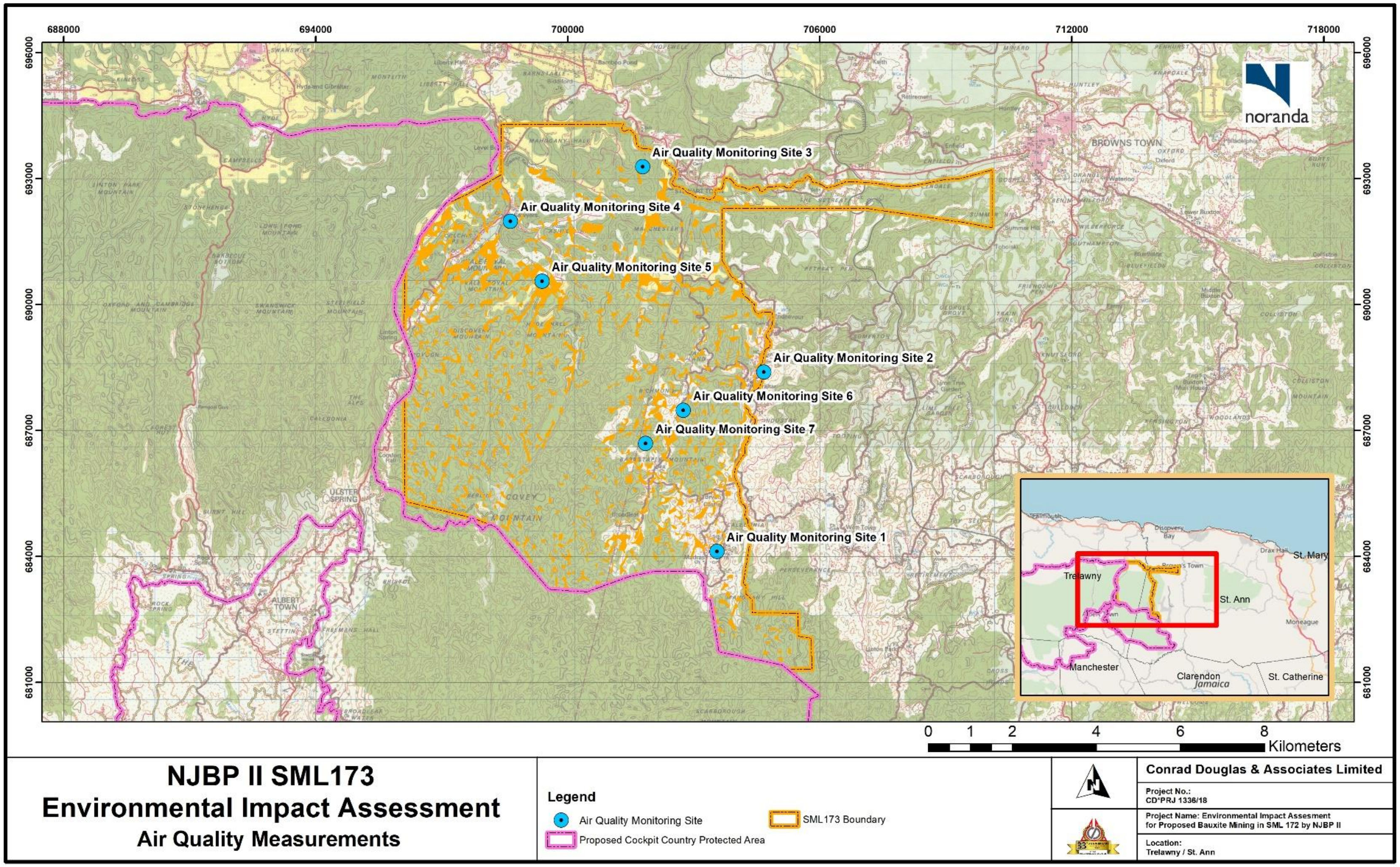


Figure 5-32: Map of Air Quality Monitoring Stations

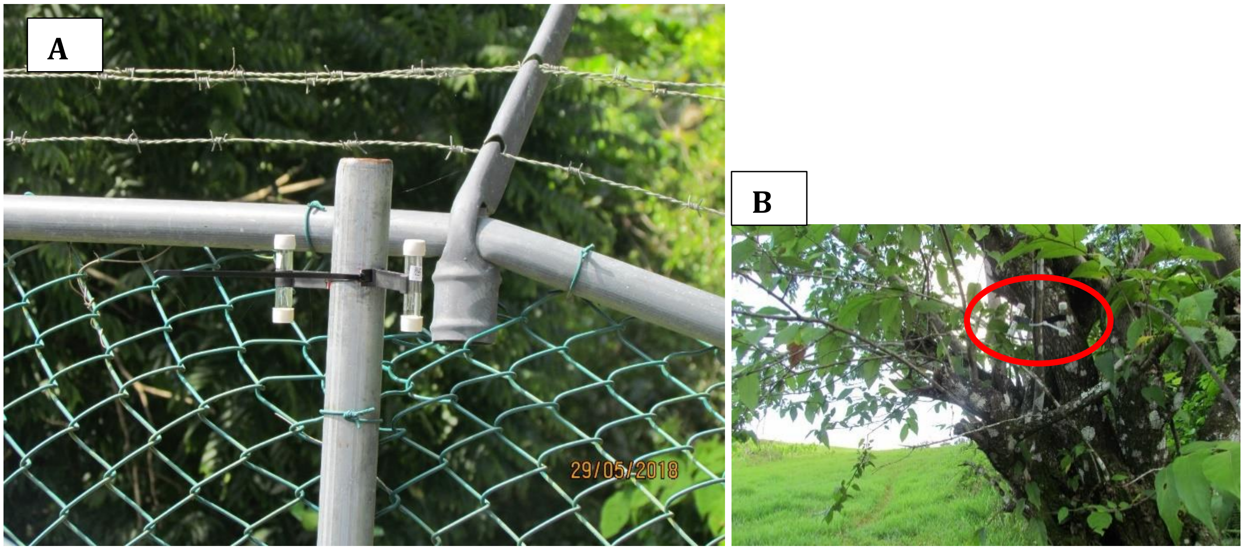


Figure 5-33: A: Passive Monitors exposed at APMS 3 | B: Passive Monitors exposed at AQMS 5 (Shown in Red Circle)Measurement of PM_{10} and TSP concentration was done at six (6) sites over the period May 29-June 14, 2018. One fraction was collected at each site during each sampling exercise. The samples were collected with a micro-volume sampler pulling air for 24 hours through a filter that was stabilized and pre-weighted in a lab. After sampling, the filter was then re-weighed on the same balance after stabilization. The concentration of particulate matter was determined from the weight of particles collected on the filter and the volume of air that passed thought the filter. The dates of sampling are provided in Table 5-3 below.

Table 5-3: Date of Sampling for TSP and PM_{10}

Location	Date of Sampling for TSP	Date of Sampling for PM_{10}
AQMS - 1	8-May-18	31-May-18
AQMS - 2	8-May-18	31-May-18
AQMS - 3	29-May-18	12-Jun-18
AQMS - 4	29-May-18	12-Jun-18
AQMS - 5	NA- no power supply at site	NA - no power supply at site
AQMS - 6	8-May-18	31-May-18
AQMS - 7	9-May-18	31-May-18

5.1.9.2. Results and Discussions

The results of the sampling exercises are presented in Table 5-4 below. The monthly average for the gaseous pollutants is presented (Appendix XII) while the 24-hour measurement is presented for particulate matter. The results of the sampling exercise indicate that the air quality within the SML during the sample exercise was good as the measurements were within the standard set for health protection. The areas are within the annual standard set for NO_2, SO_2 and the daily standard set of PM_{10} and TSP.

Table 5-4: Passive Monitor Monthly Average Results for NO_2 and SO_2 and Active Monitor Result for Particulate Matter

Site Name	Land Use at site	NO_2 (ugm^{-3})	SO_2 (ugm^{-3})	PM_{10} (ug/m^3)	TSP ($\mu g/m^3$)
		Annual: 100	**Annual:** 80	**150**	**150**
AQMS 1	Residence	5.03	2.55	25.50	23.18
AQMS 2	Residence	3.00	2.59	13.91	53.11
AQMS-3	West Wood High School	3.32	3.20	80.23	18.53
AQMS-4	Sawyers Primary School	3.86	3.18	53.30	55.60
AQMS-5	Fields and forest	3.58	3.22	-	-
AQMS-6	Residence	3.21	2.59	16.27	34.75
AQMS-7	Residence	4.08	3.29	16.21	32.44

The comparison between Jamaica Ambient Air Quality Standard (JAAQS) and the values obtained in this baseline assessment of air quality are presented in Figure 5-34 and Figure 5-35 below. These compare the 24-hour standards for PM with those obtained in the measurements associated with this study.

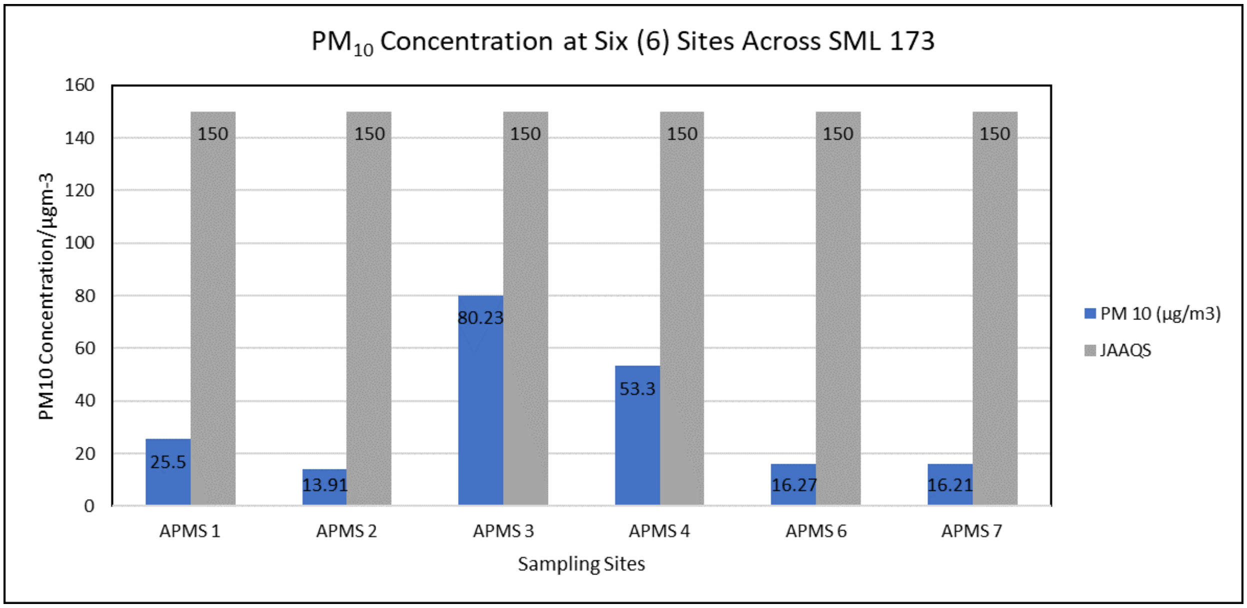


Figure 5-34: 24-hour PM_{10} measurements from Active Monitor Compared with JAAQS

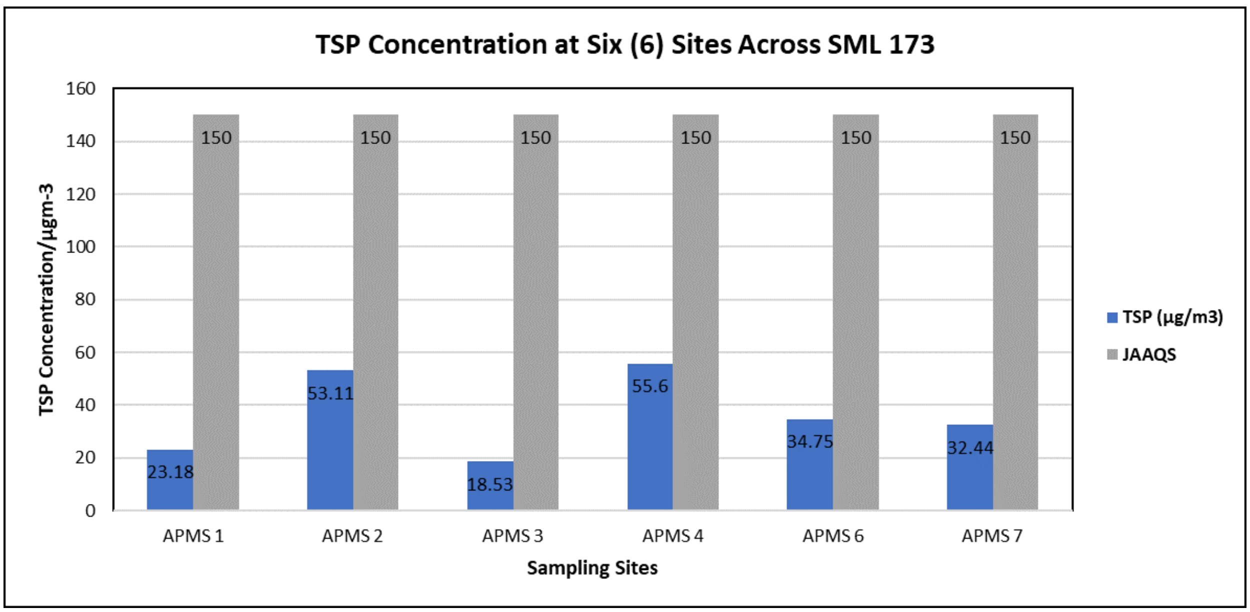


Figure 5-35: 24-hour TSP measurements from Active Monitor Compared with JAAQS

The data collected showed that the standards are not breached for any of the PM sampled in the baseline assessment. The low level of the monthly average suggests that the hourly and daily standards for the gaseous pollutants are not likely being breached.

The activities associated with the proposed project are not expected to generate excessive pollutants since the project is distributed over a large area of land. 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.

5.1.10. Audiometric and Vibration Analysis

5.1.10.1. Audiometric Analysis

An audiometric survey was conducted at seven (7) locations within the SML 173 area. Table 5-5 below shows the location of the noise quality monitoring stations (NQMS). The locations were selected based on their proximity to NJBP II planned activities and residential areas closest to the proposed projects.

A certified and calibrated hand-held digital audiometer, Norsonic 118, was used to perform the measurements.

Table 5-5: Audiometric Survey Locations

ID	Activity	Coordinates	
NQMS 1	Residence	N 18.31794°	W 077.43820°
NQMS 2	Residence	N 18.34590°	W 077.42893°
NQMS 3	Westwood High	N 18.39040°	W 077.45621°
NQMS 4	Sawyers Primary	N 18.37866°	W 077.48598°
NQMS 5	Farm/forest	N 18.36584°	W 077.47972°
NQMS 6	Residence	N 18.33094°	W 077.44946°
NQMS 7	Residence	N 18.32922°	W 077.45043°

Table 5-6 below shows the average, maximum and minimum audible decibel levels for the project site and surroundings.

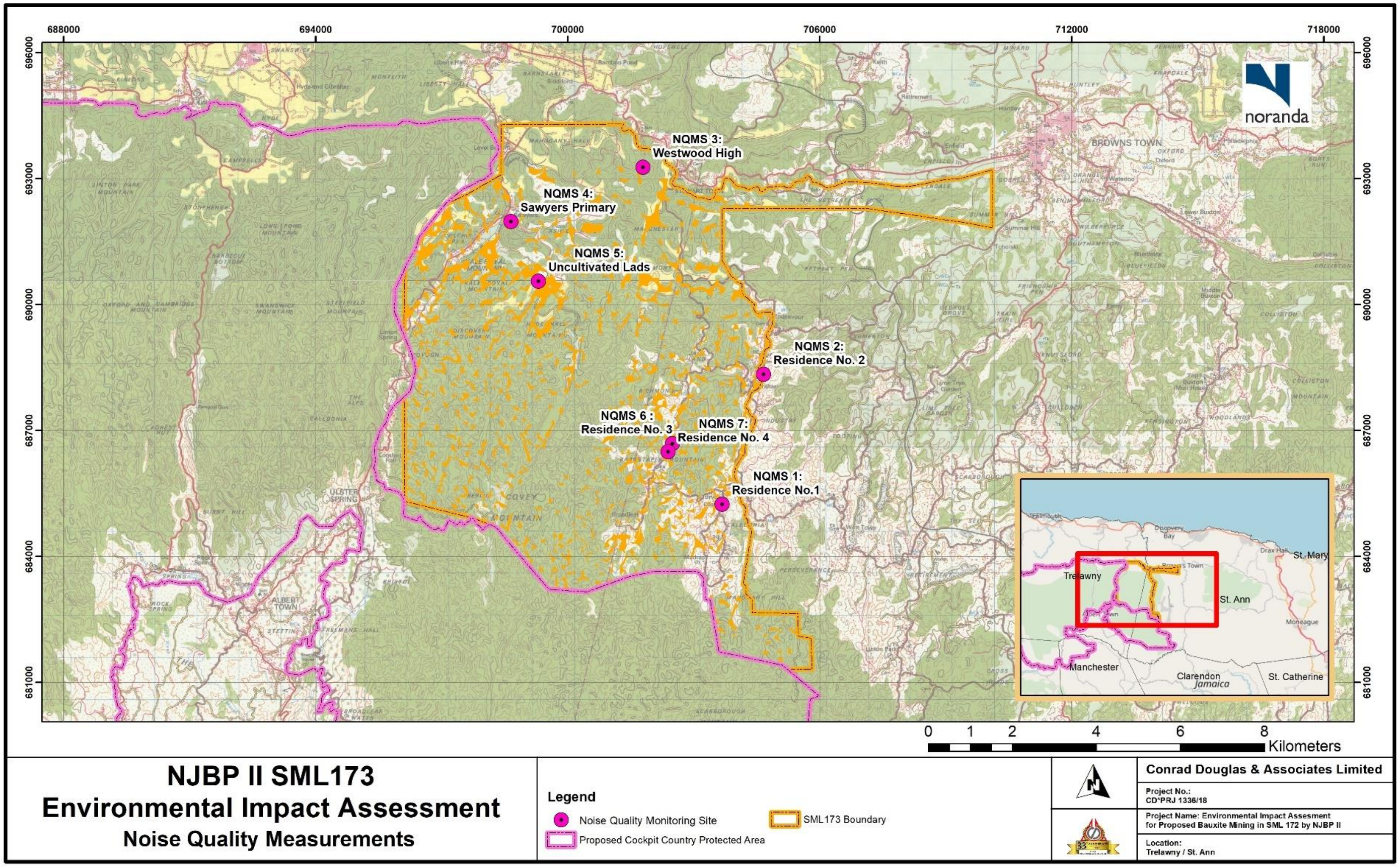


Figure 5-36: Location of Audiometric Survey Monitoring Stations

Table 5-6: Results of Noise Level Recordings

Locations	Average (dB)	Maximum (dB)	Minimum (dB)	NEPA Standard (dB)
NQMS 1	56.2	67.1	47.1	75
NQMS 2	53.18	61.7	42.7	75
NQMS 3	48.71	59.80	40.70	75
NQMS 4	48.94	57.20	40.60	75
NQMS 5	42.37	53.40	36.80	75
NQMS 6	43.52	48.9	36.1	75
NQMS 7	47.66	49.3	46.6	75

LAeq refers to the "equivalent" average sound pressure level measured using the A-weighting which is the most sensitive to speech intelligibility frequencies of the human ear

5.1.10.1. Vibration Analysis

A vibration survey was conducted at three (3) locations within the SML 173 area. Table 5-5 above shows the location of the vibration monitoring stations (VMS). The locations selected were on NJBP II planned haul routes.

A certified and calibrated hand-held digital audiometer, Extech Vibration Meter SDL800, was used to perform the measurements.

Table 5-7: Vibration Survey Locations

ID	Activity	Coordinates	
VMS 1	Planned Haul Road	18.323253	-77.437290
VMS 2	Planned Haul Road	18.327947	-77.435781
VMS 3	Planned Haul Road	18.333669	-77.451633

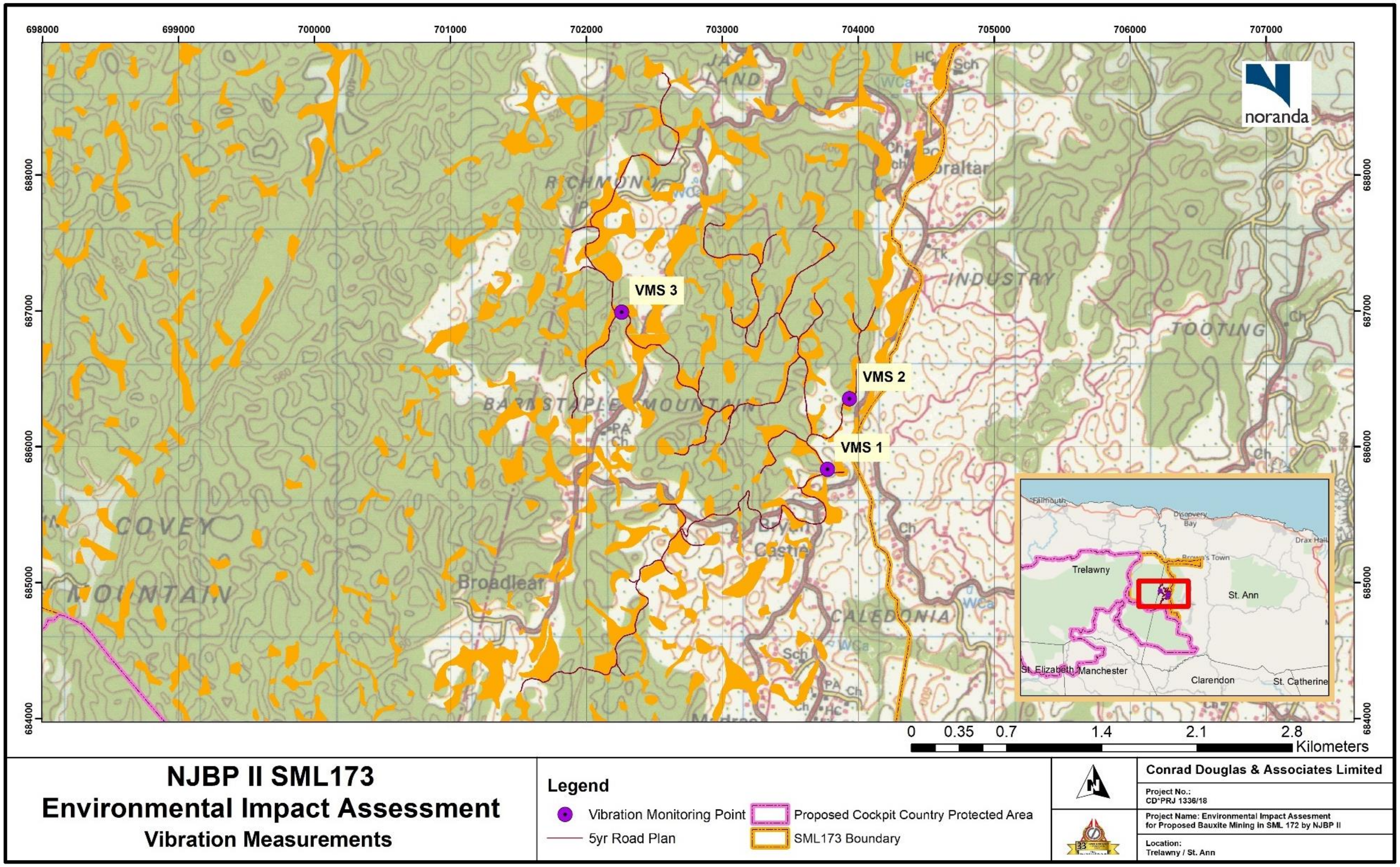


Figure 5-37: Location of Vibration Monitoring Stations

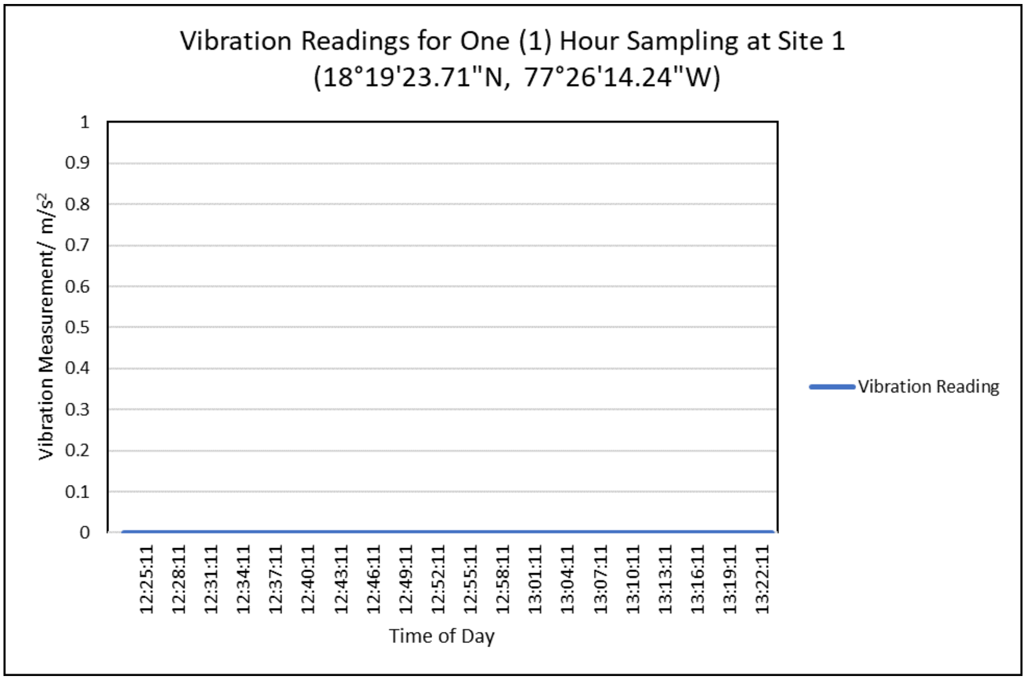


Figure 5-38: Vibration Readings for One (1) Hour Sampling at Site 1 (18°19'23.71"N, 77°26'14.24"W)

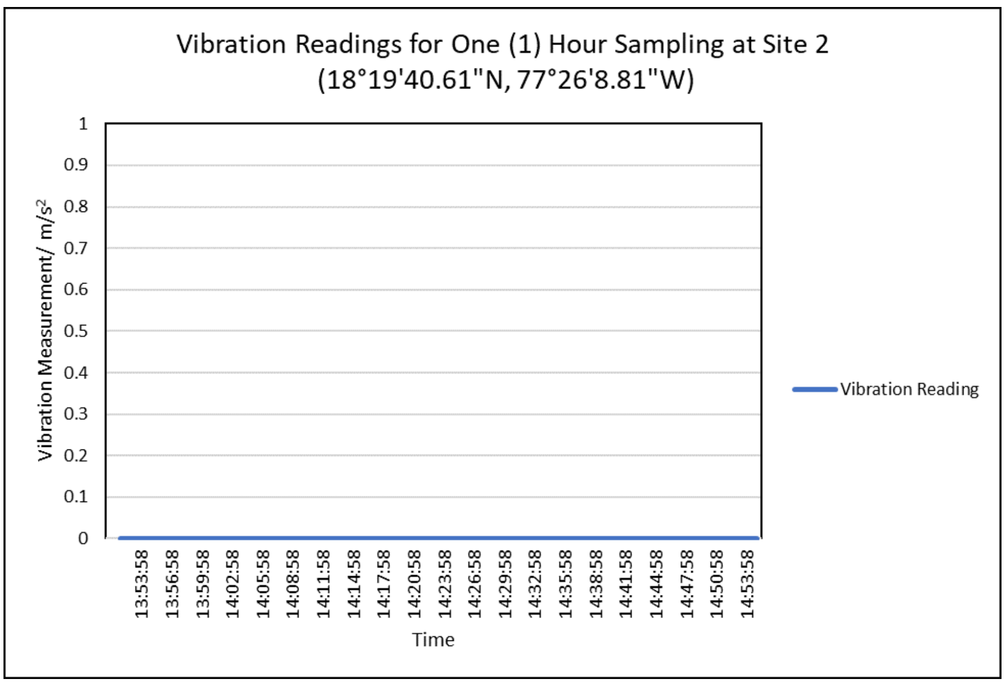


Figure 5-39: Vibration Readings for One (1) Hour Sampling at Site 2 (18°19'40.61"N, 77°26'8.81"W)

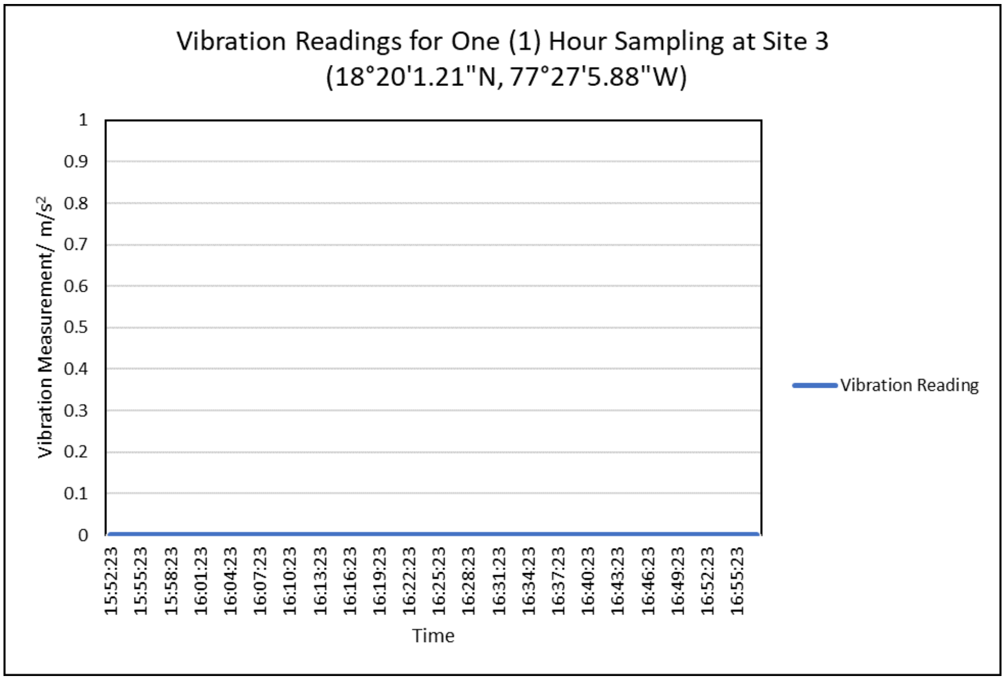


Figure 5-40: Vibration Readings for One (1) Hour Sampling at Site 3 (18°20'1.21"N, 77°27'5.88"W)

5.1.10.2. Summary

The readings of all noise measurements were within the NEPA standard of 75db.

No vibration was detected. All measurements recorded 0 m/s^2.

5.2. Natural Hazards

5.2.1. Hurricanes

Although not as vulnerable as the eastern mountains, the Cockpit Country was badly affected by Hurricane Gilbert (Eyre, 1989, Varty, 1991). While hurricanes are a part of the natural cycles in Jamaica, 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.

5.2.2. 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.

5.2.3. 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.

5.2.4. Flood and Landslides

The bottom lands are vulnerable to flooding when heavy rainfall causes natural drainage through sinkholes to be blocked.

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 5-41 below shows recorded flood and landslide events in the SML 173 area.

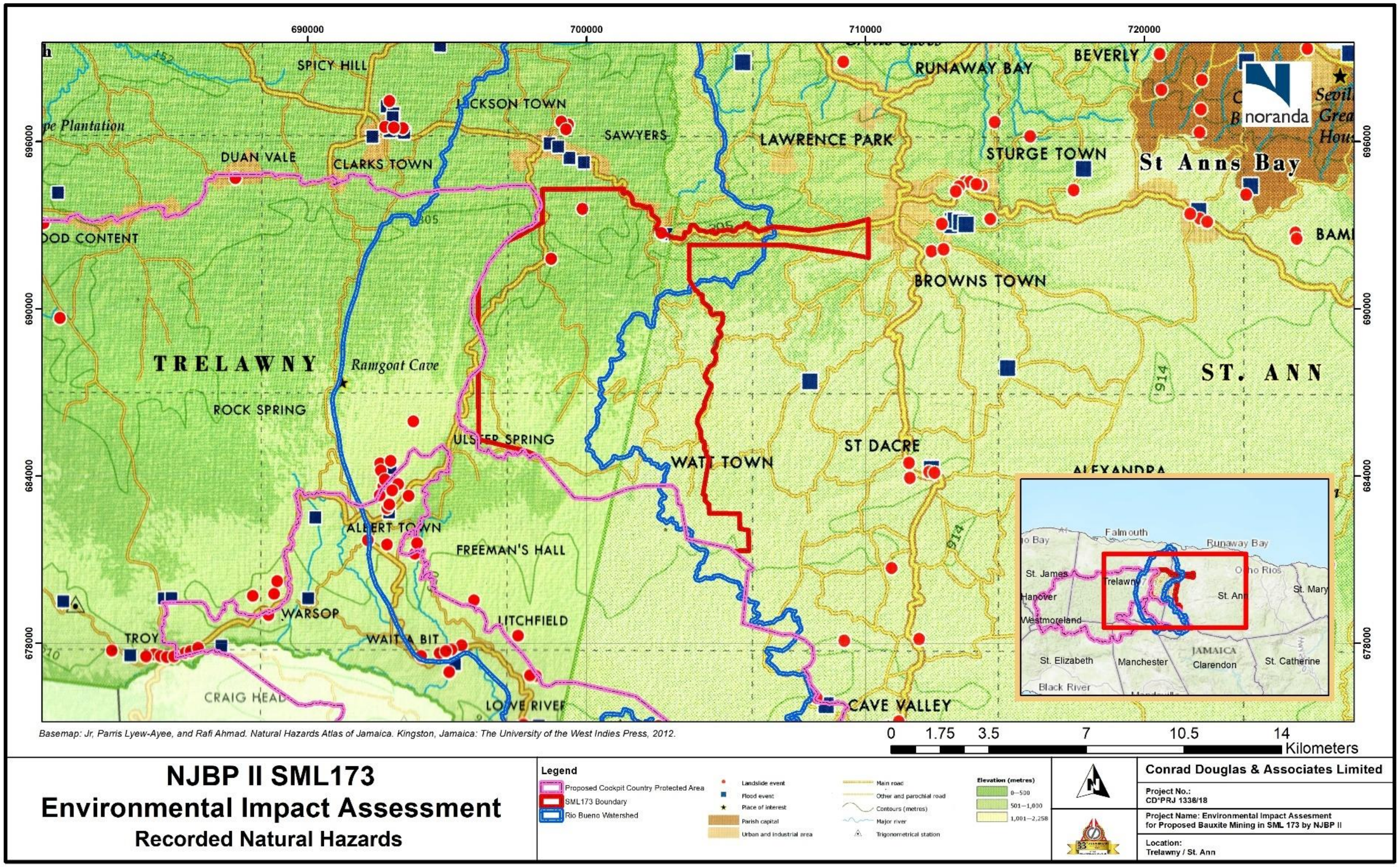


Figure 5-41: Map showing recorded Flood and Landslide Events

5.2.5. Earthquakes

Earthquakes are hazards on any of the major fault lines that traverse the Cockpit Country but are more a threat to the built environment than to the natural environment. The historical earthquake events in the SML 173 area are shown in Figure 5-42.

5.2.6. 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.

SML 173 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 was also damage and rock fall in some lowlands west of SML 173.

There have been reported landslides in the SML 173. Landslides have, however, been reported in the areas on the fringe of the SML 173 where towns and communities have developed. The lack of reports does not mean landslides do not occur.

5.2.7. Uncontrolled Exploitation

Illegal and uncontrolled exploitation of the study area and other areas within the sphere of influence continue to escalate evidence by increasing frequency of cleared areas predominantly for agricultural purposes. Eyre, 1989 estimates the annual rate of deforestation at 2.8%.

5.2.8. Considerations on Micro-Climate

It should be noted that areas where the winning of bauxite will be carried out are already under significant anthropogenic stress from agricultural activities such as yam planting and the creation of paths for accessing these areas. Therefore, any changes that may occur from the winning of bauxite and the creation of haul roads will not introduce any significant irreversible impacts on microclimates. Further, any changes that may occur are deemed substantially reversible, and will be mitigated during the rehabilitation process.

In addition, the orebodies and the haul roads represent 15% (1,250 ha) of the potentially impacted area within SML 173 area (8,335 ha) over the entire 25-year lease. Of this 15% of the potentially impacted area, haul roads account for 20% (250 ha) or 3% of the total SML 173 (8,335 ha). It should be noted that in the process of mine development, haul roads are treated in five (5) phases:

1. Planning
2. Pre-Construction
3. Construction
4. Operations
5. Closure.

Planning

The planning phase involves the design of haul roads using best practice, which includes the avoiding and minimizing cuts on the limestone hillocks as far as practicable. In several instances haul roads are not greenfield, but brownfield sites where existing pathways are expanded for the purpose of haul roads creation. The planning phase also involves the identification and planning for relocation of any sensitive species of plants, such as epiphytes, to areas that will not be disturbed and concomitantly placing any excess species in greenhouses for future planting.

Pre-Construction

The pre-construction phase involves the retrieval and replanting of any sensitive plant species and placing any excess species in greenhouses for future planting.

Construction

Construction is undertaken by cutting, filling, using the cut material, and preparing the road alignment for the traversing of vehicular traffic using suitable machinery and equipment. This process is undertaken on a phased basis over the 25 year lease.

Operations

Operations involve the continual movement of trucks and other equipment on the haul roads during each shift. The haul road surfaces are irrigated with water for the purposes of dust suppression. In addition, special innocuous dust suppressants are used. See Appendix VIII.

Closure

At the end of use, access and use of the haul roads are eliminated by making the road redundant. Based on existing activities within SML 173 that have disrupted microclimates, the overall ecology of the area demonstrates resilience. It is therefore anticipated that efforts made to restore and allow for recolonization will result in the re-establishment of the minimally impacted microclimate in the due course of time.

Conversely, as stated in the AIA, which is a companion document to this EIA, haul roads are sometimes seen as opportunities to service existing communities. The 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. (Please see AIA, attached as a companion document to this EIA Report).

Of the entire SML 173, only 3% represents haul roads. The microclimates which will be disturbed for the construction and operation of the haul roads will be temporary. Further, with retrieval, replanting and natural and aided recolonization, there will be no net decrease of the natural microclimate functions or natural biological services in the due course of time.

Given the temporary nature of mining and haul road construction, natural recolonization will occur, as well as, the replanting and re-introduction of species previously removed from the area. Consequently, the micro-climate conditions will be substantially restored.

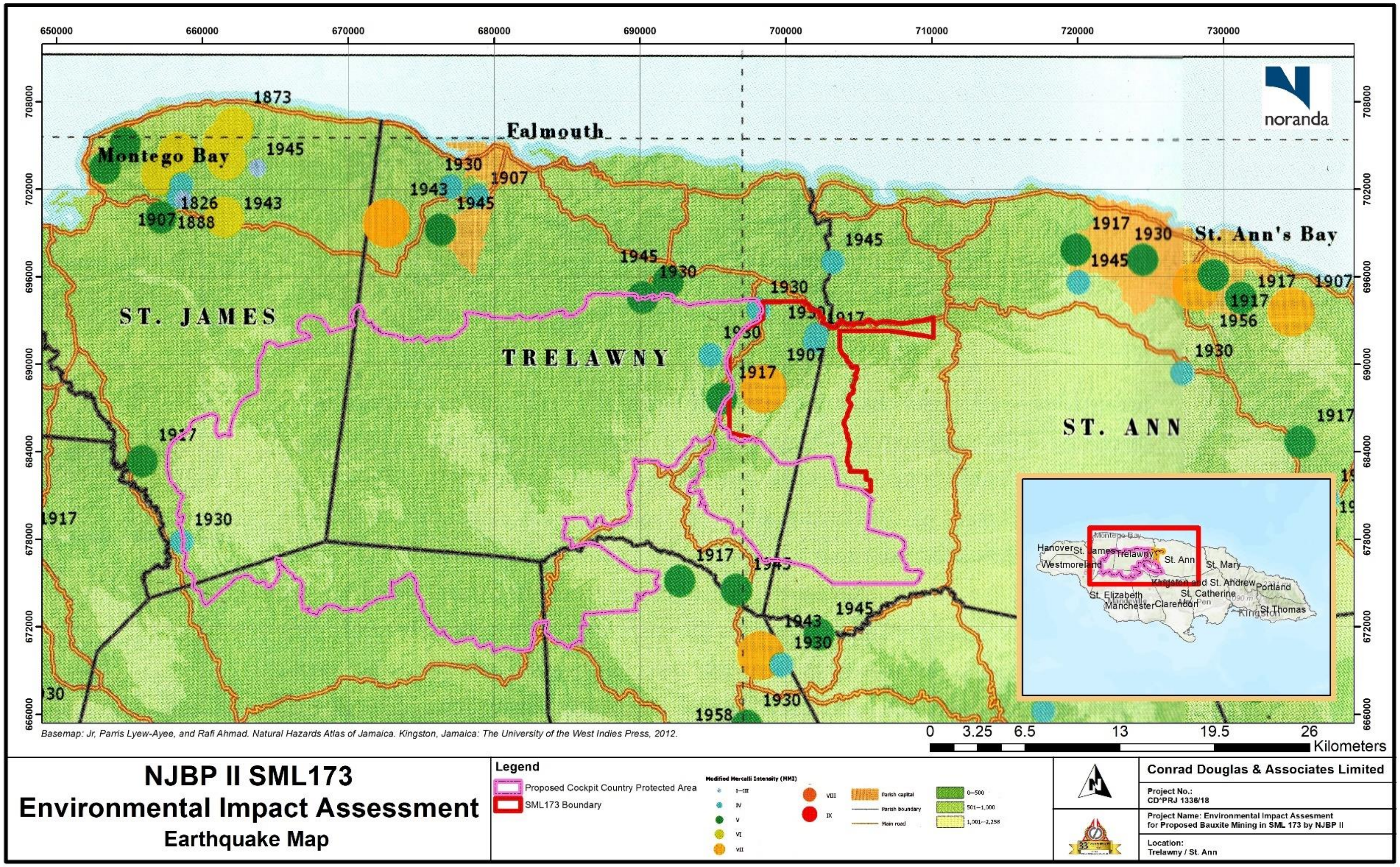


Figure 5-42: Historical Earthquake events in the SML 173 area

5.3. Biological Environment

5.3.1. Introduction

The biological assessment of the SML 173 area was conducted in accordance with the agreed Terms of Reference established for the study. The overall objectives of this study were to:

1. Conduct and prepare a characterization of the flora in the entire SML 173 area using:
    - remote sensing techniques,
    - literature-based data sources and
    - ground truthing.
2. Conduct and prepare a description of the fauna in the SML173 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 SML 173.

The agreed Terms of Reference for the EIA requires that a study of the ecological resources within SML 173 be conducted to:

1. Describe the habitats in SML 173
2. Determine the distribution of habitats and species within SML 173, 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 SML 173 and its environs over the period February 2018 to December 2019:

i. February 2018,
ii. August 2018
iii. August to September 2019 and

iv. December 2019.

An exhaustive review of literature associated with the Cockpit Country and its environs was carried out for the study with significant consultations with the relevant institutional experts such as the Department of Life Sciences, The University of the West Indies and the Institute of Jamaica. The Windsor Research Centre and Southern Trelawny Environmental Agency (STEA) were also consulted. National and internationally accepted databases were also reviewed. This included information from the Institute of Jamaica and The Forestry Department.

SML 173 is characterized by a series of:

1. forested hillocks and
2. depressions that have secondary growth, which results from human activity, within these depressions.

These formations are replicated throughout SML 173.

In SML 173 the distances between the hillocks are greater than those in the contiguous core Cockpit Country. This results from more extensive degradation by weathering over time[18]. These increased distances, and the human activities, are likely to have influenced the composition and structure of the ecological communities within SML 173. Figure 5-43 shows SML 173 overlaid on the Land Use and Land Cover map, including sections of the proposed Cockpit Country Protected Area. Areas designated as forest reserves were not investigated within this EIA, as stipulated by the agreed ToRs.

The general area can be described as disturbed forest with two major habitat types within SML 173. These are:

1. the elevated forested areas and

[18] Parris Lyew Ayee Jr., Cockpit Country Boundary, 2005

2. the open bauxite bearing grassland depressions.

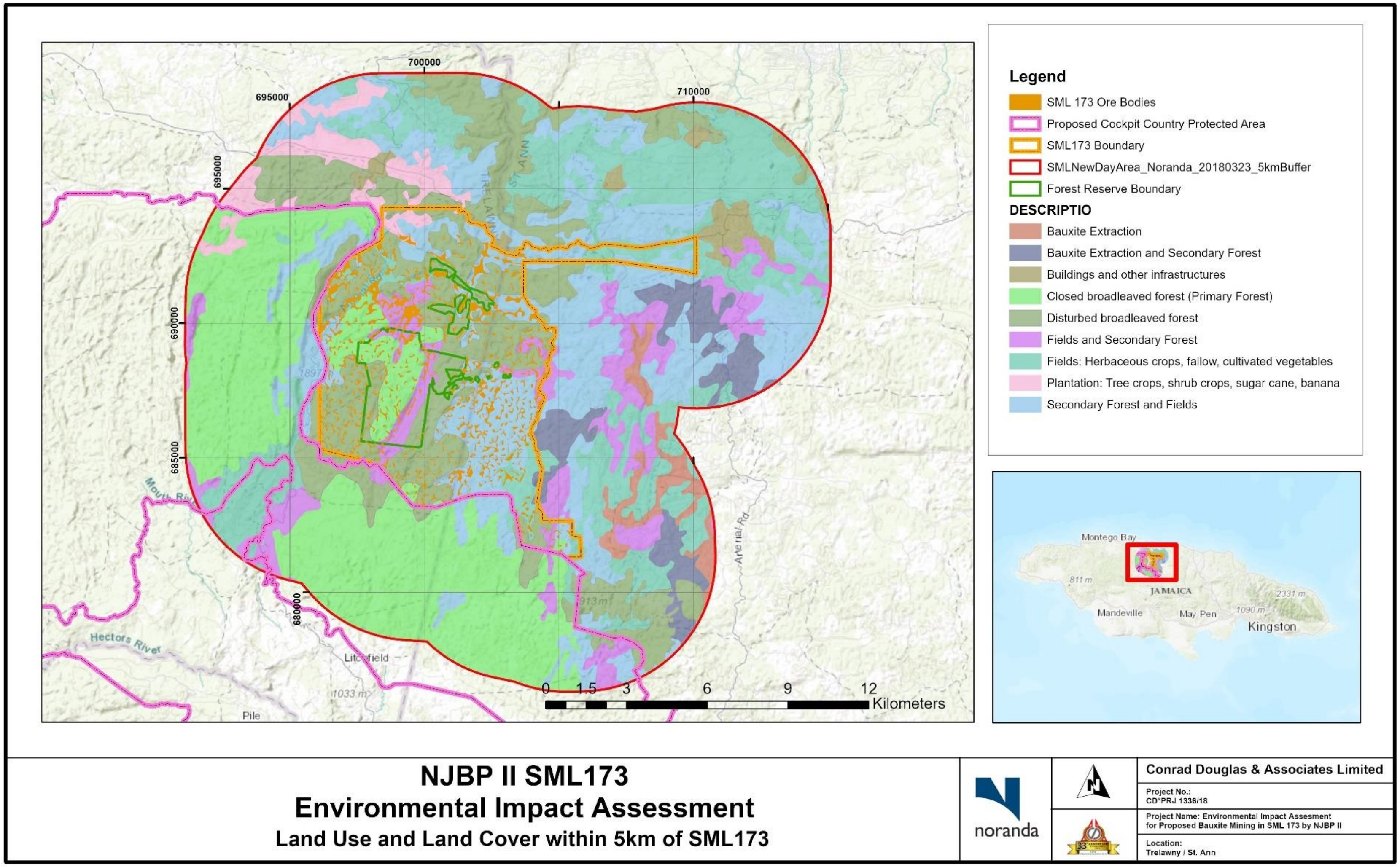


Figure 5-43: SML 173 overlaid on the Land Use and Land Cover map, including the proposed Cockpit Country Protected Area (*based on Statement by the Most Honourable Andrew Holness, Prime Minister to Parliament on the Delimitation of the Boundary of the Cockpit Country and the Cockpit Country Protected Area on November 21, 2017*)

5.3.2. 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.

In order to analyze the ecology of SML 173, excluding the forest reserves, the 8,335 hectares area was divided into nine (9) random blocks (See Figure 5-44). The exclusion of the forest reserves ensured that the requirements of the ToRs were met. Only remote sensing was done in the areas overlapping with the Forest Reserves. The nine blocks covered more that 50% of the 8,335 hectares SML 173 area, or 2.5 times of what best practice requires. It included all land uses within the area.

Data was collected during field visits employing various techniques which are described below. Satellite imagery was used to plan the spatial distribution sampling and the site visits. The locations of access routes within SML 173 were also determined from these aerial images.

Using aerial images, Figure 5-45 to Figure 5-53 below show the boundaries of the SML 173 study blocks for the ecological evaluation. Nine study blocks were identified of which seven (7) blocks were assessed in detail. The nine (9) blocks were designated as follows:

1. **Block 1** (See Figure 5-45) is peripheral to the communities of Gibraltar, Barnstaple and Richmond Pen. This block encompasses an area of land for which a 5-year mining plan, as well as details of haul road design has been developed by NJBP II.
2. **Block 2** (Figure 5-46) encompasses the community of Stewart Town and the most eastern end of SML 173 towards Browns Town. Although it is a part SML 173, most of this block will not be mined. Human settlements have encroached on a significant portion of the bauxite reserves in this block making it uneconomical to access these resources. Generally, therefore this block was characterized based on remote sensing

and basic ground truthing principles only. This area is south of the Dornoch Headwater and the wells in communities north of SML 173.

3. **Block 3** (See Figure 5-47) is the south-westernmost section of SML 173. The border of the block is east of the community of Ulster Spring.
4. **Block 4** (See Figure 5-48) is located to the southwest of the community of Stewart Town and encompasses a significant geological feature known as Dunn's Hole.
5. **Block 5** (See Figure 5-49) encompasses the community of Jackson Town. This block was characterized generally based on remote sensing and basic ground truthing principles only, since it was determined that this block would not be mined.
6. **Block 6** (See Figure 5-50) encompasses sections of the communities of Sawyers and Level Bottom.
7. **Block 7** (See Figure 5-51) encompasses the community of Broadleaf.
8. **Block 8** (See Figure 5-52) encompasses the community of Madras and represents the southeastern most section of SML 173.
9. **Block 9** (See Figure 5-53) was positioned west of the community of Barnstaple. Efforts were made to access as close as possible to the centre of SML 173.

With the exception of blocks 2 and 5, detailed studies were carried out for blocks 1, 3, 4, 6, 7, 8 and 9. Forest reserves were strategically omitted based on the requirements of the ToRs.

Since an indicator of the giant swallowtail butterfly (*Pterourus homerus,* formerly called *Papilio homerus)* is the presence of the Water Mahoe (*Hernandia catalpifolia*), intensive efforts were placed on identifying the Water Mahoe during the field work of this ecological assessment.

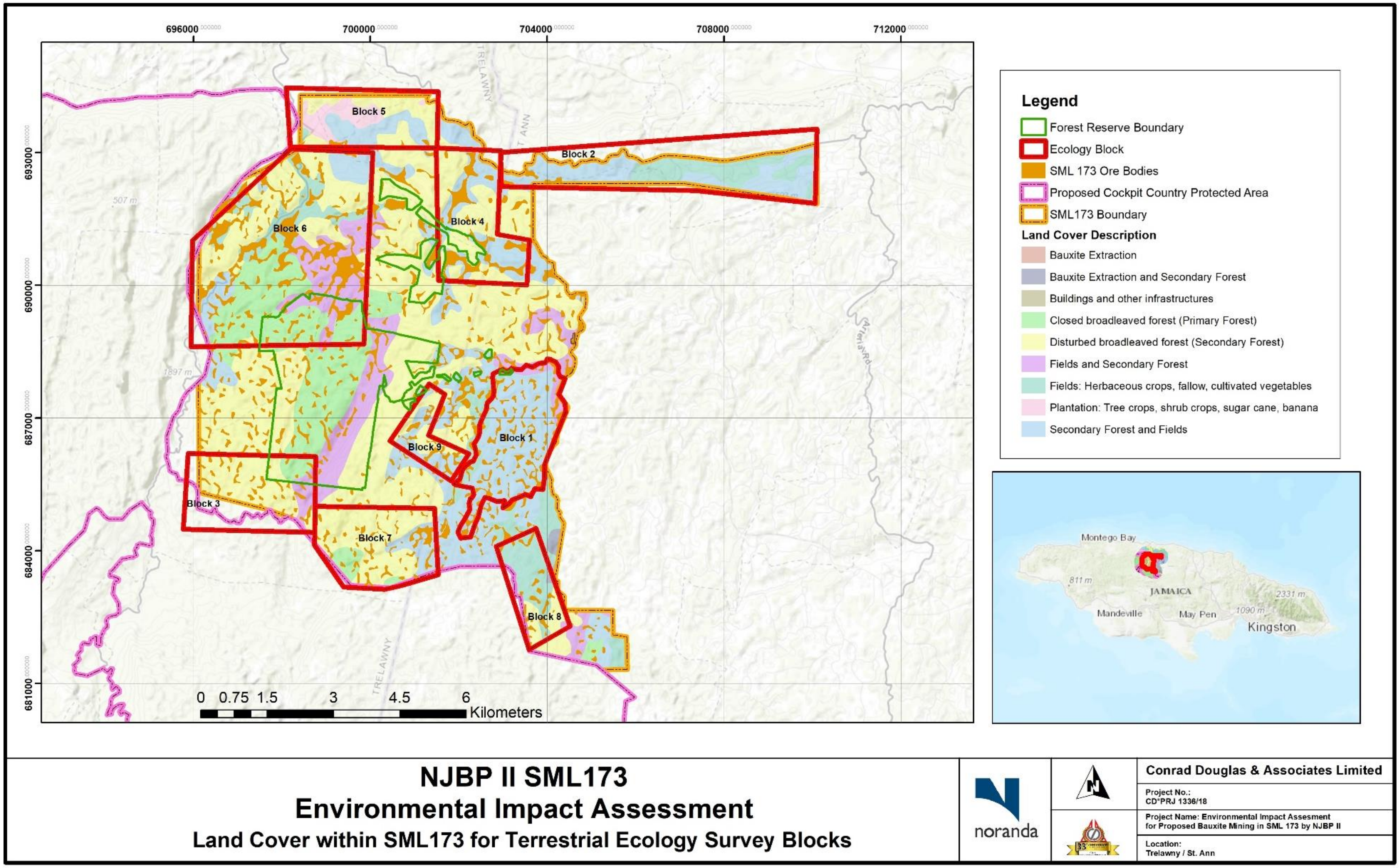


Figure 5-44: Terrestrial Ecology Study Area Blocks within SML 173 (numbered 1-9)

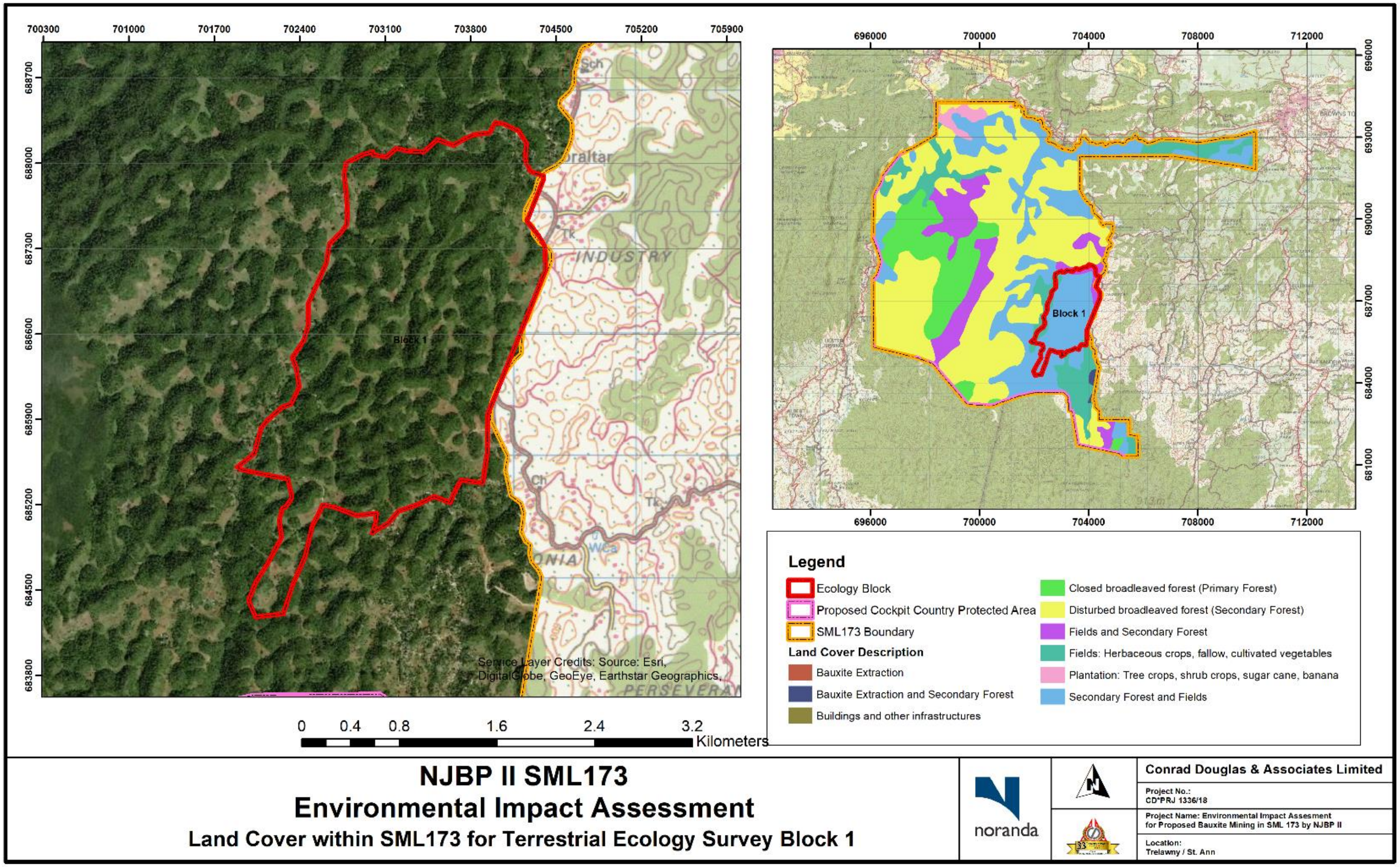


Figure 5-45: Terrestrial Ecology Study Area Block No. 1 within SML 173

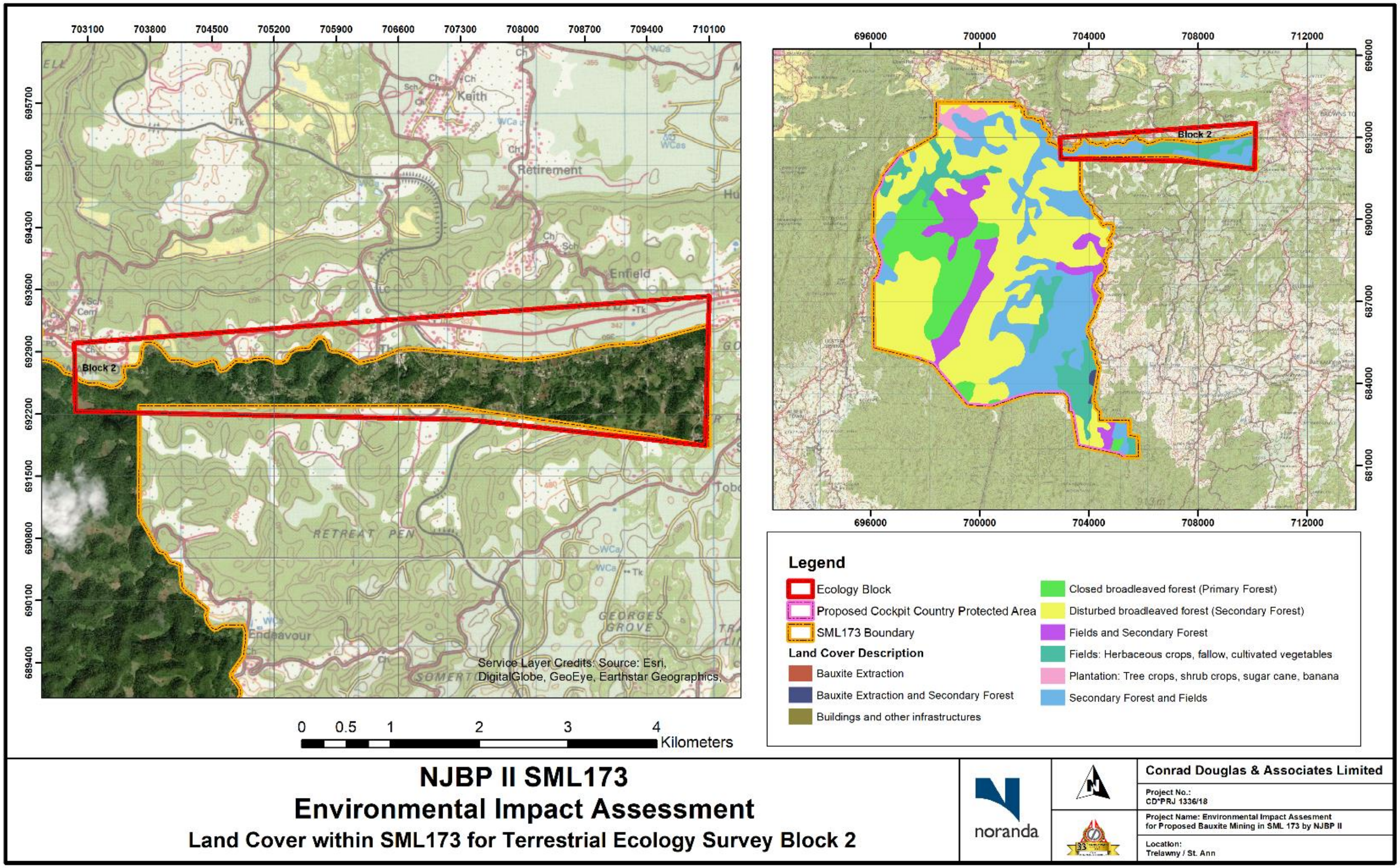


Figure 5-46: Terrestrial Ecology Study Area Block No. 2 within SML 173

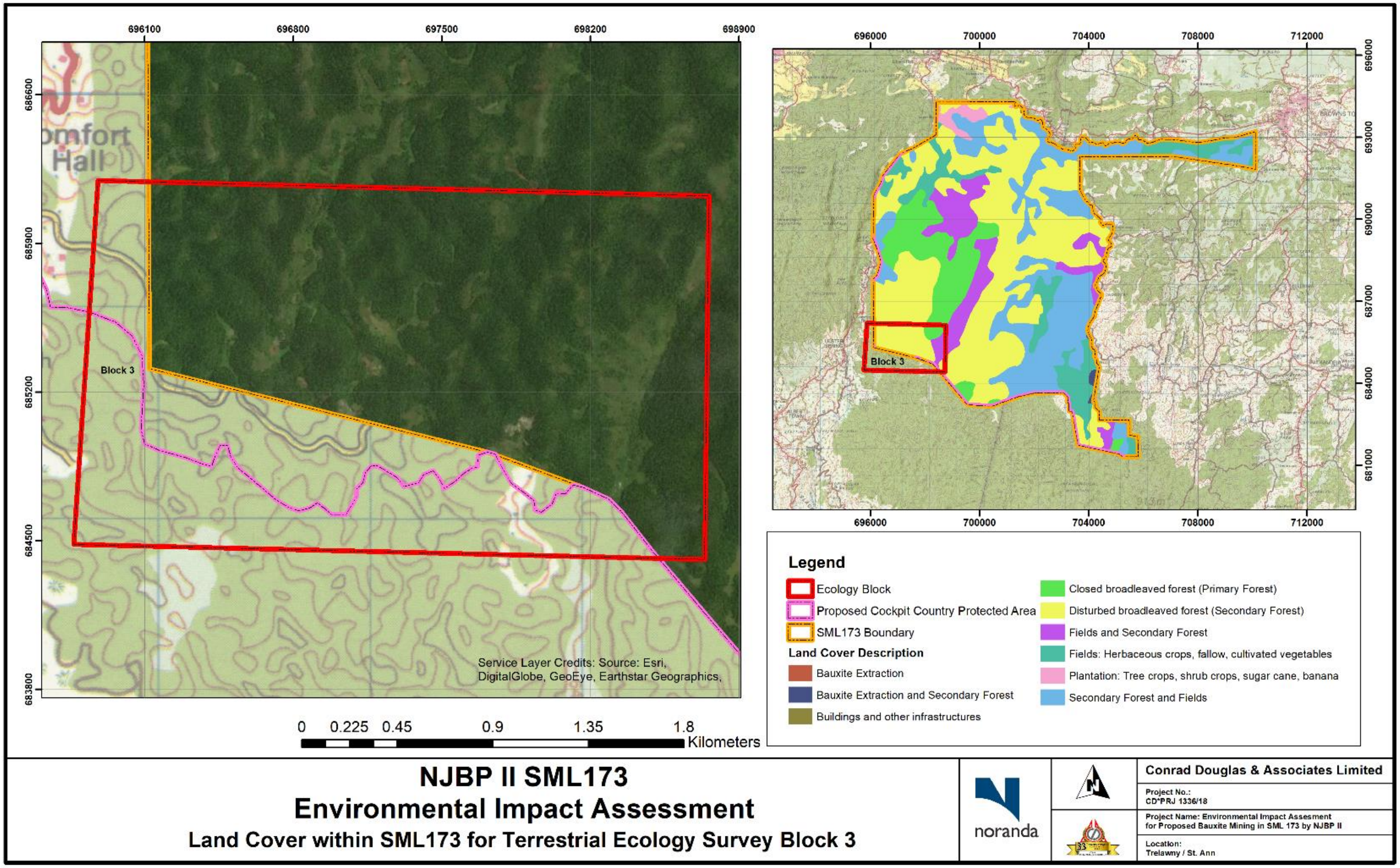


Figure 5-47: Terrestrial Ecology Study Area Block No. 3 within SML 173

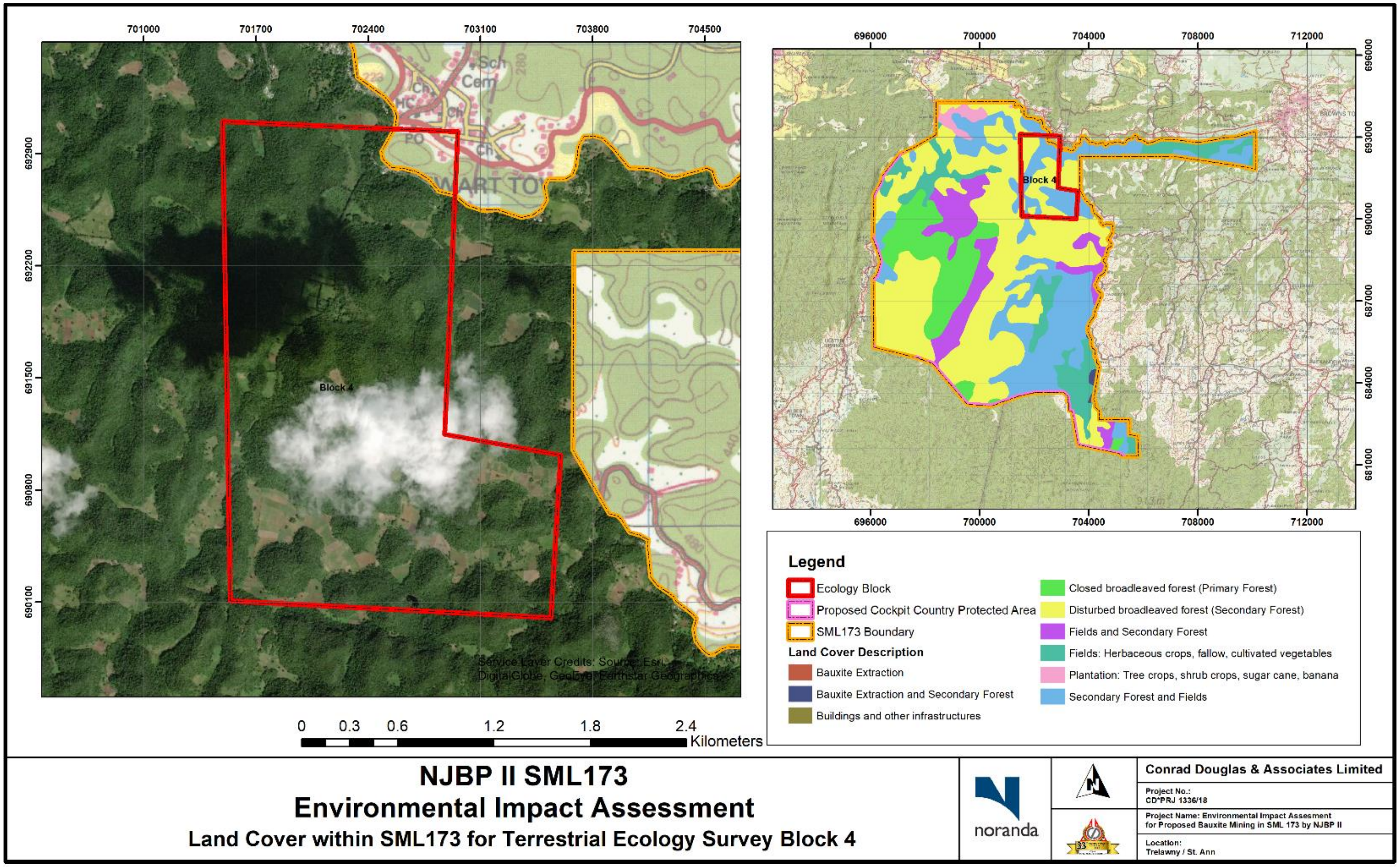


Figure 5-48: Terrestrial Ecology Study Area Block No. 4 within SML 173

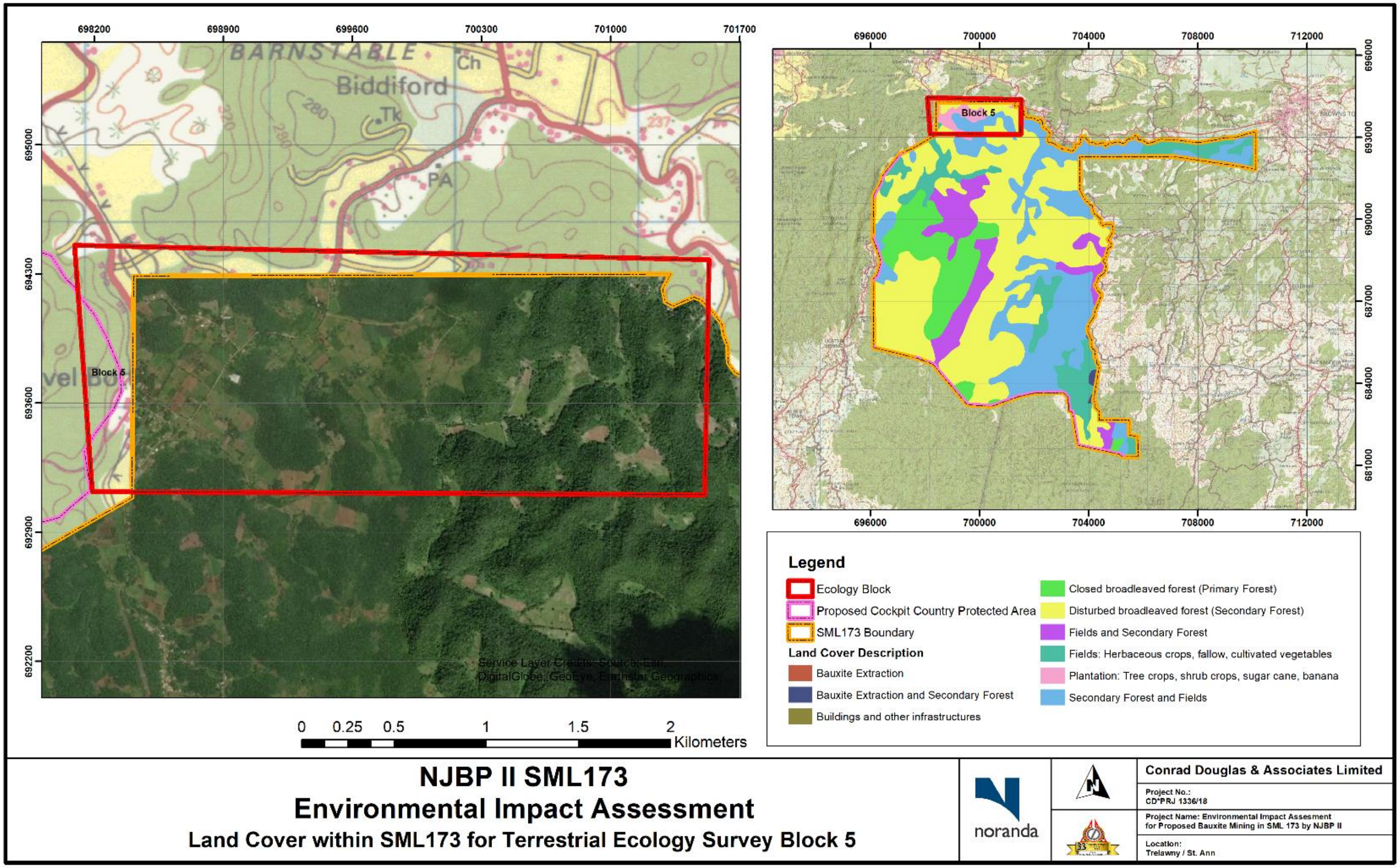


Figure 5-49: Terrestrial Ecology Study Area Block No. 5 within SML 173

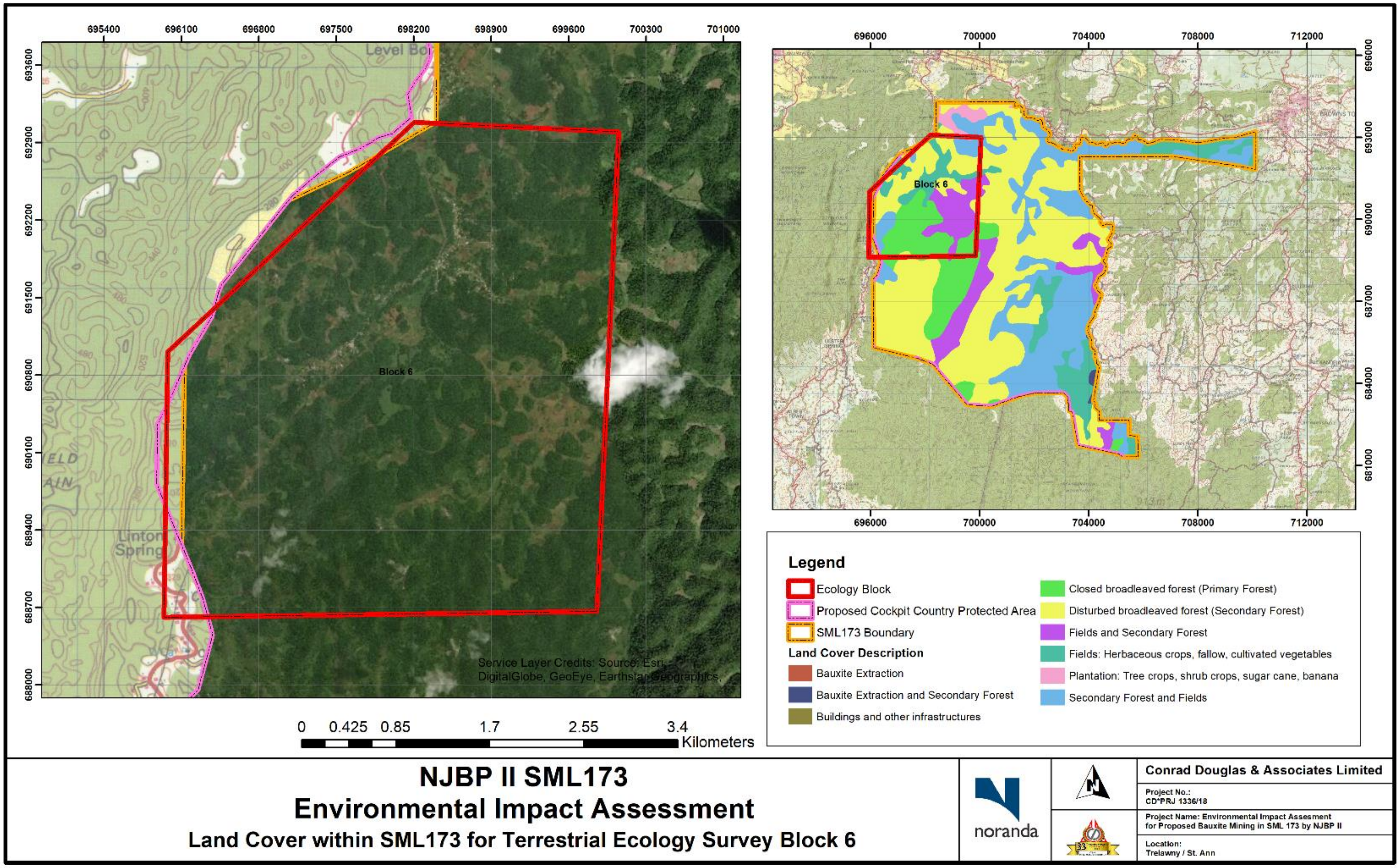


Figure 5-50: Terrestrial Ecology Study Area Block No. 6 within SML 173

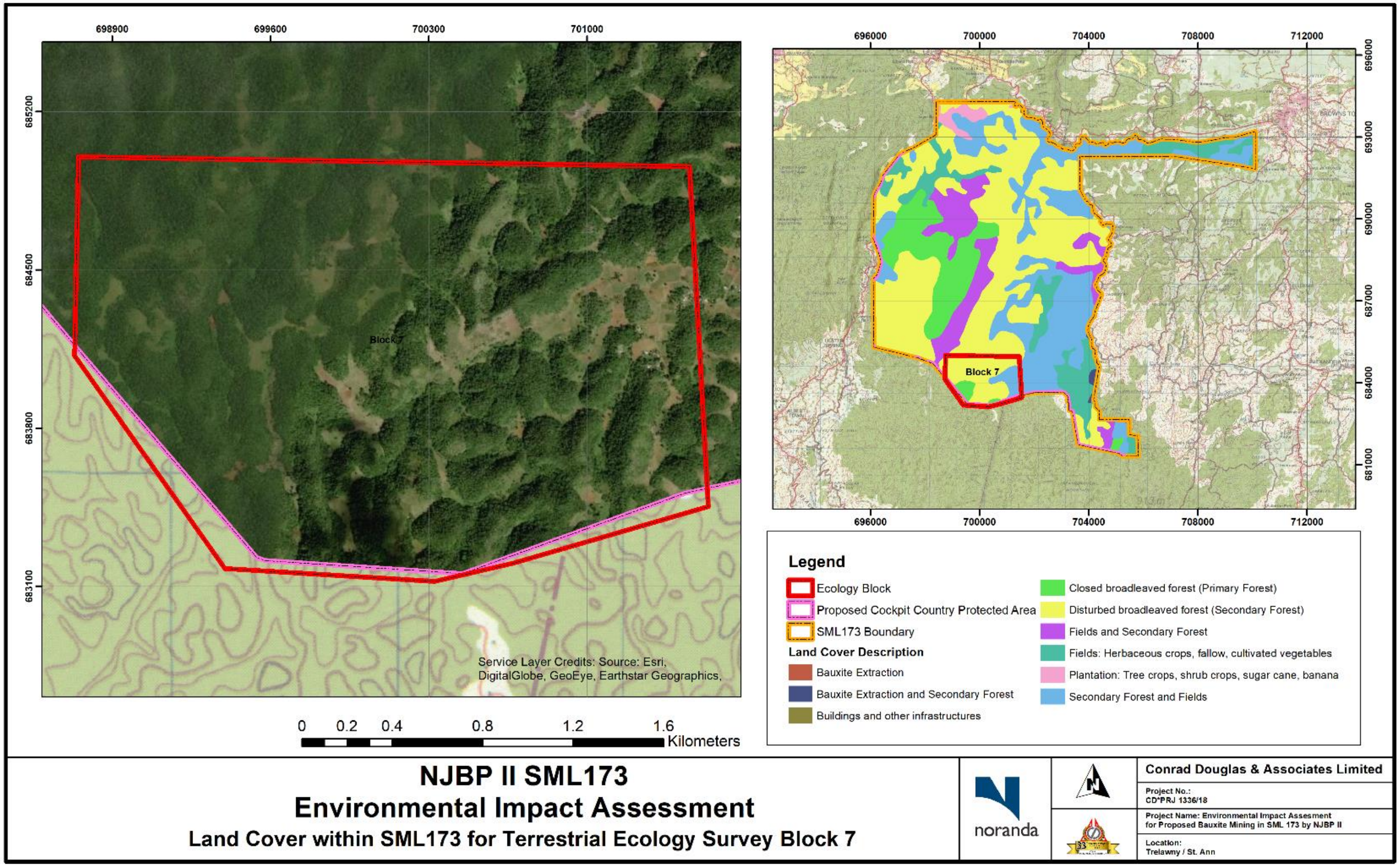


Figure 5-51: Terrestrial Ecology Study Area Block No. 7 within SML 173

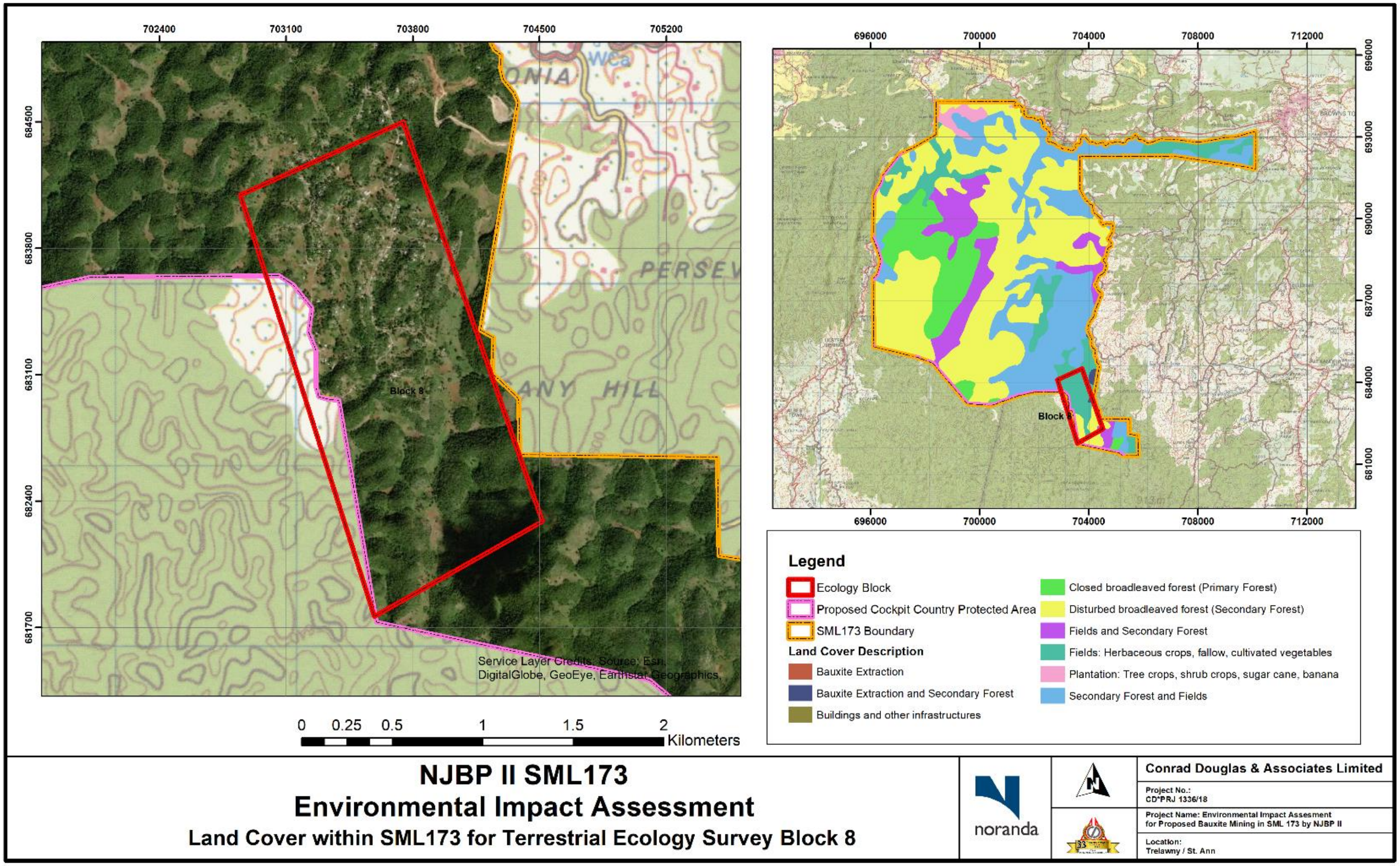


Figure 5-52: Terrestrial Ecology Study Area Block No. 8 within SML 173

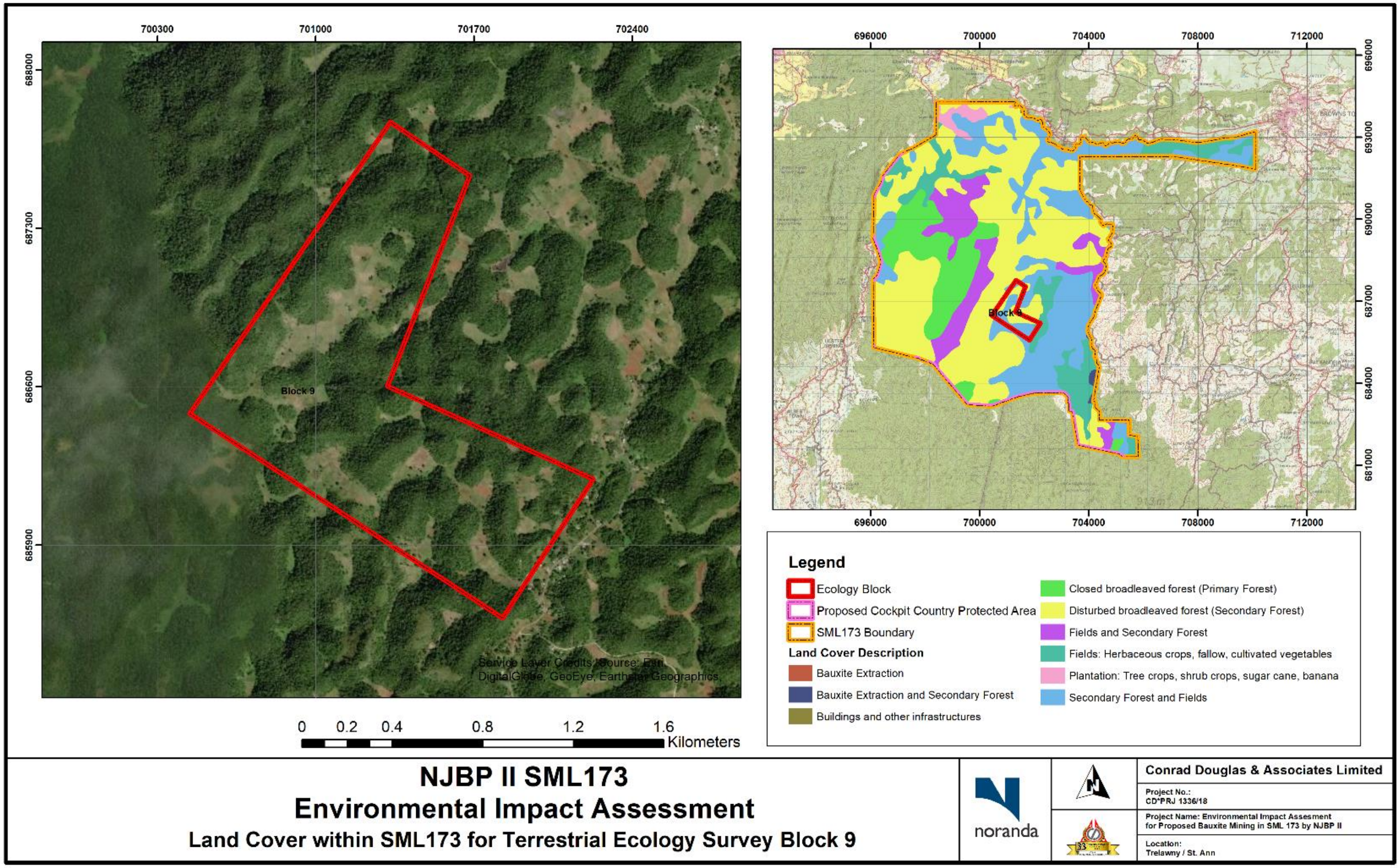


Figure 5-53: Terrestrial Ecology Study Area Block No. 9 within SML 173

Two distinct floral and faunal assessment phases were employed at SML 173:

<u>Phase 1:</u> The first phase involved the use of photogrammetric techniques and ground truthing methods to develop a baseline coverage of SML 173. Block 1 (Figure 5-45 above) was assessed over the periods February 23 and 26, 2018. The wider SML 173 area (Figure 5-46 to Figure 5-53 above) was assessed over the period September 20-22, 2018. Based on the density of the existing settlement in Block 2 (Jackson Town), it was determined that it would be uneconomical to mine and would result in a significant disruption to the community. As such, detailed assessments were not completed in this block.

<u>Phase 2:</u> The second phase involved the collection of detailed floral and fauna data along transects deployed on hillocks within SML 173, along with supplemental data for both flora and fauna collected along traverses between transect locations. This phase was conducted over the period of August 17-19, August 24-26, 2019 and September 14 – 16, 2019.

The methods described in the following sections were employed for the environmental assessments (floral and faunal).

5.3.2.1. <u>Floral Assessments –Ground Truthing Phase 1</u>

Two methods for capturing data for this component of the project was used. These methods area described below.

5.3.2.1.1. Photo-quadrats (Plotless)

Photo-quadrat data capture methods [19] [20]were employed within each of the blocks identified to facilitate the general identification of the main floral elements present within each block. Both vertical and horizontal image-capture orientations were used. Vertical orientations

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[19] https://1drv.ms/b/s!AupqDLbPAbhhsgo_MrvitJOfa4bv?e=ehuqgh

[20] The Nature Conservancy, *Field Methods for Vegetation Mapping, USGS/NPS Vegetation Mapping Program*, December 1994

were used for grass or low shrub areas and horizontal orientations being used for taller forest vegetation (see Figure 5-54 to Figure 5-57 below). In both orientations, the camera used to capture imagery was perpendicular to the floral grouping being captured,[21].

The referenced document by Mathews, NA, 2008 establishes the manner in which close range, vertically oriented images can be used for the collection of data photogrammetrically. The document uses geological and topographical features for illustration. However, the principles of photogrammetry allows for the interpretation of data and the determination of measurements of any feature from 2D and 3D imagery, as outlined in the Abstract of the paper.

The photo interpretation principles were adapted for the interpretation of and characterization of plant assemblages at the "close-in" as defined by the paper. Small scale imagery obtained from Google earth, are used to facilitate distinctions between hillock forest and depression natural/cultivated vegetation assemblages. Close-in (large scale) image analysis served to support and elaborate on interpretations made from small scale images by showing that there was an area of transition between depression and hillock vegetation.

In using this method, the objective was to obtain information in a timely manner on the ecology of the general area of SML 173 in order to develop a detailed study protocol for Phase 2 of the assessment process. This initial analysis was based on the premise that most of the biodiversity exists within the hillocks and these would not be impacted significantly by the bauxite mining within the lowland areas between hillocks.

A standard horizontal distance of three (3) meters was used for horizontal photoquadrat capture while a camera height of 1.7 meters was used for vertically oriented quadrat capture. Area coverage was calculated beforehand using a PIX4D[22] Ground Sampling Distance calculator, designed for drone-based aerial mapping.

[21] Mathews, N.A 2008. *Aerial and Close-Range Photogrammetric Technology Technical Note 428*. US Department of the Interior Denver, Colorado 42pp

[22] https://pix4d.com

Photo-quadrats varied in size, however, the standard shape was typically that of a rectangle.

Quadrat sizes varied in accordance with the vegetation type being studied. Table 5-8 below suggested sizes appropriate for various floral lifeforms. These suggested quadrat dimensions were used in the course of the survey.

Table 5-8: Suggested Quadrat Sizes for Different Floral Lifeforms[23]

Lifeform	Quadrat Area (m^2)
Mosses	0.01-0.1
Low Herbs	1-2
Tall Herbs/Low Shrubs	4
Tall Shrubs	16
Trees	100

Quadrat Images were captured with the use of a GoPro Hero 3 plus camera mounted on a telescoping monopod for both horizontally oriented and vertically oriented quadrat capture. Species identification pictures were obtained with the use of a Sony DSC-V3 camera.

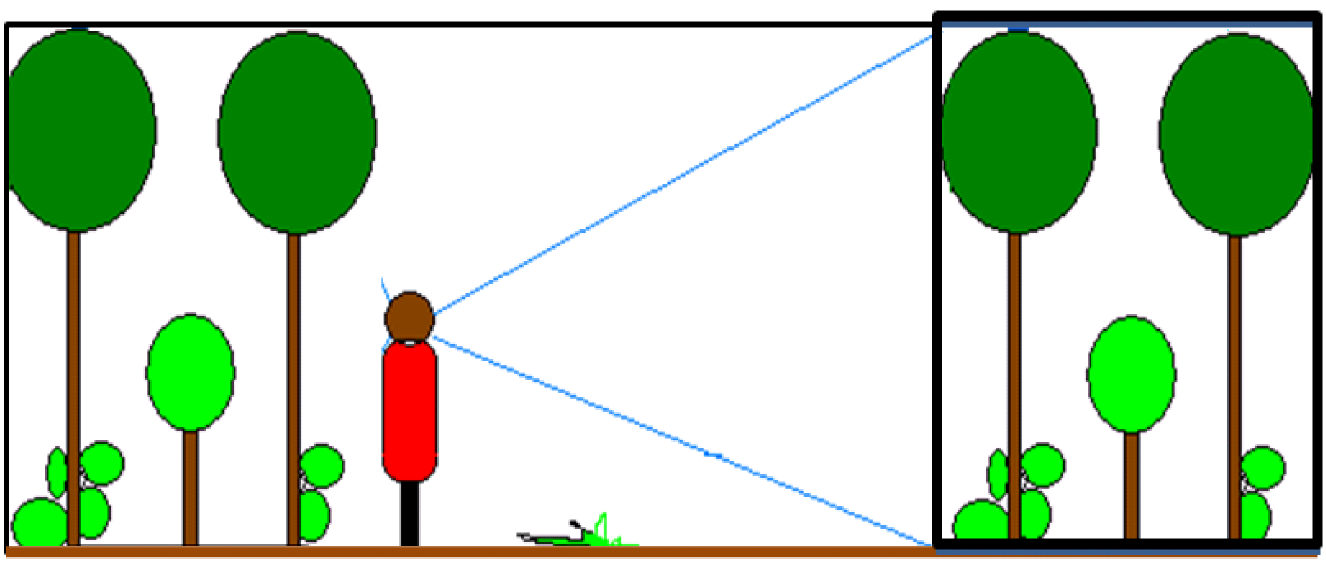

Figure 5-54: Schematic View of the Surveyed Areas Observed/Photographed Horizontally Along the Transects

[23] Cain, S.A and G.M De O Castro 1959. *Manual of Vegetation Analysis*. Harper, NY pp 325

Figure 5-55: Example of Horizontally Oriented Photo-quadrat Taken of Tree Subject at Study Site.

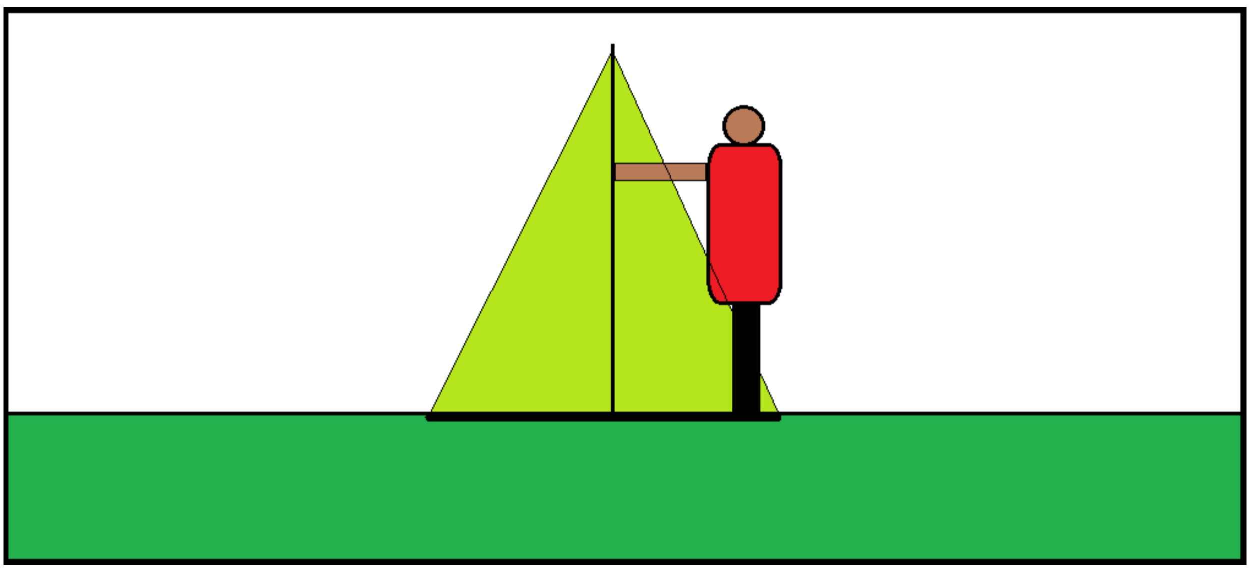

Figure 5-56: Schematic View of the Surveyed Areas Observed/Photographed Vertically Along the Transects

Figure 5-57: Example of Vertically Oriented Photo-quadrat Taken of Grass Subject at Study Site

The ground truthing information obtained was then used to assist in the creation of characterization maps of the respective study blocks (defined on Figure 5-44 above).

5.3.2.1.2. Detailed Characterization Methods (Plot-based) – Flora - Depressions and Hillock Areas

The transect methodology was utilized to obtain more detailed data on the biota of both the hillocks and the lowlands.

The main aim of the study was to:

1. Investigate the variations in diversities progressing from lowland up into the hillocks;
2. Investigate the variations in diversities between adjoining hillocks;
3. Investigate the variations in diversities between distant hillocks along a north-south and an east-west plane.
4. Investigate the overall biodiversity of SML 173

The transect method was used to conduct a comprehensive examination of the transition zone between the vegetation characteristics of the low-lying areas (bauxite bearing depressions) and the elevated biodiversity rich area (hillock). Accessible hillocks were determined from aerial images within each of the Blocks defined in Figure 5-44 above. The hillock selected for transect analysis depended on:

5. The ability to access the beginning of the survey site, and
6. The ability to access a route up the slope of the study area without creating significant disturbance to the hillock vegetation.

A 30m long transect line was deployed in the transition zone between lowland and hillock up the slope of the hillocks. In a number of cases the transect was limited to the contact with a significant geological feature on the hillock. This feature was a vertical cliff face of a height exceeding 3m in some cases (see Figure 5-58 below). This structure prevented further incursion up the hillock slope.

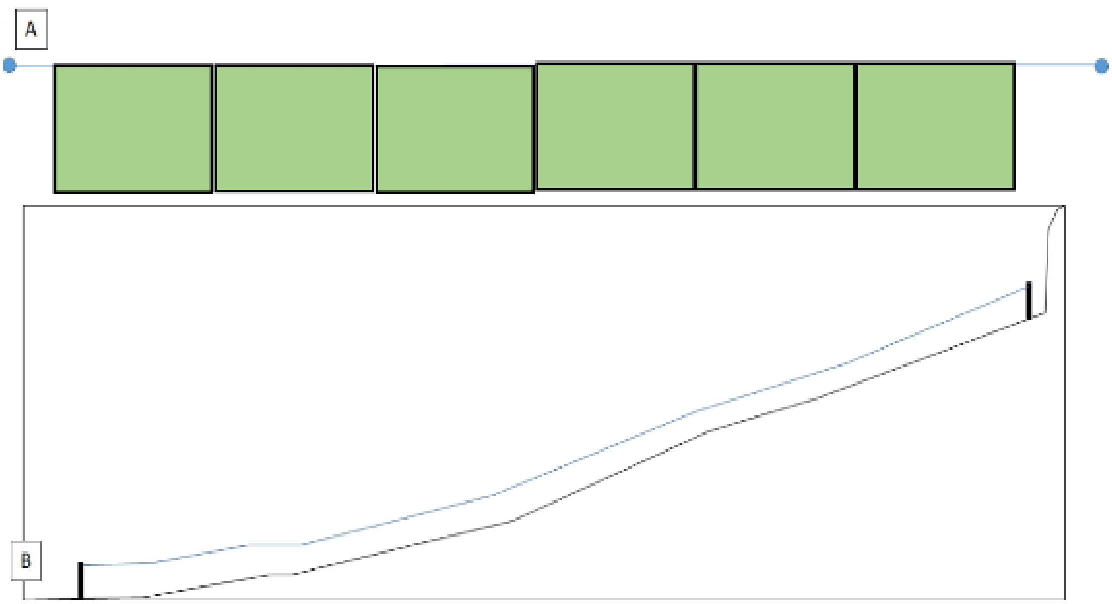

Figure 5-58: Thirty-meter-long transect line orientation at study sites showing | A: elevation orientation of 5m x 5m study quadrats and | B: Orientation up slope

Figure 5-61 to Figure 5-67 below show the locations of the transects conducted for the study. The latitude and longitude positions of each of the study transect start points is presented in Table 5-9 below. The location markers show the transect start points while SML 173 is outlined in white. Two un-numbered waypoints represent locations at which characterizations were attempted but interrupted by thunderstorms.

The start of an actual transect established is shown in Figure 5-59 below. This image was taken at waypoint 636 (18.331679°, -77.435213°). The transect extends from the lowland grass covered area into the forested hillock.

Table 5-9: List of latitude and longitude positions for study transect start points

Waypoint	Study Block	Latitude	Longitude
WPT 636	1	18.331679°	-77.435213°
WPT 658	1	18.309398°	-77.452508°
WPT 665	1	18.334251°	-77.451010°
WPT 674	4	18.364686°	-77.445231°
WPT 684	3	18.314697°	-77.509693°
WPT 687	7	18.310495°	-77.463553°
WPT 036	8	18.297346°	-77.445489°
WPT 696	9	18. 326644°	-77.454051°

Figure 5-59: Anchor point for flora transect (A) at location 665 on Figure 5-63 below

Each transect was divided into six 5m x 5m quadrats. For each quadrat the species of flora were identified, enumerated and recorded. Samples of flora species that were not able to be identified in the field were collected and taken to the University of the West Indies Herbarium for identification.

Figure 5-60: Locations of Transects Distributed Over SML 173 Overlaid onto a Google Earth Image of the Location (unnumbered flag marks = intended transects that were aborted due to rain)

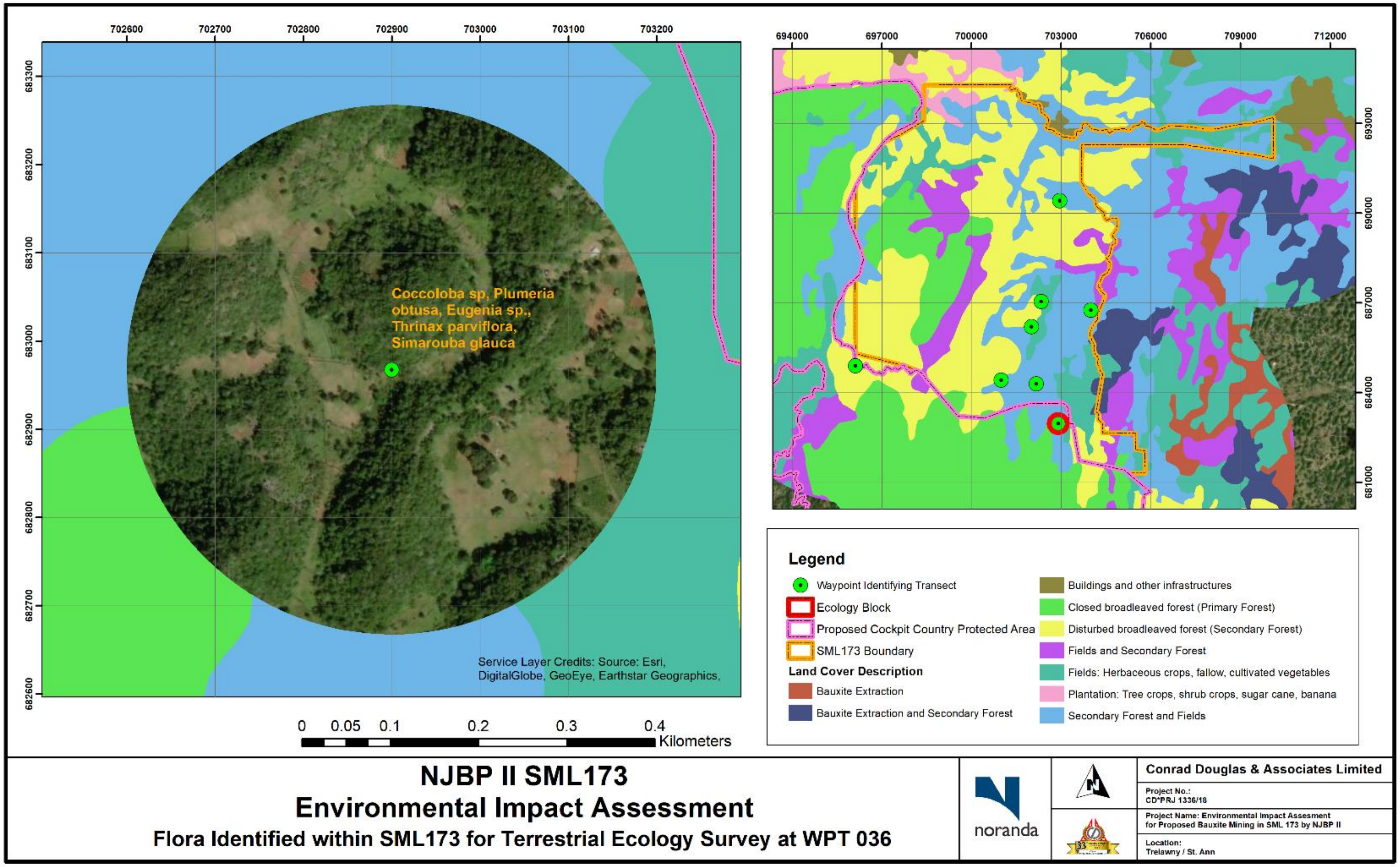

Figure 5-61: Locations of the transects conducted within the SML 173 area – WPT 036

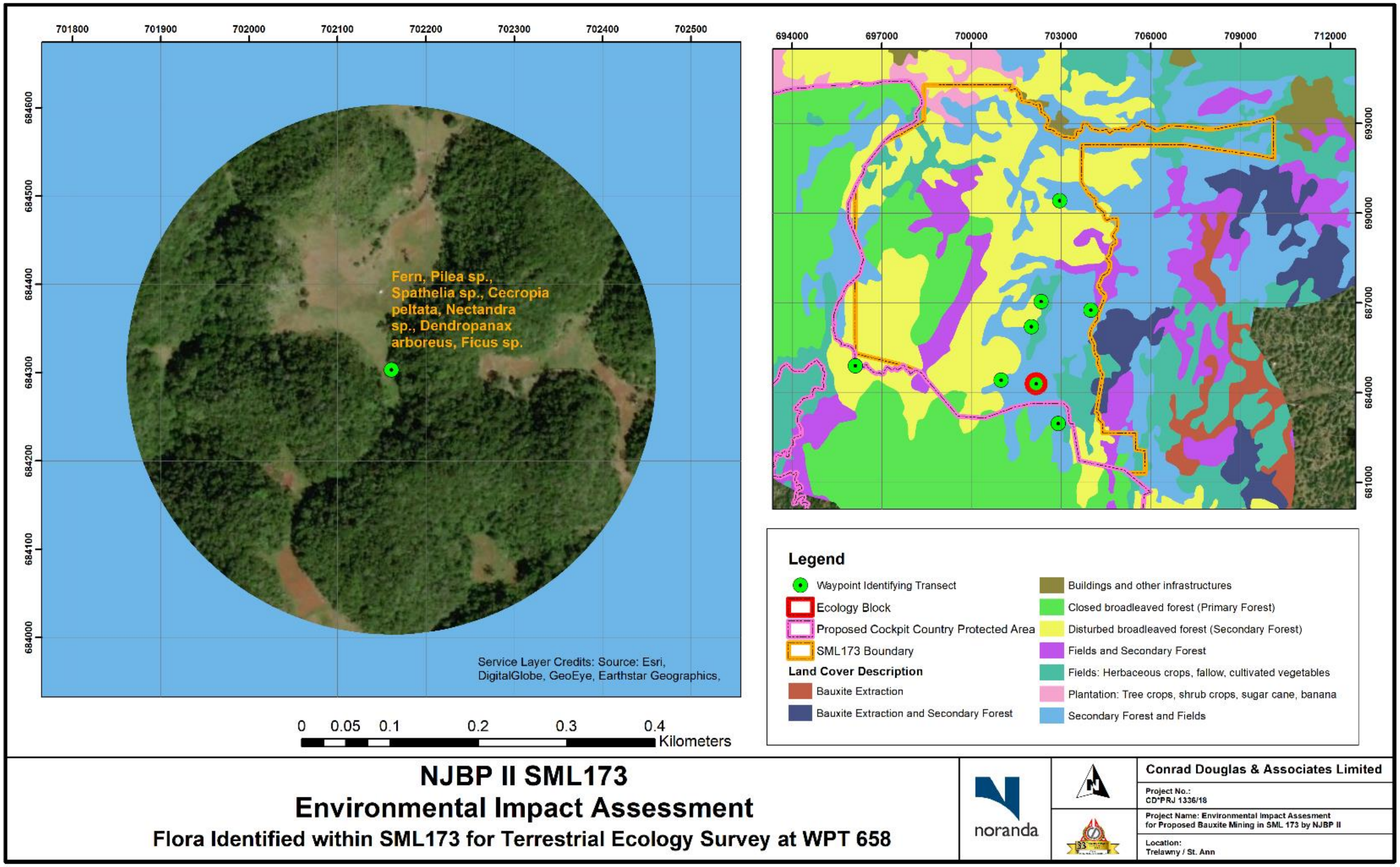

Figure 5-62: Locations of the transects conducted within the SML 173 area – WPT 658

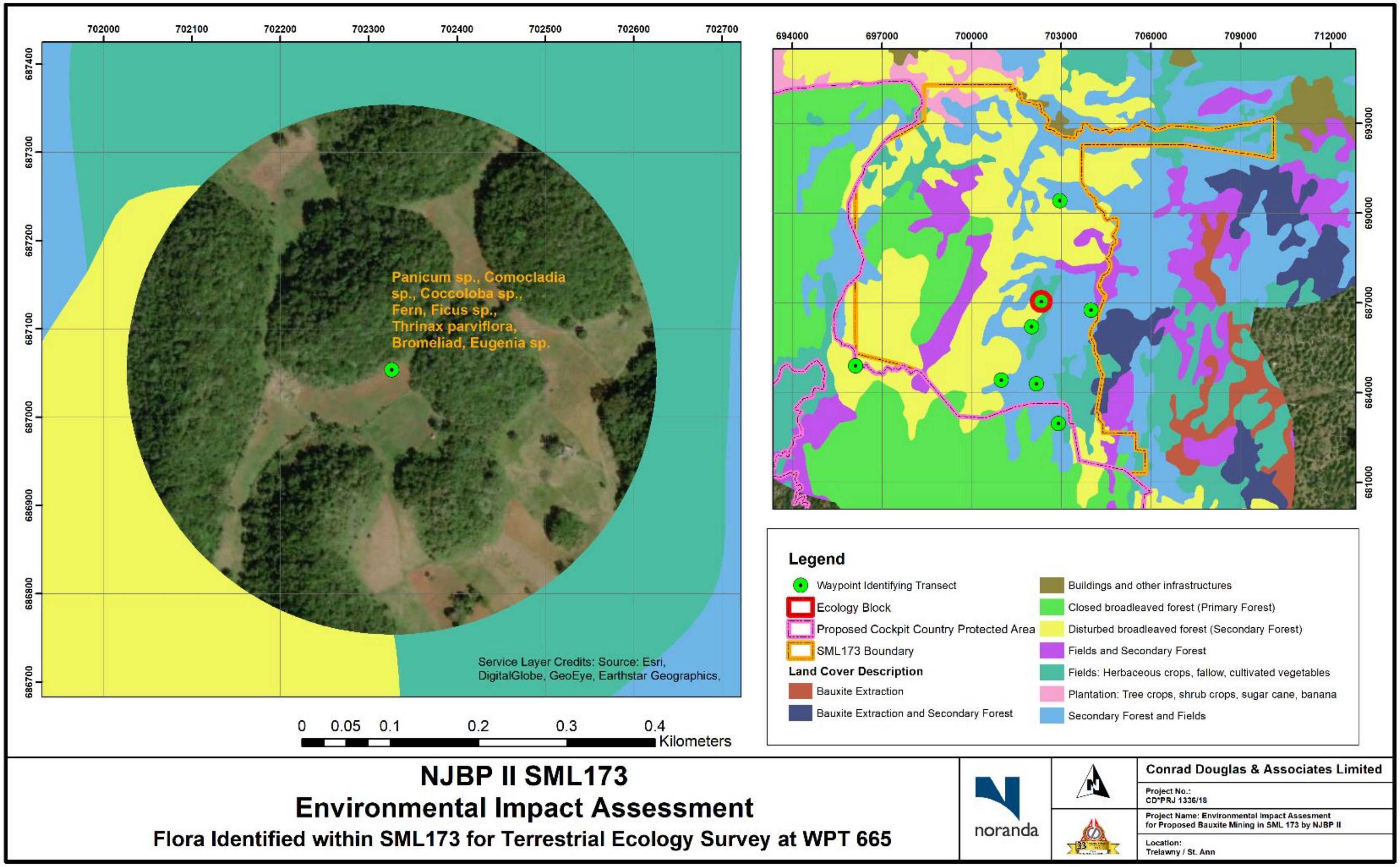

Figure 5-63: Locations of the transects conducted within the SML 173 area – WPT 665

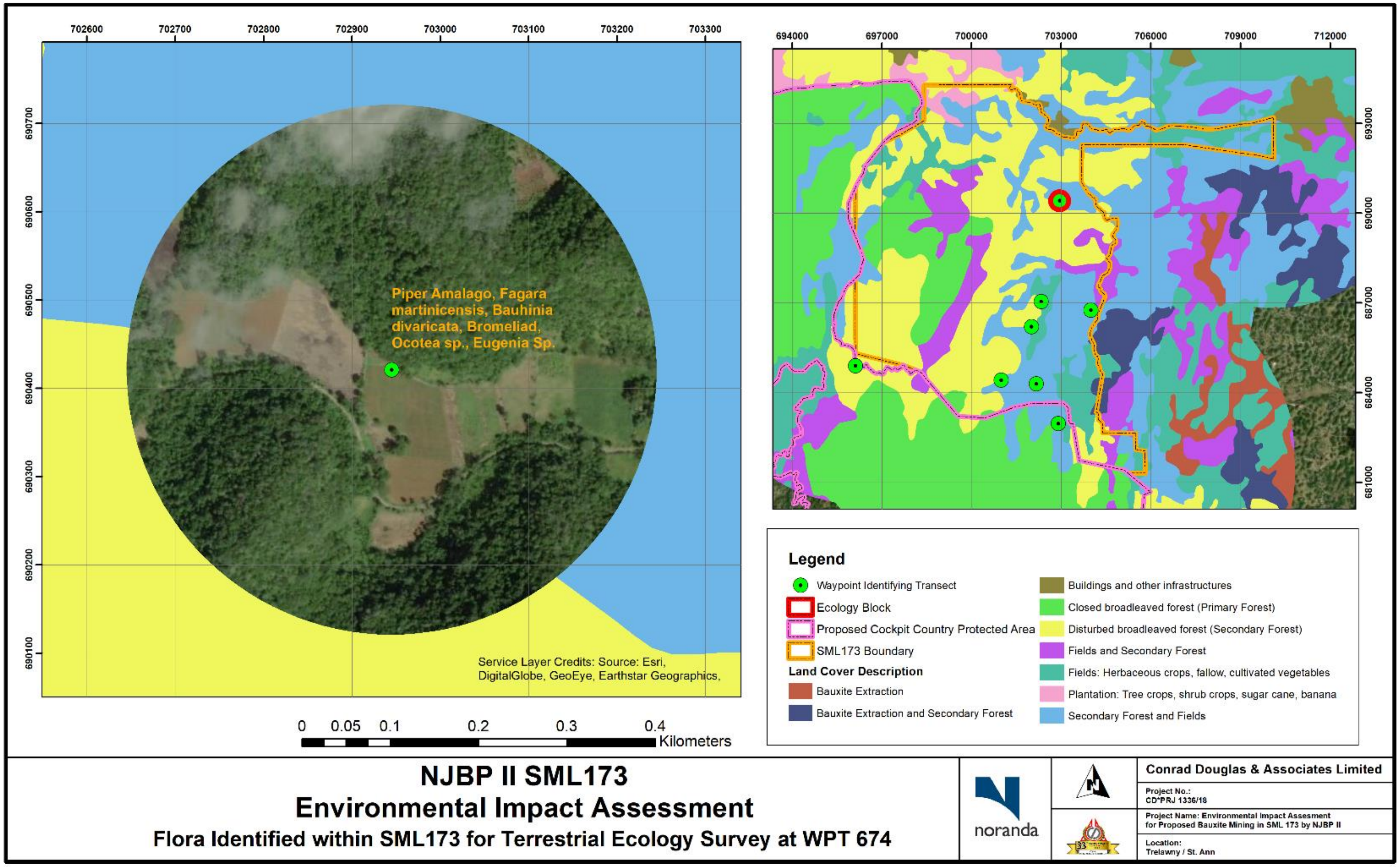

Figure 5-64: Locations of the transects conducted within the SML 173 area – WPT 674

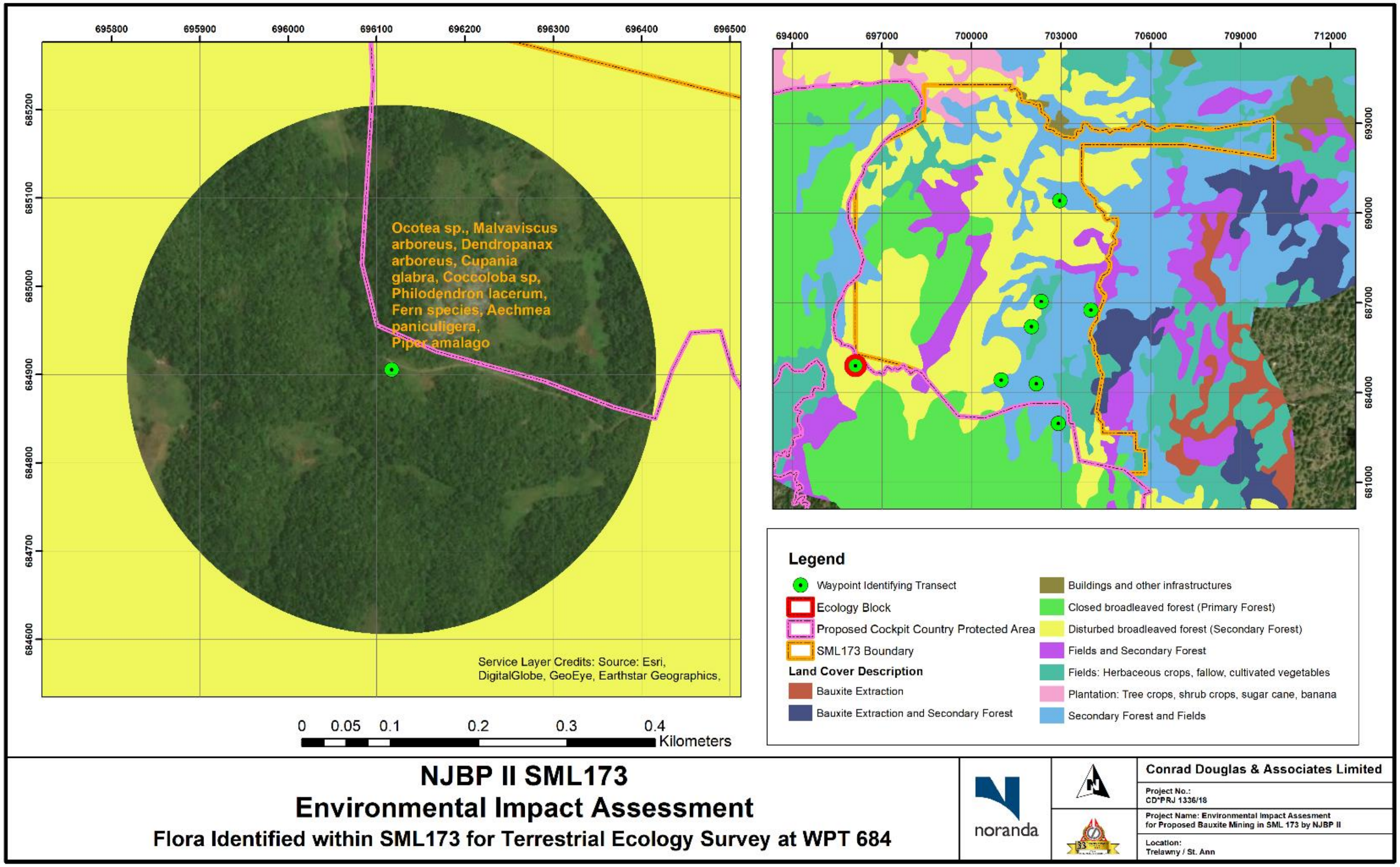

Figure 5-65: Locations of the transects conducted within the SML 173 area – WPT 684

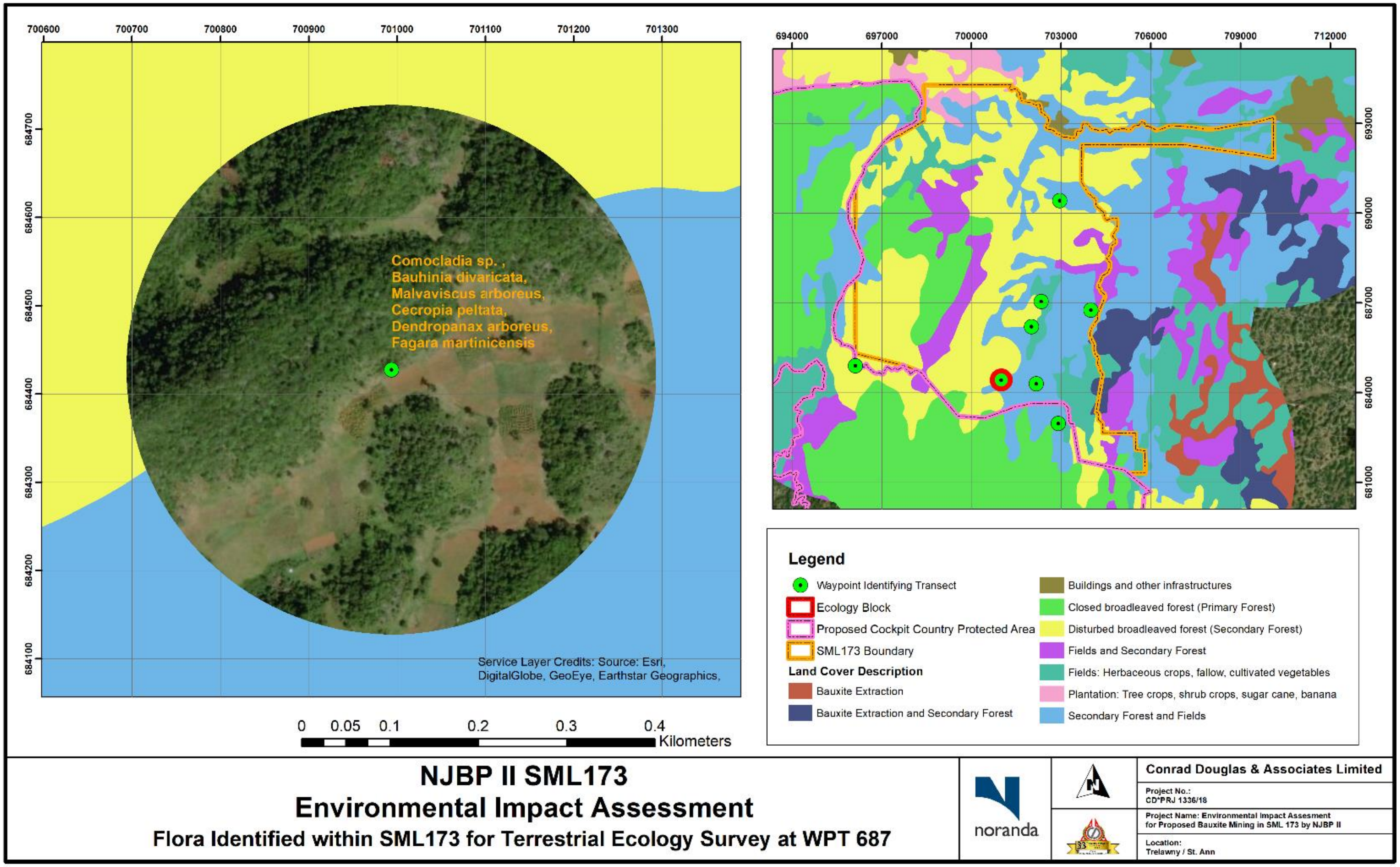

Figure 5-66: Locations of the transects conducted within the SML 173 area – WPT 687

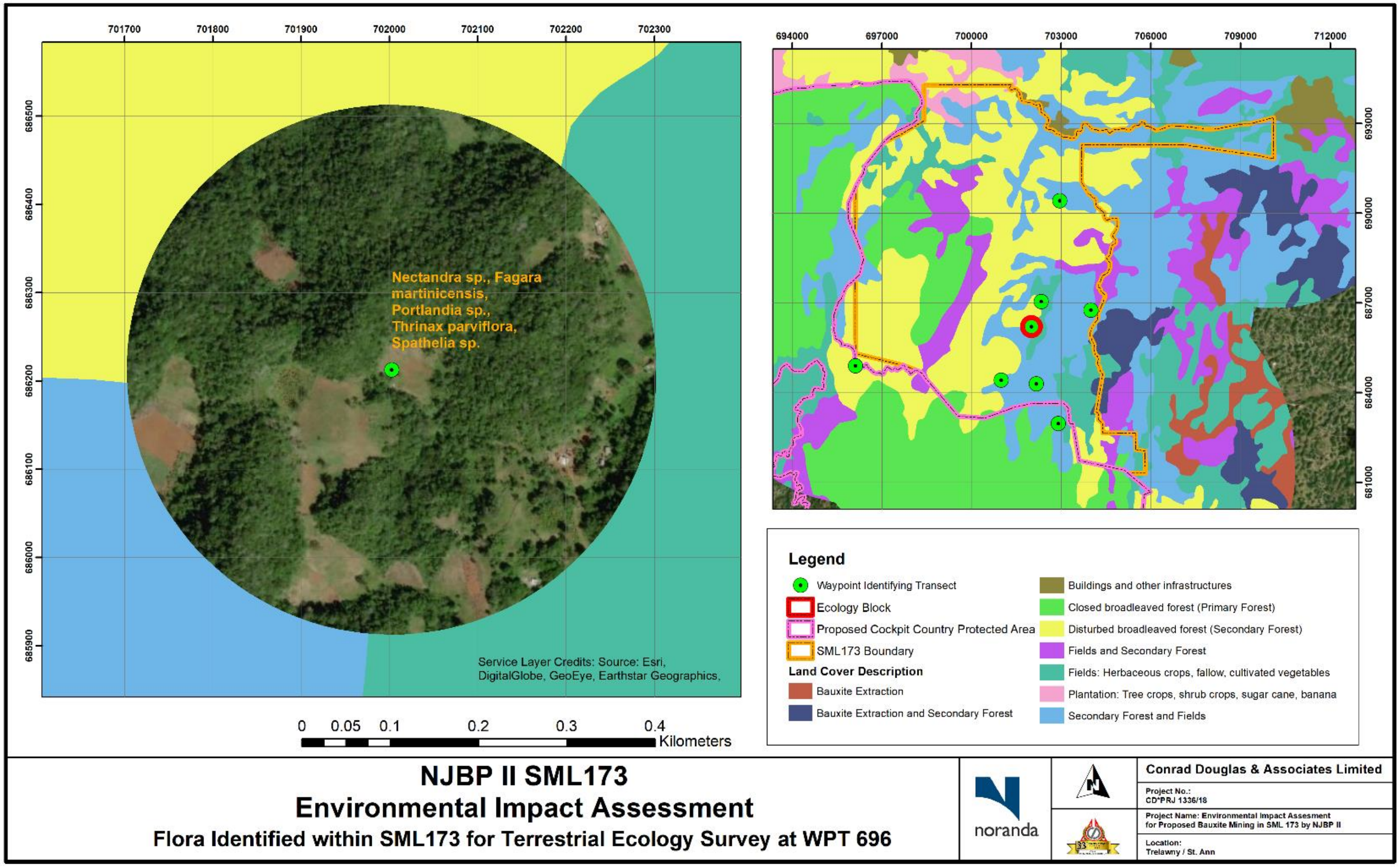

Figure 5-67: Locations of the transects conducted within the SML 173 area – WPT 696

5.3.2.2. Fauna Assessments:

Emphasis was placed on the detection and listing of the following types of fauna, which were likely to be found within the study area:

1. Avi-fauna (birds)
2. Herpetofauna (lizards) and amphibians (frogs)
3. Arthropods (insects, spiders and other segmented invertebrates)
4. Gastropods (snails)
5. Mammals (domestic and wild, inclusive of bats)

5.3.2.2.1. Avi-Fauna

Avi-fauna surveys were conducted over daytime (diurnal) (0600-1000hrs) and night-time (nocturnal) (1745-2359hrs), in order to prepare a list of fauna that might be active during those periods of the day. The walking traverses, photoquadrat stations and transect survey areas used for the floral surveys served as a baseline for the examination of faunal types within the study area.

Visual observations were also made along the traverses and at the photoquadrat stations, particularly around the periphery of observed forested areas.

Audio recordings of bird calls were also made along the traverses. The positions of the recording locations were primarily influenced by whether birds were either seen or heard.

Day and night bird visual-audio survey locations for SML 173 study area are shown in Figure 5-68.

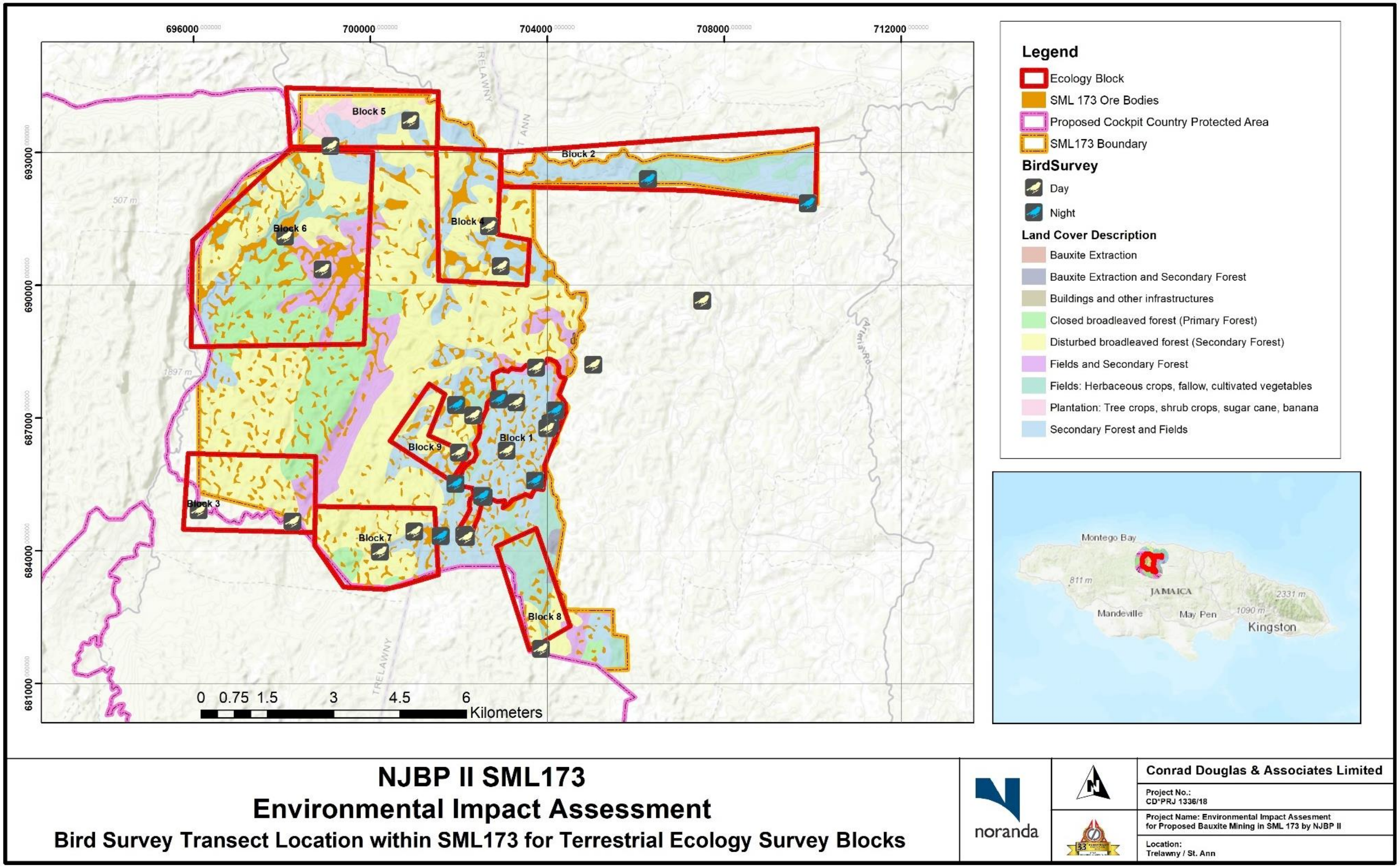

Figure 5-68: Bird survey locations within SML 173 area

For areas within SML 173 where floral assessment transects were established (see Figure 5-68 above), a more detailed assessment of bird populations was established using both point count and traverse wander mapping methods, with survey characteristics being defined below:

5.3.2.2.1.1. Point Counts

- **Timing**: The first count of each day was initiated before 1000 hours, as bird activity decreases after this time.
- **Weather**: Surveys were conducted under satisfactory weather conditions with good visibility, little or no precipitation, and light winds.
- **Human Disturbances:** Should the points be within close proximity to human settlements, the observer waited until there was no noise from that source before conducting the survey.
- **Survey Point Locations:** At least one-point count was conducted per survey location, whether it was an identified ore body or an agricultural/pasture lowland. Additional points were included if the subsequent point was 300m or more away from the previous point. This methodology reduces the chances of recording the same individual in multiple counts.
- **Survey Overview:** Each count was conducted for 10 minutes with the count being split into two 5-minute periods separated by a 30 second waiting period. Having multiple periods allowed the estimation of detectability (the probability that an individual bird will be detected if it is present at the survey site) for each species. Data was recorded in pencil Point Count sheets. Relevant information on biotic and abiotic factors was collected, where possible.

5.3.2.2.1.2. Traverse Wander Mapping

- **Routes**: Traverse Wander Mapping was conducted either between or starting at the point count locations.

- **Timing**: Traverse Wander Mapping matched the time period for point count surveys.
- **Weather**: As with the Point Count method, mapping was conducted only under satisfactory weather conditions.
- **Points**: The observer mapped along a traverse of 300m along the perimeter of the ore body or low-lying land area interfaced with adjoining hillocks.
- **Survey Overview:** After the point counts and traverse wander mapping were completed, the observer walked along the perimeter of the ore body or low-lying areas adjoining hillocks noting all birds and their relative positions, avoiding recording the same individual multiple times. The observer aimed to cover no more than 50m in a 6-minute period and, where possible the observer either drew directly onto a printed map of the study area or used a hand drawn map that matches the shape of the area. The observer also noted the presence of anthropogenic disturbances such as shelters and small buildings, as well as farming operations. Additionally, the observer noted breeding behaviour, nests as well as interactions.

An example of a Point Data Sheet and Traverse Survey Map are shown in Figure 5-69 and Figure 5-70 below, respectively.

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						
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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

Figure 5-69: Example of Point Count data sheet

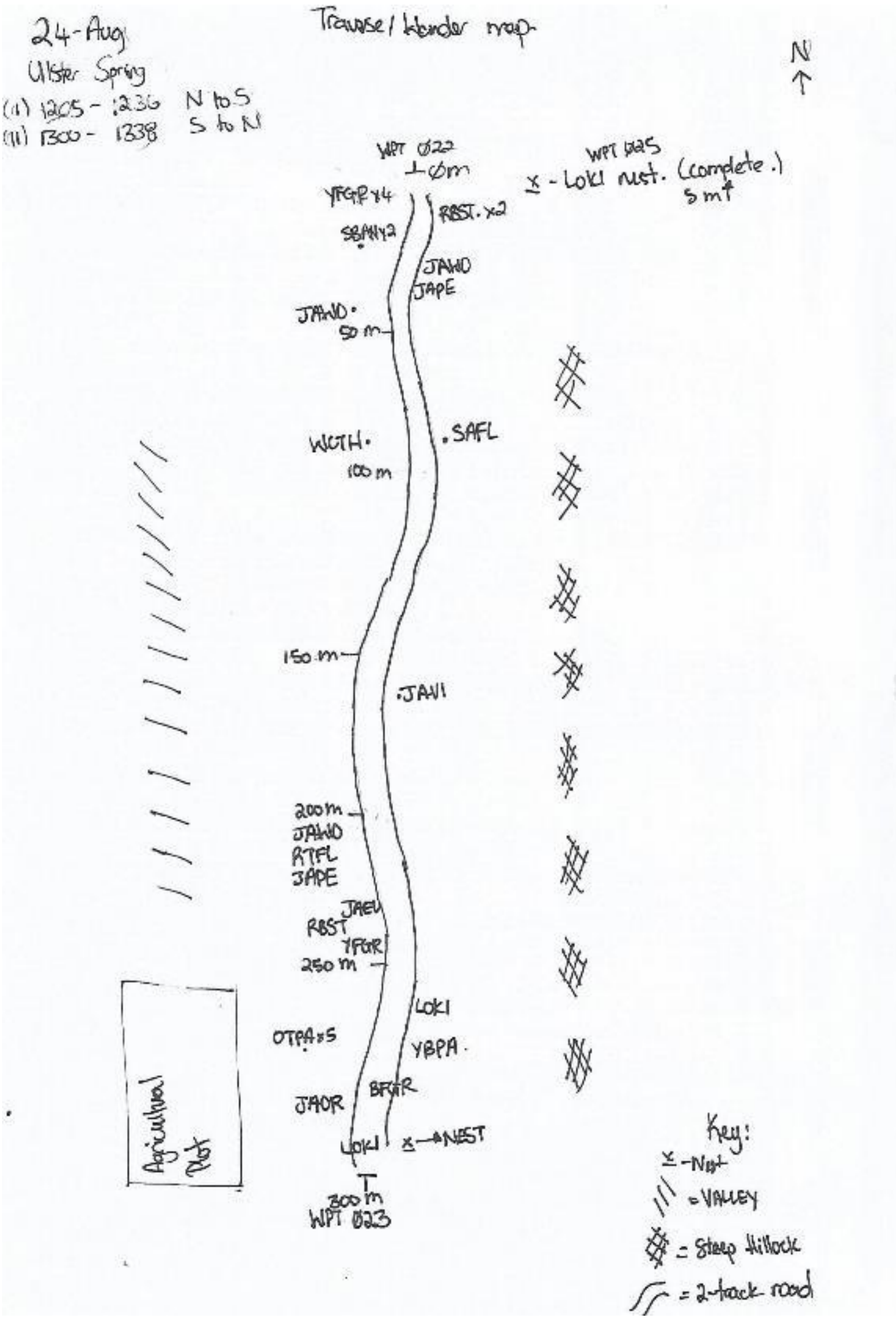

Figure 5-70: Traverse Wander map of Ulster Spring Survey area in Study Block 3

5.3.2.2.2. Herpetofauna

Both plot-based and plotless survey methods were used for the assessment of herpetofauna populations present within SML 173. Plotless methods involved conducting visual and audial methods during both daytime and nighttime traverses, between ore bodies or low-lying areas. Traverses were made between the locations of transect lines deployed for floral assessments, with trees and rock piles encountered along the traverse being examined for signs of herpetofauna.

For plot-based surveys, the 30m transects established at the transition zone between low-lying areas and hillocks for floral assessments were used. A 5x5m^2 quadrat was established on alternating sides of the transect, with a total of 6 quadrats being established, and a total of 150m^2 being covered per transect (see Figure 5-71 below). A period of approximately 90 minutes was spent doing a visual encounter survey for different reptiles and amphibians (Das, 2016[24]). This was divided into 60 minutes traversing the transect area and 30 minutes traversing different areas peripheral to the transect line deployed.

24 Das, Indraneil. 2016. *"Rapid assessment of reptile diversity: A Handbook of Techniques"*. Reptile Ecology and Conservation, pp.241-253

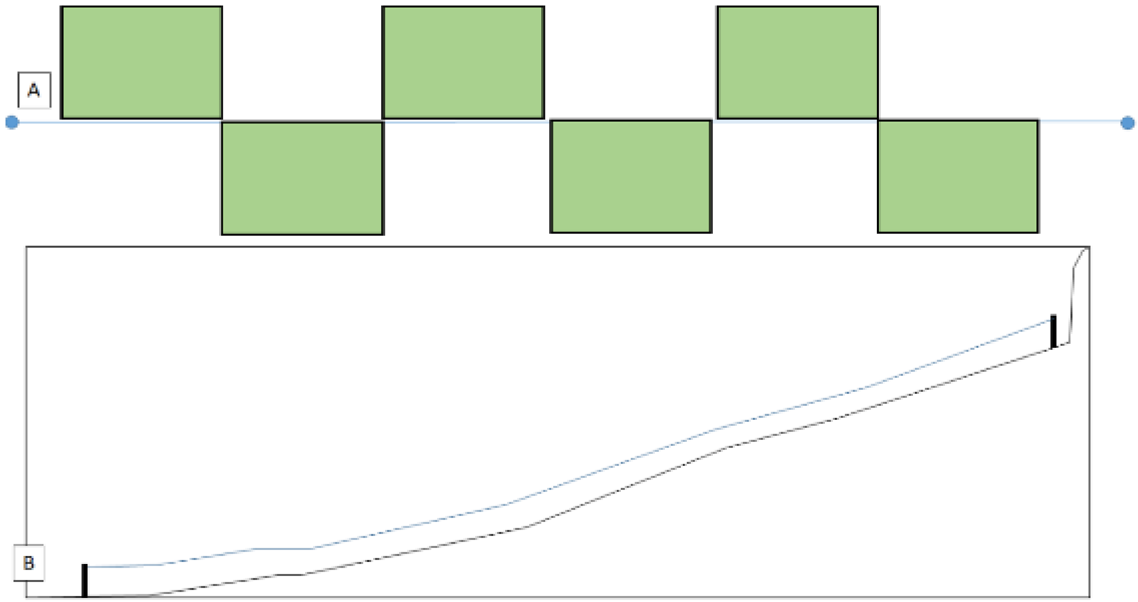

Figure 5-71: Thirty-meter-long transect line orientation at study sites showing a: elevation orientation of 5m x 5m study quadrats and b: orientation up slope

Trees present within the transect were scanned. Loose rocks observed within the quadrat or that was seen on the traverses which could be flipped were turned over and rock crevasses were checked. A stick was used to turn over leaf litter, while bromeliads that could have been accessed were checked. Any reptile or amphibian that was seen within the quadrat was counted, recorded and the GPS location taken. This procedure was repeated at each location.

The reptiles and amphibians that were seen were then identified using information known by the observer with the help of identification reference keys.

During the night observations, surveys of reptiles and amphibians were conducted. Audio detection methods for amphibians and reptiles were used along traverses during nocturnal surveys.

5.3.2.2.3. Arthropods (Insects, Spiders and Other Segmented Invertebrates)[25]

Three methods of assessment were used for the evaluation of arthropods, namely, Plotless, Plot-based and Light Trapping methods.

5.3.2.2.3.1. Plotless Method

For the plotless assessment within each study block, a record was made of the species observed during the traverse from the road to the flora study areas (transects). This method used random lengths of traverses. The time spent along each traverse varied for each location.

5.3.2.2.3.2. Plot-Based Method

The 30 metre flora transect represented the baseline along which arthropod plot-based surveys were conducted. Along each transect, 6 square $25m^2$ quadrats were demarcated, comprising a total of $450m^2$. Each successive quadrat was surveyed while alternating from one side to another in conducting the survey (refer to Figure 5-71 above). Within each 25 m^2 quadrat, the species and the number of individuals of each species were recorded for 15 minutes in the first instance. As with the plotless assessment, no specimens were collected,

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[25] **Survey Methods prepared with reference to:**

Cardoso, Pedro, Nikolaj Scharff, Clara Gaspar, Sergio S. Henriques, Riu Carvalho, Pedro H. Castro, Jesper B. Schmidt, et al. 2008. "Rapid Biodiversity Assessment of Spiders (Araneae) Using Semi-Quantitative Sampling: A Case Study in a Mediterranean Forest." *Insect Conservation and Diversity* 1 (2): 71–84. https://doi.org/10.1111/j.1752-4598.2007.00008.x.

Convention on Biological Diversity. 2019. "What Is Impact Assessment?" http://www.cbd.int/impact/whatis.shtml.

Liana, Ana. 1996. "The Type Material of Pseudophyllidae (Orthoptera) in the Museum and Institute of Zoology PAS, Warsaw." *Sciences-New York*, no. 1: 91–99.

Maldonado-Capriles, J. 1960. "Assassin Bugs of the Genus Ghilianella in the Americas." *Proceedings of the United States National Museum* 112 (2): 36. https://doi.org/10.4039/Ent3436-2.

Monaghan County Council. 2010. "Biodiversity and Habitats." https://tidytownsnetworkmonaghan.files.wordpress.com/2013/01/biodiversity-notes-session-1.pdf.

Ojija, Fredrick, Eliaman Sapeck, and Thomas Mnyalape. 2016. "Diversity Analysis of Insect Fauna in Grassland and Woodland Community at Available Online Www.Jsaer.Com Journal of Scientific and Engineering Research , 2016 , 3 (4): 187-197 Diversity Analysis of Insect Fauna in Grassland and Woodland Community at Mbe," no. September.

Oliver, Ian, and Andrew J. Beattie. 1993. "A Possible Method for the Rapid Assessment of Biodiversity." *Conservation Biology* 7 (3): 562–68. https://doi.org/10.1046/j.1523-1739.1993.07030562.x.

Windsor Research Center. 2016. "Welcome to the Cockpit Country." 2016. https://www.cockpitcountry.com/index.html.

but were classified to the level of family, where possible, with significantly different representatives denoted as different species. Social and swarming insects, such as ants (Formicidae), termites (Nasutitermitidae), bees (*Apis mellifera*) and mosquitoes (Culicidae) were too numerous to be counted but were collectively recorded as a species identified.

The first period of assessment, denoted as the alpha period ranged from August 17, 2019 to August 19, 2019. This period was the preliminary assessment phase to establish and test the basis of a rapid assessment method for the arthropod fauna present within SML 173. A total of six (6) locations were systematically selected for arthropod assessment in the alpha period as identified below:

Table 5-10: Arthropod Study Data for Alpha Period

Block Number	Date	Activity	Waypoint	Latitude	Longitude	Data Type	Transect
1	August 17, 2019	Diurnal	636	18.331679°	-77.435213°	Plotless	N/A
1	August 17, 2019	Nocturnal	649	18.335296°	-77.433474°	Plotless	N/A
3	August 17, 2019	Nocturnal	650	18.357814°	-77.402075°	Plotless	N/A
1	August 18, 2019	Diurnal	658	18.309398°	-77.452508°	Plotless + Plot-based	1
5	August 18, 2019	Diurnal	665	18.334251°	-77.451010°	Plotless + Plot-based	2
4	August 19, 2019	Diurnal	674	18.364686°	-77.445231°	Plotless + Plot-based	3

5.3.2.2.3.3. Light Trapping (Nocturnal Assessments)

A light trap was established at WPT 650 for 1-hour in the alpha period (*August 17, 2019 to August 19, 2019*) (refer to Figure 5-73 below). Night survey was attempted at WPT 649.

In the beta period, light trapping was conducted between the hours of 2200 hrs to 0200 hrs on August 23, 2019 and August 26, 2019. A white sheet of cloth, measuring at least 1.5 m on each side was strung up amidst shrubs and trees at the ecotone of the valleys and hillocks. A light trap was constituted by shining light on a white sheet for a minimum of 90 minutes (see Figure 5-72 below).

As indicated on Figure 5-73 below, random nocturnal surveys were carried out at three locations (675, 676 and 677) within SML 173. After an elapsed time of 90 minutes, the light trap was assessed for a period of 10 minutes both on and around the sheet. The species present and number of individuals were recorded.

Figure 5-72: Light Trap Setup

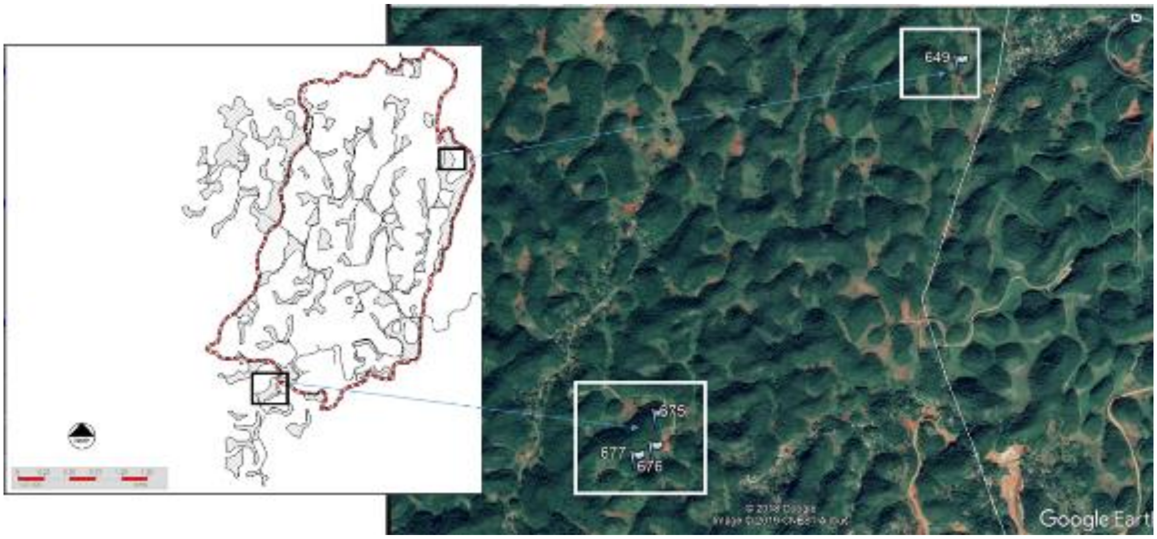

Figure 5-73: Arthropod Night Sample Locations Present Within Study Block 1 of SML 173

5.3.2.2.4. Gastropods

Gastropod observations were initially made along walking traverses at the periphery of the depression or orebody locations and within the hillocks during the plotless surveys. In the plot-based surveys, the transects were assessed for snail populations.

5.3.2.2.5. Mammals:

Identification of mammals was done at all locations visited during the study. These were intensified while conducting traverses between floral transect locations. All mammals seen during these traverses were identified and recorded. A more specialized method was used for the bat study. Caves within SML 173 were visited to identify the bat species that might be present in roosts within the caves while observing any instances of emergence. During night surveys special emphasis was placed on bat sightings.

Figure 5-74 below shows the positions of three caves within SML 173 that were visited during plot-based and plotless surveys. Dunn's Hole (Figure 5-75) and Drip Caves (Figure 5-76) are listed on the Jamaica Caves Organization website. For Dunn's Hole (the most westerly square red marker), the environs were inspected during the visit. Detailed information on Dunn's Hole is presented at http://www.jamaicancaves.org/dunns-hole-

060331.htm. The other two caves (Drip Cave and an unnamed cave [Figure 5-77]) were found with the assistance of local farmers. The caves were assessed internally, and observations were made for bat species present.

Figure 5-74: Location of three caves within SML 173 that were visited during plot-based and plotless surveys

Figure 5-75: View Looking Down into Dunn's Hole (18.361775°N 77.447559°W)

Figure 5-76: View Looking into Drip Cave located (18.364918°N 77.454984°W)

Figure 5-77: View Looking into Unidentified Cave (18.350463°N 77.429600°W)

A bat survey as part of a wider fauna survey was carried out within SML 173 (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 SML and serve other ecological purposes therefore required special attention for the compilation of the EIA.

This section outlines the method and technology used to identify caves and the different bat species present within SML 173. 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 SML for bat analysis
- To determine the presence/absence of studied bat species within SML 173
- To record bats in roosting environments (caves) within SML 173
- To identify the different bat species, present within SML 173

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 recorded in Jamaica and more than 149 of them have been confirmed as bat roosts (Figure 1). Approximately nine (9) caves have been identified within SML 173, three (3) of which were selected to conduct this survey and are shown (circled in blue) in Figure 5-78 below. The three (3) 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[26]. 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 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 SML is therefore necessary for preservation and conservation of these critical environmental service providers.

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

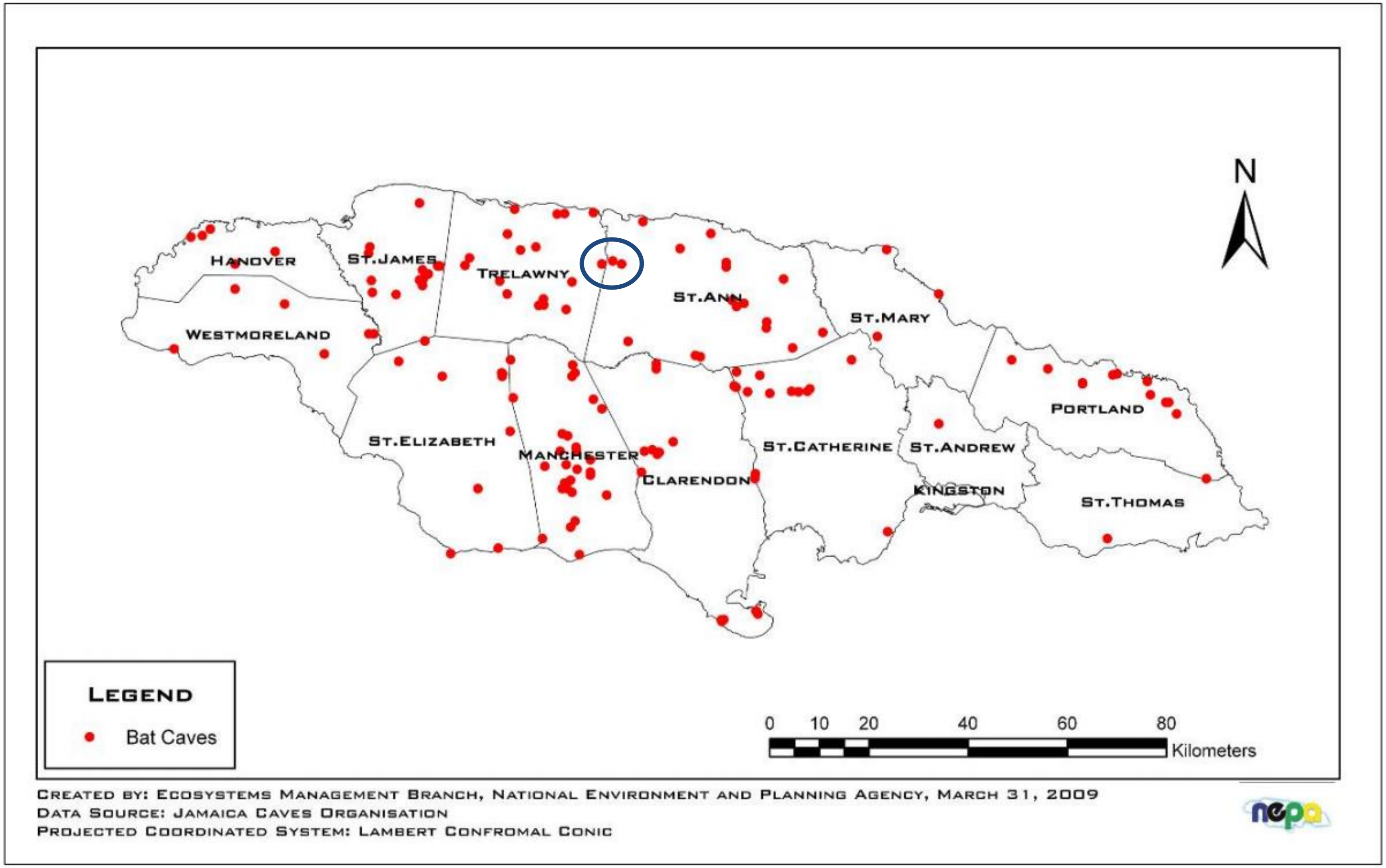

Figure 5-78: Map of Jamaica showing the distribution of known bat cave roost and the survey area

5.3.2.2.6. Abiotic Factors

The following abiotic data was collected at each of the floral assessment transects deployed:

- ✓ wind,
- ✓ temperature,
- ✓ incident light and
- ✓ humidity

This information was collected with a hand-held ambient weather meter, as well as a light meter. For light data, the unit used was lux[27, 28].

For incident light, a clear distinction between three light incidence regimes could be made based on levels of overhead vegetative cover, namely:

1. Open cover (characteristic of the open conditions on the lowlands),
2. Partial cover (characteristic of forest areas disturbed by man-made conditions, such as lumber cutting or natural conditions, such as the falling of a tree, or transitional areas)
3. Closed cover (prevailing light conditions under undisturbed canopies).

Slope angles of the hillocks surveyed were obtained with the use of a hand-held clinometer, while the orientation and position of the transects deployed were obtained with a hand-held compass and a Global Positioning System (GPS). The abiotic factors obtained were used as a means of providing additional insight into reasons for any changes in presence, abundance or diversity of floral and faunal species that may be detected during the surveys.

5.3.2.3. <u>Comparative Examinations with Control Sites – Rehabilitated and Unrehabilitated Mines</u>

Figure 5-79 below shows the location of two additional survey transects that were deployed at locations adjacent to SML 173. One location (waypoint 046 near to Tobolski) was present

[27] The **lux** is the SI derived unit of illuminance and luminous emittance, measuring luminous flux per unit area. It is equal to one lumen per square metre – wikipedia.org

[28] The lumen is the SI derived unit of luminous flux, a measure of the total quantity of visible light emitted by a source per unit of time -wikipedia.org

at the base of a hillock immediately adjoined to an area that had been mined out in excess of 15 years (deduced from Google Earth image records) and was regarded as a rehabilitated orebody. The second location (WPT 047 east of the Gibraltar Primary School) is immediately adjacent to an unrehabilitated orebody.

The objective behind accessing these locations was to determine if there were any differences that could be identified in floral and faunal characteristics (as compared with those determined with methods described in sections 5.3.2.1 and 5.3.2.2 above) that could be attributed to the process of mining.

Figure 5-79: Locations of transects distributed outside of the SML 173 study area overlaid onto a google earth image of the location

Table 5-11: Locations of transects distributed outside of the SML 173 study area

Waypoint	Study Block	Latitude	Longitude
WPT 046	Outside SML 173	18.331679°	-77.402075°
WPT 047	Outside SML 173	18.344664°	-77.425380°

In general, the data collection process for SML 173 included the following:

5.3.2.3.1. Flora

General observations of the area were made along the walk to and from the study areas. The general zonation and succession of different species of plants were observed during the walk and any abnormality identified within the vegetation was recorded.

The base of different hillocks in the area were observed for two (2) reasons;

1. To study the transition of the vegetation from the ore body, to the base of the hillock and along the slope of the hillock.
2. To choose a location to lay the transect.

The location chosen for the transect was based entirely on the accessibility to the base of the hillock and up slope each hillock. After a suitable location was chosen, a 30m transect was laid from the edge of the ore body and into the hillock. The transect was then divided into 5x5m quadrats (alternate). The species and abundance of plants for each quadrat were observed and recorded. Special attention was paid to the abundance of endemic plant species and the Water Mahoe plant. This process was repeated for all the sites visited.

5.3.2.3.2. Fauna - Birds

Bird species were observed along the walk to and from the study area to provide a complete species list for SML 173 area. Point counts were done from the base of the each transect; these were done in two 5-minutes periods with an interval of 30 seconds.

The base of the flora transect was also used as a start point to map a 300m transect that was used along the boundary of the ore body and hillock to further observe and account for presence of birds including ambiguous and quiet species of birds. This process was repeated for all the sites visited.

5.3.2.3.3. Fauna - Insects

General observations of the different species of insects were made during the walk to and from the chosen area of study. A more detailed observation was made within the ore body that was at the base of the hillock that provided the most suitable access up the slope. Species and species abundance were observed and recorded.

The 5x5m quadrats created for the flora study were also used in the reptile data collection. Approximately 15 minutes were spent in each quadrat to observe and record the different insect species and their numbers present. Abiotic data was taken and recorded for each quadrat as well. This process was repeated for all the sites visited.

5.3.2.3.4. Fauna - Reptiles

Observations of species of reptiles, along with their numbers were made during the walk to and from the study areas to give a complete record of what is present within SML 173. Rocks were overturned in this process to gain a more accurate observation.

The 5x5m quadrats created for the flora study were also used in the reptile data collection. Approximately 15 minutes were spent in each quadrat to observe and record the different reptile species and their numbers present. This process was repeated for all the sites visited.

5.3.2.3.5. Fauna - Mammals

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 SML 173. 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 SML 173.

The caves visited by the CD&A team during the initial flora and fauna assessment indicated the presence of bats from the:

- 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 identified as follows and are shown in Figure 5-80,Figure 5-81, and Figure 5-82 below:

- Drip Cave
- Dunn’s Hole
- “Cave 3 - Gibraltar” (since the local name is unknown)

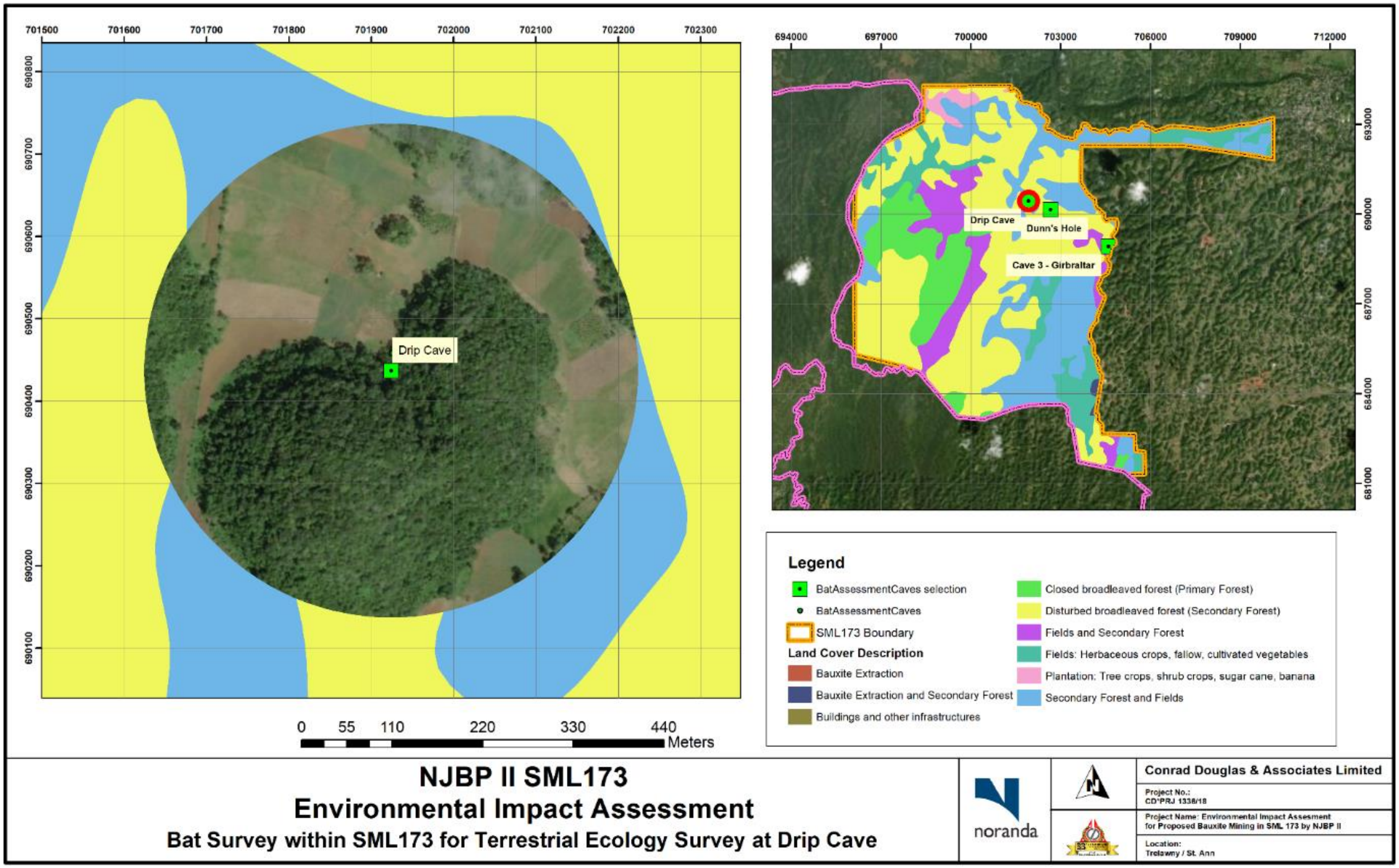

Figure 5-80: Bat Survey within SML 173 for Terrestrial Ecology Survey at Drip Cave

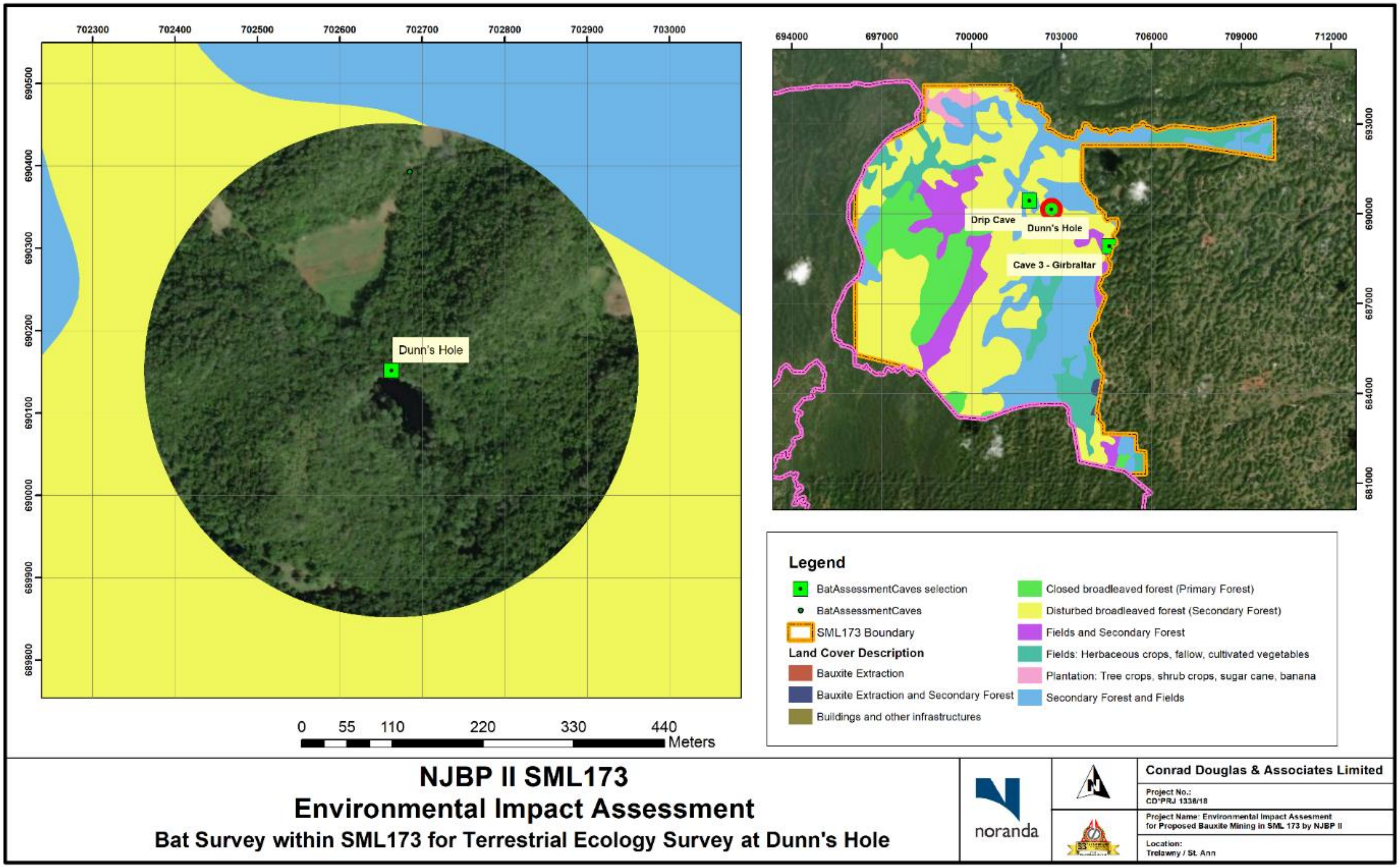

Figure 5-81: Bat Survey within SML 173 for Terrestrial Ecology Survey at Dunn's Hole

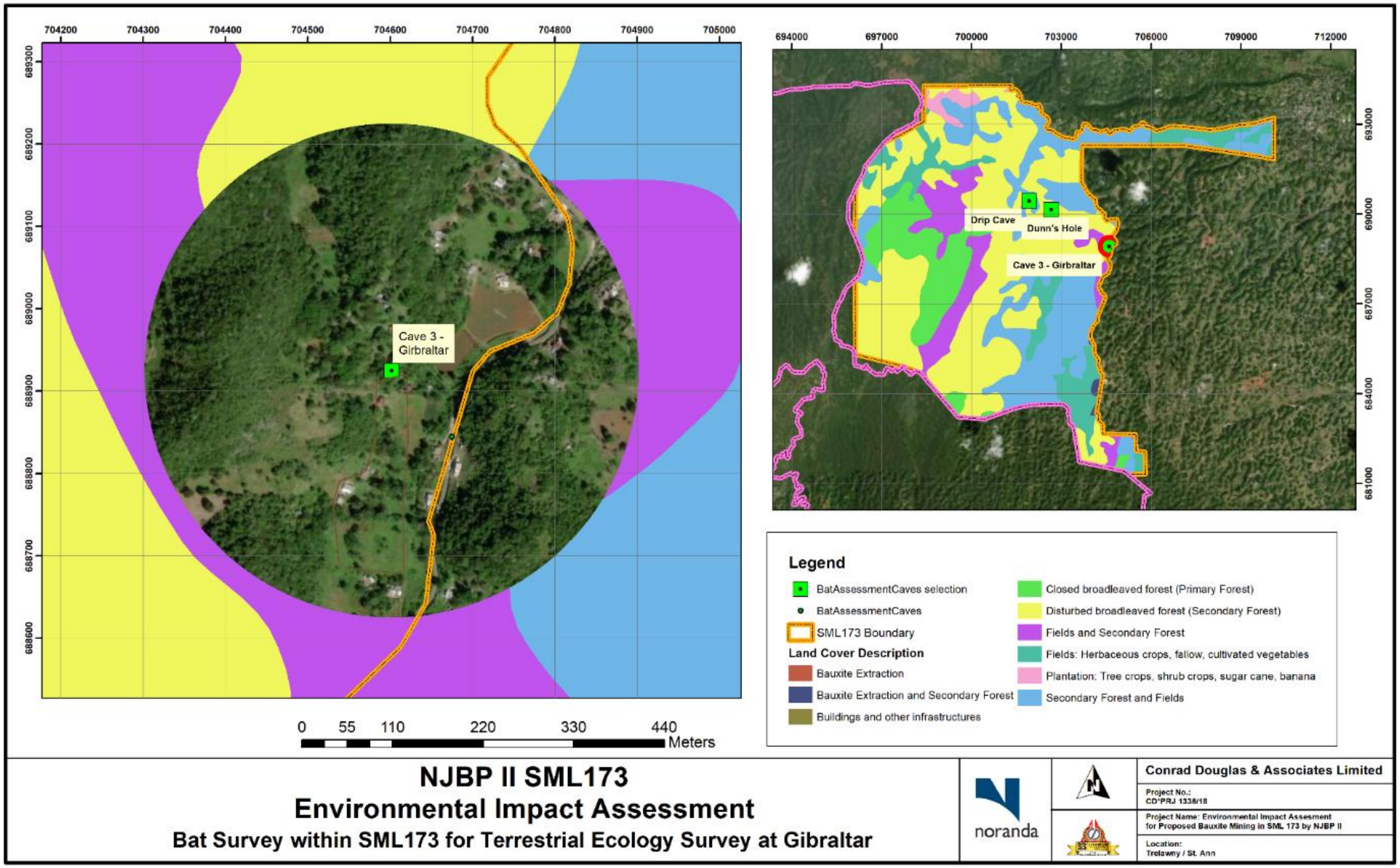

Figure 5-82: Bat Survey within SML 173 for Terrestrial Ecology Survey at “Cave 3 – Gibraltar”

The extensive ecological survey of SML 173 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 assessment of the bats present in the caves found within SML 173:

- *Programming of Devices (Audiomoth):*
  - ✓ Each Audiomoth device was programmed to run for 13 hours, from 5pm to 6am. During this 13-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)
  - ✓ Two (2) Audiomoth devices were then carefully placed into Ziploc™ bags and folded to reduce the possibility of water reaching the recorder.
  - ✓ A suitable area at the entrance of the cave was found to place the Ziploc™ bags as seen in Figure 1.

Figure 5-83: Audiomoths installed (yellow circle) at the entrance of the cave (Drip Cave)

- ✓ The devices were secured in place using cable ties as seen in Figure 2.

-

Figure 5-84: Audiomoths (yellow circles) installed at entrance of cave – Drip Cave

- ✓ 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 SML173

- *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 the species were selected.
- 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.

5.3.2.4. Flora and Fauna Significance Ranking

The status of the flora and fauna observed was highlighted through the use of a DAFOR scale. DAFOR represents the categories: Dominant, Abundant, Frequent, Occasional, Rare. The DAFOR scale is used for semi-quantitative sampling, to provide a quick estimate of the relative abundance of species (generally plants) in a given area[29].

Value	Percentage cover	Notes
D - Dominant	> 75%	Rarely used in practice.
A - Abundant	51 - 75%	Very common over most of the site
F - Frequent	26 - 50%	
O - Occasional	11 - 25%	
R - Rare	1 - 10%	

Additionally, the status of the species observed, as defined by the International Union for Conservation of Nature (IUCN) was used to rank conservation risk. Each species was compared with the IUCN's Red List and the following designations applied:

1. Extinct (EX) – beyond reasonable doubt that the species is no longer extant.

29 http://www.greenmansoftware.co.uk/products/fieldnotes/documentation/answers/surveymethods/dafor.htm

2. Extinct in the wild (EW) – survives only in captivity, cultivation and/or outside native range, as presumed after exhaustive surveys.
3. Critically endangered (CR) – in a particularly and extremely critical state.
4. Endangered (EN) – very high risk of extinction in the wild, meets any of criteria A to E for Endangered.
5. Vulnerable (VU) – meets one of the 5 red list criteria and thus considered to be at high risk of unnatural (human-caused) extinction without further human intervention.
6. Near threatened (NT) – close to being at high risk of extinction in the near future.
7. Least concern (LC) – unlikely to become extinct in the near future.
8. Data deficient (DD)
9. Not evaluated (NE)

5.3.3. Findings

5.3.3.1. Flora Literature Review

5.3.3.1.1. General

The characteristics of the flora in the general area of SML 173 can be divided into three distinct categories:

1. Those occurring within the depressions – (shrubs and grasslands)
2. Those occurring on the hillocks – (highly diverse, many endemics, forested)
3. Those occurring at the transition areas between the hillocks and the depressions

Figure 5-85 shows the distinction that is obvious from the aerial images of SML 173. The vegetation within the bauxite bearing depressions is sparse in comparison to the heavily vegetated hillocks. The transition zone would typically fall on the purple lines (See Figure 5-85).

Asprey *et al* postulated that the difference in vegetation between the hillocks and the depressions in SML 173 are due to anthropogenic activities over the history of Jamaica. The depressions were cleared for farming and other activities, hence all the depressions are classified as secondary vegetation. There are also several sections of the elevated areas of hillocks which show similar characteristics of anthropogenic activities.

Figure 5-85: Google Earth Image of Section of SML 173 with depressions outlined in purple

The 1998 Land Use/Cover Map of Jamaica[30] divides natural forest area into two main categories, namely, Open and Closed Forests. Open forests are communities with trees at least 5 metres tall and 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 metres 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

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

(evergreen). 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, based on the amount of rainfall, altitude, underlying geology and level of human-induced disturbance. Mesic Limestone Forests[31] 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 introduced 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.

The character of SML 173 matches that typical of the presence of Mesic forests. Camirand and Evelyn, 2004[32] concurred with the description of the proposed development area as a Mesic Limestone Forest. These forest types typically have vertical stratification, with tall emergent trees achieving heights of 24 metres, a main tree canopy of between 16-20 metres and an understory of between 3-10 metres. Ferns are very common in these forest types as well as lianas, aroids and tank epiphytes. Camirand and Evelyn (2004) outlined that both cedar and sweetwood tree varieties are the dominant 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[33] has listed over 100 tree species typical of these types of forests, suggesting a diverse floral system.

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

[32] Roland Camirand and Owen B. Evelyn – National Forest Inventory Report 2003 Volume 1 of 2 – Main Report and Appendices I-V 2004.

[33] Forestry Department - Forest Inventories in Natural Forests [UNDP/FAO, 1972; Swedforest Consulting, 1981;

FIDCO, 1982-83; TFT Project, 1998-99

5.3.3.1.2. Location Specific References

Asprey and Robbins (1953) defined the areas of the Cockpit Country (and by extension, similar surrounding areas including the study area) as comprising "*limestone hillocks surrounding circular depressions (dolinas) filled by bauxitic soils with accumulated humus from the surrounding rim of the limestone rock*".

The vegetation composition of the hillocks is more lush than the drier coastal limestone areas of the island (owing to the availability of moisture) and have more forest trees, epiphytes, lianas, aroids, bromeliads and orchids present (See Figure 5-86 below). The understory and shrub areas of these forests tend to be sparsely populated, owing to the rocky nature of the underlying substrate.

Figure 5-86: Typical Forest Vegetations at Study Site

Figure 5-87 below (labeled as Fig 20) 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. The list was used as a guide during plot-based and plotless investigations of the hillocks during field work. Table 5-12 lists vines, bromeliads, ferns, aroids and mosses that would be expected to be observed within the forested hillock areas of the study site based on Asprey and Robbins 1953.

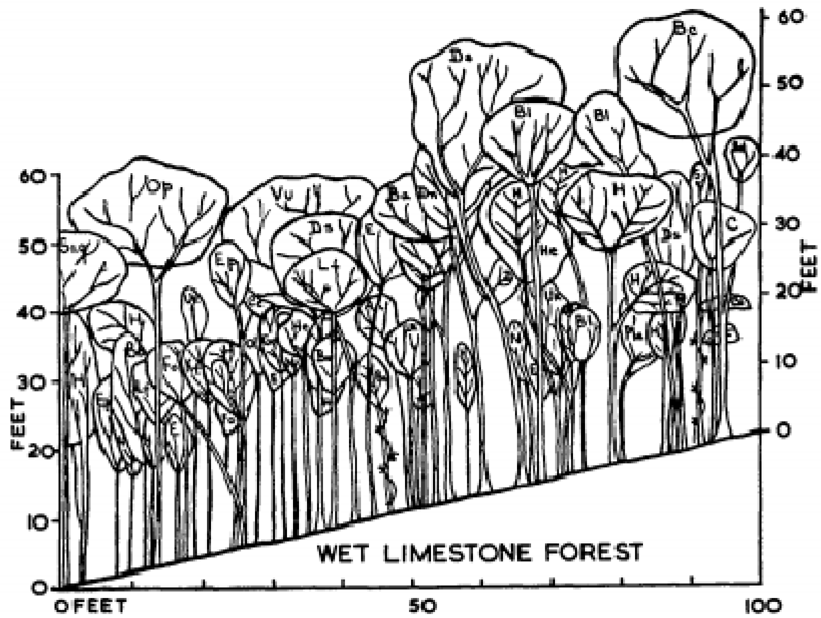

FIG. 20. Profile diagram of Wet Limestone Forest measured in the Cockpit country. The trees are included from a strip 100 ft. long and 25 ft. wide.

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 5-87: Profile Diagram of Wet Limestone Forest measured in the Cockpit Country. Extracted from Asprey and Robbins (1953)

Table 5-12: 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 donnellii* *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 underwoodii* *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*

5.3.3.1.3. Lowlands - Cockpits

At the time of their description, Asprey and Robbins described the lowlands or 'cockpits' as being dominated by the tree types *Terminalia latifolia* and *Cedrela odorata*. This is not currently the case. The presence of deep pockets of soil have resulted in most of the lowlands or 'cockpits' being defoliated of their forest vegetation to facilitate subsistence agriculture and pasture land usage (See Figure 5-88 and Figure 5-89 below).

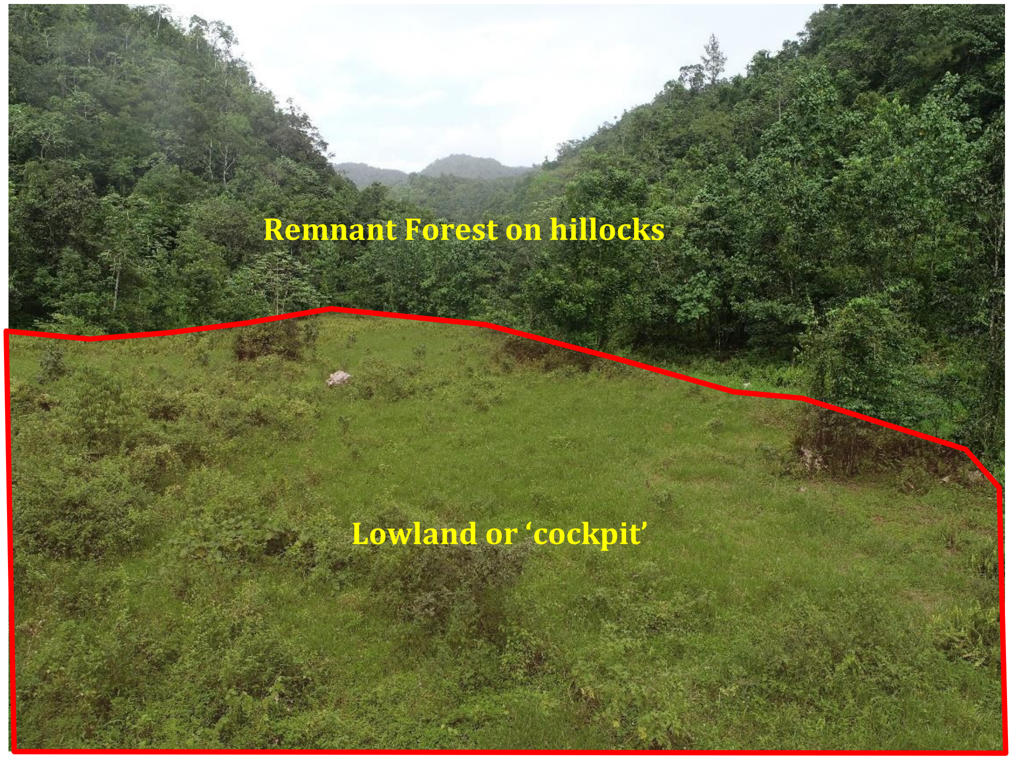

Figure 5-88: Lowland ('cockpit' Area – Shaded and Outlined in Red) Showing Pasture and Subsistence Agricultural Vegetation

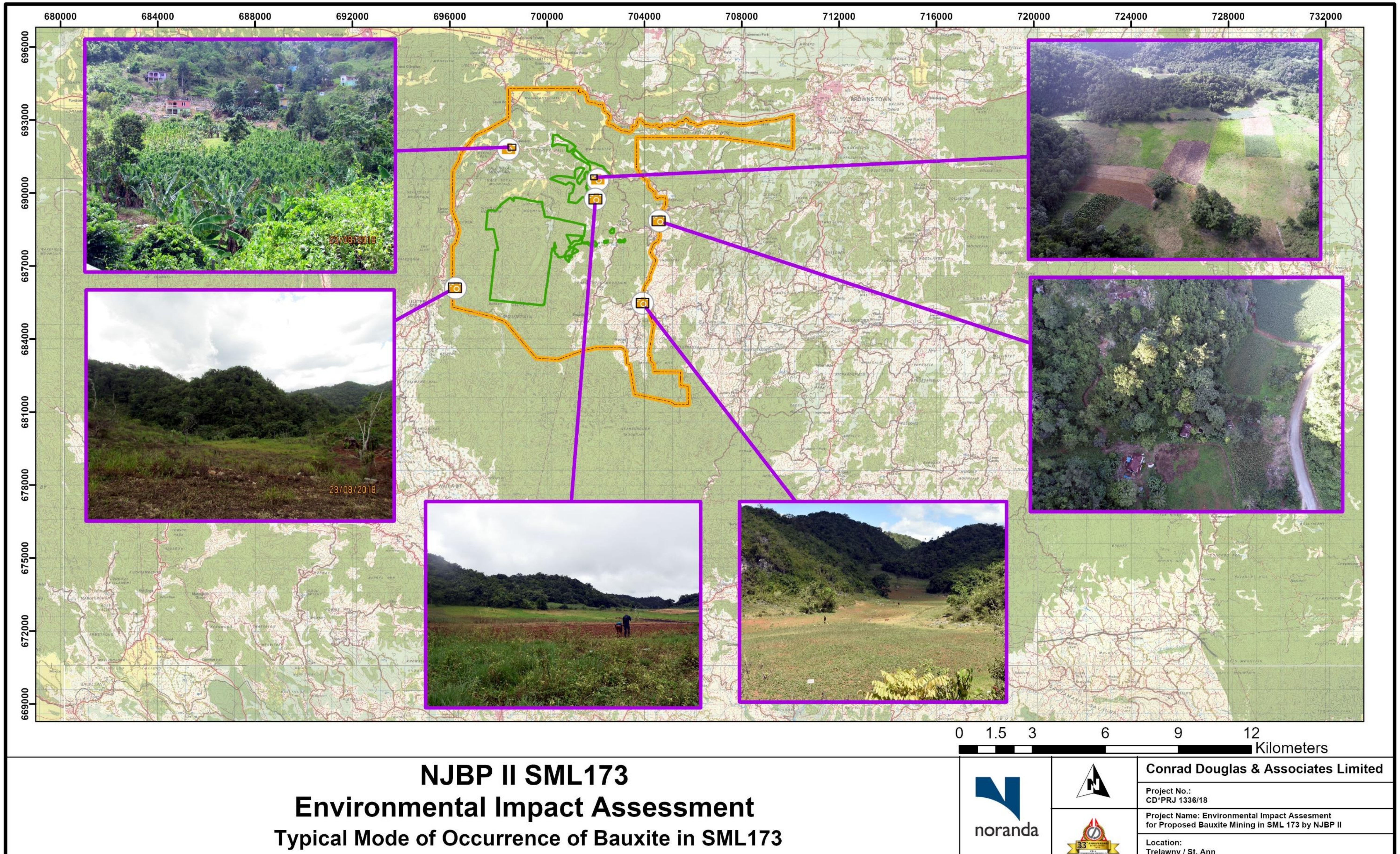

Figure 5-89: Typical Mode of Occurrence of Bauxite in SML 173

5.3.3.2. Vegetation Observations – Plotless Characterization:

5.3.3.2.1. Spatial Extent – Block 1 -9

Figure 5-90 below shows the spatial extent of SML 173 and the Blocks (1-9). These are overlaid on a Google Earth image of the area. The land use in each Block is colour coded and has been verified by field observations made along trails bisecting Blocks 1-9. Each Block in Figure 5-90 is separately presented in Figure 5-91 to Figure 5-101. These show the spatial relationship between naturally occurring forest vegetation on hillocks present within the study blocks, agricultural vegetation found in soil-filled depressions and other land uses. These uses are as follows:

1. Cleared Hillsides
2. Grass-covered Depressions
3. Settlements
4. Mixed Settlements/Agriculture/Grasslands on Variable Terrain
5. Agriculture covered depressions and
6. Hillock Forest

Figure 5-91 below, prepared from a photo-interpretation of Google Earth images of the area, shows the spatial relationship between naturally occurring forest vegetation on hillocks present within Block 1 and modified vegetation found in the depressions between the hillocks. The depressions are primarily cleared agricultural plots or agricultural plants. The study area enclosed approximately 796.2 hectares of land, approximately 186.6 hectares of which were identified as agricultural lands. The remaining lands (609.6 Ha) were interpreted to be mesic forests atop hillocks. The differences in vegetation types are generally depicted on Figure 5-92 to Figure 5-93 below.

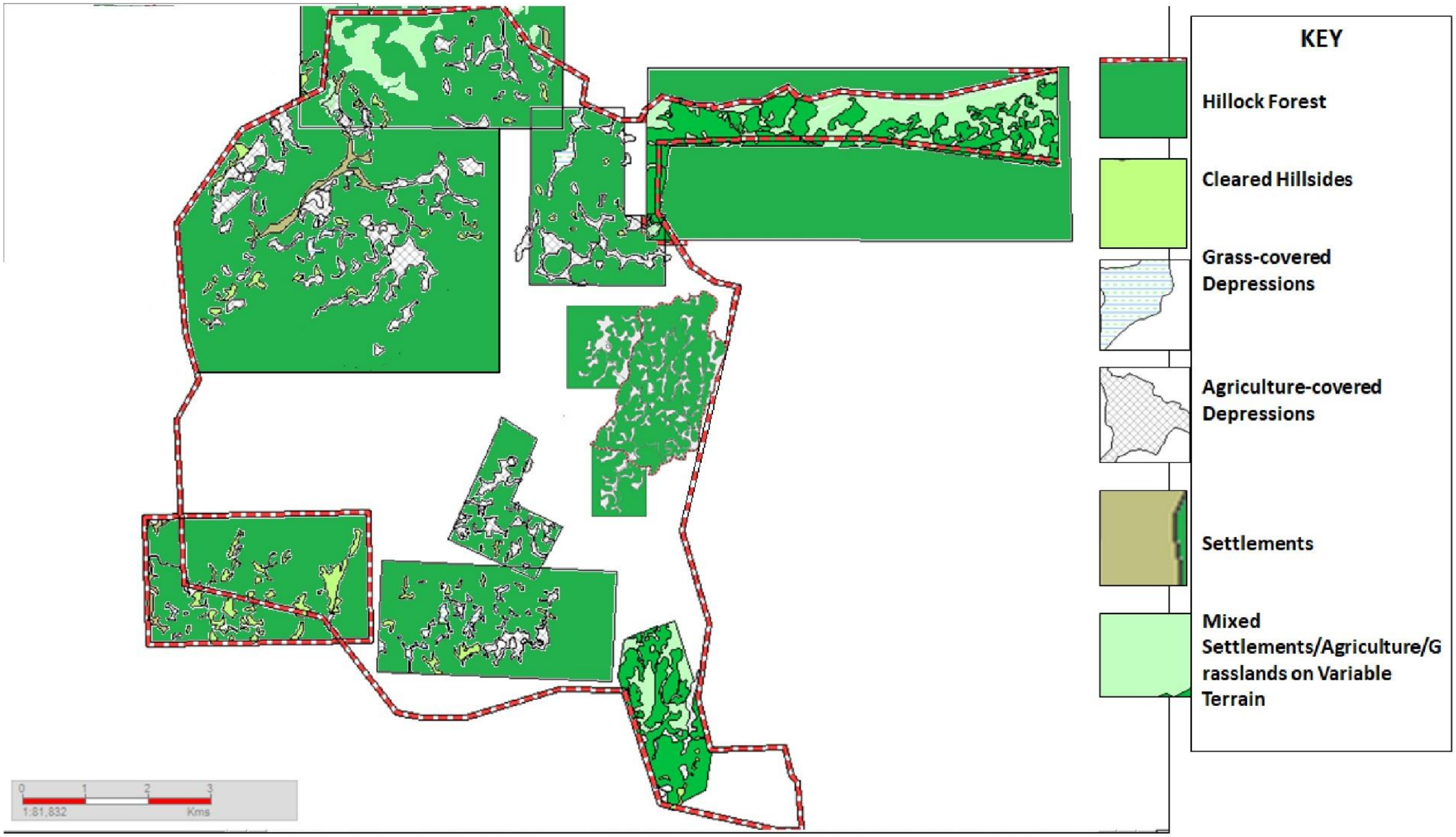

Figure 5-90: Land use within the study blocks in SML 173

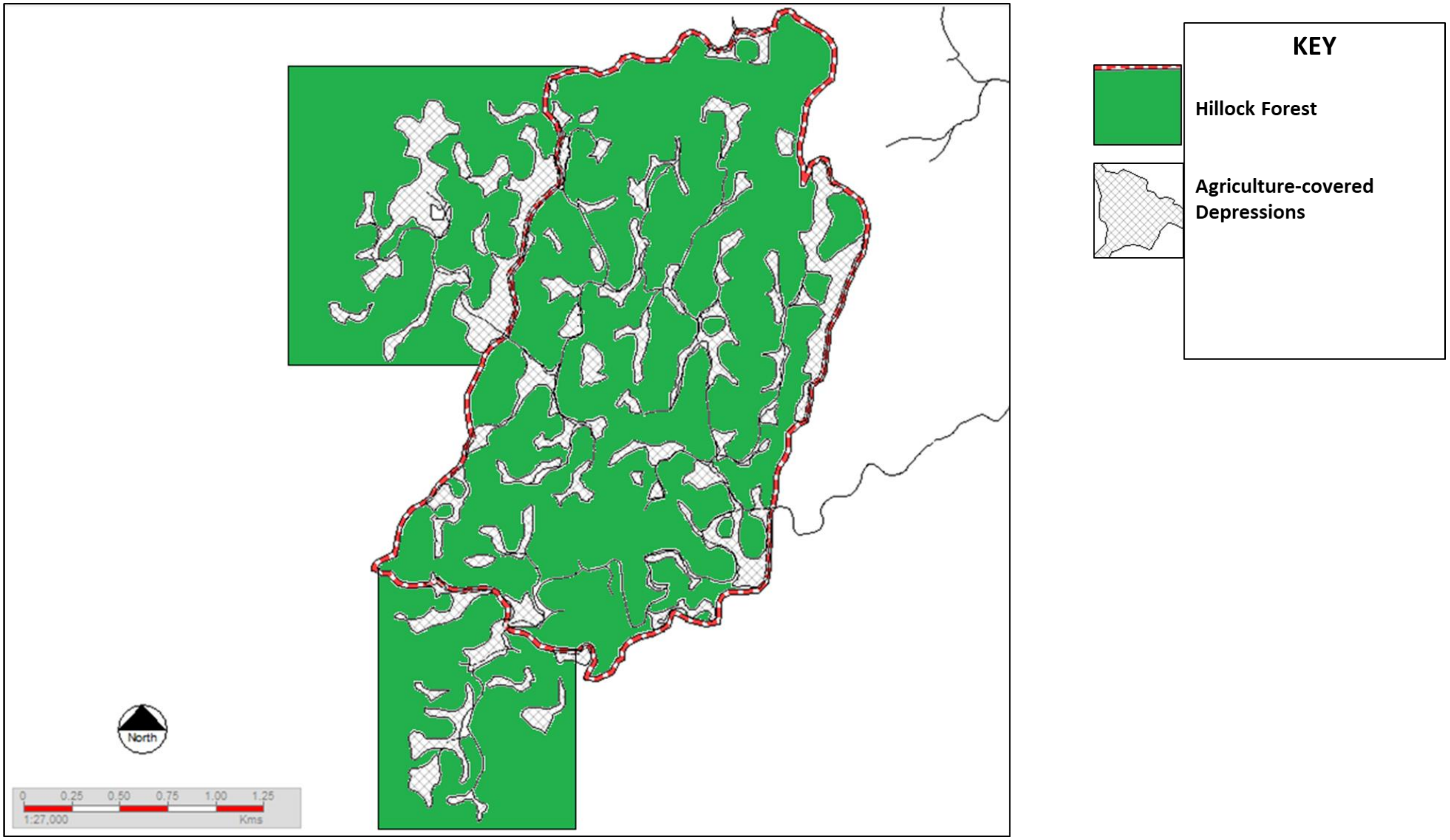

Figure 5-91: Spatial relationship between naturally occurring forest vegetation on hillocks and modified vegetation in Block 1 of SML 173

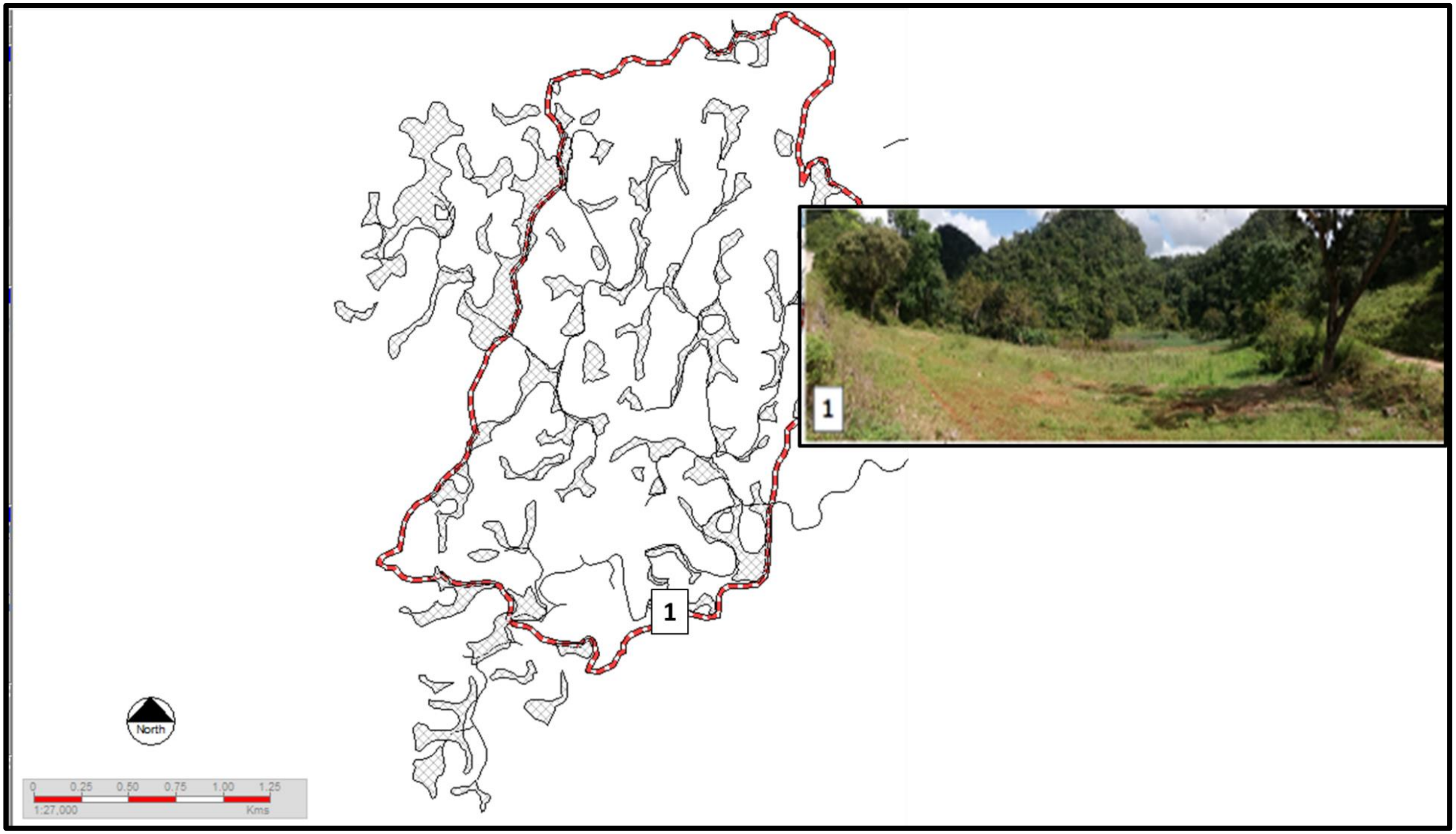

Figure 5-92: Map of Block 1: Depressions shaded. Photograph taken at Location 1 showing modified vegetation - pasture/subsistence agriculture lands in the foreground and vegetated hillocks in the background

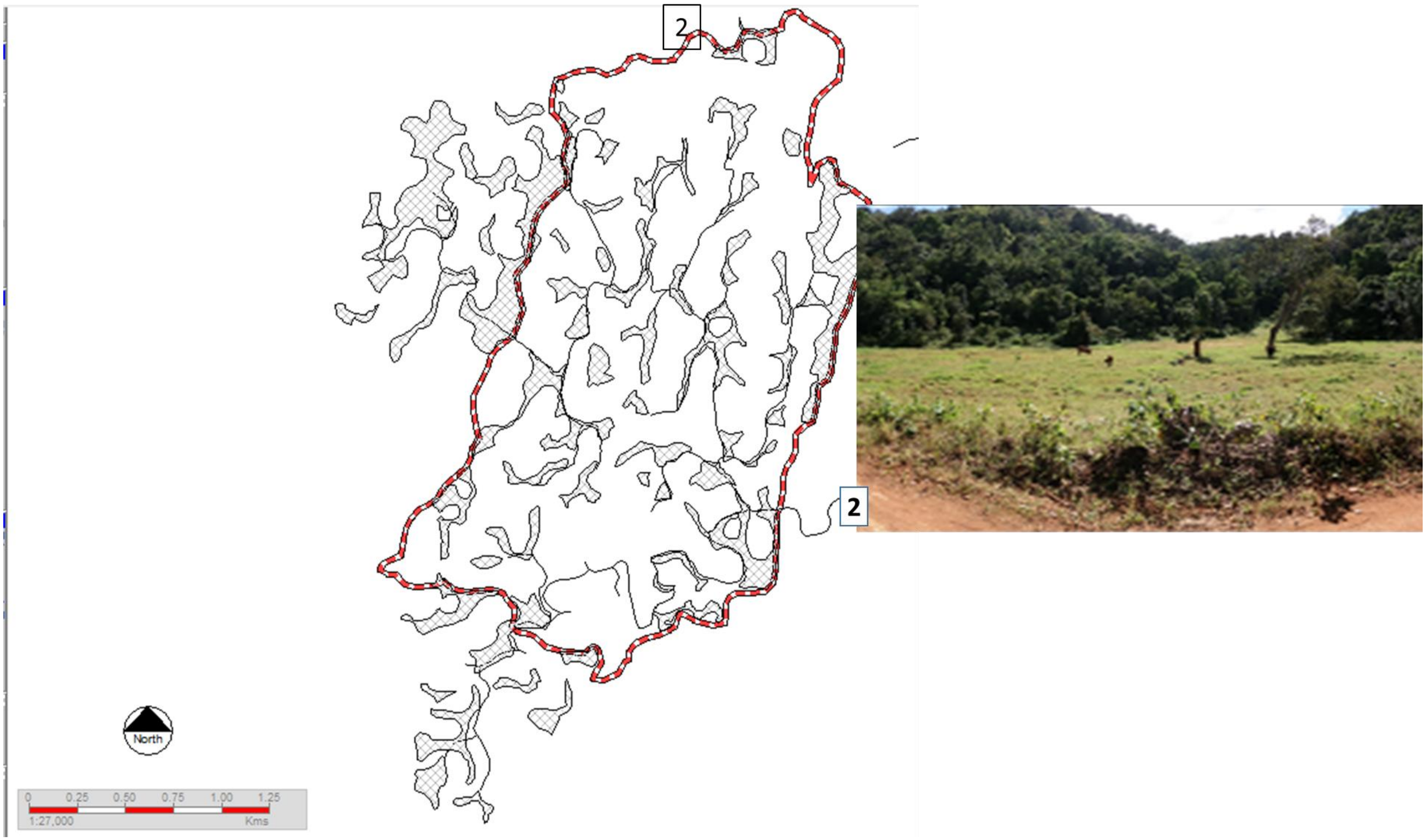

Figure 5-93: Map of Block 1: Depressions shaded. Photograph taken at Location 2 showing modified vegetation - pasture/subsistence agriculture lands in the foreground, vegetated hillocks in the background and existing access road

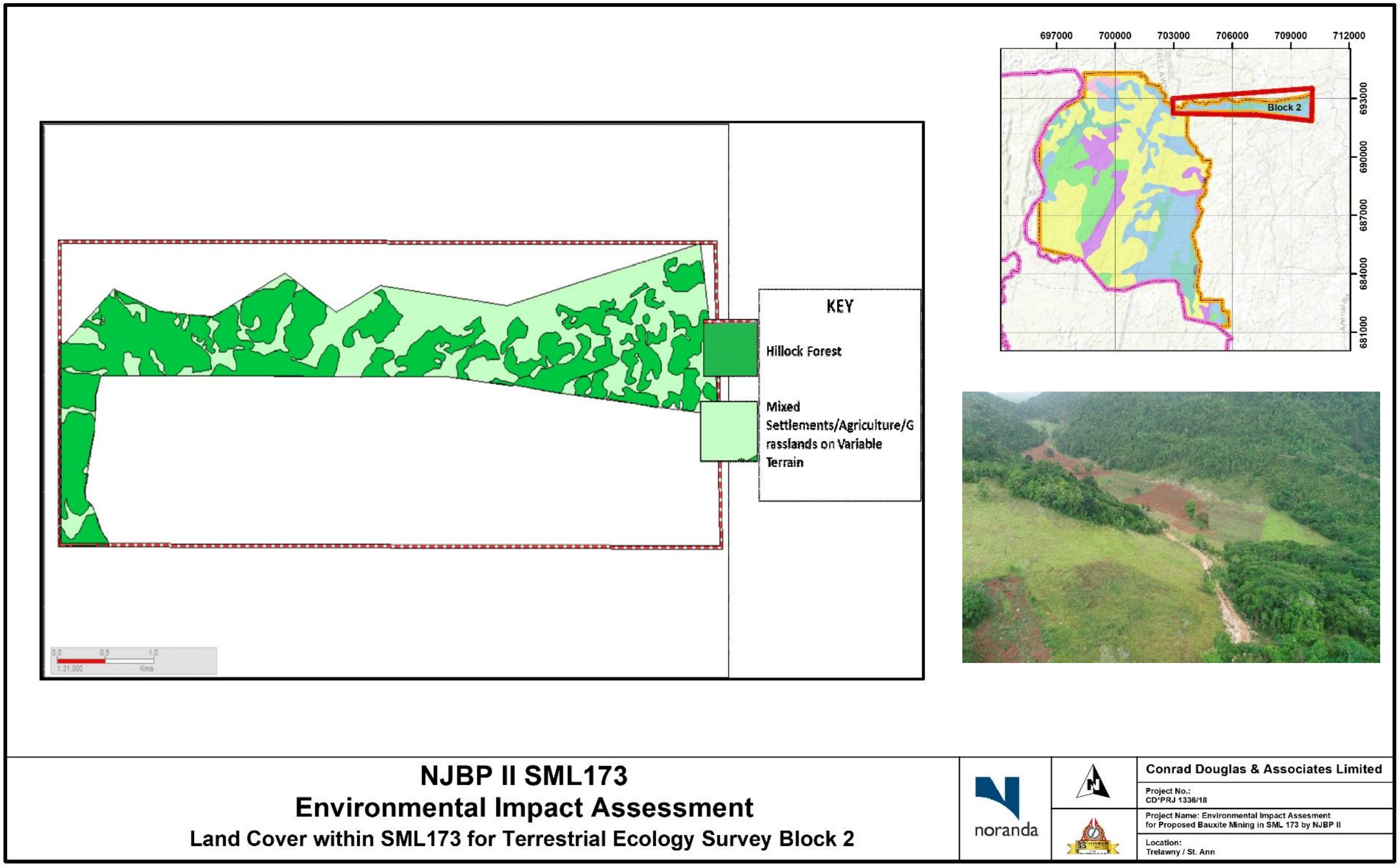

Figure 5-94: Block 2 Existing Land Use

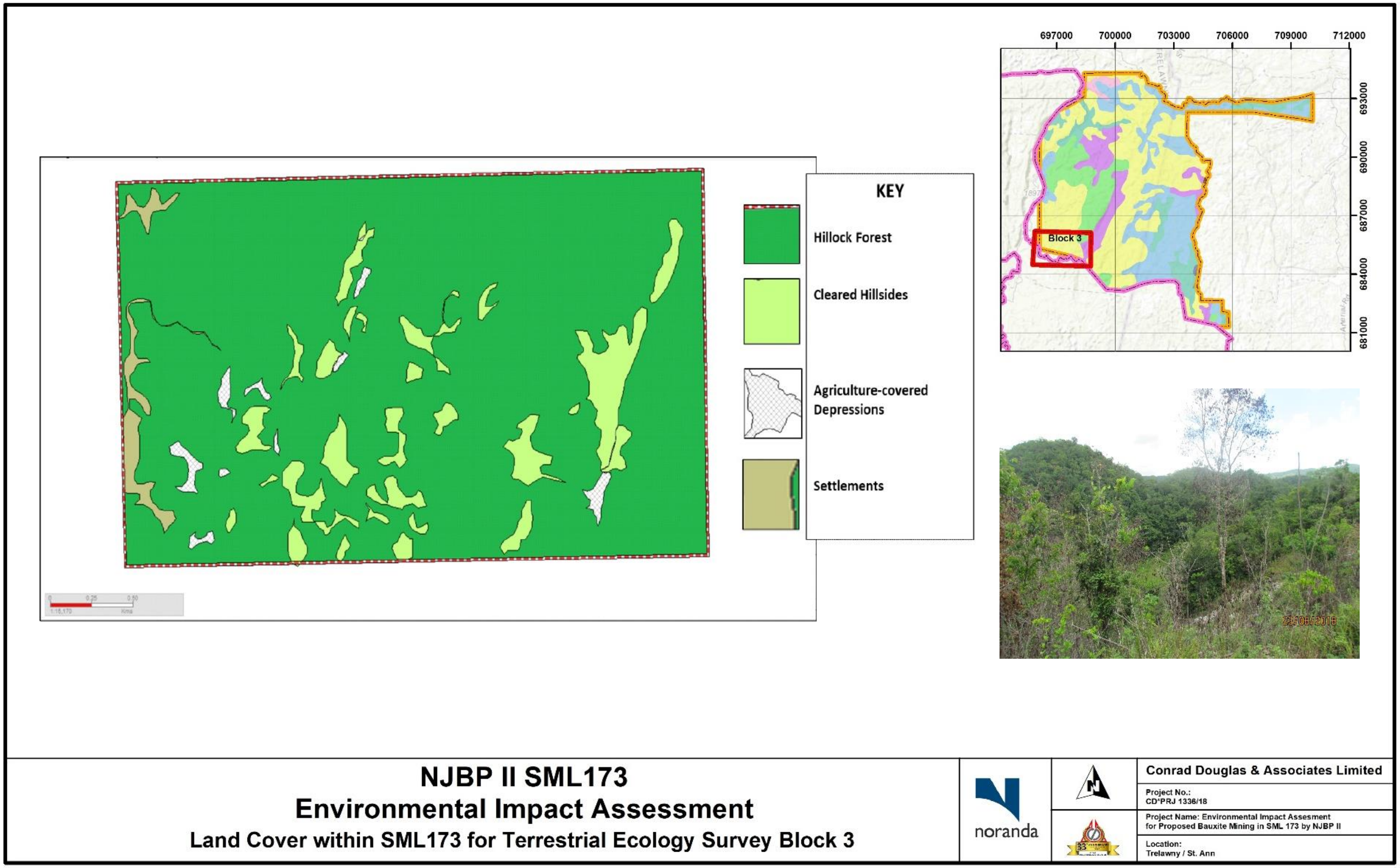

Figure 5-95: Block 3 Existing Land Use

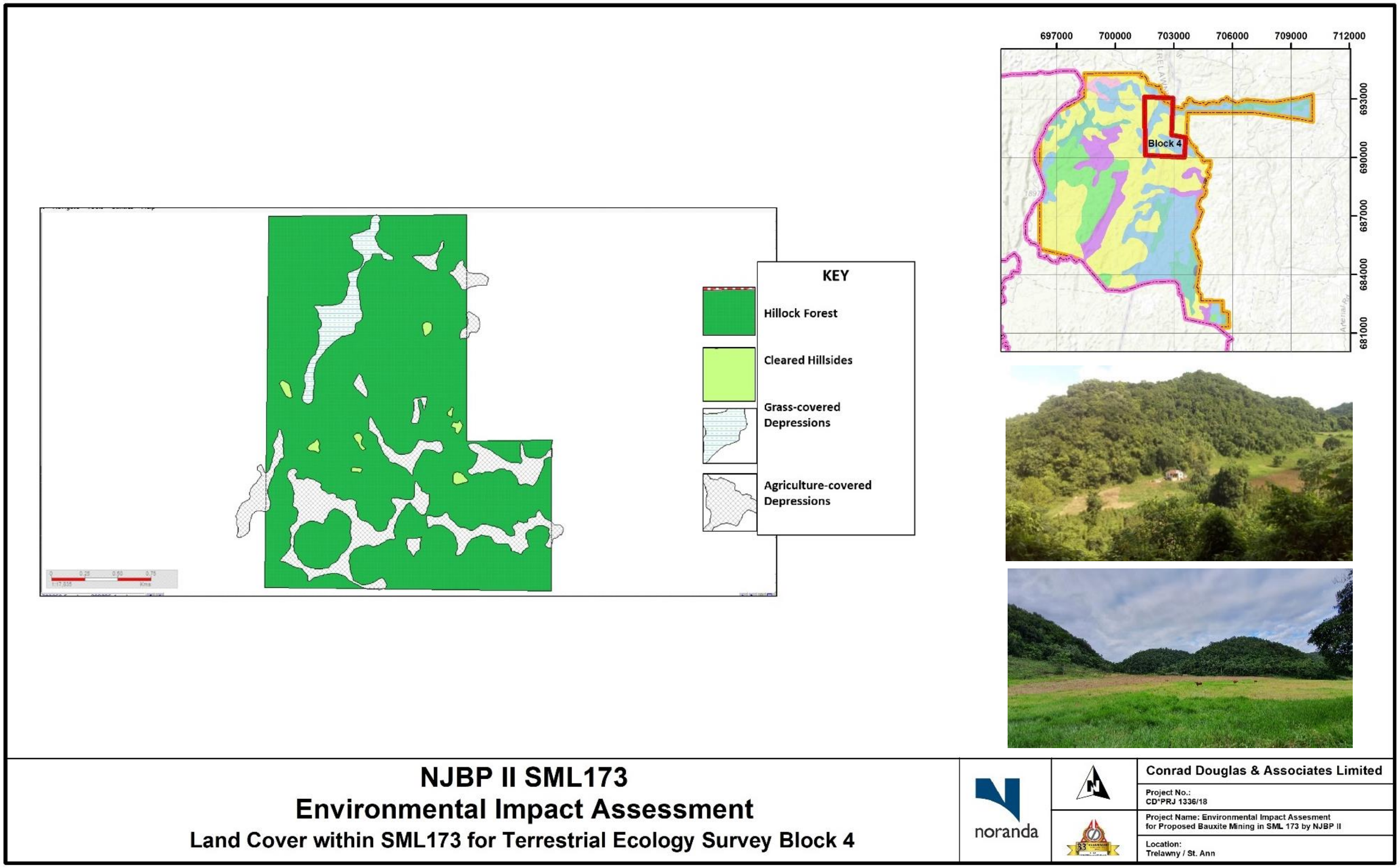

Figure 5-96: Block 4 Existing Land Use

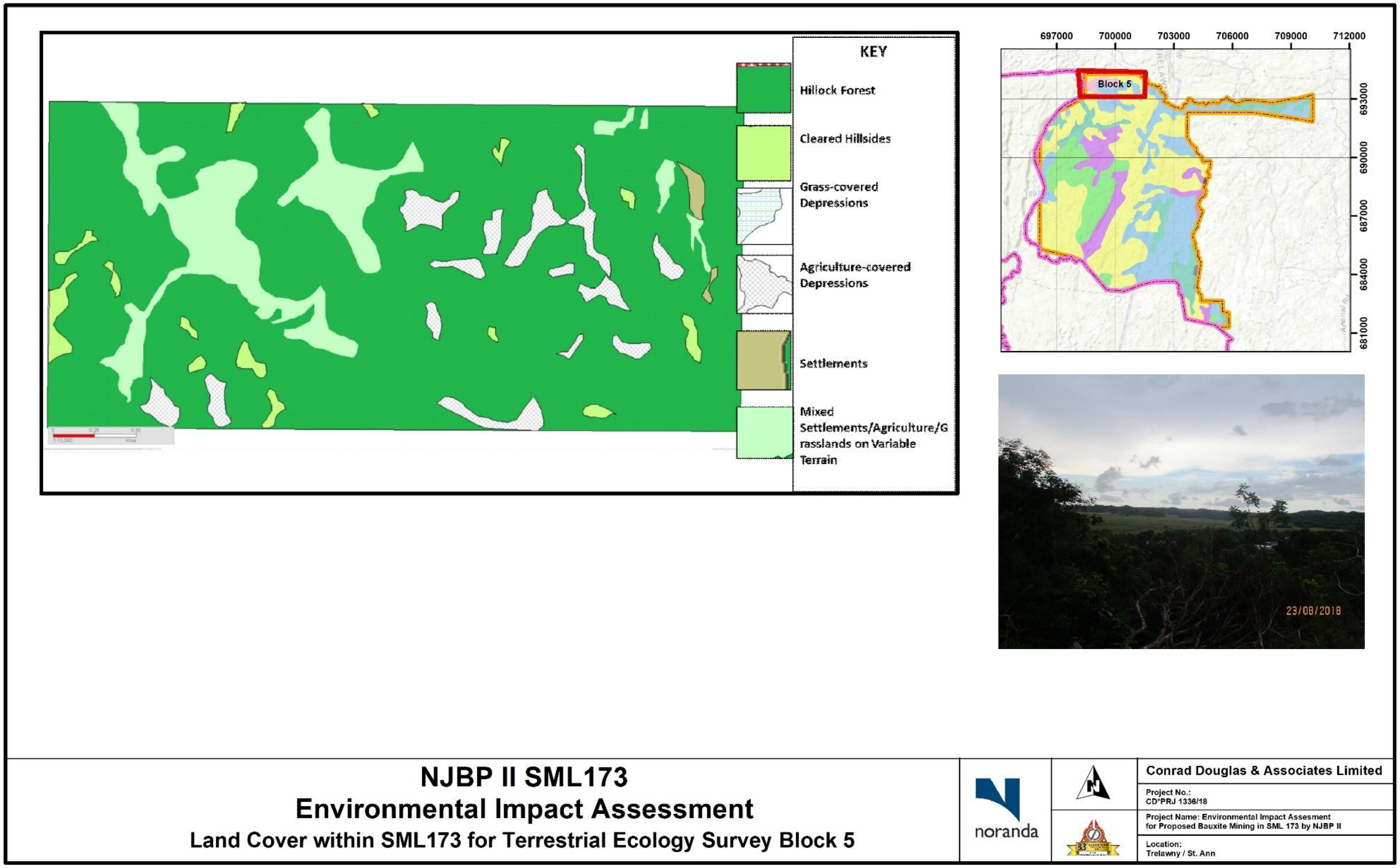

Figure 5-97: Block 5 Existing Land Use

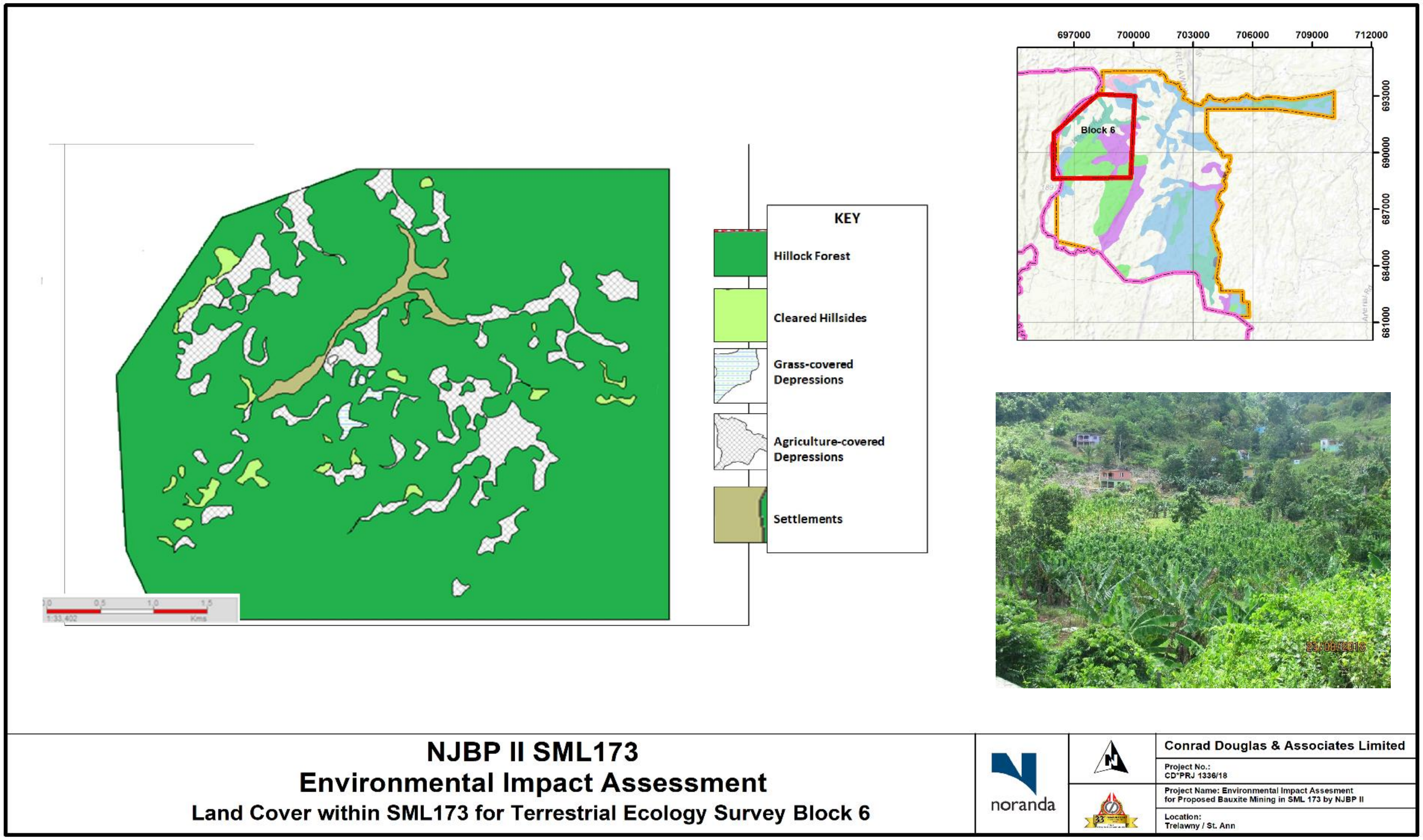

Figure 5-98: Block 6 Existing Land Use

Aerial photographs and maps of sections of Block 6 showing greater details of human activity, development and fragmentation. These are illustrated in* Appendix XXIII*. This area represents the clawed back area, in which bauxite mining will not be carried out. This is a major proposed potential beneficial socio-economic impact. Its avoidance is a mitigation strategy.

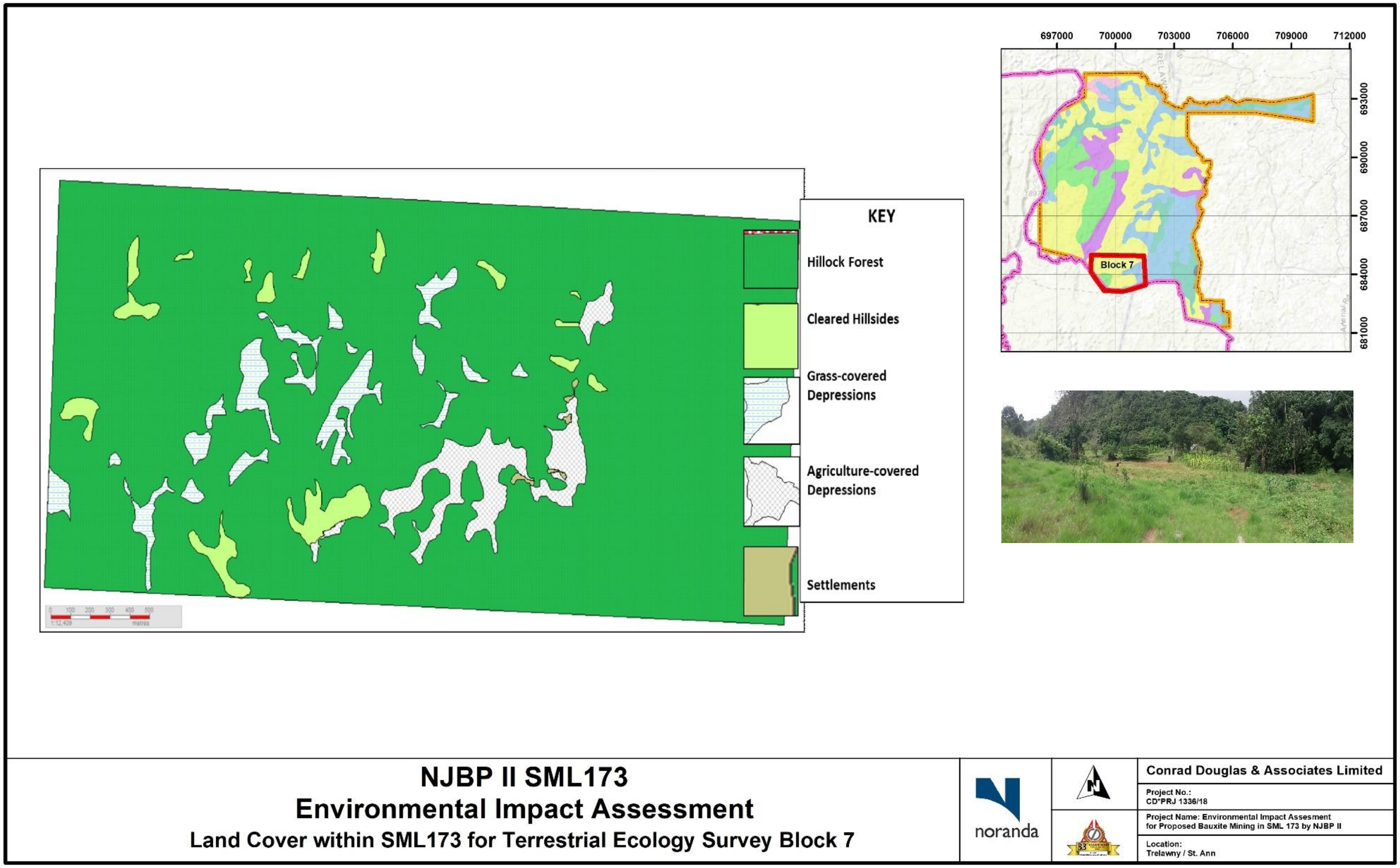

Figure 5-99: Block 7 Existing Land Use

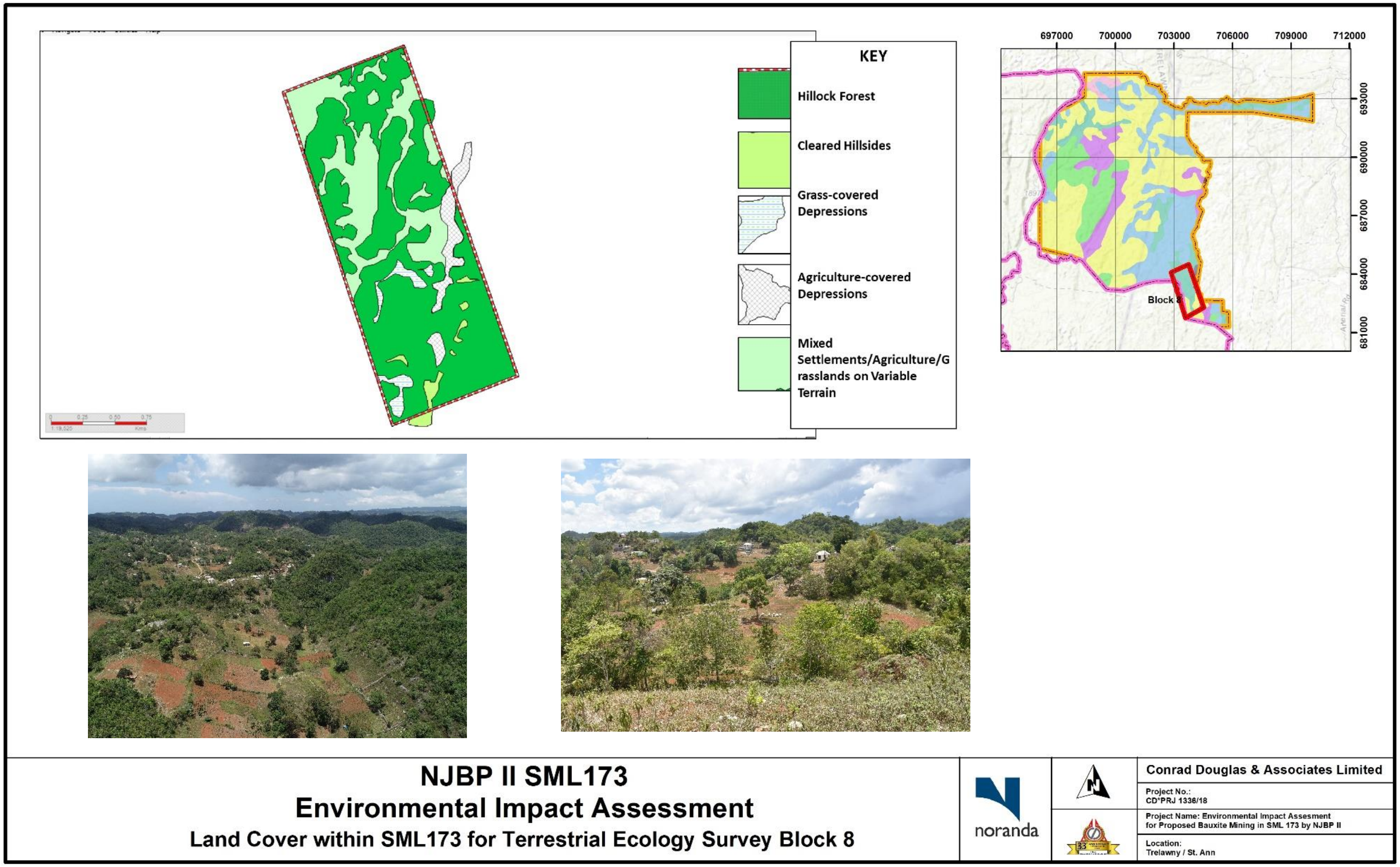

Figure 5-100: Block 8 Existing Land Use

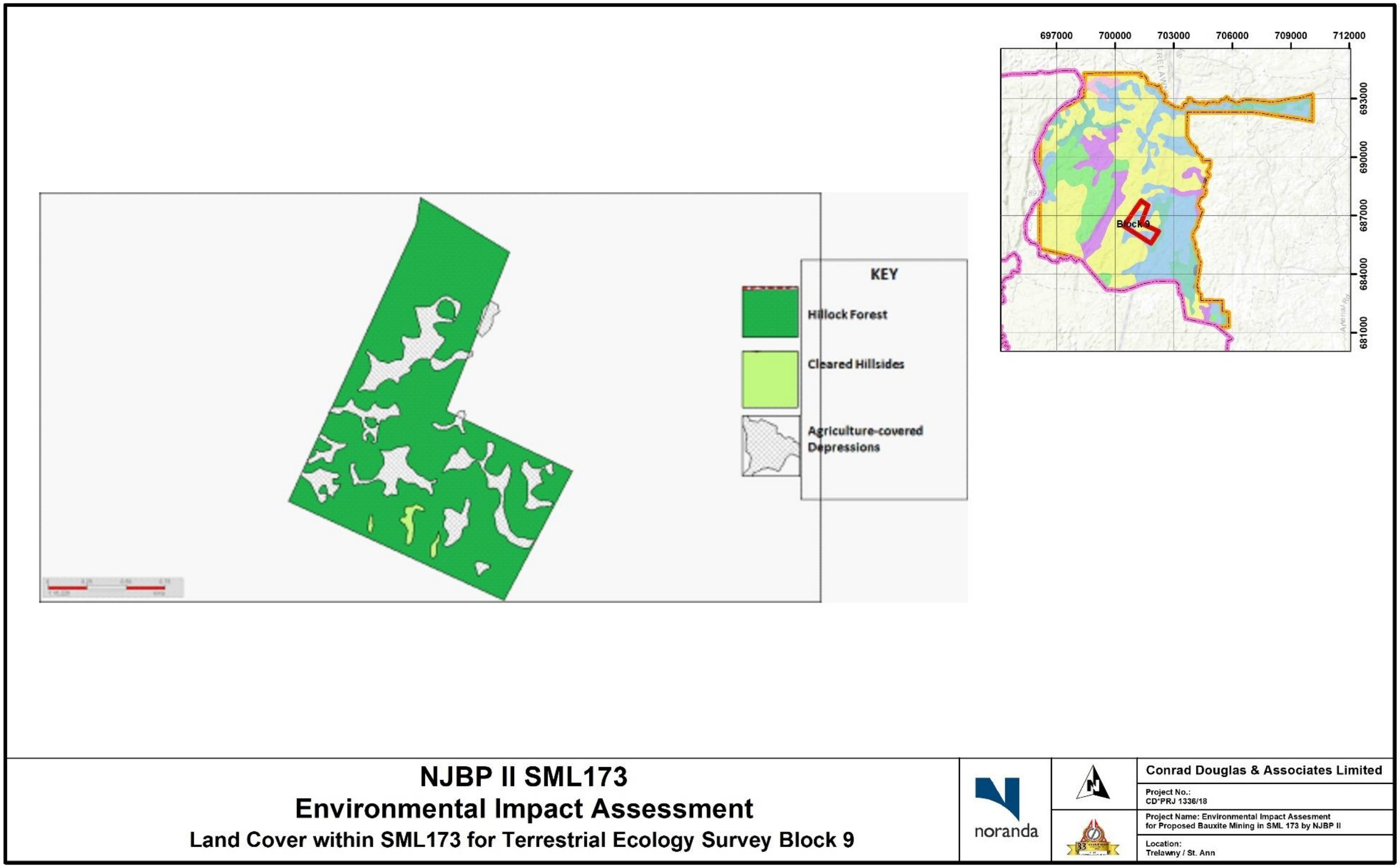

Figure 5-101: Block 9 Existing Land Use

Based on the nine (9) blocks delineated within the study area (outlined on Figure 5-91) estimates of naturally occurring forest vegetation on hillocks and estimates of disturbed/modified areas were determined and are represented in Table 5-13. The following categories are combined to represent the disturbed/modified areas:

1. Agricultural areas in depressions
2. Cleared Hillsides
3. Grass-covered Depressions
4. Settlements
5. Mixed Settlements/Agriculture/Grasslands on Variable Terrain

Table 5-13: Relationship Between Undisturbed Hillock Vegetation and Modified Areas (Depressions) Within Study Areas Defined on Figure 5-90

Block No.	Block (See Figure 5-91 to Figure 5-101) (Hectares)	Undisturbed Hillock Vegetation (Hectares)	Modified Areas (Hectares)	% of Modified Areas
1	796.2	609.6	186.6	23%
2	612.09	350.12	261.97	43%
3	721.01	641.49	79.51	11%
4	495.55	396.84	98.71	20%
5	822.26	549.38	272.88	33%
6	1862.67	1563.75	298.92	16%
7	656.4	596.2	60.2	9%
8	289.3	108.09	181.21	63%
9	219.03	174.94	44.09	20%
Total	**5,819.11**	**3,583.41**	**2,235.6**	38%

The analysis indicates that approximately 62% of the total area examined through aerial imagery interpretation could be defined as undisturbed hillock forest vegetation. The remainder (~38%) supports the list of land modifications outlined above.

5.3.3.3. Vegetation Characterizations: Plot-Based Assessment

5.3.3.3.1. Limestone Hillocks – Transect Surveys

A total of eight (8) vegetation transects were surveyed within the study area. The locations of the transects are shown in Figure 5-60. Table 5-14 lists the various plant forms found within the hillock survey transects. Highlighted areas represent endemic species while the DAFOR[34] scale highlights relative abundance of the identified species.

The limestone communities surveyed were highly variable in structure and species composition. Structure ranged from wet hilly slopes with thickets of vegetation to more open medium-saturated, evergreen forests. The vegetation showed similar assemblages with previously characterized regions. Among the 95 species of flora recorded within the 9 locations, 9 species were shared among the wet limestone forests. Only two (2) of them were among the most common species. There were 4 shared tree genera (*comocladia, ficus, coccoloba* and *eugenia*).

Where there were disturbances, indicator species such as Trumpet Tree (*Cecropia peltata*), John Crow Bush (*Bocconia frutescens*) and Bracken Fern (*Pteridium sp.*) were observed. The fern species observed from the base of the hillock to the forest floor among each area were consistent with the "Resurrection Fern" (*Polypodium polypoides*), "Cow tongue fern" (*Campyloneurum phyllitidis*) and *Nephrolepis sp*. A total of 18 endemic species were observed (shown in Table 5-14). Species richness fluctuated along the slope with some locations having greater species counts within the upper slope, some within the middle and others at the lower region.

A defining characteristic amongst most of the study regions was a 5m cliff wall at approximately 30m upwards the slope. This cliff face effectively prevented further ascents on most of the hillocks surveyed.

There were no observations of the Water Mahoe (*Hernandia catalpifolia*) in SML 173 during the plotless and the plot-surveys. The Water Mahoe is critical for supporting the giant swallowtail butterfly (*Pterourus homerus,* formerly called *Papilio homerus*).

[34] DAFOR Dominant, Abundant, Frequent, Occasional, Rare - The DAFOR scale is used for semi-quantitative sampling, to provide a quick estimate of the relative abundance of species (generally plants) in a given area http://www.greenmansoftware.co.uk/products/fieldnotes/documentation/answers/surveymethods/dafor.htm

Table 5-14: Vegetation Categories and Species Lists for Hillocks in Study Area

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
Endemics highlighted in yellow and bold			
Vegetation Category	**Species**	**DAFOR scale**	**IUCN Ranking**
Trees	*Alchornea latifolia*	*O*	LC
	Bauhinia divaricate	*F*	LC
	Bumelia nigra	*R*	NE
	Bumelia rotundifolia	*R*	NT
	Calliandra sp.	*O*	- No Info Found
	Calyptranthes sp.	*O*	- No Info Found
	Cassia emarginata	*R*	NE
	Cecropia peltata	*A*	NE
	Citharexylum fruticosum	*R*	NE
	Clethra occidentalis	*F*	NE
	Coccoloba sp.	*A*	- No Info Found
	Comocladia pinnatifolia	*A*	NE
	Cupania glabra	*O*	LC
	Daphnopsis americana	*R*	NE
	Dendropanax arboreus	*D*	NE
	Erythroxylum confusum	*O*	NE
	Eugenia amplifolia	*A*	NT
	Eugenia axillaris	*A*	NE
	Eugenia sp.	*O*	- No Info Found
	Fagara martinicensis	*A*	NE
	Ficus pertusa	*O*	LC
	Ficus sp.	*D*	- No Info Found
	Lagetta lagetto	*O*	NE
	Malvaviscus arboreus	*F*	LC
	Nectandra sp.	*F*	- No Info Found
	Ocotea sp.	*O*	- No Info Found
	Plumeria obtuse	*R*	NE
	Pisonia aculeata	*O*	LC
	Portlandia sp.	*R*	- No Info Found
	Psidium guajava	*F*	LC
	Securidaca browneii	*R*	NE
	Securidaca longipedunculata	*R*	NE
	Simarouba glauca	*R*	
	Spathelia sp.	*A*	NE
	Ziziphus chloroxylum	*R*	- No Info Found

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
Endemics highlighted in yellow and bold			
Vegetation Category	**Species**	**DAFOR scale**	**IUCN Ranking**
			NE
Bromeliads	***Aechmea paniculigera*** *Tillandsia fasciculata* *Tillandsia bulbosa* *Tillandsia juncea* ***Hohenbergia sp.*** *Vriesea sp.*	*F* *F* *F* *F* *O* *R*	*NE* *LC* *NE* *NE* *- No Info Found* *- No Info Found*
Aroids	*Anthurium grandifolium* *Philodendron lacerum* *Syngonium auritum*	*F* *F* *D*	*NE* *NE* *NE*
Orchids	*Epidendrum cochleate* ***Oncidium tetrapetallum*** *Spiranthes elata*	*R* *R* *R*	*NE* *NE* *NE*
Ferns	*Campyloneurum phyllitidis* *Nephrolepis sp.* *Polypodium polypoides* *Pteridium aquilinium var. caudatum*	*D* *D* *F* *O*	*NE* *- No Info Found* *NE* *LC*
Herbs	*Bidens Pilosa* *Borreria laevis* *Bryophyllum pinnatum* *Eupatorium odoratum* *Eupatorium villosum* *Gesneria sp* *Lantana camara* *Lantana trifolia* *Peperomia amplexicaulis* *Peperomia glabella* *Rhytidophyllum tomentosum* *Selenicereus grandifloras* *Tournefortia sp.* *Tragia volubilis*	*A* *O* *F* *F* *O* *R* *F* *F* *O* *O* *O* *R* *R* *R*	*NE* *NE* *NE* *NE* *NE* *- No Info Found* *NE* *NE* *NE* *NE* *NE* *LC* *- No Info Found* *NE*

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
Endemics highlighted in yellow and bold			
Vegetation Category	**Species**	**DAFOR scale**	**IUCN Ranking**
Vines	*Bidens reptans*	*F*	*NE*
	Callisia repens	*O*	*NE*
	Centrosema pubescens	*O*	*NE*
	Cionosicyos pomiformis	*R*	*NE*
	Cissampelos pareira	*R*	*NE*
	Dioscorea polygonoides	*F*	*NE*
	Hyperbaena prioriana	*R*	*NT*
	Ipomoea tiliacea	*F*	*LC*
	Ipomoea ternate	*R*	*NE*
	Marsdenia troyana	*R*	*NE*
	Merremia umbellata	*F*	*NE*
	Passiflora rubra	*R*	*NE*
	Passiflora suberosa	*R*	*NE*
	Piper amalago	*F*	*CR*
	Smilax balbisiana	*F*	*NE*
	Vitis tiliifolia	*R*	*NE*
Shrubs	***Acidoton urens***	*F*	*NE*
	Allophylus cominia	*R*	*NE*
	Blakea trinervia	*R*	*NE*
	Bocconia frutescens	*D*	*NE*
	Cassia obtusifolia	*R*	*NE*
	Cestrum diurnum	*R*	*LC*
	Clematis dioica	*R*	*NE*
	Clusia flava	*A*	*LC*
	Cordia globose	*F*	*NE*
	Hyptis verticillata	*R*	*NE*
	Malpighia sp.	*R*	-
	Melochia nodiflora	*R*	*NE*
	Miconia laevigata	*A*	*NE*
	Moghania strobilifera	*R*	*NE*
	Paulinia jamaicensis	*R*	*NE*
	Piper arboretum	*O*	*NE*
	Psychotria sp.	*F*	-
	Solanum erianthum	*A*	*NE*
	Thrinax parviflora	*F*	*NE*
	Triumfetta semitriloba	*R*	*LC*

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
Endemics highlighted in yellow and bold			
Vegetation Category	**Species**	**DAFOR scale**	**IUCN Ranking**
	Wallenia sp.		-
Grass	*Bambusa vulgaris* *Lasiacis divaricate* *Panicum sp.*	*A* *R* *D*	*NE* *NE-*

Vertical vegetation profiles were prepared using data collected along each transect at the various waypoints studied (trees not drawn to scale). Each transect was divided into six subplots (5x5m) where the species present were characterized and their distance along the transect noted. Each species was given a suitable representative symbol for identification. Initials were attached to each symbol to produce a key for identification. The altitude was plotted along the y-axis and the distance of the transect was plotted on the x-axis.

The heights of the trees were estimated and the diameter at breast height (DBH) measured. The methodology for estimating the height of the tree involved trigonometry. A clinometer was used to measure the angle and the distance measured from the base of the tree. The heights are estimated because the tops of the canopies are difficult to distinguish and the base of the trees are hard to discern given the leaf litter. The vegetation density varied between each site and each profile gives a relative representation of the species present and the coverage along the transect. The general observation from plot surveys is that the canopy of the trees along the transects are interlocked. At breast height of the field technician, a ruler (caliper) was used to measure the width of the tree. Each of the transect findings are outlined below:

5.3.3.3.1.1. Block 1 - Transect at WPT 636 - 18.331679°N, 77.435213°W

This location adjoined an ore body adjacent to the community of Gibraltar and represented the only study area where it was possible to get to the summit of a hillock, without destroying the existing environment. The assessment was completed without the use of the quadrat survey methods in an effort to rapidly ascend the hillock. Figure 5-102 illustrates the location and orientation of the survey path taken up the hillock. Figure 5-103 and Table 5-15 illustrate the vegetation profile and vegetation identification key plotted for the transect.

Figure 5-102: Transect Survey Site at WPT 636

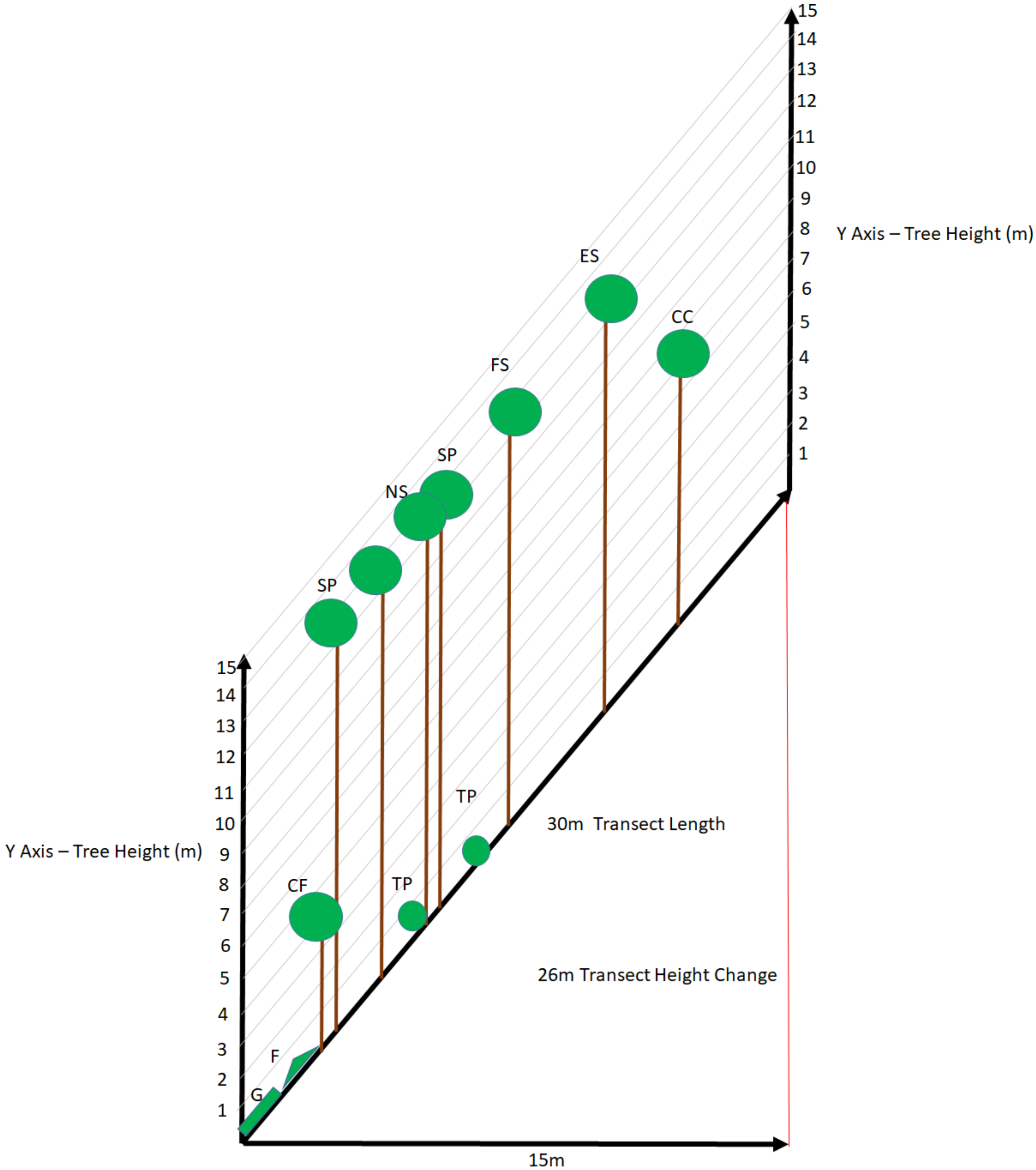

Figure 5-103: Vegetation Survey Plot for WPT 636

Table 5-15: Vegetation Profile Identification Key for WPT 636

Initials	Name	Average DBH (cm)	Average Height (m)
SP	*Spathelia sp.*	12	>10
FS	*Ficus sp.*	36	>10
ES	*Eugenia sp.*	30	>10
CF	*Clusia flava*	10	6
CC	*Coccoloba sp.*	5	8
Ns	*Nectandra sp.*	25	>10
F	Fern	-	0.2
G	*Sporobolus sp*	-	*<0.5*

The starting point of the survey transect at the WPT 636 study area showed evidence of previous disturbances where some or a few cut tree stumps were observed. There were also anthropogenic disturbances within the depression where agricultural use was observed. Crops observed included potato, corn and yam. Similar zonation patterns were observed within the other depressions investigated. Grassland (Gramineae) as well as small perennial herbs dominated the depression core. While the depressions/low lands supported mainly monocotyledonous plants, within pasture land a few introduced domesticated fruit trees such as (*Mangifera indica*, citrus, *Syzygium malaccense*) were identified towards the centre.

Few species showed clustered distribution in the shaded regions at the periphery of the depression/low land (*bryophyllum pinnatum, Bidens pilosa, Mimosa pudica*). The base of the hillock was skirted with dense light tolerant ferns indented by a few shrubs. Also, a dense population of shrubs such as *Pilea sp*. and *Tectaria sp.* As the distance increased upwards, the vegetation transitioned from grassland to a woodland forest. The transition zone was mainly characterized by its shift from dense ferns to the bromeliads, vines and trees. Identified climbers included aroids such as *P. lacerum* and *Syngonium auritum*. Large bromeliads (*Aechmea paniculigera*) were observed growing at the base of taller trees. These plants serve as water reserves for small terrestrial crustaceans (such as crabs), frogs and invertebrates such as mosquitoes.

Lower levels of the forest were occupied by treelets and seedlings of woody plants in the family Lauraceae. True woody trees were observed at the summit of the hillock. As the hillock ascended the number of bromeliads was reduced as a result of canopy opening.

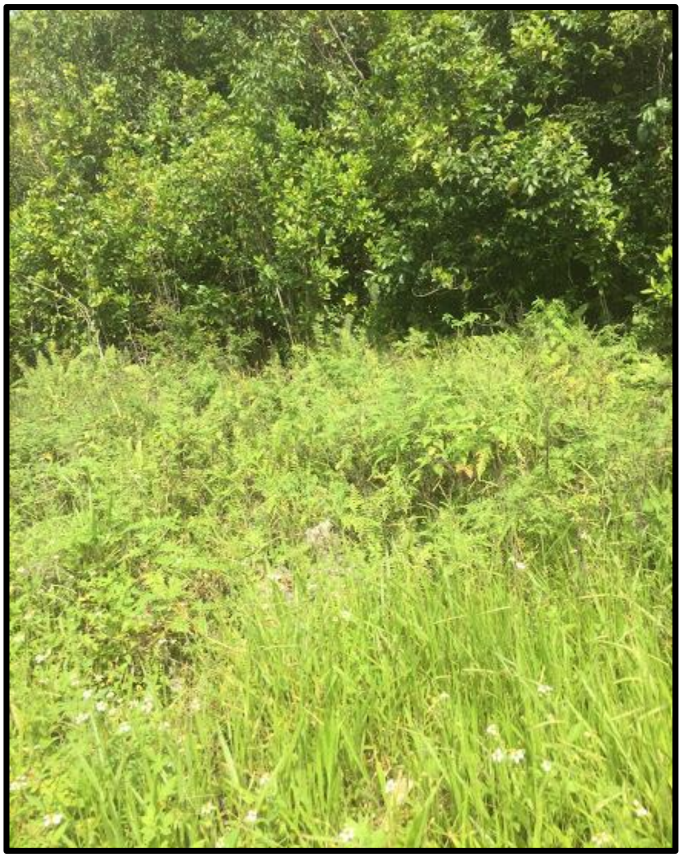

Figure 5-104: Slope site WPT 636. Thickets of grass indented by *Bidens alba* flowers. The middle band of light-tolerant *Nephrolepis sp.* Foreground dominated by small, woody trees ranging between 1-5m in height.

Figure 5-105: Herbaceous species : *Bidens pilosa* (left) and *Asclepia curassavica* (right)

Figure 5-106: Fern species observed: *Campyloneurum phyllitidis (left)* and *Nephrolepis sp. (right)*

Figure 5-107: *Ficus sp* (left)observed at WPT 638, 1628 ft. "*Card gum*", *Clusia flava* (left) observed at the lower level of the forest.

Figure 5-108: Inflorescence of the bromeliad, *Aechmea paniculigera*

5.3.3.3.1.2. Block 1 - Transect at WPT 658 18.309398° -77.452508

WPT 658 study area consisted of a more stony terrain with thick leaf litter. The transect line is shown in white in Figure 5-109. The general trend along the transect was a transition from grassland to shrubs and then woody trees. This site showed evidence of little to no previous disturbance occurring.

The average humidity was 86.2%. The depression/low lands was being used as pasture land for cattle. Trumpet tree, *Cecropia sp*, was a common woody plant observed within the forest. A few hillocks surrounding the low land appeared to have been previously affected by fires.

A high density of light-tolerant ferns dominated the rocky slope along with a few treelets showing evidence of forest regeneration. Similar observations were made at WPT 660. The "mountain pride" *Spathelia sp.* was observed consistently at various elevations along the slope. Epiphytes such as *Tillandsia sp, Syngonium auritum* and *P. lacerum*, extended from at least 7m upwards the slope site. Shrubs and tree seedlings were observed growing within the cracks of rocks. Figure 5-110 and Table 5-16 illustrate the vegetation profile and vegetation identification key plotted for the transect.

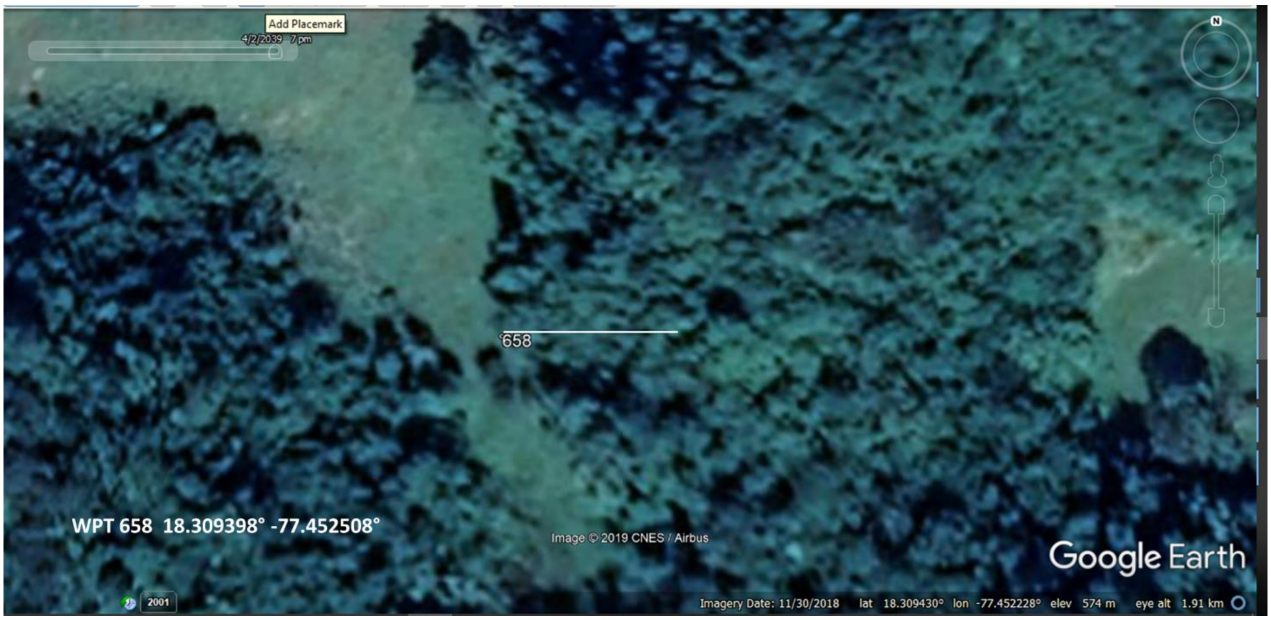

Figure 5-109: Transect Survey Site at WPT 658

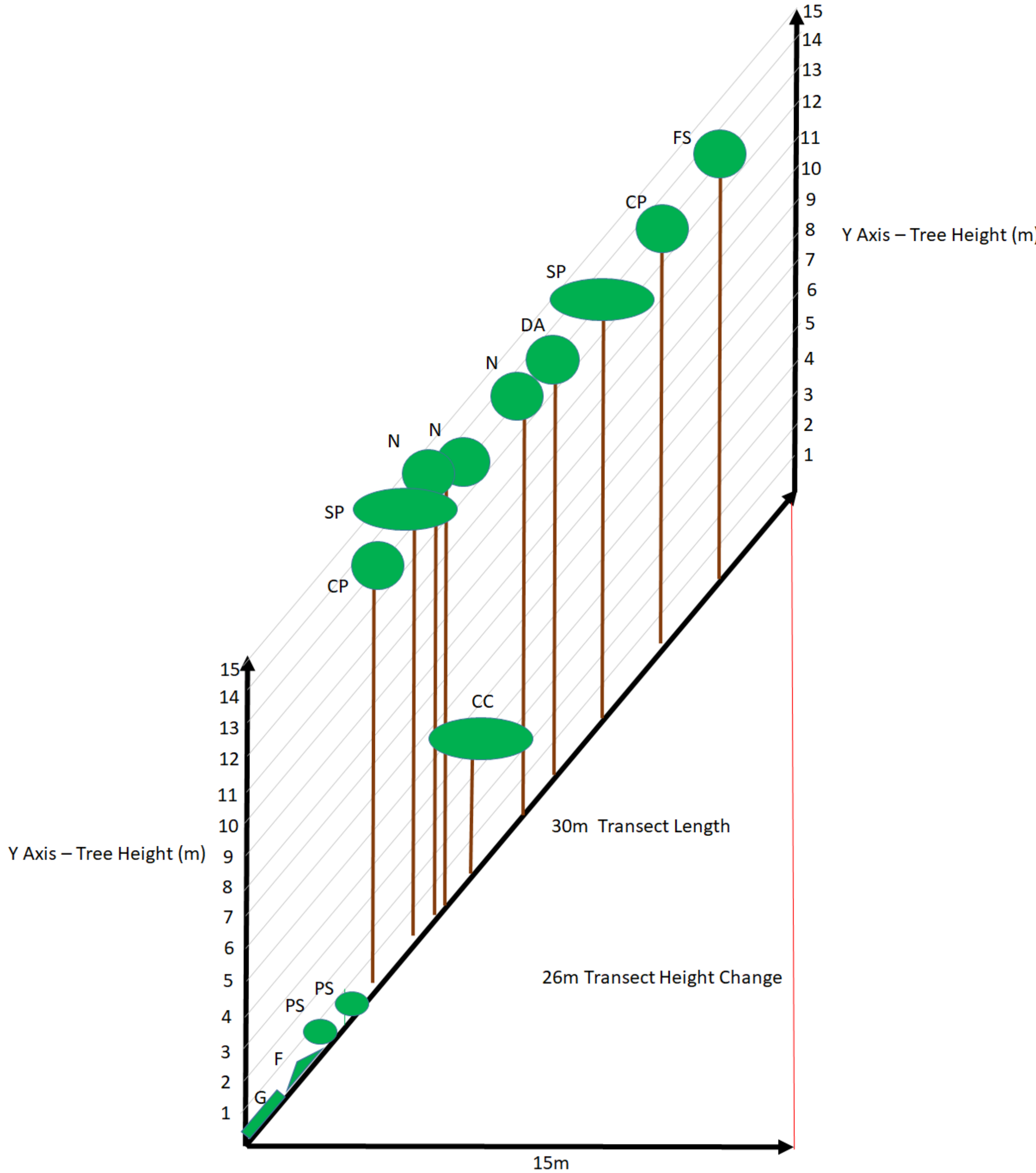

Figure 5-110: Vegetation Survey Plot for WPT 658

Table 5-16: Vegetation Profile Identification Key for WPT 658

Initials	Name	Average DBH (cm)	Estimated Average Height (m)
F	Fern	-	0.2
PS	*Pilea sp.*	-	*0.4*
SP	*Spathelia sp.*	*12*	*>10*
CP	*Cecropia peltata*	*15*	*>10*
N	*Nectandra sp.*	*32*	*>10*
DA	*Dendropanax arboreus*	*36*	*>10*
FS	*Ficus sp.*	*45*	*>10*
CC	*Coccoloba sp.*	*8*	*3*
G	*Sporobolus sp*	-	*<0.5*

5.3.3.3.1.3. Block 1 - Transect at WPT 665 - 18.334251° -77.451010°

This study site (Figure 5-111) showed evidence of high disturbance as tree stumps trailed inward showing that trees were previously cut, possibly for timber. Canopy cover was quite denser allowing only a little light to penetrate the forest floor. Average humidity in this region was 90.2%. The upper region of the forest floor appeared to be dominated (approximately 8 in one quadrat) by tank bromeliads, both epiphytic and non-epiphytic. *Syngonium auritum* was observed on tall (>15m) trees with broad stems. A few (3) endemic fan palms, *Thrinax parviflora* showed scattered distribution throughout the forest.

Depth of leaf litter increased as the slope was ascended. This allowed for taller trees with thicker buttress roots to occupy higher elevations. Woody climbers (Lianas) were entangled around a few trees. Moving outward the density of trees decreases and small shrubs and ferns occupied the lower levels. Similar to previous hillocks, the base showed evidence of zonation where ferns grow in thickets which skirted the hillocks.

Extending to the lowlands were grasslands, shrubs and herbaceous plants (*Bryophyllum pinnatum*) which served as habitats for invertebrates. The lowlands orebody at this site contained several plots used for agriculture and cattle grazing.

Figure 5-111 and Table 5-17 illustrate the vegetation profile and vegetation identification key plotted for the transect.

Figure 5-111: Transect Survey Site at WPT 665

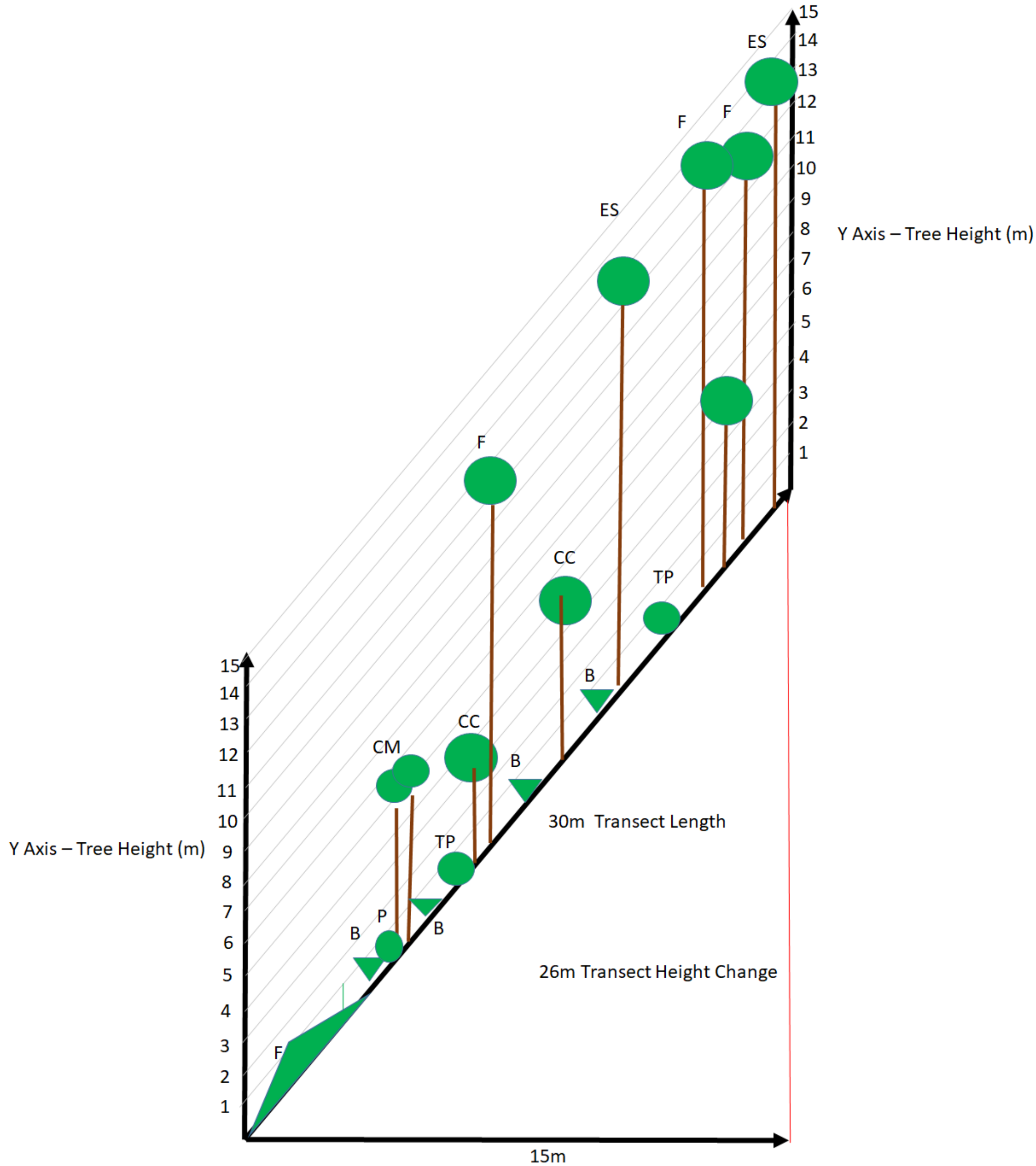

Figure 5-112: Vegetation Survey Plot for WPT 665

Table 5-17: Vegetation Profile Identification Key for WPT 665

Initials	Name	Average DBH (cm)	Average Height (m)
P	*Panicum sp.*	-	0.09
CM	*Comocladia sp.*	6.5	7
CC	*Coccoloba sp.*	8	6
f	Fern	-	0.7
F	*Ficus sp.*	35	>10
TP	*Thrinax parviflora*	7	1.3
B	Bromeliad	-	0.8
ES	*Eugenia sp.*	25	>10

Figure 5-113: Grasslands in the unmined ore body at WPT 665 being grazed by cattle

Figure 5-114: Endemic fan palm *Thrinax parvifolia* (left) b.) Aroid: *Syngonium auritum* (right)

5.3.3.3.1.4. Block 4 - Transect at WPT 674 - 18.364686° -77.445231°

This study area showed an irregular distribution of large (>10m tall) woody trees. The canopy was more open given that there was only a small abundance of trees in the understory. This allowed for more light to reach the forest floor. The path of the transect is shown as a white line in Figure 5-115.

Average humidity was approximately 75%. There was a decline in the number of woody and herbaceous climbers when compared to WTP 665. A small number of ferns (*Nephrolepis, Campyloneurum phyllitidis*) were sparsely dispersed throughout the forest floor.

Ascending inwards at 5m, *Nephrolepis sp.* dominated the base of the hillock. The prickly stemmed *Fagara martinicensis* was observed approximately 10 m into the forest. Some woody trees showed more clumped distribution in the marked plots. "Bull's hoof", *Bauhinia divaricata*, was observed approximately 25m into the forest. Also, another sighting was made along the roadside where butterflies were observed feeding. The diameter at breast height (DBH) of the trees increased with increasing distance inwards. The height, however, varied across the transect. Aroids such as the *Syngonium auritum* were no longer observed within the transect area at this location compared to the other sites. This seems to support the hypothesis that similarity in biodiversity is reduced with increasing distance between two hillocks. Notable was a number of endemic fan palms (seven), *Thrinax parviflora*, along the transect.

The lowland showed a greater density of plants from the Gramineae as well as some agricultural crops such corn (*Zea mays)*.

Figure 5-116 and Table 5-18 illustrate the vegetation profile and vegetation identification key plotted for the transect.

Figure 5-115: Transect Survey Site at WPT 674

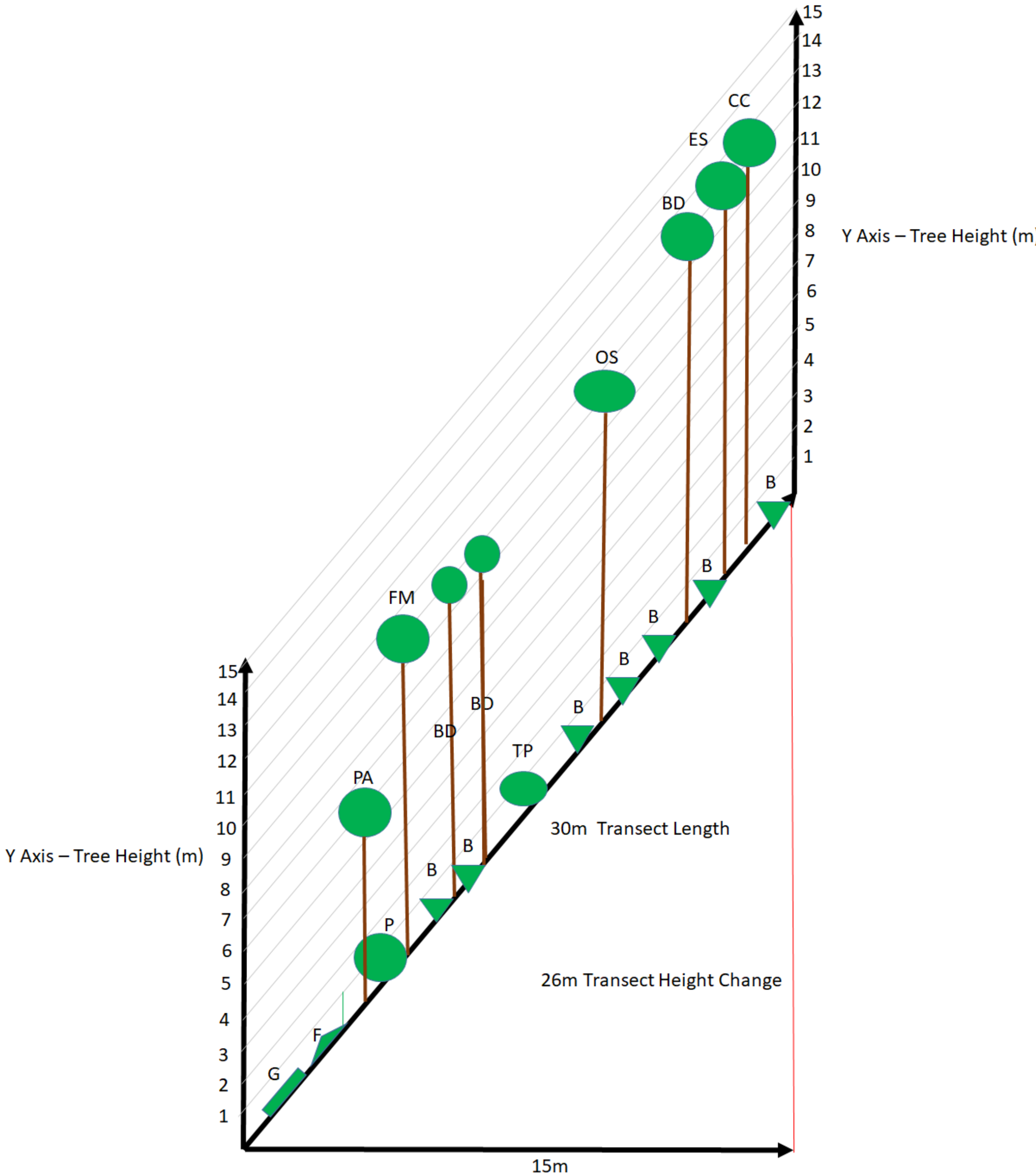

Figure 5-116: Vegetation Survey Plot for WPT 674

Table 5-18: Vegetation Profile Identification Key for WPT 674

Initials	Name	Average DBH (cm)	Average Height (m)
PA	*Piper amalago*	-	*7*
FM	*Fagara martinicensis*	*24*	*15*
BD	*Bauhinia divaricata*	*20*	*13*
B	*Bromeliad*	-	0.3
F	Fern	-	0.2
TP	*Thrinax parviflora*	*7*	*1.3*
OS	*Ocotea sp.*	*20*	*>10*
ES	*Eugenia Sp.*	*30*	*>10*
G	*Sporobolus sp*	-	*<0.5*
CC	*Coccoloba sp.*	*8*	*3*
P	*Panicum sp.*	-	*0.09*

5.3.3.3.1.5. Block 3 - Transect at WPT 684 - 18.314697° -77.509693°

This study area could be described as a closed broadleaf forest with evidence of human disturbance. The low-lying valley was comprised mainly grassland (*Panicum* sp.) blended with small herbaceous plants (*Bryophyllum pinnatum, Eupatorium odoratum*). The greatest species count was recorded between 20-30 m (woodland) of the slope (17 species recorded). Several tree species were recorded in that range including *Ocotea sp. Comocladia sp, Coccoloba sp, Malvaviscus arboreus* and *Dendropanax arboreus*. Fruit tree species such as *Psidium guajava* and *Mangifera indica* were represented in the central region of the surrounding ore body. Endemic plant species, *Blakea trinervia* and *Securidaca longipedunculata* were identified along this transect.

Approximately 12m left of the transect was a clear-cut pathway with sparse vegetation. At the foot of the slope was a small dumpsite recorded at WPT 679. Throughout was an indicator species known as “Johncrow Bush”, *Bocconia frutescens*. It was indicative of disturbance and degradation of habitat as it thrives in high light intensity areas and become readily established in a cleared area.

Figure 5-118 and Table 5-19 illustrate the vegetation profile and vegetation identification key plotted for the transect.

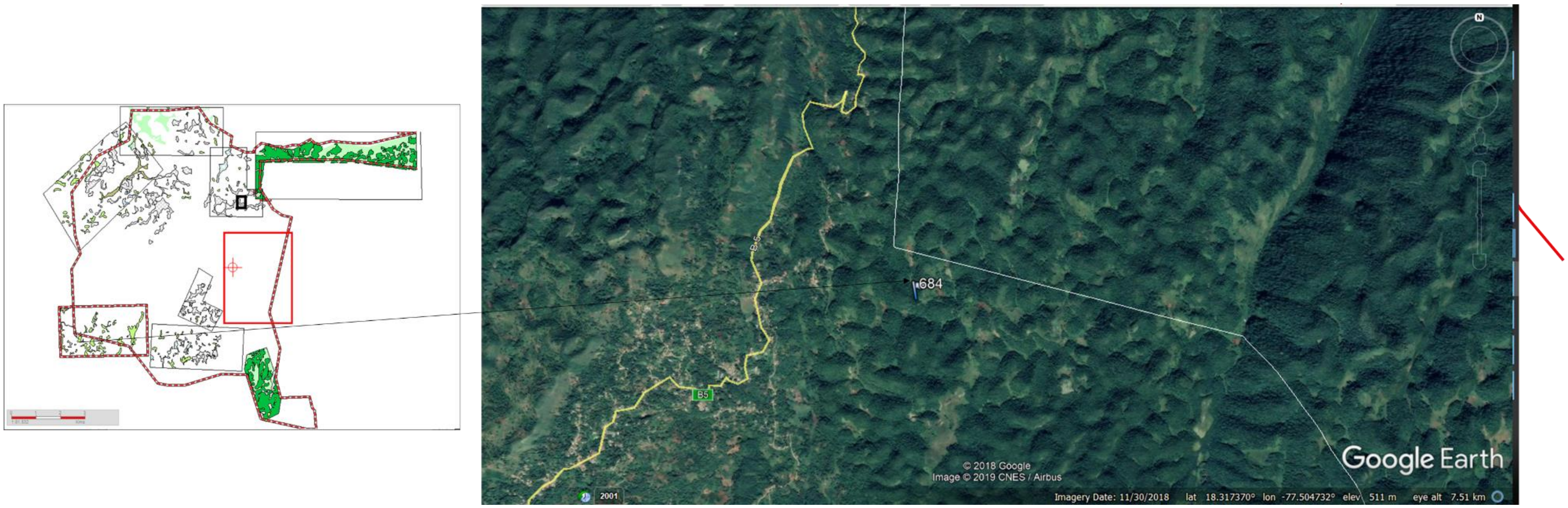

Figure 5-117: Transect Survey Site at WPT 684

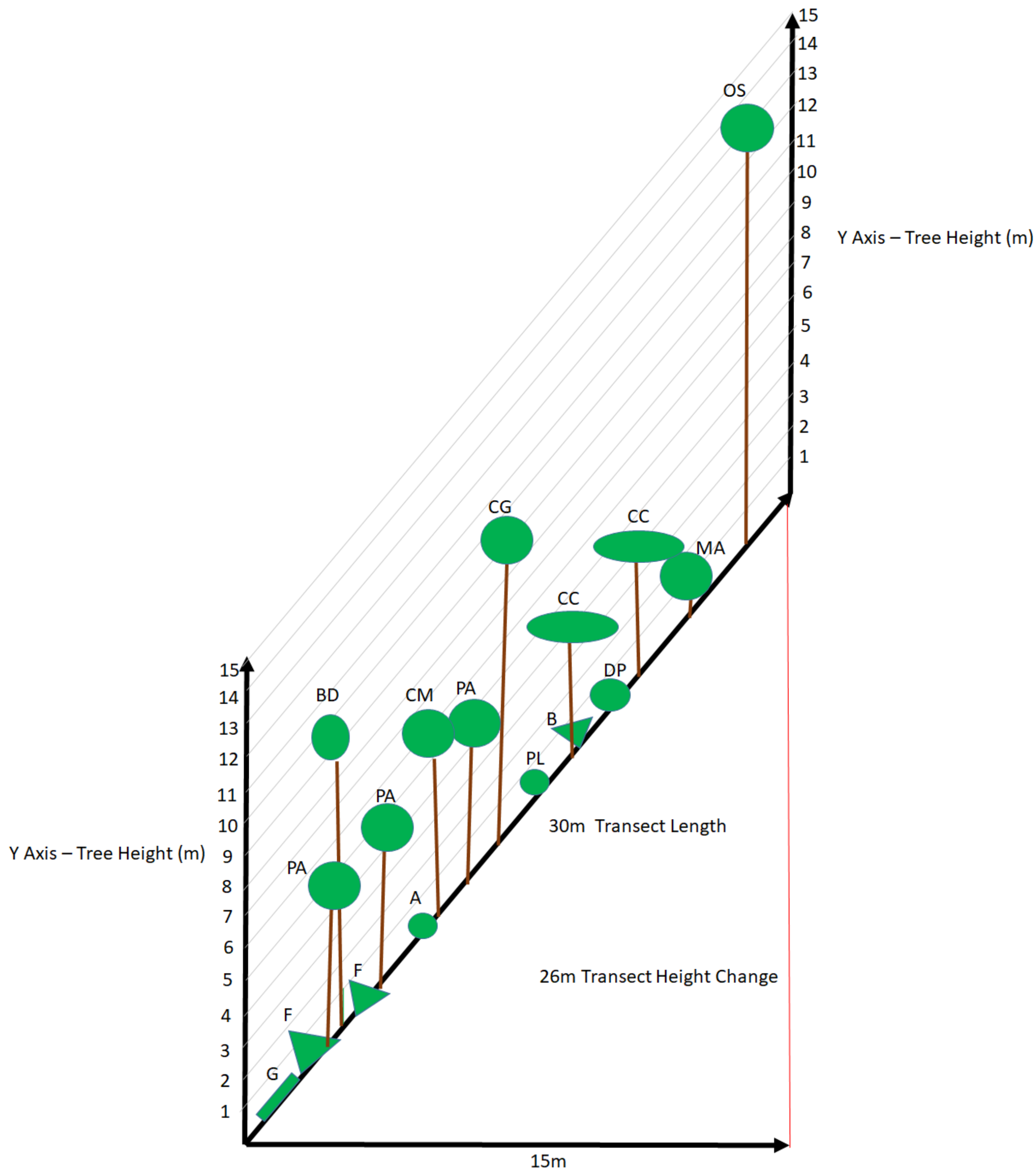

Figure 5-118: Vegetation Survey Plot for WPT 684

Table 5-19: Vegetation Profile Identification Key for WPT 684

Initials	Name	Average DBH (cm)	Average Height (m)
OS	*Ocotea sp.*	25	>10
MA	*Malvaviscus arboreus*	30	1.3
DP	*Dendropanax arboreus*	25	0.8
CG	*Cupania glabra*	22	10
CC	*Coccoloba sp*	5	4
PL	*Philodendron lacerum*	-	3
F	*Fern species*	-	0.8
A	*Aechmea paniculigera*	-	1.2
PA	*Piper amalago*	-	5
CM	*Comocladia sp.*	*6.5*	*7*
BD	*Bauhinia divaricata*	*20*	*>10*

Figure 5-119: Evidence of anthropogenic activities: small garbage clutter observed at the foot of the slope.

Figure 5-120: Set up of transect along a clearly defined pathway

5.3.3.3.1.6. Block 7 - Transect at WPT 687 - 18.310495° -77.463553°

This study area (Figure 5-121) was defined by its dense, closed canopy with relatively high humidity (75.2%). There was almost no evidence of human disturbance, placing this among the pristine areas. The most abundant species along the transect was bracken fern, *Pteridium sp*. This presented as evidence of disturbance. However, it was also noted that a significant amount of plants observed were dried up and burnt between 20-30m of the transect. It is possible that a recent fire could have brought about this disturbance. Medicinal tree species such as *Rhytidophyllum tomentosum* were present on the lower slope. The forest floor was densely covered with a number of ferns, bromeliads and orchids. The two main orchid species observed were *Epidendrum cochleatum* and *Oncidium tetrapetallum*. Frequent sightings of hummingbirds were made in the vicinity of the flowering tree, *Malvaviscus arboreus*.

Figure 5-121 and Table 5-20 illustrate the vegetation profile and vegetation identification key plotted for the transect.

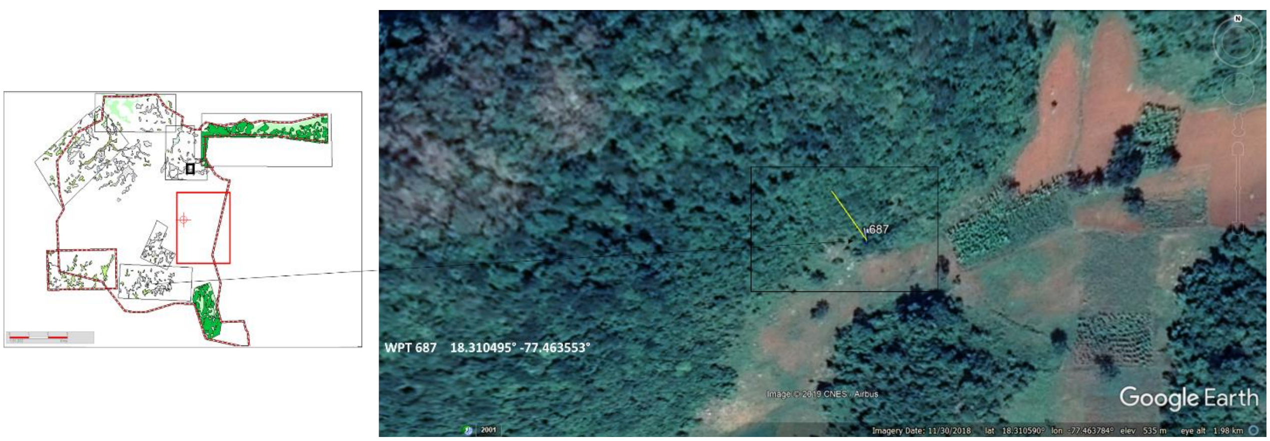

Figure 5-121: Transect Survey Site at WPT 687

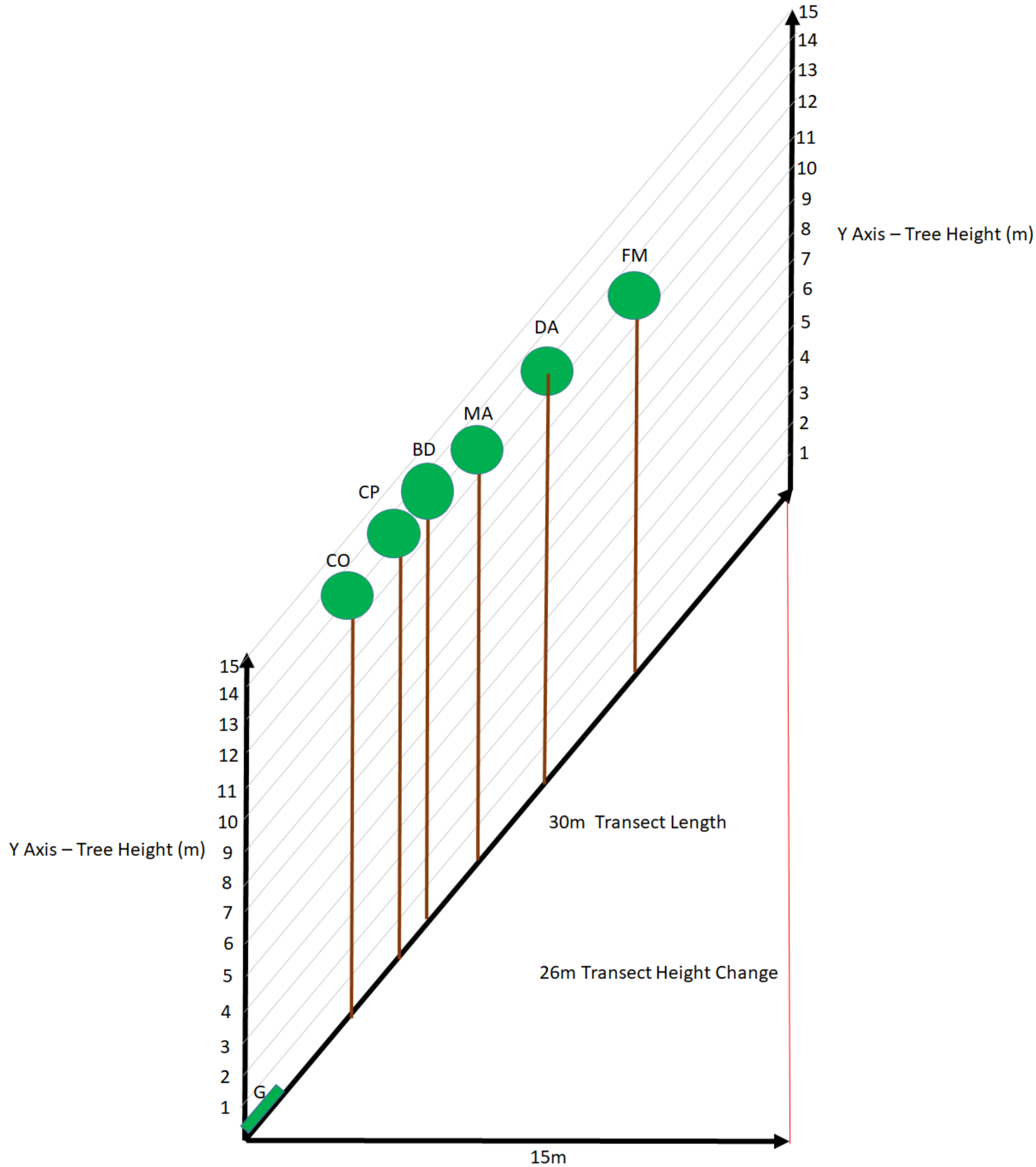

Figure 5-122: Vegetation Survey Plot for WPT 687

Table 5-20: Vegetation Profile Identification Key for WPT 687

Initials	Name	Average DBH (cm)	Average Height (m)
CO	*Comocladia sp.*	8	10
BD	*Bauhinia divaricata*	22	>10
MA	*Malvaviscus arboreus*	25	>10
CP	*Cecropia peltata*	17	>10
DA	*Dendropanax arboreus*	35	>10
FM	*Fagara martinicensis*	21	>10

Figure 5-123: *Epidendrum cochleatum*

Figure 5-124: Forest vegetation at WPT 687

Figure 5-125: Flowering *Malvaviscus arboreus*

5.3.3.3.1.7. Block 8 - Transect at WPT 036 - 18.297346° -77.445489°

This study area could be described as a disturbed broadleaf forest. Non-overlapping canopy cover allowed for greater amounts of light to penetrate the forest floor. This area was defined by a number of tree species. Two of these species were only observed at this location: *Simarouba glauca and Plumeria obtusa*). Vegetation along the forest floor was primarily defined by aroids (*Syngonium auritum, Philodendron lacerum*,), bromeliads (*Aechmea paniculigera, Hohenbergia sp.*), orchids (*Epidendrum sp*.), ferns (*Campyloneurum phyllitidis, Polygonum polypoides, Nephrolepis*) and a few herbs (*Pilea sp.*).

Figure 5-127 and Table 5-21 illustrate the vegetation profile and vegetation identification key plotted for the transect.

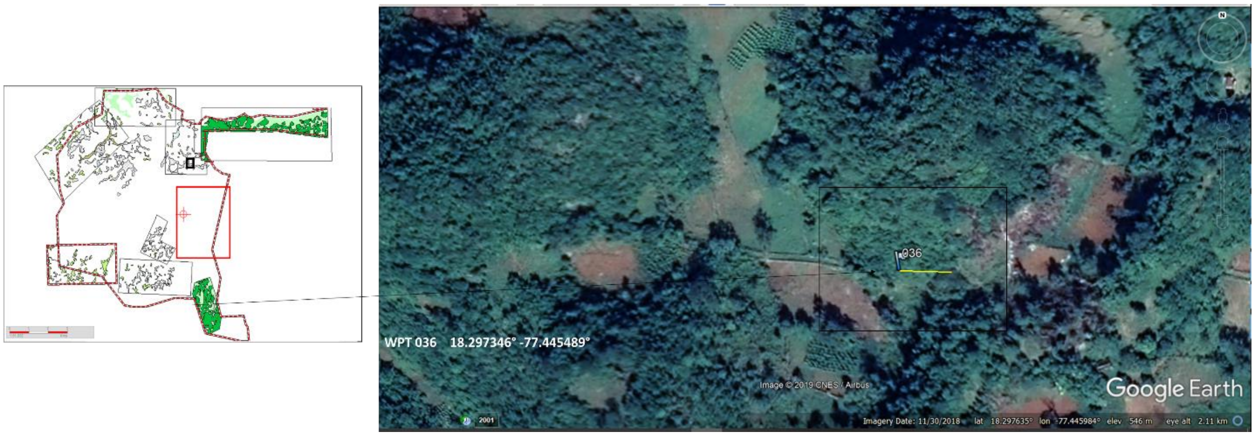

Figure 5-126: Transect Survey Site at WPT 036

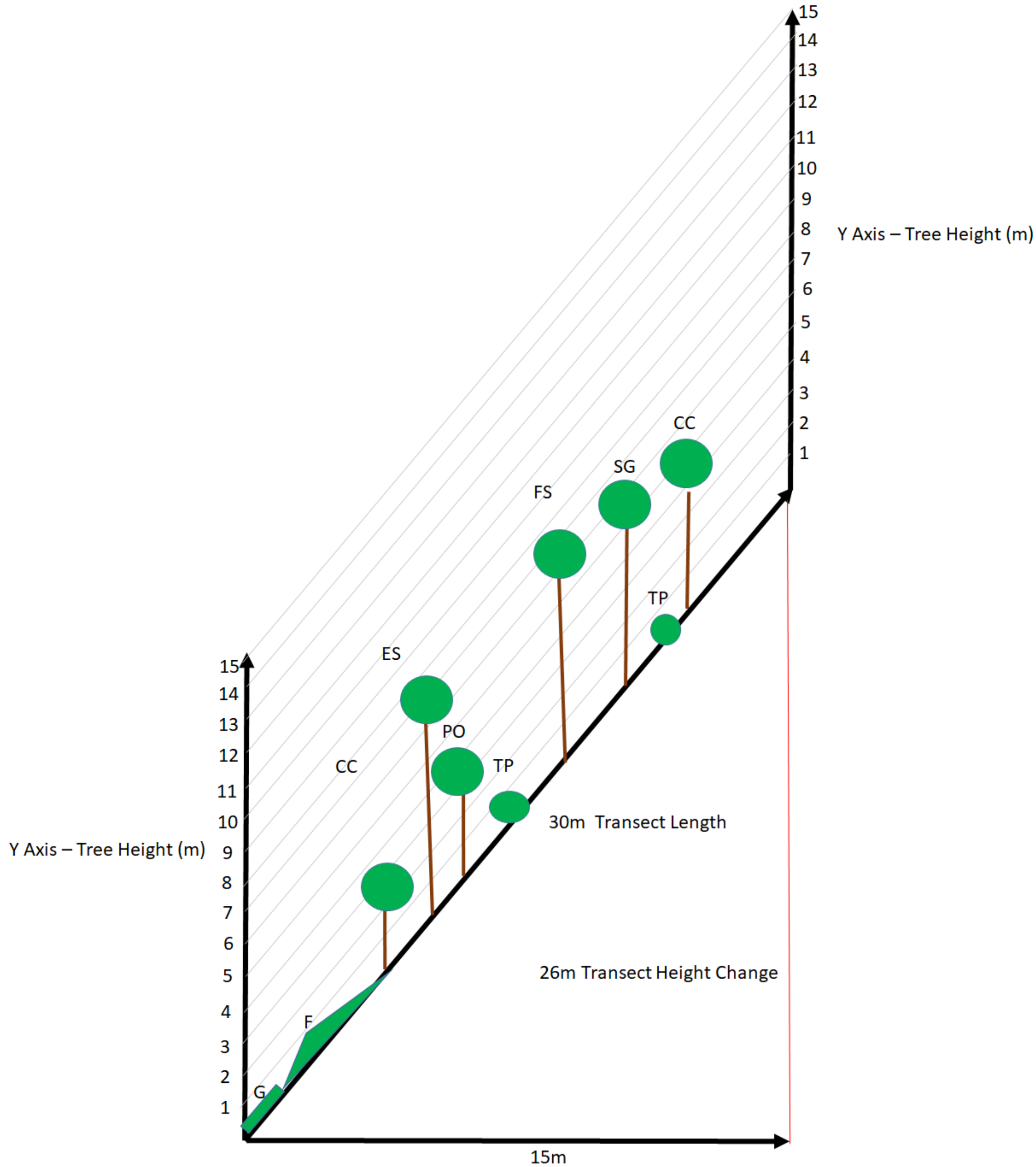

Figure 5-127: Vegetation Survey Plot for WPT 036

Table 5-21: Vegetation Profile Identification Key for WPT 036

Initials	Name	Average DBH (cm)	Average Height (m)
CC	*Coccoloba sp*	6	5
PO	*Plumeria obtusa*	9	7
ES	*Eugenia sp.*	24	>10
TP	*Thrinax parviflora*	8	2
FS	*Ficus sp.*	*45*	*>10*
SG	*Simarouba glauca*	11	>10
F	Fern	-	0.2
G	*Sporobolus sp*	-	*<0.5*

5.3.3.3.1.8. Block 9 - Transect at WPT 696 - 18.326644° - 77.454051°

This study area (Figure 5-128) was represented as a mixture of disturbed and closed broadleaf forest. The first 10m of the slope showed thicket of ferns and shrub species intertwined with vines. This created a closed canopy arrangement. Ascending the slope, the canopy became more open. The species count was greatest between 10-15m of the slope (19 species). The most abundant tree type observed at the upper slope was the endemic *Portlandia* sp. Vegetation on the forest floor was sparse and the area was defined mainly by tree species. (*Coccoloba sp, Comocladia sp, Bumelia nigra, Spathelia sp., Ziziphus chloroxylum*). Approximately 4 individual endemic fan palms, *Thrinax parviflora* were noted along the study region. There was a reduction in the number of epiphytes and climbers observed as the canopy was more open moving upwards with gaps of light penetrating the forest floor. The open canopy allowed for the presence of endemic birds such as the Jamaican Tody. A number of Anolis species were observed with seven (7) counts recorded along the trunks of the trees and on the leaf litter.

Figure 5-128 and Figure 5-129 below illustrate the vegetation profile and vegetation identification key plotted for the transect.

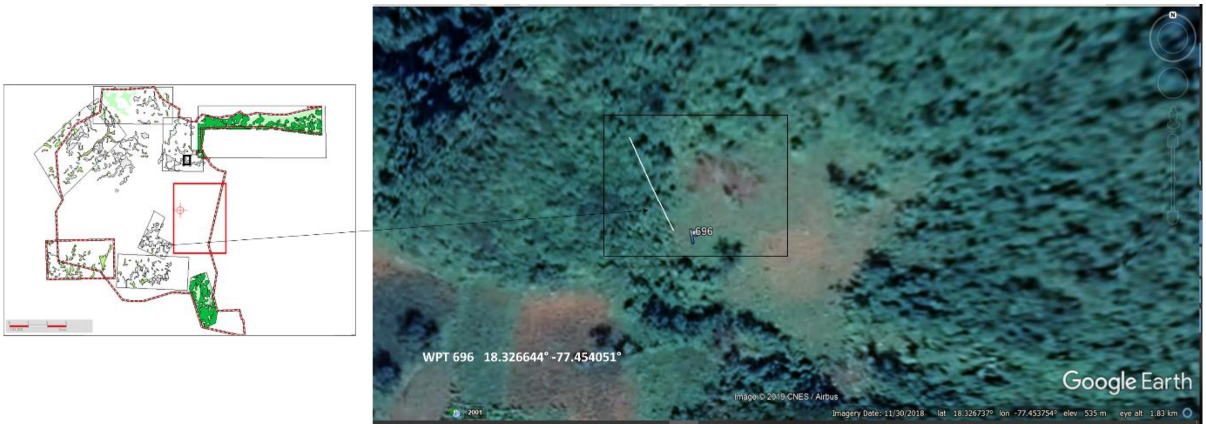

Figure 5-128: Transect Survey Site at WPT 696

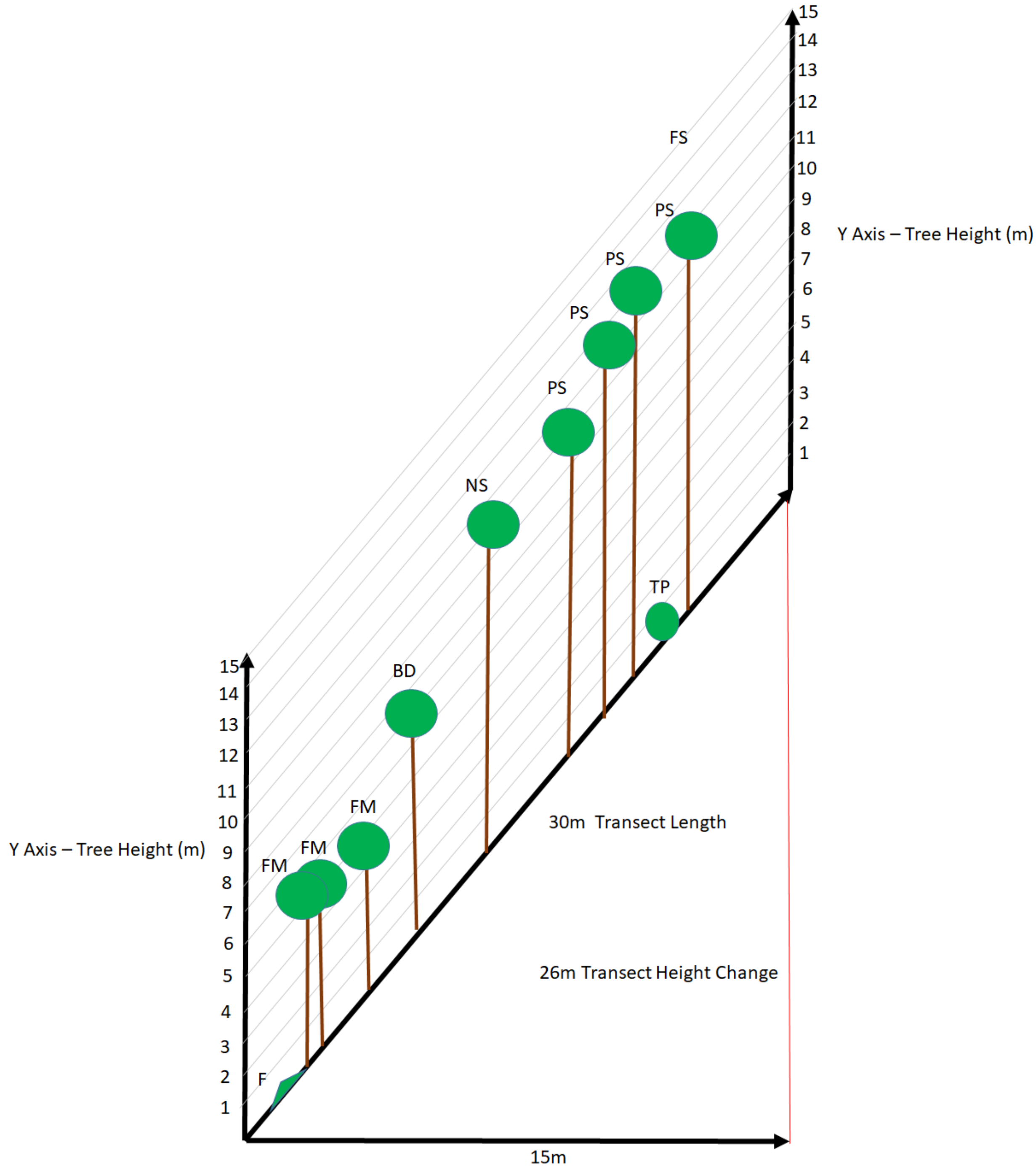

Figure 5-129: Vegetation Survey Plot for WPT 696

Table 5-22: Vegetation Profile Identification Key for WPT 696

Initials	Name	Average DBH (cm)	Average Height (m)
NS	*Nectandra sp.*	25	>10
FM	*Fagara martinicensis*	14	7
PS	*Portlandia sp.*	19	>10
TP	*Thrinax parviflora*	6	2
SP	*Spathelia sp.*	13	>10
BD	*Bauhinia divaricata*	*22*	*>10*
F	Fern	-	0.2

5.3.3.3.2. Transition Zone Between Hillocks and Lowlands

The border between highland tree forest and lowland grasslands (as shown in Figure 5-130) was defined by a vegetation zone of approximately 3-5 meters in thickness, along the perimeter of all orebodies. This area was dominated by shrubs and herbs. All orebodies assessed had this feature. The transects mentioned in Section 5.3.3.3.1 above details the species identified within this area. However, additional assessments were also done due to the extensive perimeter of the orebodies. The plants most frequently observed during the assessment of the perimeters of the orebodies are listed in Table 5-23 below.

Table 5-23: Most Obvious Plants Occupying the Transition Zone Between Hillock and Cockpit Vegetation Zones

Common Name	*Scientific Name*	DAFOR Scale	IUCN Ranking
Lantana	***Lantana camara***	**F**	- No Info Found
Bitterbush	***Eupatorium villosum***	***O***	- No Info Found
Spanish Needle	***Bidens pilosa***	***F***	- No Info Found
Duppy Gun	***Ruellia tuberosa***	***O***	- No Info Found
Wild Frangipani	***Plumeria obtusa***	***O***	- No Info Found
Snake Plant	***Sansevieria trifasciata***	***O***	- No Info Found
Shame Me Lady	***Mimosa pudica***	***O***	LC
Cockspur	***Pisonia acculeata***	***O***	- No Info Found
Wild Hop	***Moghania stribilifera***	***O***	- No Info Found
Ram Goat Dash along	***Turnera ulmifolia***	***O***	- No Info Found
	Piper amalgo	***O***	- No Info Found
	Piper arboreum	***O***	- No Info Found
Vervine	***Stachytarpheta jamaicensis***	***O***	- No Info Found

Figure 5-130: Depiction of vegetation transition zone between hillock and lowland vegetation (white box). Cultivation shown at left of image.

5.3.3.3.3. Lowlands:

The lowlands were populated by a combination of grass pastures and agricultural plants.

5.3.3.3.3.1. Grasses

Grasses were by far the most abundant vegetation type present on the lower depressions found between limestone hillocks on the site. ***Sporobulus virginicus*** was the overwhelmingly dominant grass type found within the lowland areas (see Figure 5-131 to Figure 5-132 below).

Figure 5-131: *Sporobolus sp* dominated the lowland or 'cockpit' area

Figure 5-132: *Sporobolus sp* observed in lowlands at the site

5.3.3.3.3.2. Agricultural Plants (O)

Subsistence farming was observed within the lowland areas – throughout SML 173 (see Figure 5-133). Table 5-24 below outlines the various types of agricultural trees and plants observed within the lowlands.

Figure 5-133: Agricultural plots present within the lowland or 'cockpit' area (crop = sweet potato)

Table 5-24: Types of agricultural trees and plants observed within the lowland areas

Common Name	Scientific Name
Carrot	*Daucus carota*
Callaloo	*Amaranthus viridis*
Escallion	*Allium fistulosum*
Mango	*Magnifera indica*
Coco	*Colocasia esculenta*
Spanish needle	*Bidens cynapiifolia*
Cabbage	*Brassica oleracea*
Pak choi	*Brassica rapa*
Pineapple	*Ananas comosus*
Cactus	*Hylocereus triangularis*
Sweet Potato	*Ipomoea batats*
Leaf of Life	*Byrophyllum pinnatum*
Pumpkin	*Curcurbita pepo*

5.3.3.4. Fauna Findings

5.3.3.4.1. Fauna Literature Review

Camirand and Evelyn (2004) speak generally to the presence/absence of mammals, reptiles and land-birds within these forested areas. Only three naturally occurring terrestrial mammals are known to frequent forest types like these. These are the (i) rare Jamaican Hutia, (ii) the introduced, and now naturalized mongoose, (iii) and up to 21 species of bats.

Reptiles are represented by 43 species including lizards and at least four snake species. Also included are 67 species of birds.

5.3.3.4.2. Endemism

Jamaica has been recognized as having a high level of endemism within its floral and faunal groups, a fact that is overshadowed by the level of disturbance that has occurred within the supporting habitats due to human interventions[35].

An examination of endemism amongst various lifeform groups was done with the view of obtaining lists of endemic species, which could then be used for comparison with field findings. These are discussed below:

5.3.3.4.2.1. Birds

Dickinson, E.C. (2003)[36] described 29 species of locally found birds that are regarded as being endemic to Jamaica. These are listed in Appendix XIV.

The area is known to support 67 resident breeding land birds twenty-eight (28) of which are endemic species.

[35] http://www.worldwildlife.org/wildworld/profiles/terrestrial/nt/nt0218_full.html

[36] Dickinson, E.C. (Ed.) (2003) The Howard and Moore Complete Checklist of the Birds of the World. Revised and enlarged third edition. Princeton University Press, Princeton.

5.3.3.4.2.2. Reptiles

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. Reptiles are important predators of insects (including those which are agricultural pests), small vertebrates (such as rodents) and some that may consume fruits. They are also preyed upon by mammals, birds, fish, large invertebrates (such as spiders and mantids) and they are prey for smaller reptiles, making them also important in the food web.

Jamaica has approximately 33 endemic reptile species (Wilson, 2011[37]), 20 of which can be found in the general area (Windsor Research Centre, 2014[38]). These are listed in Appendix XV.

Of the 20 reptile species that can be found in the area, two (2) have habitats exclusively in the contiguous Cockpit Country. These are Bromeliad Galliwasp (*Celestus fowleri)* and Eyespot Shpaero *(Sphaerodactylus semasiops)* (Windsor Research Centre, 2014) and has been categorized as Data Deficient (DD) by the International Union for Conservation of Nature (IUCN), meaning that little or no information is available on the abundance and distribution of the species (IUCN, 2019). Jamaican Slider *(Trachemys terrapen*) and Jamaican Boa *(Chilabothrus subflavus*) have 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), while the other 17 reptiles have been categorized as Not Evaluated (NE) by the IUCN, meaning that the species has not yet been studied for any risk to be quantified and published (IUCN, 2019).

5.3.3.4.2.3. Frogs

Amphibians play a role as an important indicator in an ecosystem, as they all possess a thin and highly permeable skin that offers them little protection against environmental stressors.

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[37] Wilson, Byron S. 2011. "*Conservation of Caribbean Island Herpetofaunas Volume 2: Regional Accounts of the West Indies*". Brill.

[38] Windsor Research Centre. 2014. "*Reptile Checklist*". https://www.cockpitcountry.com/ReptileChecklist.html, Date Accessed 20/08/2019.

This makes them sensitive to changes in aquatic and terrestrial environments (Waddle, 2006[39]). As such, they are able to detect changes in the environment, and respond to changes. The responsiveness of the amphibian to the stressor depends on the type of stressor and the type of amphibian (Waddle, 2006[40]).

Frost D.R. (2004) [41] described 21 species of frogs endemic to Jamaica. These are listed in Appendix XVI. The Windsor Research Centre's Amphibian Checklist makes reference to 26 species of frogs and toads in Jamaica. Of this list, 19 are known to occur, or have been seen within the general area and two species, the Leaf Mimic Frog (*Eleutherodactylus sisyphodemus*) and the Cockpit Frog (*Eleutherodactylus griphus*) are known to range only within the contiguous Cockpit Country and are regarded as being critically endangered (CR).Four species of frogs use bromeliads for reproduction, with eggs being laid in water pools enclosed in the long leaves of the bromeliad plants.

Cane Toad *(Rhinella marina*), Bull Frog *(Lithobates catesbianus*), Cuban Flathead Frog *(Eleutherodactylus planirostris*) and Lesser Antillean Frog *(Eleutherodactylus johnstonei*) are all invasive species and all have an IUCN rank of Least Concerned (LC). Jamaican Forest Frog *(Eleutherodactylus gossei*) and Jamaican Laughing Treefrog *(Osteopilus ocellatus*) are Endemic frogs with an IUCN status of Least Concerned (LC) (IUCN, 2019). Jamaican Snoring Treefrog *(Osteopilus crucialis*), Jamaican Yellow Treefrog *(Osteopilus marianae*), Jamaican Green Treefrog *(Osteopilus wilderi*), Jamaican Pallid Frog *(Eleutherodactylus grabhami*), Jamaican Bromeliad Frog *(Eleutherodactylus jamaicensis*) and Jamaican Masked Frog *(Eleutherodactylus luteolus*) all have an IUCN status of Endangered (EN) all are endemic frogs.

Jamaican Yellow-bellied Frog *(Eleutherodactylus pantoni*) has an IUCN status of Near threatened (NT)). *Eleutherodactylus cundalli* has been given the status of Vulnerable (VU),

[39] http://etd.fcla.edu/UF/UFE0016760/waddle_j.pdf

[40] http://etd.fcla.edu/UF/UFE0016760/waddle_j.pdf

[41] Frost, D.R. (2004) Amphibian Species of the World: an Online Reference. 3.0 (22 August 2004). American Museum of Natural History, New York, USA.

Rock Pocket Frog *(Eleutherodactylus junori*) and the Jamaican Ear-spot Frog *(Eleutherodactylus fuscus*) have been given the status of Critically Endangered (CR) (IUCN, 2019).

5.3.3.4.2.4. Arthropods

Arthropods are invertebrates that have an exoskeleton, a segmented body and paired, jointed appendages[42]. Butterflies represent the most conspicuous of flying invertebrates in Jamaica[43].

Of the 125 species of butterflies found locally, at least 94 are found within the general area. Eighteen species of Jamaican butterflies have been identified as being endemic. These are listed in Appendix XVII. All have been reported to be found in the general area.

Of note is the giant swallowtail butterfly (*Pterourus homerus,* formerly called *Papilio homerus)*, which is the largest in the new world and one of the largest in the world[44]. It's distribution is shown in Figure 5-134 below. Studies by Lenhert, 2013[45] states that populations are found in the core of the cockpit country. From the literature review and field investigations there is no evidence of the *Pterourus homerus,* formerly called *Papilio homerus* in SML 173.

The Giant Swallowtail Butterfly is a protected, threatened and an endemic species which has been observed in the Blue and John Crow Mountains National Park, the Dolphin Head Mountains and the core Cockpit Country. The Water Mahoe (*Hernandia catalpifolia*) is

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[42] https://en.wikipedia.org/wiki/Arthropod

[43] http://nhmj-ioj.org.jm/ioj_wp/wp-content/uploads/Biodiversity_Manual_Cockpit-Country_Acknowlegdement.pdf

[44] Discovering Jamaican Butterflies and their relationships around the Caribbean, by Thomas Turner and Vaughan Turland, 2017

[45] *Male-Male Interactions in the Endangered Homerus Swallowtail, Papilio homerus (Lepidoptera: Papilionidae), in Jamaica*, Matthew S. Lehnert, Thomas C. Emmel, and Eric Garraway, Caribbean Journal of Science, Vol. 47, No. 1, 57-66, 2013, College of Arts and Sciences, University of Puerto Rico, Mayaguez

accepted as the main feeding source for the *Pterourus homerus,* formerly called *Papilio homerus.* It also requires specific micro-climatic conditions to support its life cycle including high relative humidity and other physico-chemical characteristics. The likely presence of *Pterourus homerus* is indicated by the Water Mahoe. Therefore, special emphasis was placed on the identification of the Water Mahoe during the field work for this ecological study, including measurements of micro-climatic conditions. No Water Mahoe was observed.

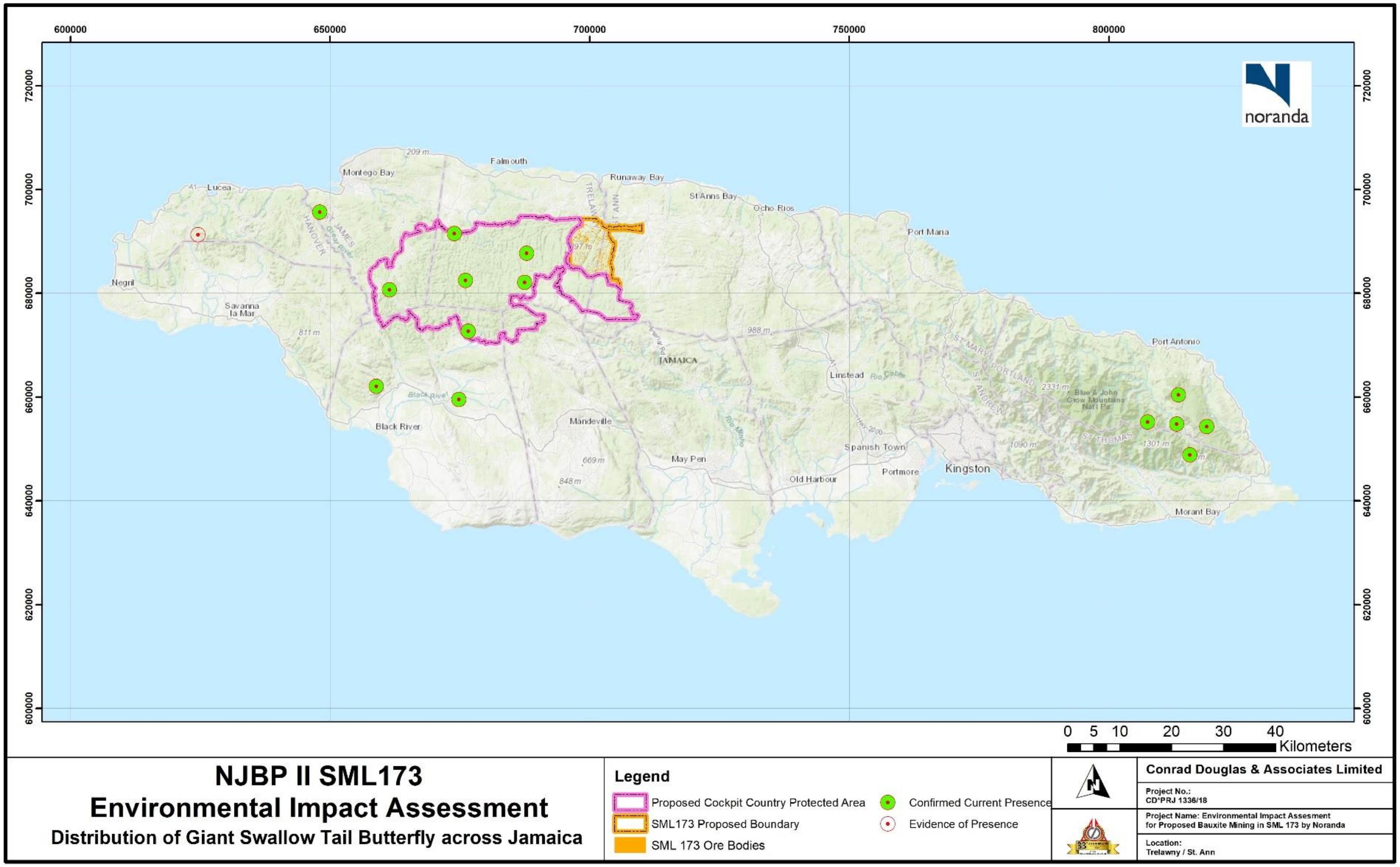

Figure 5-134: Distribution Map for Giant Swallowtail (*Source: Turner and Turland, 2017*)

5.3.3.4.2.5. Gastropods

Rosenberg and Muratov (2006) [46] have identified a total of 562 Snails and Slugs in Jamaica, of which 505, or over 90% are endemic. No lists were found, however, *Eurycratera jamaicensis* and *Poteria sp* are two examples of endemic snails identified within wet limestone environments such as the study area. With such a high percentage of endemism, it is likely that any typical snail found within an area could be an endemic species.

5.3.3.4.2.6. Mammals

Wilson, D.E. & Reeder, D.M. (2005)[47] 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 and 16 are known to inhabit the general area and its environs[48]. These are listed in Appendix XVIII.

Both Dunn's Hole and Drip (Belmont) caves are described in the Jamaica Caves Organization's Jamaican Caving Notes[49,50], with sightings of the following fauna having been described from previous visits:

Drip/Belmont Caves:

1. Jamaican Rock Frog (*Eleutherodactylus cundalli*), an endemic species regarded as being near threatened by the IUCN's Red List.
2. Amblypygid Arachnids
3. Numerous Cave Crickets
4. Numerous unidentified bats

[46] Rosenberg G. & Muratov I. V. (2006). "Status Report on the Terrestrial Mollusca of Jamaica"*Proceedings of the Academy of Natural Sciences of Philadelphia* **155**(1): 117-161. doi:10.1635/i0097-3157-155-1-117.1.

[47] 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.

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

[49] http://www.jamaicancaves.org/belmont_drip_060602.htm

[50] http://www.jamaicancaves.org/dunns-hole-060331.htm

Dunn's Hole:

1. Jamaican Rock Frog (*Eleutherodactylus cundalli*), an endemic species regarded as being near threatened by the IUCN's Red List.
2. Bats

Other than Bats, both the Mongoose (*Herpestes sp.*) and Mice/Rats represent mammals that are likely to be seen in the natural environment within the SML 173 area. The Jamaican Coney (*Geocapromys brownii*) is a rodent which is endemic to Jamaica. However, sightings of this endemic mammal have been rare.

Global bat populations have been reported as being on the decline[51]. 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 XIX) 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

1 [51] 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

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.

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[52]. The accepted frequency profiles of the common bat species in Jamaica as presented by the WRC are shown in Figure

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

5-135 below. The bat scientific names and species codes, for each frequency, are listed in Table 5-29 below.

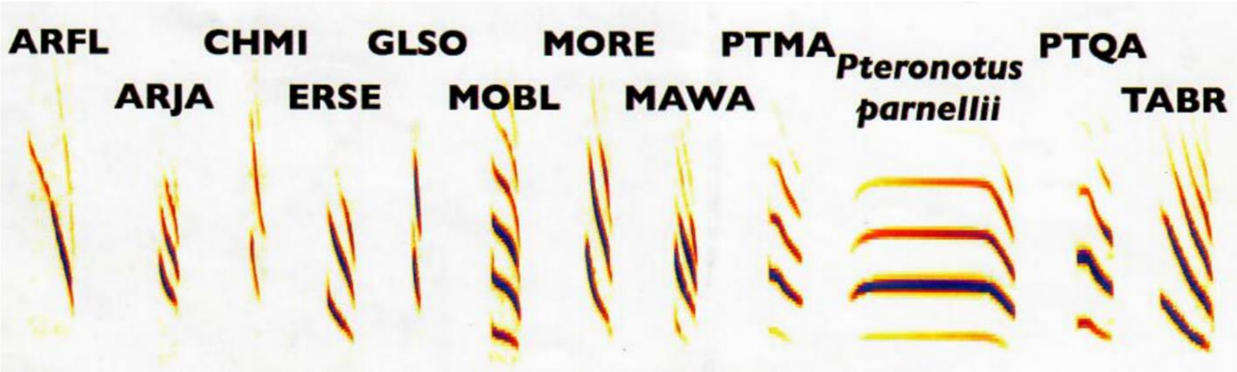

Figure 5-135: Bat Calls Frequency Profiles for Local Jamaican Bats - Windsor Research

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.

5.3.3.5. Field Observations

5.3.3.5.1. Birds

5.3.3.5.1.1. Bird Observations

The following types of birds were observed during day surveys conducted at the site (see illustrations of endemics* on Figure 5-136).

Table 5-25: Birds observed during day surveys conducted at the site

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
No.	**Species List** (endemic*)	**DAFOR Scale**	**IUCN Ranking**
1	American Kestrel (*Falco sparverius*)	O	LC
2	Antillean Palm Swift (*Tachornis phoenicobia*)	O	LC

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
No.	**Species List** (endemic*)	**DAFOR Scale**	**IUCN Ranking**
3	Arrow-headed Warbler (*Setophaga pharetra*)*	O	LC
4	Bananaquit (*Coereba flaveola*)	O	LC
5	Barn Owl (*Tyto alba*)	O	LC
6	Black-Faced Grassquit (*Melanospiza bicolor*)	R	LC
7	Black-whiskered Vireo (*Vireo altiloquus*)	O	LC
8	Cattle Egret (*Bubulcus ibis*)	O	LC
9	Cave Swallow (*Petrochelidon fulva*)	F	LC
10	Chestnut-bellied Cuckoo (*Coccyzus pluvialis*)*	O	LC
11	Common Ground Dove (*Columbina passerina*)	F	LC
12	Gray Kingbird (*Tyrannus dominicensis*)	O	LC
13	Greater Antillean Bullfinch (*Loxigilla violacea*)	O	LC
14	Greater Antillean Grackle *(Quiscalus niger*)	O	LC
15	Green Rumped Parrotlet (*Forpus passerines*)	R	-
16	Jamaican Becard (*Pachyramphus niger*)*	R	LC
17	Jamaican Crow (*Corvus jamaicensis*)*	F	LC
18	Jamaican Euphonia (*Euphonia Jamaica*)*	O	LC
19	Jamaican Mango (*Anthracothorax mango*)*	O	LC
20	Jamaican Lizard Cuckoo (*Saurothera vetula*)*	O	LC
21	Jamaican Owl (*Pseudoscops grammicus*)*	R	LC
22	Jamaican Peewee (*Contopus pallidus*)*	O	LC
23	Jamaican Spindalis (*Spindalis nigricephala*)*	O	LC
24	Jamaican Tody (*Todus todus*)*	R	LC
25	Jamaican Vireo (*Vireo modestus*)*	R	LC
26	Jamaican Woodpecker (*Melanerpes radiolatus)**	R	LC
27	Loggerhead Kingbird (*Tyrannus caudifasciatus*)	O	LC
28	Northern Mocking Bird (*Mimus polyglottos*)	O	LC

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)			
No.	**Species List** (endemic*)	**DAFOR Scale**	**IUCN Ranking**
29	Northern Potoo (*Nyctibius jamaicensis*)	R	LC
30	Jamaican Parakeet (*Epusitulla nana*) Formerly, Olive-throated Parakeet (*Aratinga nana*)	O	-
31	Orangequit (*Euneornis campestris*)*	O	LC
32	Prairie Warbler (*Setophaga discolour*)	R	-
33	Red-Billed Streamertail (*Trochilus polytmus*)*	O	LC
34	Rufous-tailed Flycatcher (*Myiarchus validus*)*	O	LC
35	Sad Flycatcher (*Myiarchus barbirostris*)	O	LC
36	Saffron Finch (*Sicalis flaveola*)	R	LC
37	Shiny Cowbird *(Molothrus bonariensis*)	R	LC
38	Smooth-billed Ani (*Crotophaga ani*)	F	LC
39	Stolid Flycatcher (*Myiarchus stolidus*)	O	LC
40	Turkey Vulture (*Cathartes aura*)	F	LC
41	Vervain Hummingbird (*Mellisuga minima*)	O	LC
42	White-chinned Thrush (*Turdus aurantius*)*	R	LC
43	White-Crowned Pigeon (*Patagioenas leucocephala*)	O	NT
44	Yellow-Billed Parrot (*Amazona collaria*)*	O	VU
45	Yellow-faced Grassquit (*Tiaris olivaceus*)	F	LC
46	Zeneida Dove (*Zenaida aurita)*	O	LC

Birds listed above, with the exception of the Vultures, Hawks, Doves, Parrots and the Jamaica Crows were primarily observed associated with the stands of trees present at the periphery of the grassland areas.

Night observations were conducted using point counts and traverses. The Species that were observed included a Barn Owl (*Tyto alba*) in flight after hearing its screeching call and a Jamaican Owl (*Pseudoscops grammicus-endemic*) perched on a tree adjoining a roadway. Both observations were made towards the northwestern section of the study area. A

Northern Potoo (*Nyctibius jamaicensis*) was heard at the southern end of SML 173 during night survey traverse.

In total, thirteen (13) endemic species of birds were observed during the February/September 2018 study period and six (6) were observed in the August 2019 study period.

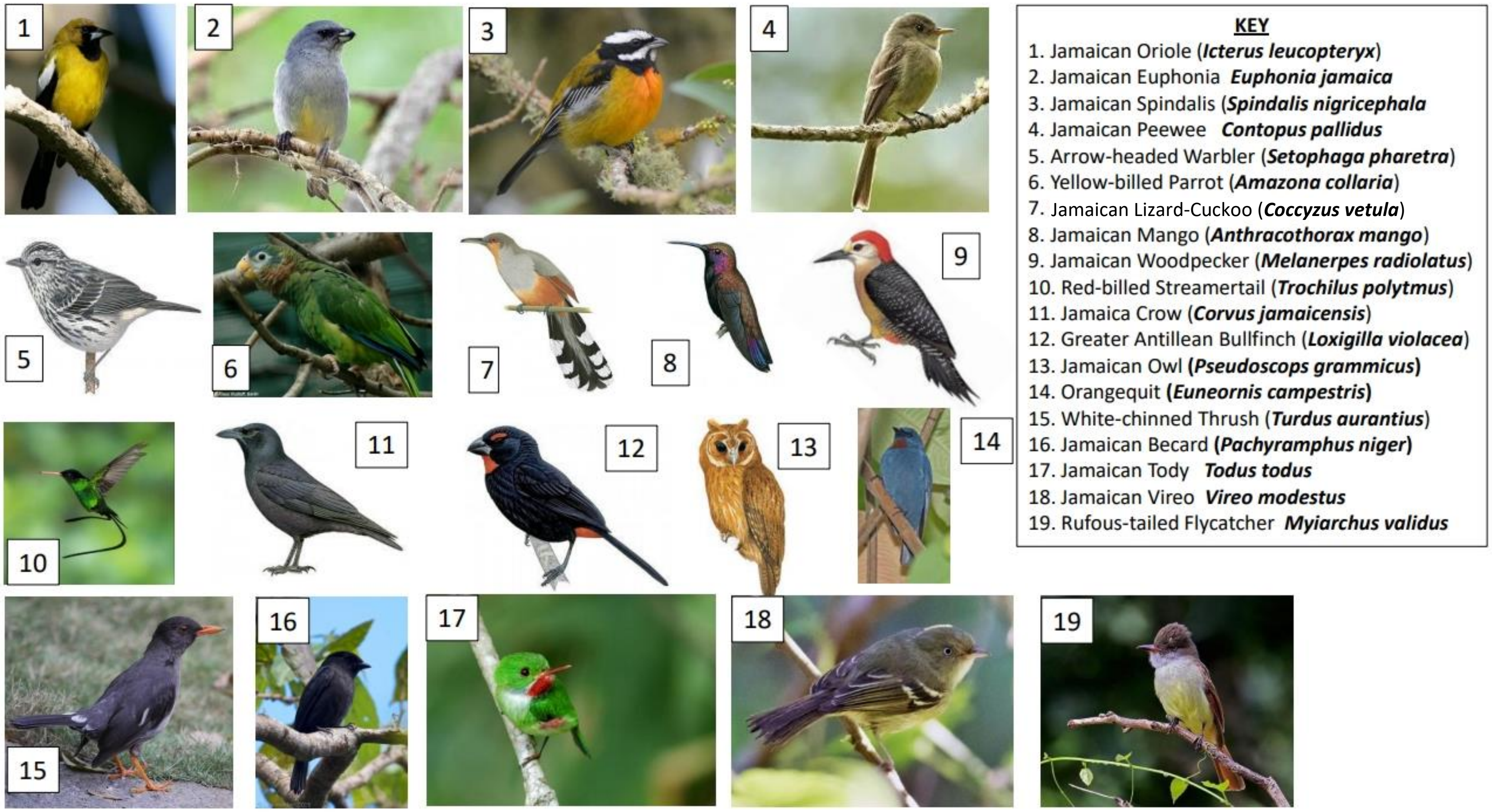

Figure 5-136: Endemic bird species observed within SML 173 (images obtained from the internet and correlated with images present in "*A Photographic Guide To The Birds Of Jamaica 2009*", Sutton et al)

Table 5-26 shows a listing of the numbers of various bird species observed within each of the survey study blocks visited.

Table 5-26: Total numbers of species observed per study block assessed

Block	Total Number of Species Detected	Species Detected During Point Count	Number of Species Detected During Traverse
1	22	7	19
1	9	6	9
4	14	8	14
3	18	6	15
9	18	4	15
7	25	13	19
8	12	4	10
6	18	14	12

There was no significant variation in species richness with the exception of site two (2) in Study Block 1. The surveys conducted at this site were undertaken later in the day and were also affected by intermittent showers of rain. Birds such as the Yellow-Faced Grassquit and Black-Faced Grassquit, Sad Flycatcher and Loggerhead Kingbird were commonly observed foraging near or within small agricultural plots while the Jamaican Peewees and other Flycatchers spent more time foraging along the transitional zone from Grassland/Lowland into the Hillocks. Jamaican Parakeet, the Jamaica Crow, Jamaican Peewee, Jamaican Woodpecker and the Smooth-billed Anis were the birds most frequently detected among the hillock habitat and were usually only detected by call as they spent a significant amount of time in the upper canopy of the Hillock forests. These areas were not easily accessible as the hillocks were heavily vegetated.

5.3.3.5.1.2. Bird Nests and Breeding Observations:

A total of eleven (11) nests were found and determined to be at varying stages of development and activity. Two (2) nests were confirmed to be active; one of a Bananaquit (*Coereba flaveola* - see Figure 5-137) that was seen taking multiple flights to the area where the nest was found and the other for a pair of Jamaican Euphonias (*Euphonia sp*). The pair was seen making multiple trips to the nest and the female was seen carrying nesting material. The nest was estimated to be <50% complete.

An old parakeet nest, in an old termitary mound, was also found. The nest was deemed to be inactive as no birds were seen going to and from it. Jamaican Parakeets breed in March (Cornell.edu[53]) and the breeding season for the Amazon Parrots concluded in late July (Koenig, 2001). It was concluded that the nest most likely belonged to a Parakeet, as the Amazon Parrots are known to be non-excavating cavity nesters (Koenig, 2001[54]). Evidence of nests were also observed for the Jamaican Woodpecker and Becard, the third and fourth of the 18 endemics recorded confirmed to be breeding in the area. Multiple Logger Headed Kingbirds nests were found as well. The Grey Kingbird nests were also found on transformers and power line poles.

[53] https://neotropical.birds.cornell.edu/Species-Account/nb/species/oltpar1/overview

[54] Susan E. Koenig, *The Breeding Biology Of Black-Billed Parrot Amazona Agilis And Yellow-Billed Parrot Amazona Collaria In Cockpit Country*, Jamaica Bird Conservation International (2001) 11:205–225. ? Birdlife International 2001

Figure 5-137: Clockwise from top left: Bananaquit nest, Jamaican Parakeet nest, Jamaican Vireo nest, Jamaican Euphonia nest.

5.3.3.5.2. Reptiles and Amphibians:

Both Animal groups were surveyed jointly. Figure 5-138 shows the locations at which lizards and frogs were observed or heard.

Figure 5-138: Locations of reptile and amphibian observations made at the SML 173 study area

The following observations were made on traverses over the SML 173 study area:

WPT 642 - Block 1:

While traversing through the area an Giant anole *(Anolis garmani*) was seen at the hillock summit (WPT 642 – See Figure 5-139) within the canopy of the trees and three (3) Opal bellied anole (*Anolis* opalinus) were seen on the tree trunks in the hillock and one (1) Brown anole *(Anolis Sagrei*) was also seen within the leaf litter while ascending the hillock.

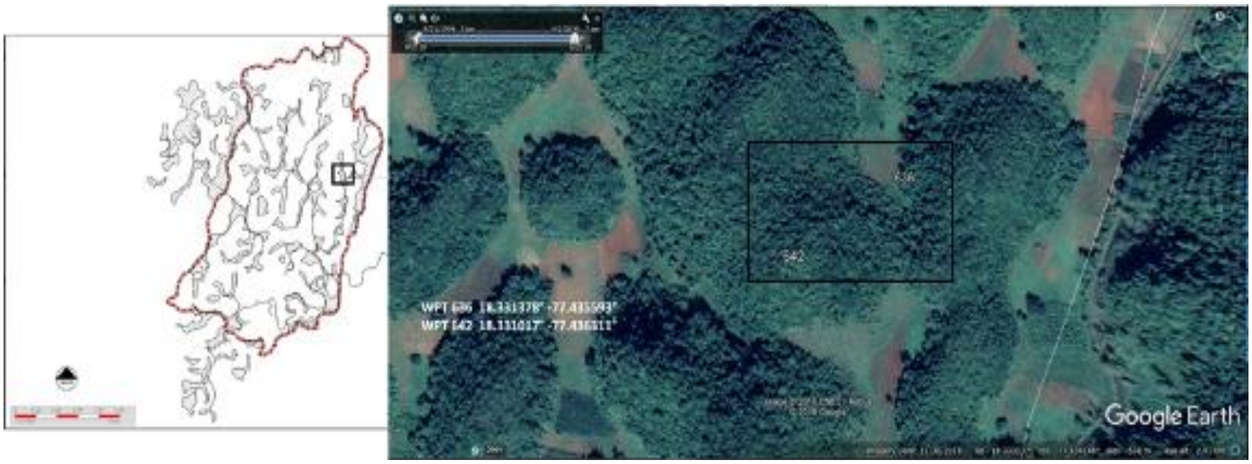

Figure 5-139: Location of Waypoint 642

WPT 654 - Block 1:

A Stippled Sphaero/Polly lizard *(Sphaerodactylus argus*) was seen under a rock in an exposed area with no tree canopy.

Figure 5-140: Location of Waypoint 654

WPT 649 - Block 1:

During night observations at the location depicted on Figure 5-141 above, the sounds of two (2) Croaking Lizards *(Aristelliger praesignis*) were heard along with the sounds of several *Eleutherodactylus johnstonei* an invasive alien frog species.

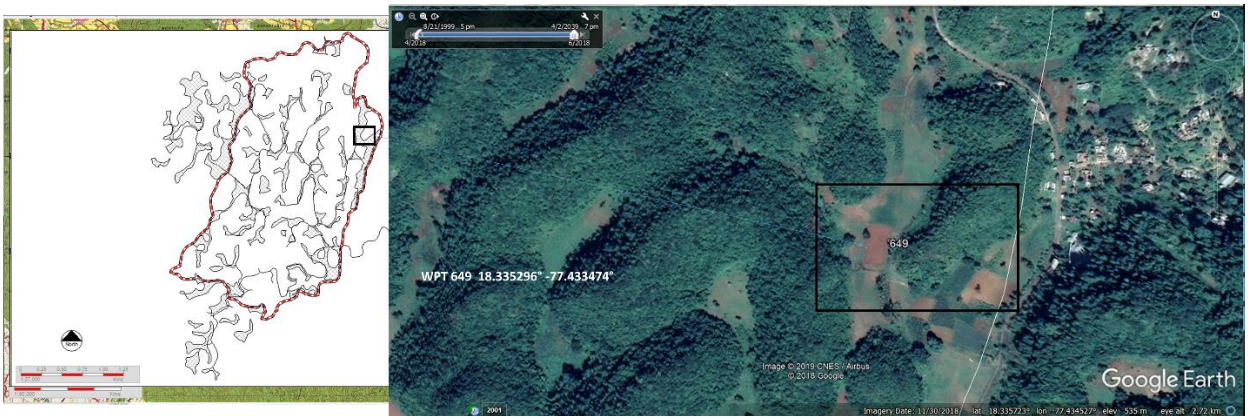

Figure 5-141: Location of Waypoint 649

WPT 658 - Block 7:

Two (2) lizard species were seen while traversing a transect deployed at this location. An *Anolis opalinus* was seen on a tree bark while an *Aristelliger praesignis* was seen in a rock crevasse below on the ground with amongst scattered leaf litter. No amphibians were seen while traversing this transect.

Figure 5-142: Location of Waypoint 658

WPT 659 - Block 7:

One (1) Stippled Sphaero/Polly lizard *(Sphaerodactylus argus*) (See Figure 5-143 and Figure 5-144) was seen under a sunlight-exposed rocky area with no forest canopy cover.

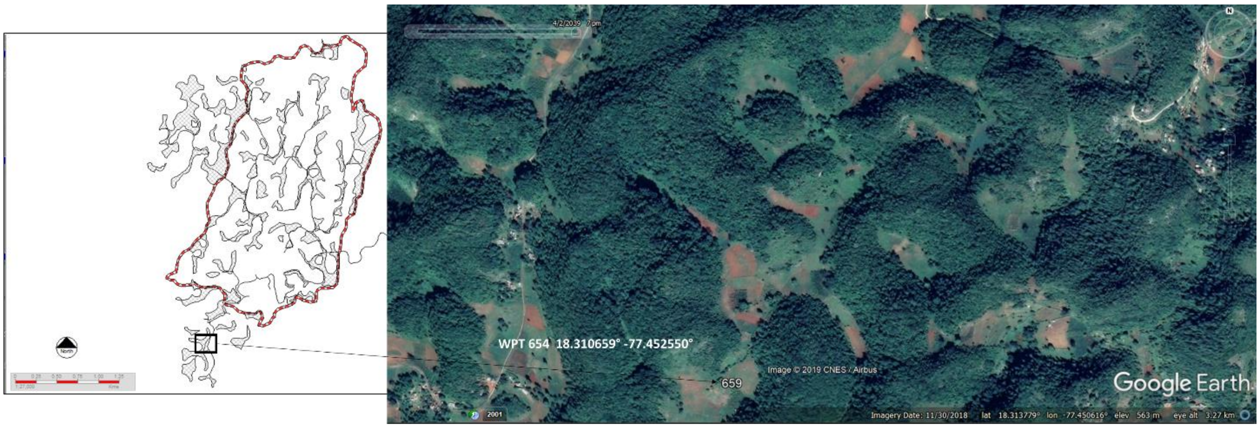

Figure 5-143: Location of Waypoint 659

Figure 5-144: Sphaerodactylus argus (Stippled Sphaero/Polly lizard)

WPT 660 -Block 7:

A Stippled Sphaero/Polly lizard *(Sphaerodactylus argus*) was seen under a similar exposed rocky area with no canopy cover to the Sphaerodactylus observation made at WPT 660 (See Figure 5-145). Figure 5-146 depicts the habitat within which the Polly Lizard was found. These piles of rocks appear to have been made by residents of the area to be used as wall-making material.

Figure 5-145: Location of Waypoint 660

Figure 5-146: Habitat type of the Stippled Sphaero/Polly lizard (*Sphaerodactylus argus*)

WPT 674 - Block 4:

One (1) Gray anole *(Anolis lineatopus*) was seen on a tree trunk and two (2) Brown anole *(Anolis sagrei*) were seen on the leaf litter along the study transect deployed at the location (Figure 5-147) into a hillock.

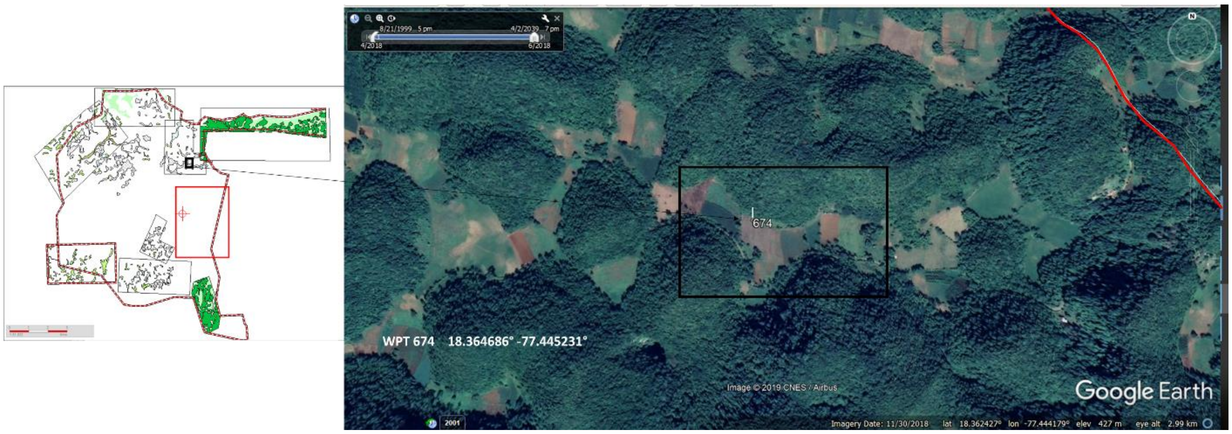

Figure 5-147: Location of Waypoint 674

Night Surveys at WPTs 675, 676 & 677 - Block 1:

Approximately seven (7) Croaking lizard *(Aristelliger praesignis*) were heard throughout the area of the night survey. The lizards started to vocalize at about 2200 hrs and would sound off approximately every 15 minutes. They would spend approximately 2 minutes croaking then stop and resume at 15 minutes intervals. This start-pause vocalization continued up to, the time of departure at 0130hrs (see Figure 5-148).

More than ten (10) frogs could also be heard within the area. The vocalizations of Lesser Antillean Frog (*Eleutherodactylus johnstonei)* (See Figure 5-149) could be heard along with the sounds of Jamaican Forest Frog *(Eleutherodactylus gossei*).

Figure 5-148: Location of Waypoints 675,676 & 677

Figure 5-149: Lesser Antillean Frog *(Eleutherodactylus johnstonei*) seen in the grass within the area during the night survey

WPTs 678,681 & 684 - Block 3:

Observations were made around the vicinity of a study transect deployed on a hillock at the site. While ascending the hillock transect, two (2) *Anolis opalinus* were seen. They were both seen on tree trunks near the foot of the hillock which was close by an open trail/road. While ascending the hillock clearcutting of a trail was observed. A similar observation was made at the peak of the hillock. One (1) *Anolis grahami* was seen at the top of the hillock along with one (1) *Anolis sagrei* and one (1) *Anolis valencienni*. All anoles were seen in the area of the open canopy which also had an exposed rocky ground.

The other location to be visited experienced harsh weather conditions which resulted in no work being conducted in that area (see Figure 5-150).

Figure 5-150: Location of Waypoints 678,681 & 684

Block 8 - WPT 693 & 036:

The following observations were noted at this study location:

1. Jamaican Forest Frog *(Eleutherodactylus gossei*) and Lesser Antillean Frog *(Eleutherodactylus johnstonei*) was heard.
2. Five (5) lizards were seen: One (1) *Anolis Garmani*, three (3) *Anolis Opalinus* and one (1) *Anolis sagrei* along with anole eggs in an exposed rock face (Figure 5-152 to Figure 5-155).
3. The sounds of two (2) Jamaican Forest Frog *(Eleutherodactylus gossei*) and two (2) Lesser Antillean Frog *(Eleutherodactylus johnstonei*) were heard. Figure 5-156 shows the forest conditions present at the site.

Figure 5-151: Location of Waypoints 693 & 036

Figure 5-152: ***Anolis opalinus***

Figure 5-153: ***Anolis garmani***

Figure 5-154: ***Anolis sagrei***

Figure 5-155: Anole eggs within a rock crevasse

Figure 5-156: Vegetation transect and area where the anoles were seen

WPT 696 - Block 9:

Seven (7) *Anolis sagrei* were observed in the last two (2) quadrats of the transect. The trees of the area were not densely populated allowing for more foraging area on the ground (see Figure 5-157).

Figure 5-157: Location of Waypoint 696

Table 5-27 summarizes the reptile and amphibian observations made during the survey while Table 5-28 illustrates numbers observed per study block visited. Note that Table 5-28 does not document night reptile and amphibian audial observations, which were numerous.

Table 5-27: Reptile and amphibian observations made during the survey

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)		
Species List	**DAFOR Scale**	**IUCN Ranking**
Reptiles		
Giant Anole (*Anolis garmani)*	O	LC
Opal Bellied Anole *(Anolis opalinus)*	F	LC
Brown Anole *(Anolis Sagrei)*	O	No Info Found
Stippled Sphaero/Polly lizard *(Sphaerodactylus argus)*	O	LC
Croaking Lizard (*Aristelliger praesignis)*	A (at night)	No Info Found
Grey Anole (*Anolis lineatopus)*	R	LC
Cuban Brown Anole (*Anolis sagrei)*	F	No Info Found
Jamaican Twig Anole (*Anolis valencienni)*	R	LC

IUCN Key: Extinct (EX) | Extinct in the wild (EW) | Critically endangered (CR) | Endangered (EN) | Vulnerable (VU) | Near threatened (NT) | Least concern (LC) | Data deficient (DD) | Not evaluated (NE)		
Species List	**DAFOR Scale**	**IUCN Ranking**
Amphibians		
Cane Toad (*Rhinella marina)*	O	LC
Jamaican Forest Frog (*Eleutherodactylus gossei)*	A (at night or after rain)	LC
Eleutherodactylus johnstonei an invasive alien frog species.	A (at night or after rain)	LC

Table 5-28: Numbers observed per study block visited

Study Block	Observations Reptile Species	Observations Amphibian Species
1	9	2
7	4	0
4	3	0
3	5	*0*
8	5	2
9	7	0

5.3.3.5.3. Arthropods Alpha Period (August 17-19, 2019)

5.3.3.5.3.1. Nocturnal Assessment

5.3.3.5.3.1.1. Light Trapping

Light trapping was able to attract sixteen (16) species of insects, dominated by six (6) Dipterans and four (4) Coleopterans. Nocturnal Lepidopterans and Cicadellids comprise the majority of the remainder of insects.

5.3.3.5.3.2. Diurnal Assessment

Figure 5-158 below illustrates the species richness of the qualitative and quantitative assessments of the waypoint locations visited. Waypoint 636 (Block 1) had the most species, while waypoint 649 (Block 1) had the lowest. In comparing the qualitative and quantitative elements, the quantitative routinely identified more species than the qualitative. The quantitative identified 79% to 220% more species than the qualitative.

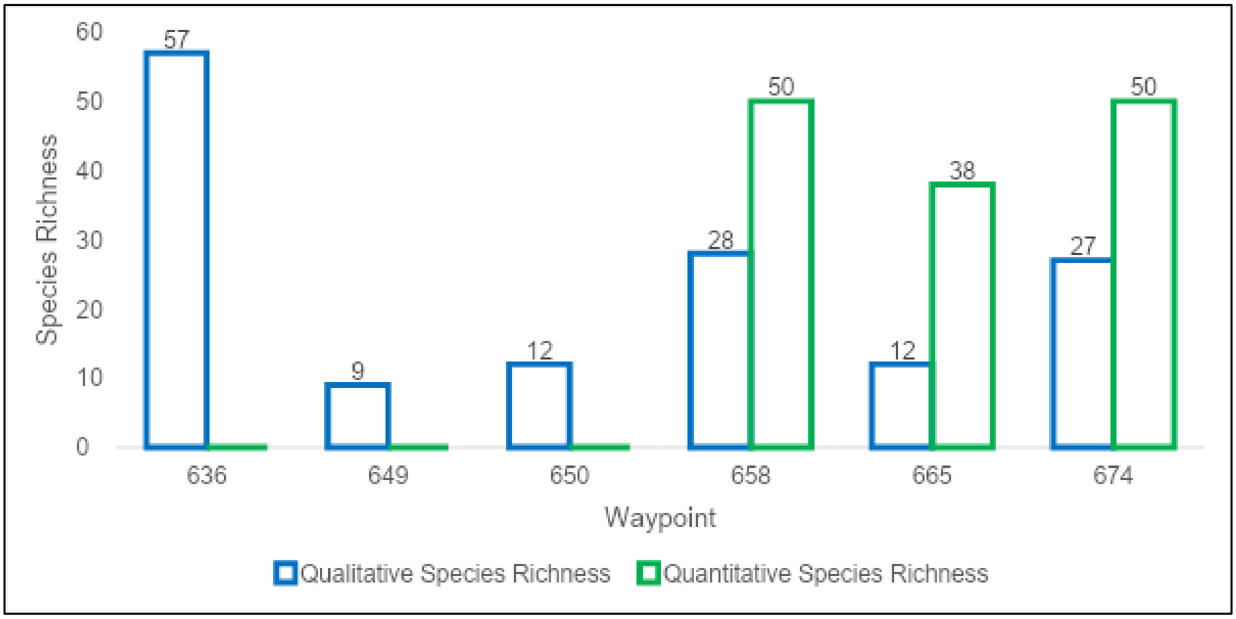

Figure 5-158: Arthropod species richness of qualitative and quantitative assessment

5.3.3.5.3.3. Plotless Assessment

Most notable here is the presence of the endemic ***Heliconius charitonius simulator*** and ***Drya iulia julia*** butterflies.

5.3.3.5.3.4. Plot-based Assessment

Figure 5-159 shows the species richness of the different quadrats of the transect. Quadrat 1 represents the region closest to the lowland, while Quadrat 6 was predominantly uphill within the hillock. Moving from the lowland inward, there is an overall decrease in species richness. Initially, species richness decreased, then increased around the 5th and 6th quadrat. Quadrat 1 of Waypoint 658 (Block 1) had the greatest species richness, followed by quadrats 1 and 6 of Waypoint 674 (Block 4). Waypoint 665 (Block 1) had the lowest values for each respective waypoint quadrat, except quadrat 2.

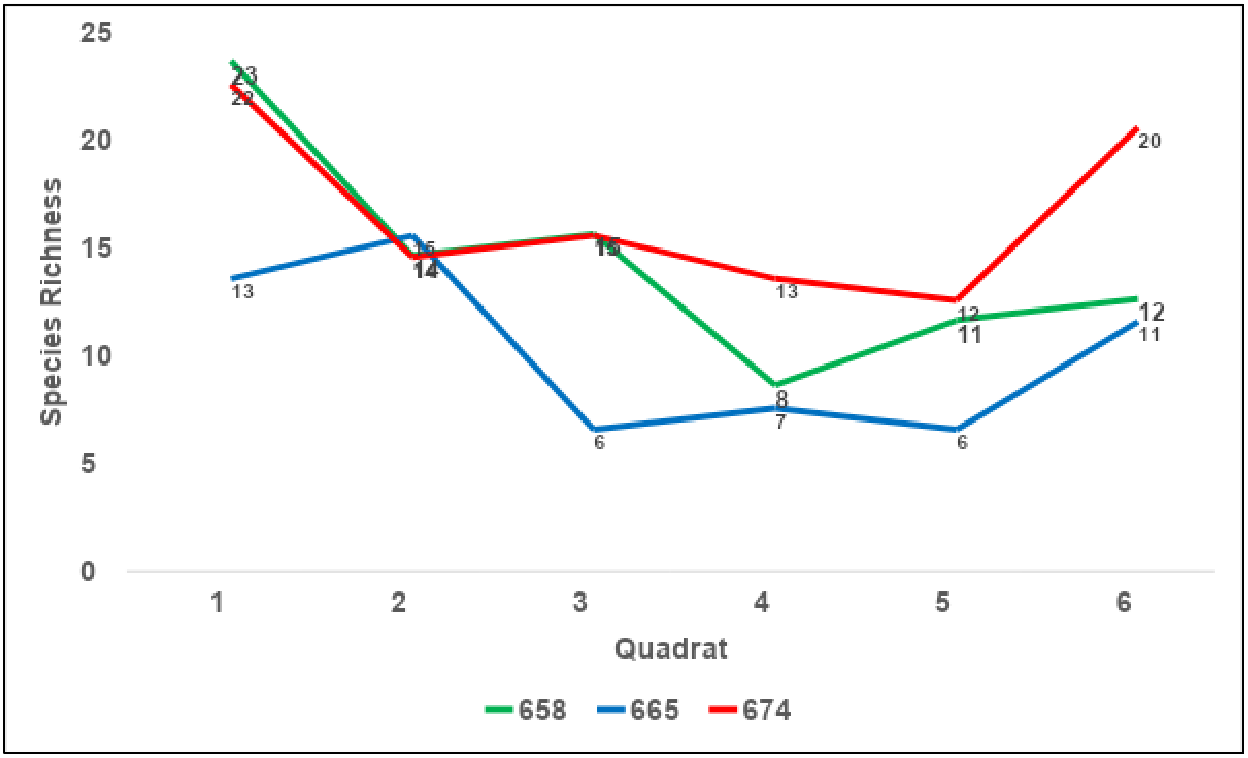

Figure 5-159: Species Richness by Quadrats Surveyed in Blocks 1 and 4

An adapted cricket was captured on a branch at Waypoint 665 (Block 1), camouflaging itself from predators. This cricket is shown in Figure 5-160.

Figure 5-160: Adaptive Cricket (*Pseudophyllidae*) Camouflage

Figure 5-161 shows a Cicad, which illustrate another of the microhabitats found within the area.

Figure 5-161: Cicad under vegetation

Below are additional images of arthropod fauna taken throughout the course of the study. Additionally, Carabid beetles were noted as numerous running along the ground.

Figure 5-162: Sarcophagid Fly

Figure 5-163: Pyrrhocorid Adult

Figure 5-164: Scarabaeidae Larvae

Figure 5-165: Glossy Flower Beetle (Endemic)

Figure 5-166: Red Millipede

Figure 5-167: *Emesa* sp.

Figure 5-168: Adult Grasshopper

Figure 5-169: Dragonfly on Tank bromeliad

Figure 5-170: Unidentified caterpillar species A

Figure 5-171: Unidentified Caterpillar Species B

Figure 5-172: Caterpillar Species C

Figure 5-173: Yellow Syrphid Fly

5.3.3.5.4. Arthropods Beta Period (August 24-26, 2019)

5.3.3.5.4.1. Nocturnal Assessment

A total of 274 individual arthropods of 47 species were recorded, with flies being the most diverse group. Diptera included four (4) species of Dolicopodidae, three (3) species of Drosophilidae and Muscidae, two (2) species of Chloropidae and one species each for Bombylidae, Culicidae and Pipunculidae. Four (4) other fly species were present which were not identified, but were noted as different species overall. Dipterans species accounted for the greatest proportion of species, 43%, followed by Lepidoptera (19%). Chilipoda and Thysanoptera were represented by one (1) species (2% of the sample) each (see species richness illustration on Figure 5-174).

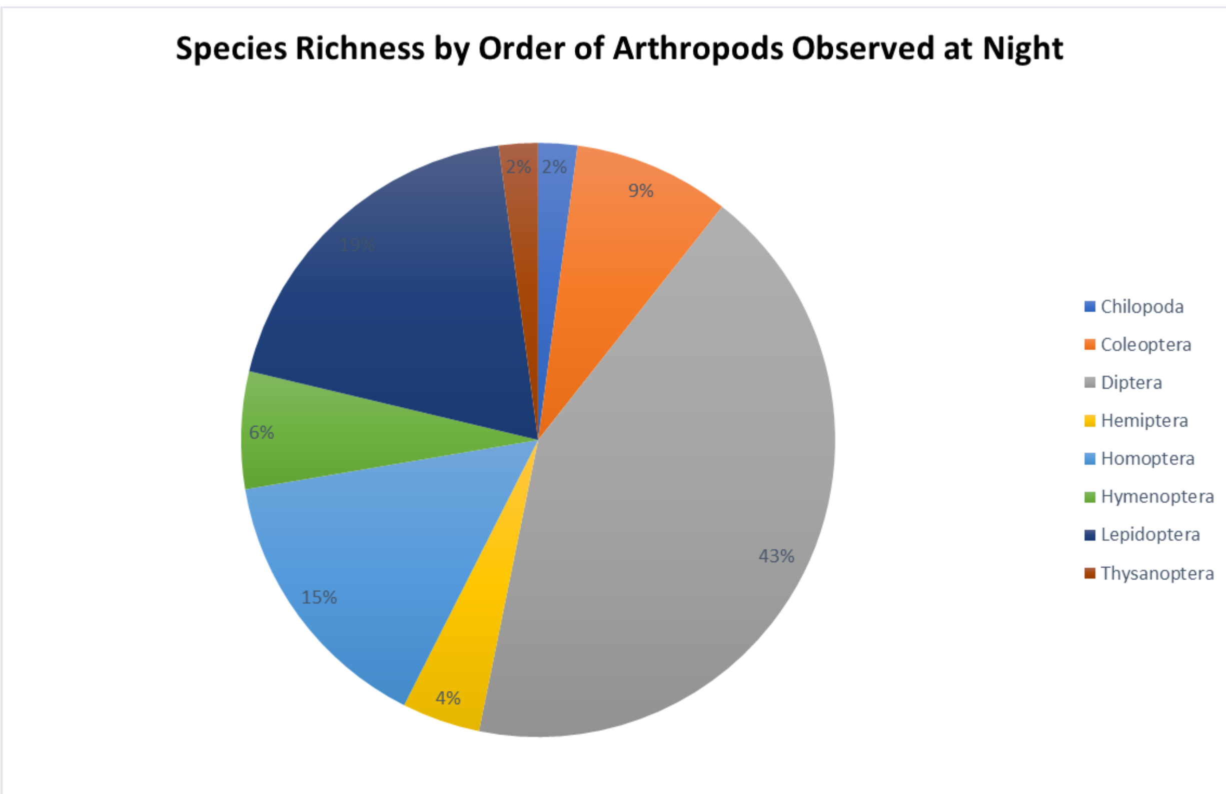

Figure 5-174: Species Richness by Order of Arthropods Observed at Night

Figure 5-175 shows the number of individuals of each species recorded within the light traps. Chloropidae A and Cicadellidae A had the highest number of individuals. Hemiptera A was also well represented. Most other species had few individuals. Social hymenoptera

(Formicidae) were not counted individually, but rather represented by "1", denoting its presence solely as counting individuals was not feasible.

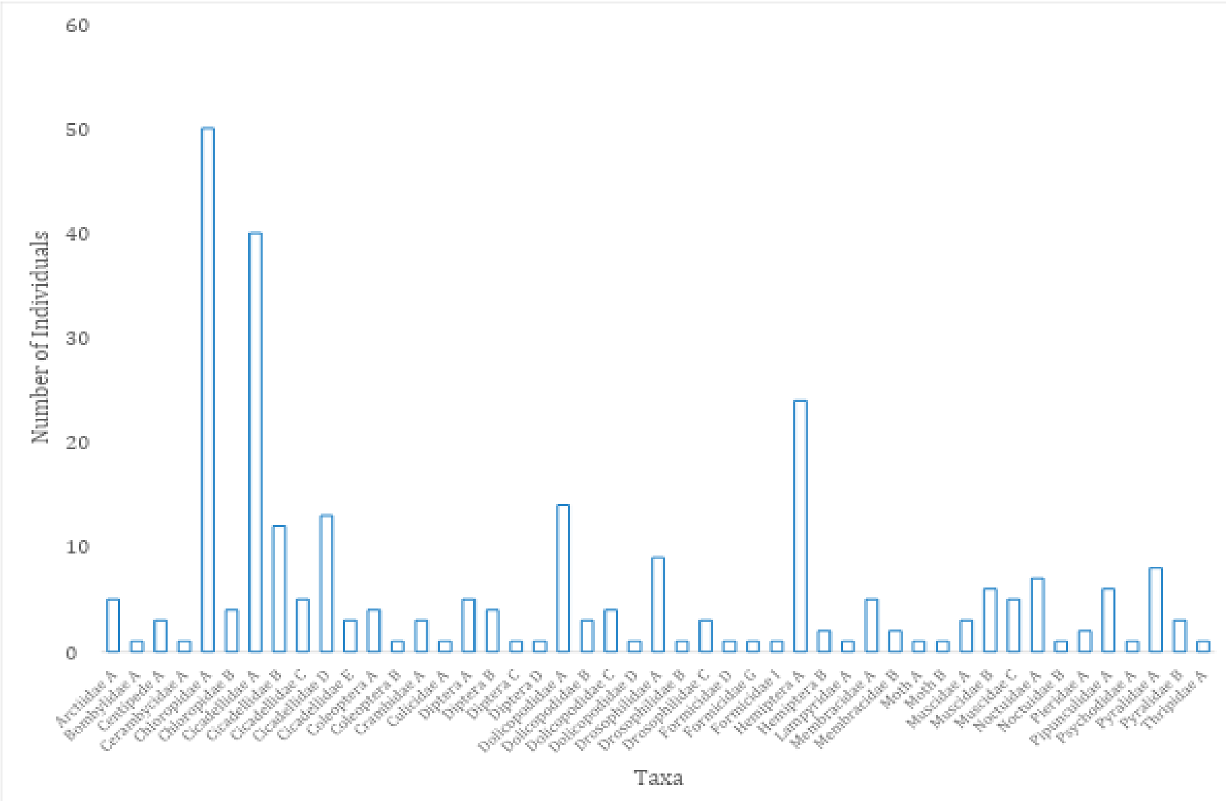

Figure 5-175: Number Individuals per Species Recorded by the Light Trap

Despite three (3) species having the greatest numbers of individuals, beta diversity recorded from the light trap was relatively high, 0.922 on the Simpson's Index.

In assessing species diversity using the Simpson's Index, the plot-based assessment noted a very high diversity value of the area of 0.946 (with social and swarming insects underrepresented) and 0.932 (without social and swarming).

5.3.3.5.5. Gastropods

Two (2) types of terrestrial snails were observed during inspections conducted within the study area. These were the arboreal *Thelidomus cognate* (see Figure 5-176), and a ground snail *Pleurodonte peracutissima*. One live *Pleurodonte peracutissima* specimen was observed on a traverse between survey transects (see Figure 5-177), but numerous shells were observed on the ground, in particular, in the forested areas of SML 173.

Figure 5-176: Arboreal *Thelidomus cognate*

Figure 5-177: Ground Snail (*Pleurodonte peracutissima)*

Slugs, possibly the Pancake Slug (*Veronicella sloanii* - see Figure 5-178) were observed under rocks surveyed during traverses and under leaf litter within transect areas.

Figure 5-178: Pancake Slug (*Veronicella sloanii*)

A number of *Thelidomus cognate* individuals were observed on tree trunks within the transect deployed. Numbers are listed below:

1. Waypoint 658 (Block 1) two (2) individuals
2. Waypoint 674 (Block 4) one (1) individual
3. Waypoint 665 (Block 1) three (3) individuals

4. Waypoint 036 (Block 8) one (1) individual

5.3.3.5.6. Mammals:

Domestic mammals were frequently observed on the lowland areas of SML 173. These were cows, donkeys and goats.

Three (3) non-domestic mammals were observed during traverses over SML 173. Figure 5-179 shows 1 of 2 partially eaten field mice (*Mus sp.*) observed in close proximity to waypoints 665 and 697 (all in Block 1). Additionally, two adult mongooses (*Herpestes sp.*) were also observed on traverses.

Figure 5-179: Partially Eaten Field Mice (*Mus Sp.*) Observed Near to Waypoints 665 and 697

At dusk, bats were observed flying around in both populated areas, as well as, in the vicinity of low-lying depressions. The identity of these bats could not be ascertained.

Roosting and flying bats were observed within two of the three caves visited. At least two types of bats were deemed to be present within both caves, based on the size of the bats observed.

Sampling captured approximately 380 recordings per location per device over the 72-hour period. The image of the analysis of one recording file is shown in Figure 5-180 below.

Figure 5-181 and Figure 5-182 show the details of the spectrograph at different zoom levels, which are reflected on the time scale on the x-axis of the spectrograph (2.1s and 580 ms respectively). The software uses the six (6) letter species code for bat name. The nomenclature is presented below.

Table 5-29: 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 parnellii	**PTEPAR**	*Natalus jamaicensis*	**NATJAM**
Pteronotus macleayii	**PTEMAC**	*Chilonatalus micropus*	**CHIMIC**
Pteronotus quadridens	**PTEQUA**	*Eptesicus fuscus (lynni)*	**EPTFUS**
Macrotus waterhousii	**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**

Figure 5-183 and Figure 5-184 show images with the spectrograph zoomed to "ms" scale which were used to identify species that were not in the default library of Kaleidoscope.

This was repeated for each spectrograph.

The findings from all analyses are presented in Table 5-30 and Table 5-31 in the next section.

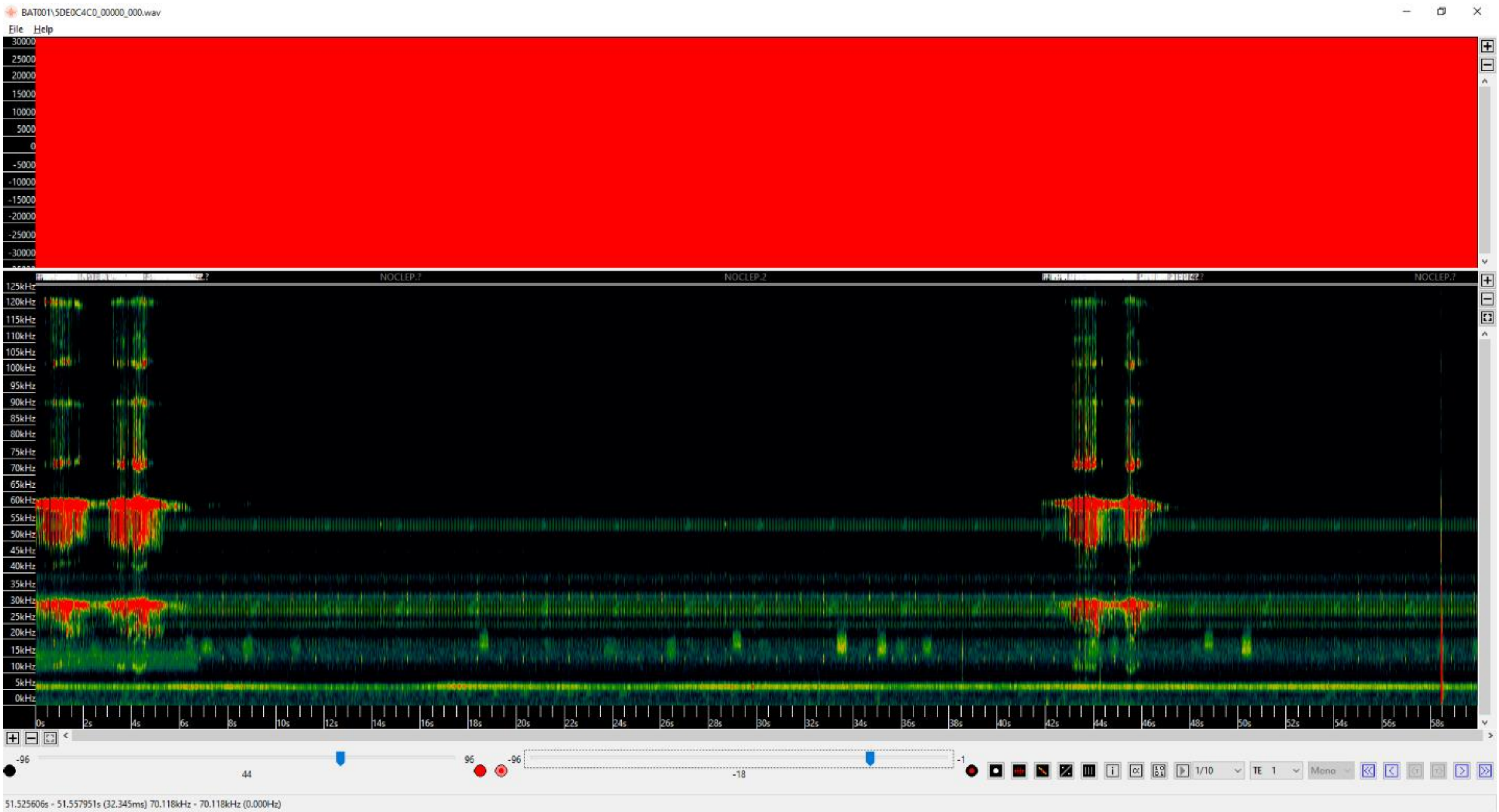

Figure 5-180: Raw Spectrograph Data from Kaleidoscope Pro

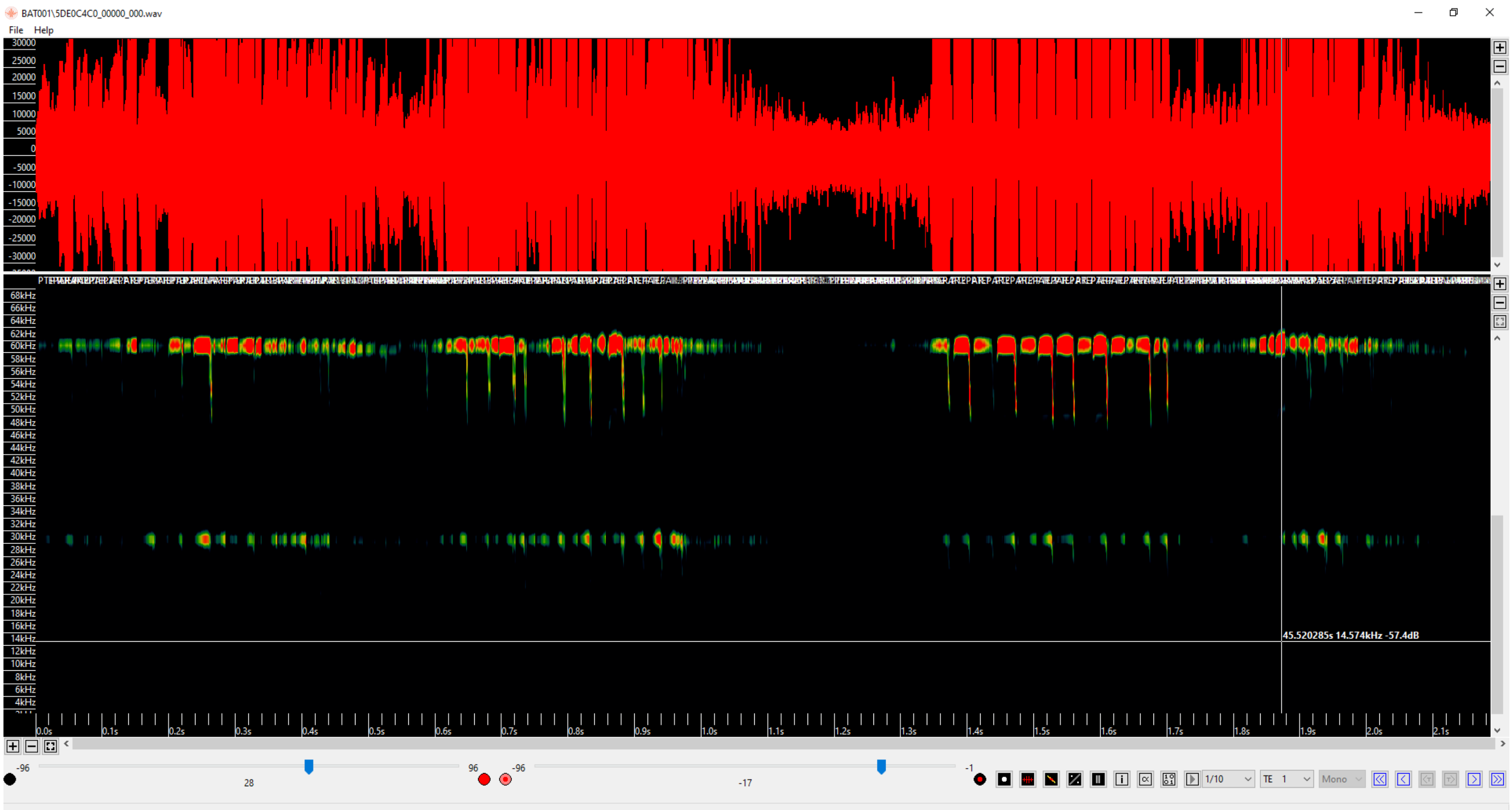

Figure 5-181: Refined and Zoomed Spectrograph from Kaleidoscope - Zoomed into area with visible calls

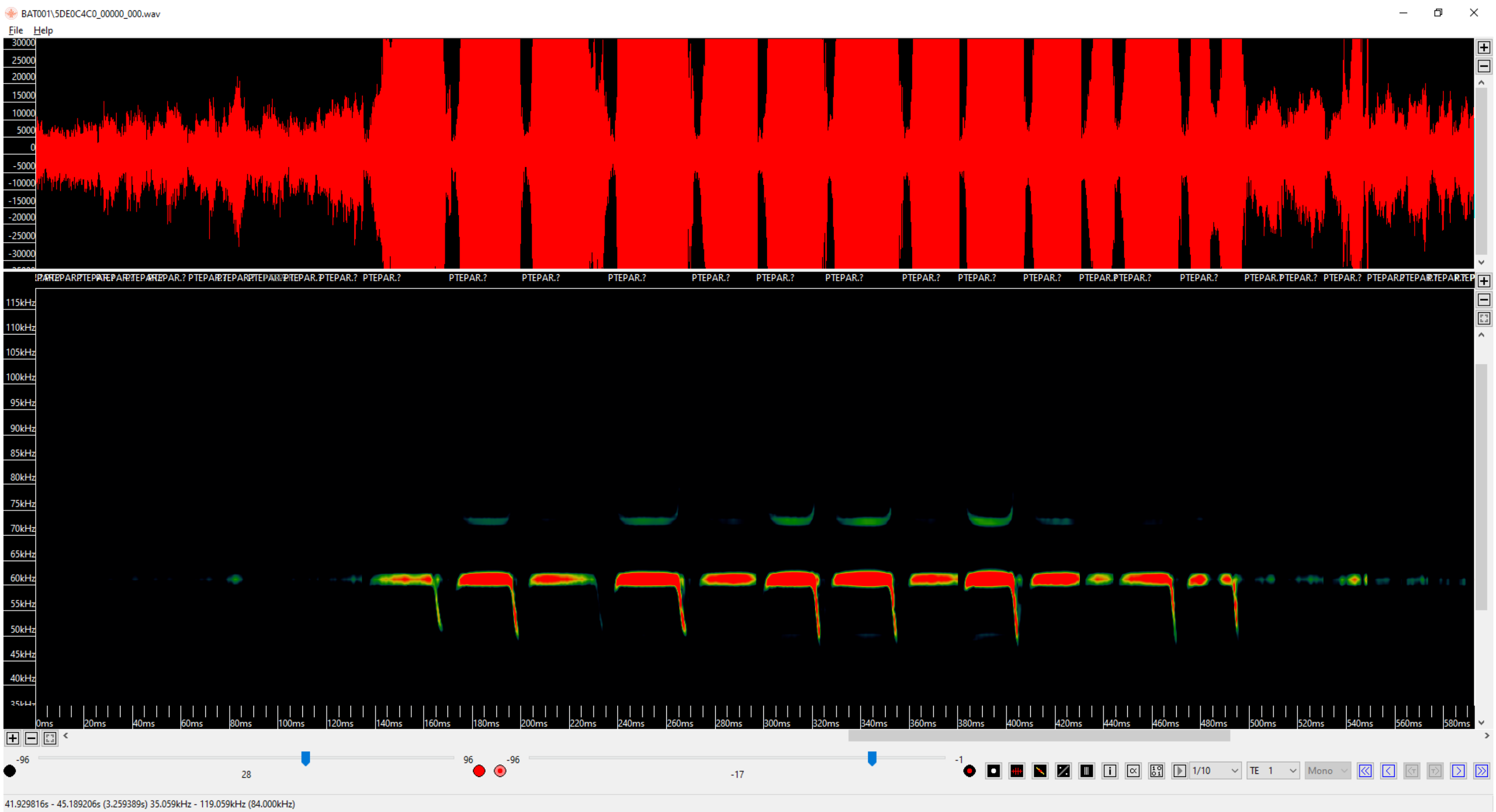

Figure 5-182: Higher resolution of Area with identified calls in Kaleidoscope

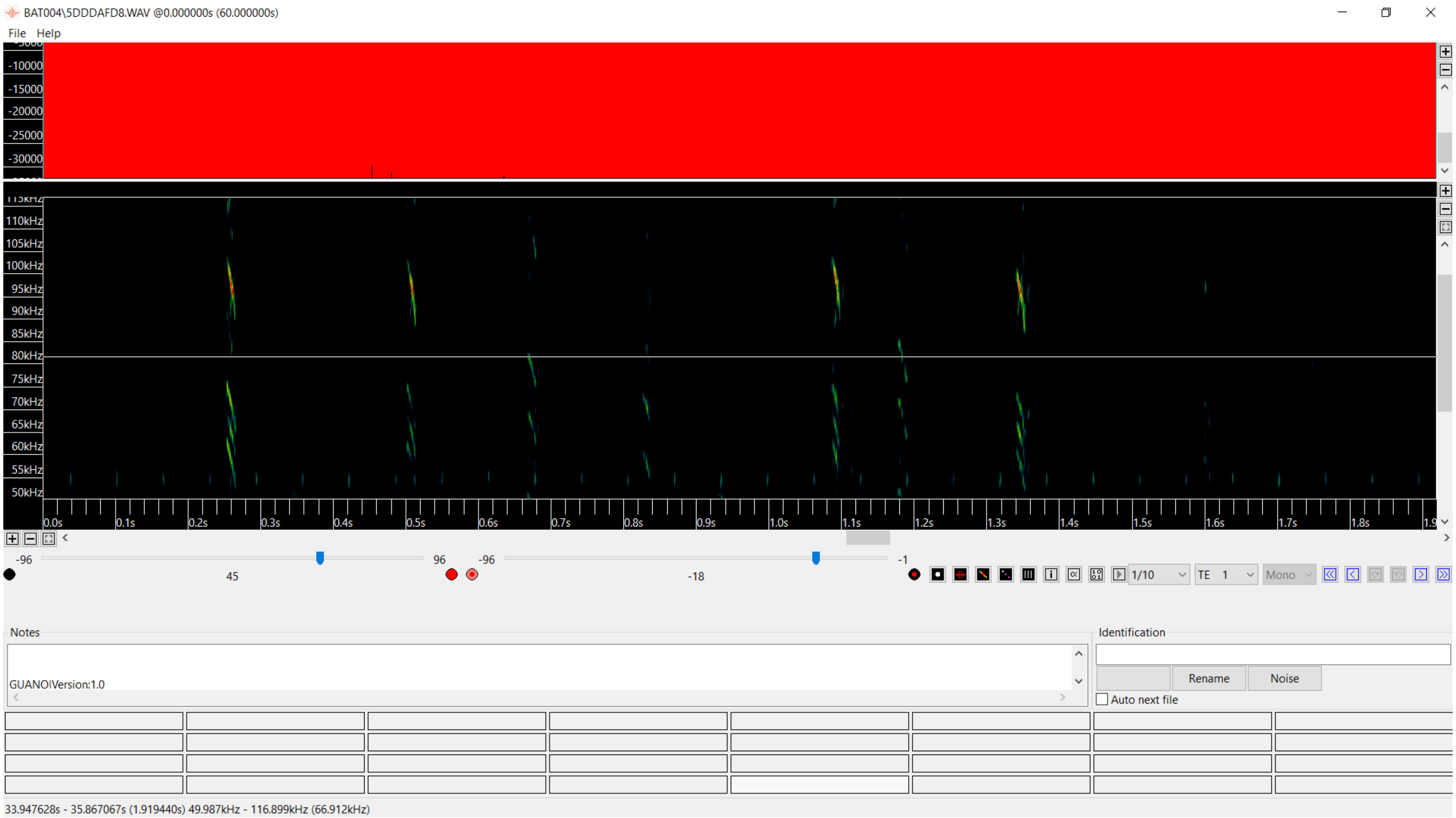

Figure 5-183. Manual Analysis of Spectrograph for Profiles presented by Windsor Research Center

Figure 5-184: Manual Analysis of Spectrograph for Profiles presented by Windsor Research Center

The Kaleidoscope software automatically identified eight (8) species of bats within the three caves sampled. These are shown in Table 5-30 below.

Table 5-30: Bat Species detected by Kaleidoscope Pro from the three Cave sampled

Caves	Species detected by Kaleidoscope Pro Software							
Drip Cave	NOCLEP	NYCMAC	PTEPAR	PTEMAC				
Dunns Hole	NOCLEP	NYCMAC	PTEPAR		TADBRA	MOLMOL		
Cave 3 - Gibraltar	NOCLEP	NYCMAC	PTEPAR		TADBRA	MOLMOL	EPTFUS	PTEQUA

Table 5-31: Bat species manually identified from Spectrographs developed by Kaleidoscope

Caves	Species detected from Comparison with Windsor Research Center Data							
Drip Cave	ARIFLA[55]	GLOSOR		CHIMIC	MORBLA			
Dunn's Hole		GLOSOR			MORBLA			
Cave 3 - Gibraltar			PTEPAR		MORBLA			

5.3.3.5.7. Abiotic Findings – Measurement of Physical Parameters

Figure 5-185 shows temperature and humidity average values obtained for four locations assessed. Waypoints 036 in Block 8, 687 in Block 7 and 696 in Block 9 were obtained on transect surveys under the canopy of hillock forests during the daytime on different days while 676 in Block 1 was obtained at the transition point between a lowland and a hillock at 2200hrs with a low fog over the location.

For the transect survey areas it was observed that the forest cover at waypoint 036 was more disturbed than waypoints 687 and 696, with more exposure to sunlight may have influenced the humidity at the site.

[55] *A. flavescens* - Tree Dwelling Bat

Figure 5-185: Temperature and humidity average values obtained for four locations assessed during phase 2 of the SML 173 assessment

Regarding exposure to sunlight, the three transect locations for which weather data was obtained and two additional transects were located on the southern slopes of hillocks. The southern slopes in northern latitudes received more sunlight than the northern slopes for varying times of the year[56]. Thus, if there are disturbances in the continuity of the hillock canopy for man-induced or weather or biotic reasons, the gaps in the canopy will be influenced by greater light incursion to the forest floor on southern slopes, as opposed to north-facing slopes.

The second location (Waypoint 676) had the highest mean temperature and relative humidity of all sites, while the third (677) had the lowest of each (see Figure 5-186 to Figure 5-188)

[56] https://sciencing.com/differences-between-north-southfacing-slopes-8568075.html

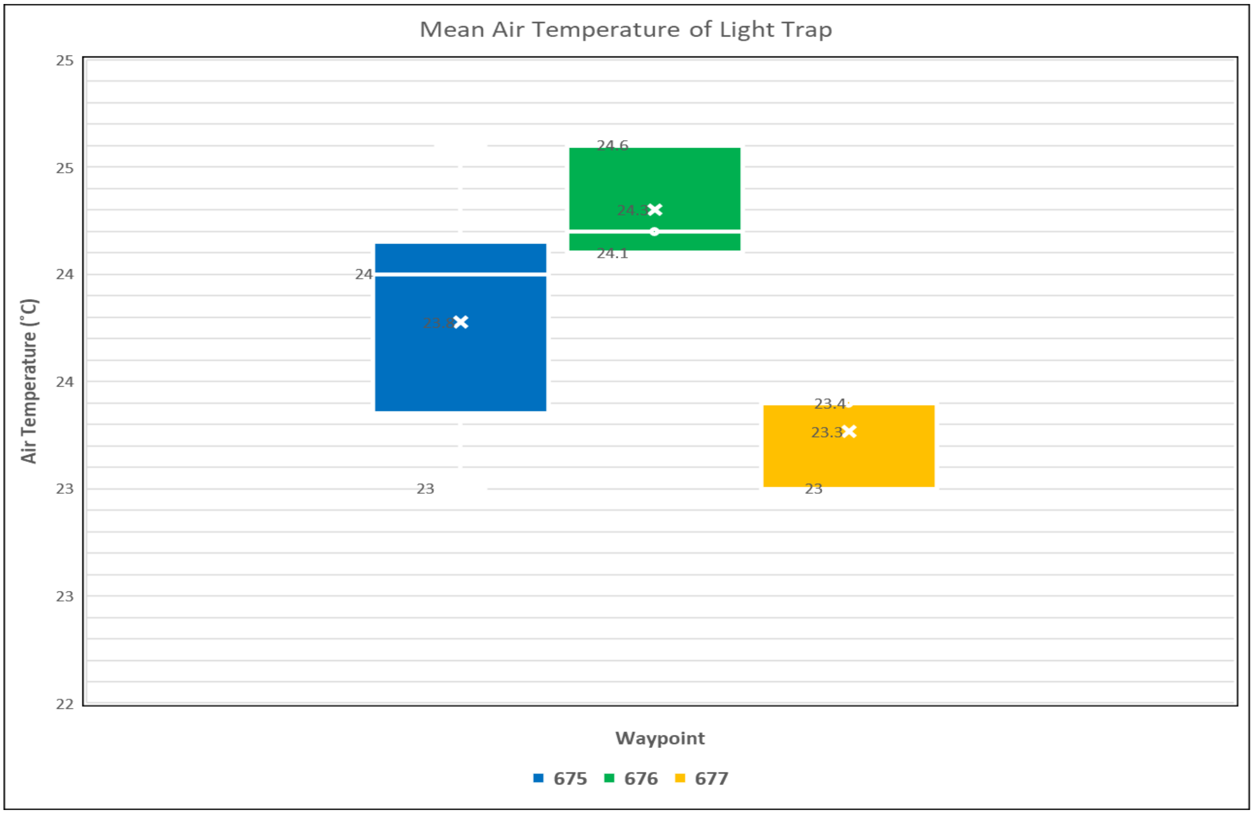

Figure 5-186: Light Trap Conditions (The mean of the samples is represented by the "x") – Mean Air Temperature

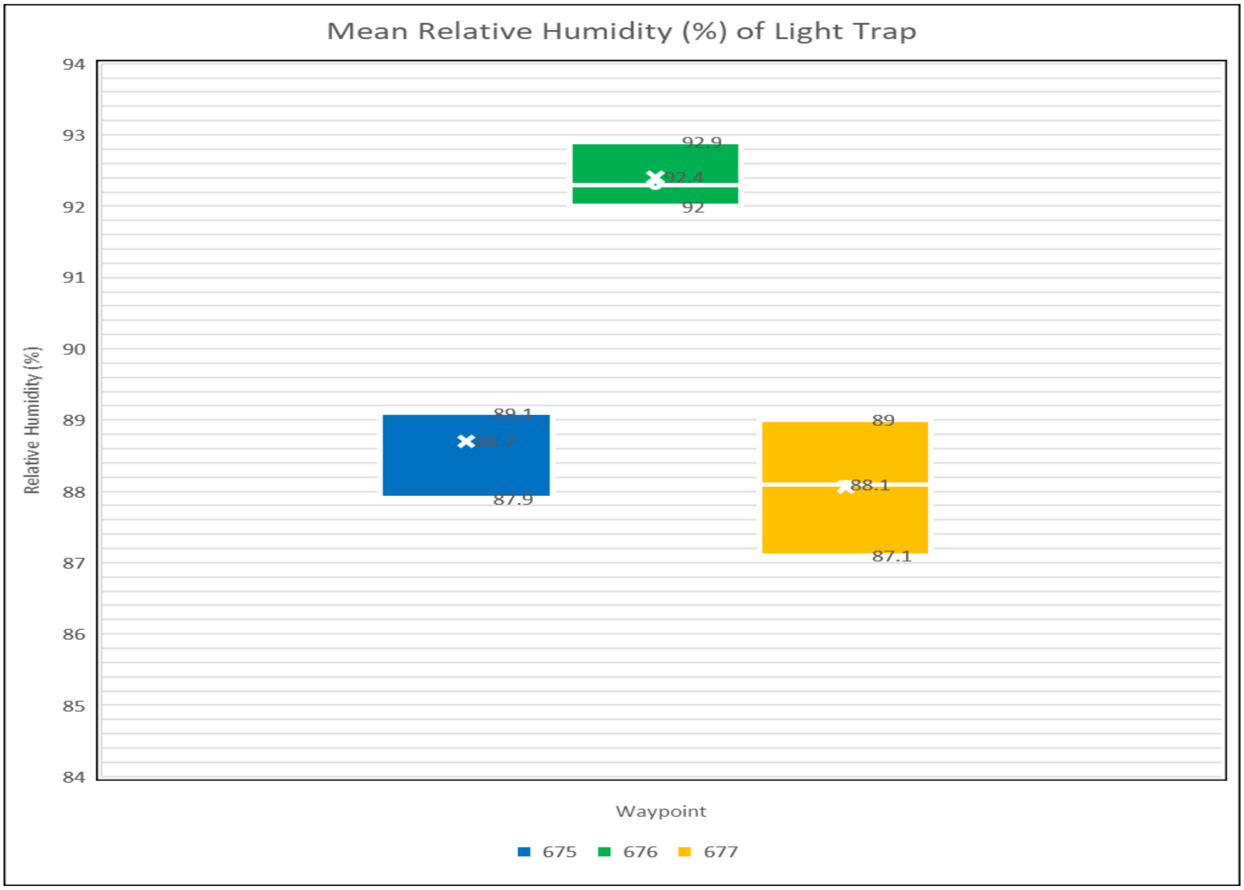

Figure 5-187: Light Trap Conditions (The mean of the samples is represented by the "x") – Mean Relative Humidity

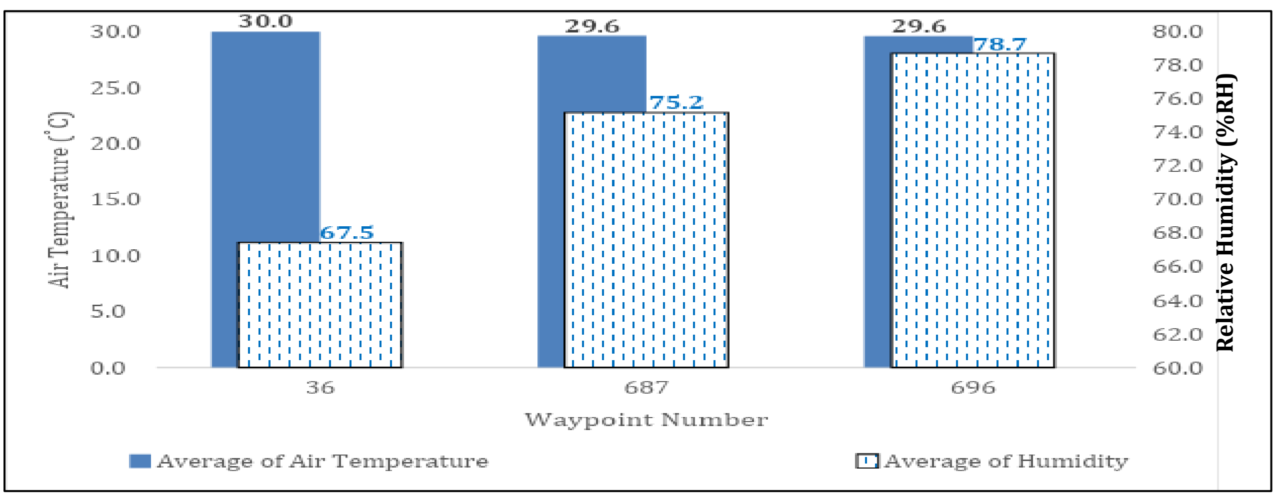

Figure 5-188: Mean Physico-chemical Data for Transects

5.3.3.5.8. Diurnal Assessment

Waypoint 696 in Block 9 was the most humid on average (78.7 %RH), followed by 687 in Block 7 (75.2 %RH), then 036 in Block 8 (67.5 %RH). Waypoint 036 was the hottest (30°C), though only marginally. It also has the highest wind speed of 0.5m/s, followed by Waypoint 687 with 0.4m/s, then Waypoint 696 at 0.0m/s (illustrated on Figure 5-188).

The grassland fields were hotter and less humid than the hillocks of Waypoint 696 on average.

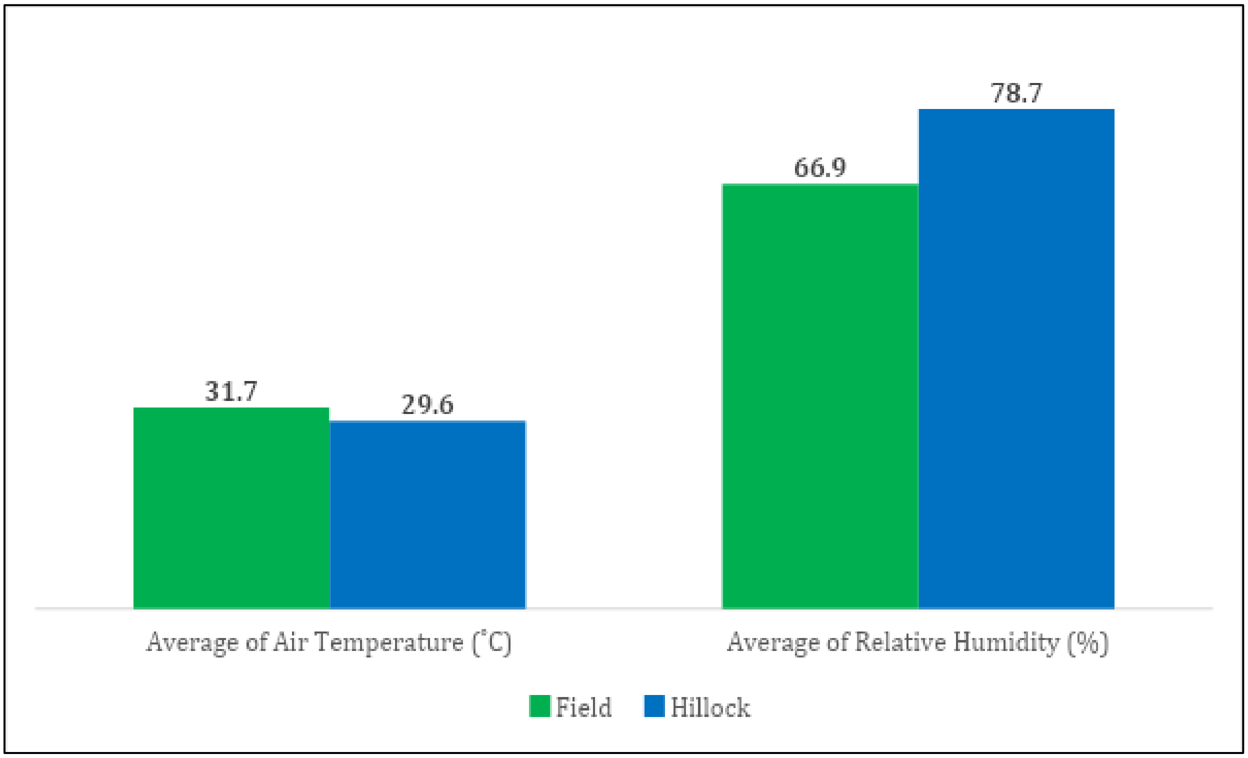

Figure 5-189: Field and Hillock Physico-chemical Comparison

On average, temperature and humidity both decreased moving from quadrat 1 (near the grassland fields) to quadrat 6 (higher into the hillocks –see Figure 5-190).

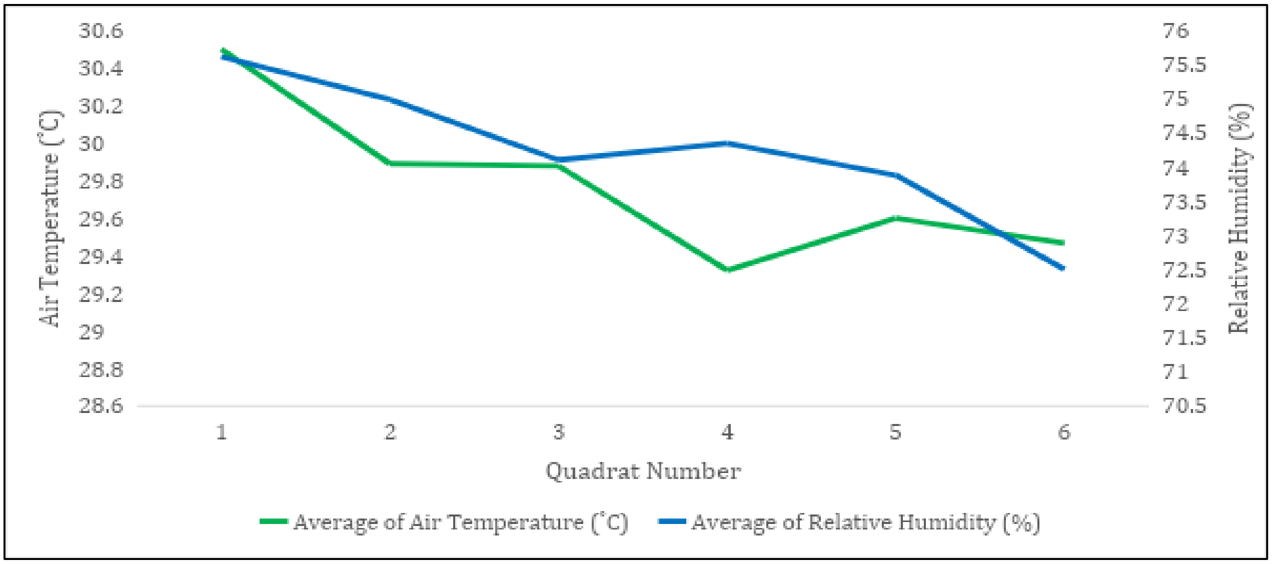

Figure 5-190: Physico-chemical Conditions of Transect Quadrats

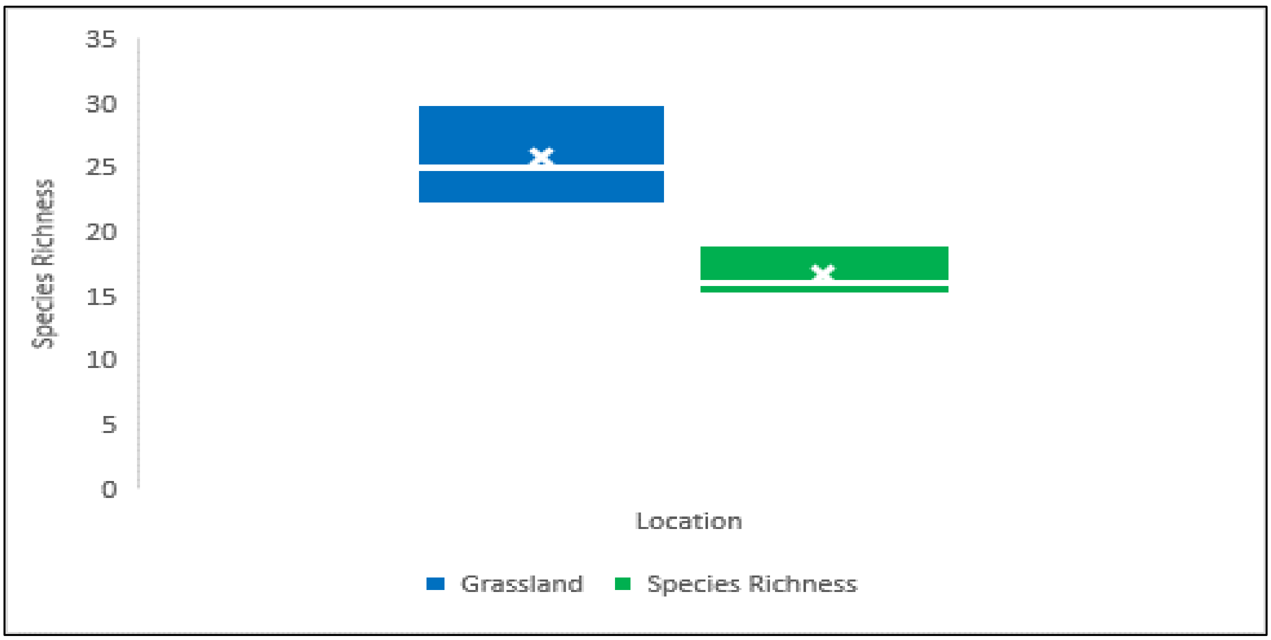

Figure 5-191: Species Richness Comparison

Data represented are for Waypoints 36 and 696 only as they were the only sites with suitable areas for comparison, containing three (3) grassland and three (3) forest quadrats each.

Light Incidence:

Average light incidence values for the three (3) locations examined were averaged and are presented below:

1. Open cover (characteristic of the open conditions on the lowlands) - ,32.67 Lux
2. Partial cover (characteristic of forest areas disturbed by man-made conditions, such as tree cutting or natural conditions, such as the falling of a tree, or transitional areas) – 1.85 Lux
3. Closed cover (prevailing light conditions under undisturbed canopies) - 0.79 Lux

As expected, illumination decreased as one transitioned from the exposed conditions of the depression/ore body areas to that of the canopy-covered understory of the forested areas.

5.3.4. Habitat Delimitations

The results of the study of the flora and fauna of SML 173 area indicate the general characterization of the habitats within SML 173 into four main categories, namely:

1. Naturally occurring hillock vegetation
2. Disturbed depressions areas comprising agricultural/grassland vegetation
3. Naturally occurring transitional vegetation between hillock and cockpit vegetation types
4. Caves and sinkholes

Figure 5-192 shows a section of SML 173 centered around position 18.365940° N and 77.453722° W, which was used as a means of illustrating various faunal habitats associated with the above-listed floral assemblages. The location was also selected because it has two cave locations represented within its borders, which, of themselves, are a special faunal habitat.

Plants provide the foundational habitats for the sustenance and survival of fauna and Figure 5-193 defines these habitats spatially within the area of examination.

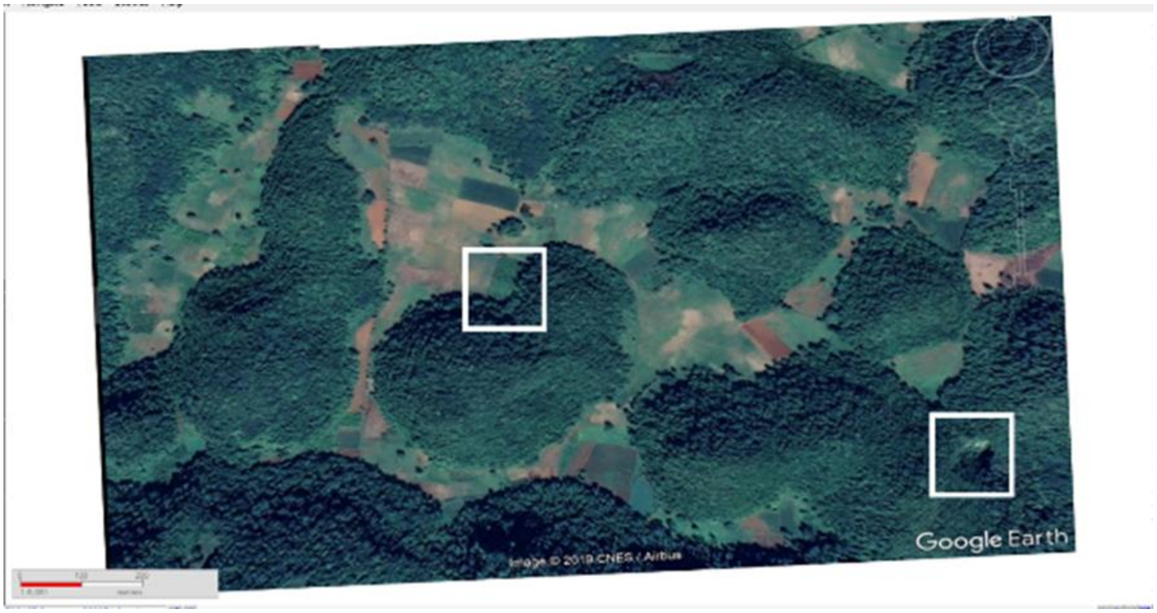

Figure 5-192: Representative area of SML 173 used for habitat delimitations (white squares = cave locations).

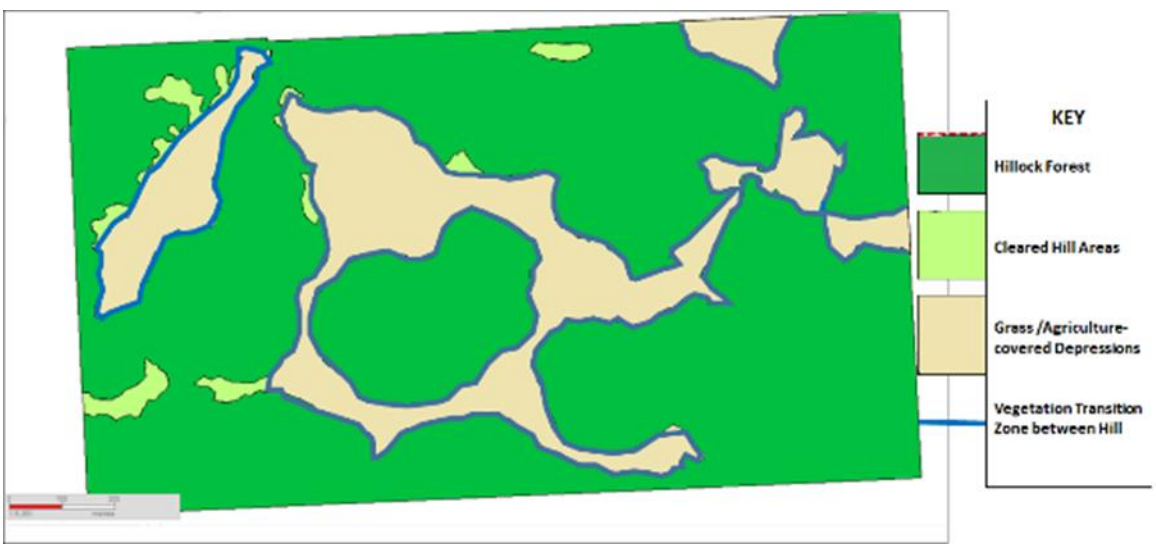

Figure 5-193: Plant Assemblages Representing Habitats for Fauna Within the SML

5.3.4.1. Delimitation of Avi-Fauna Habitats

This study has shown that 55% of the bird species observed were insectivores, 17% were herbivorous and 19% were omnivorous. Figure 5-194 shows the location of insect sightings throughout the study area. The majority of these insects were observed within the grassland/agricultural areas of the lowlands and the transitional areas between depressions and hillocks. Figure 5-192 above illustrates the spatial extent of grass and agricultural areas as well as the transitional areas, both of which would have provided sustenance for both the herbivores and omnivores. It was therefore surmised that the low lying areas, as well as the transitional areas, served as vital feeding areas for 91% of the birds observed within the study area (Figure 5-195).

Figure 5-194: Geographical Range of Insect Habitats/Sightings Over Sample Area.

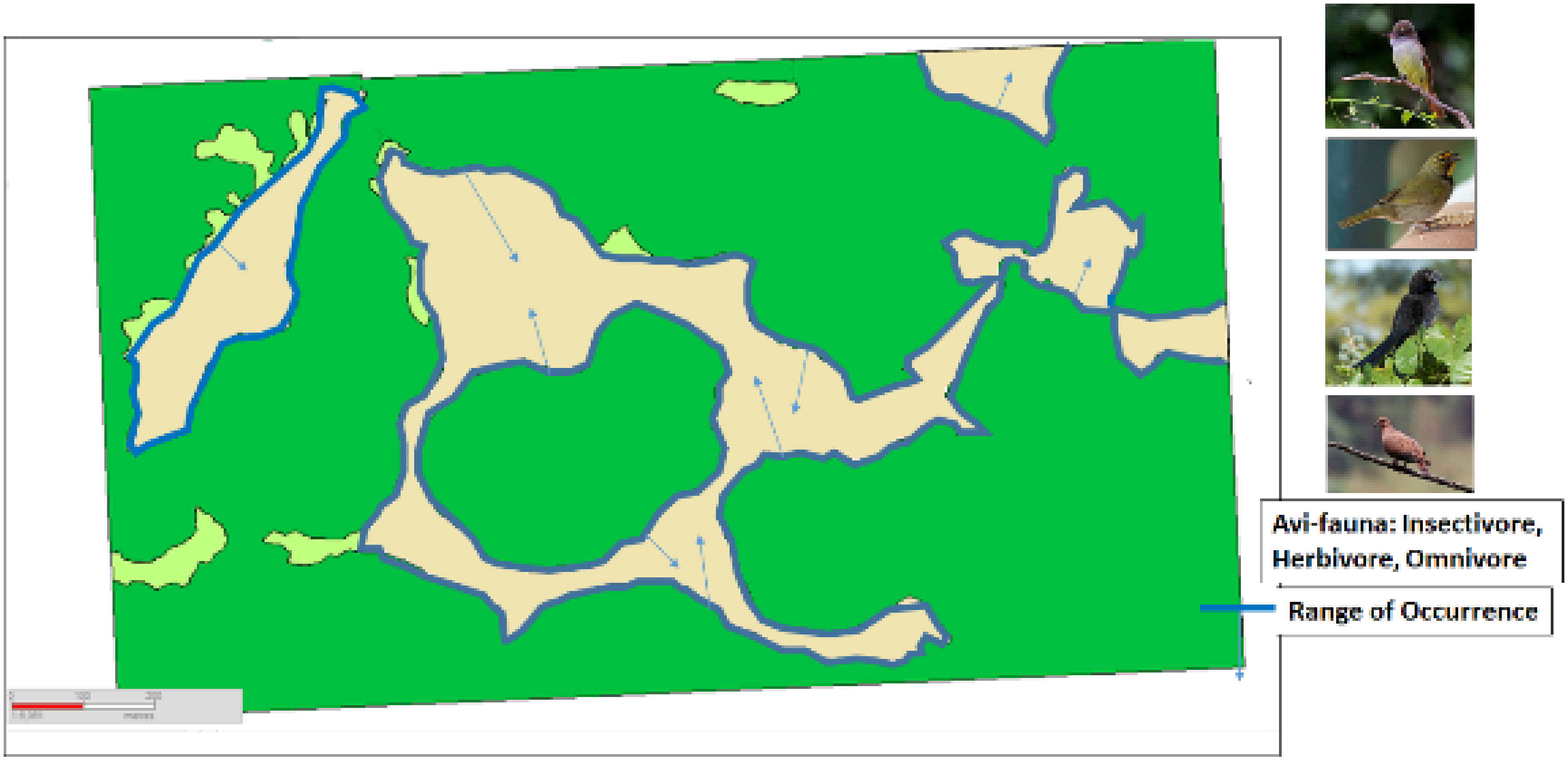

Figure 5-195: Geographical Range of Insectivore, Omnivore and Herbivore Habitats/Sightings Over Representation of SML Area.

Frugivorous 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 5-196).

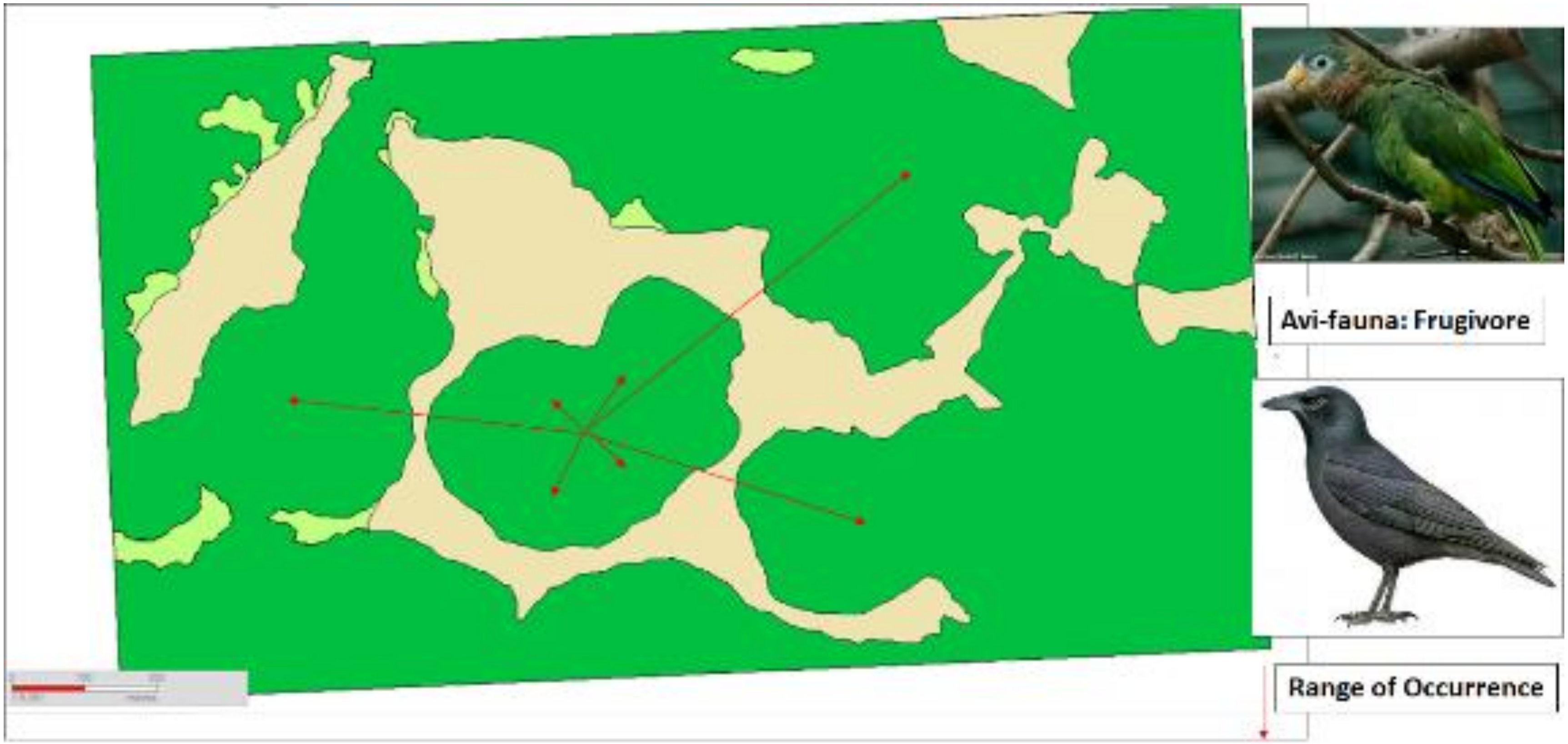

Figure 5-196: Geographical Range of Frugivore Habitats/Sightings Over Representation of SML Area.

5.3.4.2. Delimitation of Reptile Habitats

Figure 5-197 shows the locations of reptile sightings within the representational study area, with blue lines representing the transitional vegetation zone and trees at the base of the hillocks, where lizards were seen during the day and Geckos were heard at night. Gecko eggs were observed within the depressed area, up to about 50 meters away from the hillock base, suggesting that their range extends from the hillock treeline, through the transition vegetation zone and into the cockpit areas. The red lines on Figure 5-197 represents Gecko ranging.

Note that reptile habitat areas coincide with that of insects, the primary source of food for the reptiles.

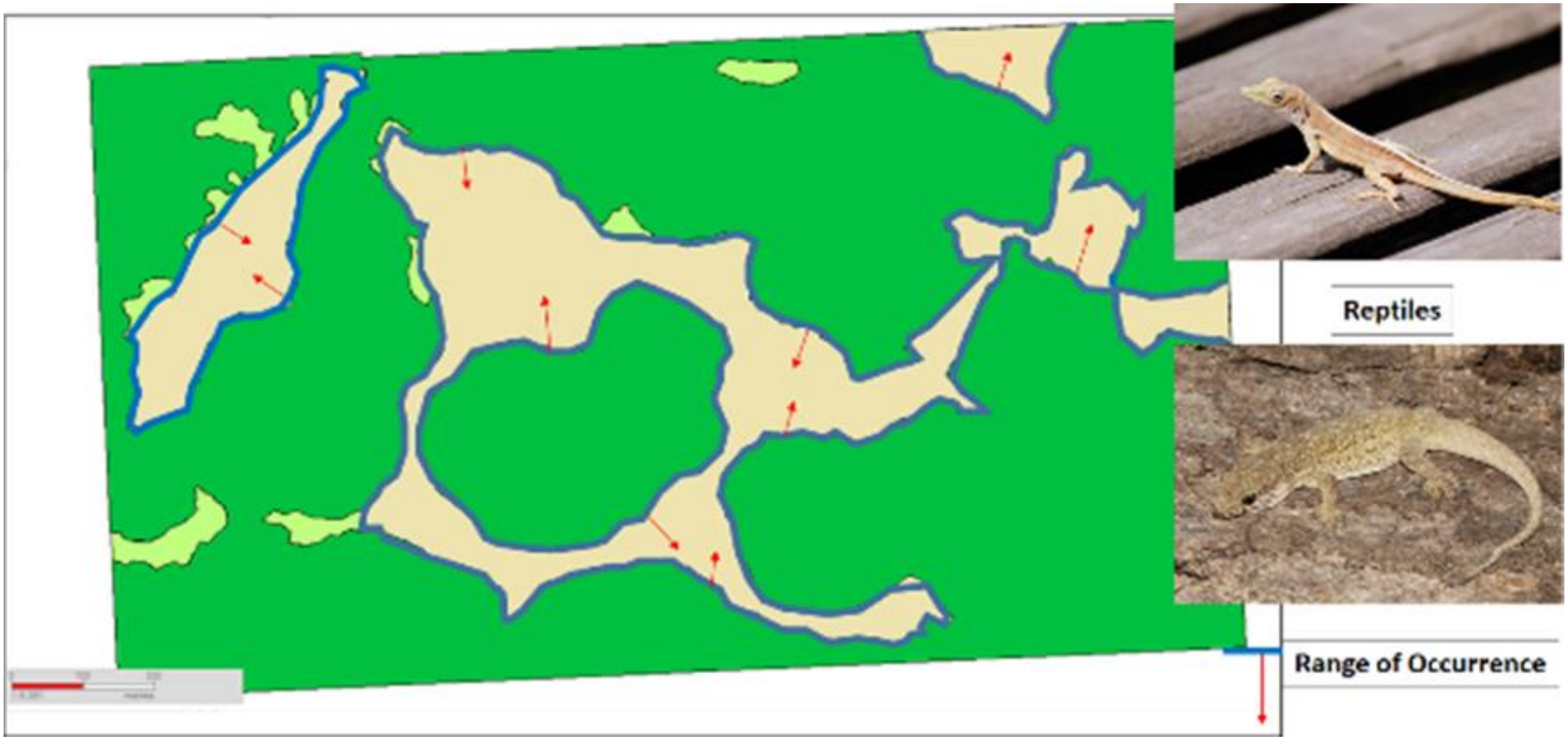

Figure 5-197: Reptile Habitat/Observation Ranges Within Representation of SML Area

5.3.4.3. Delimitation of Amphibian/Gastropod Habitats

Figure 5-198 outlines Amphibian and Gastropod observation ranges, with visual/audial observations being made between the vegetation transition zone and 30 meters up the slopes of the hillocks. Amphibian eggs were observed in tank bromeliads present within the limits of the 30-meter study transect lines deployed from the boundary of the transition vegetation zone into the hillock vegetation. Gastropods were observed either on the ground for ground gastropods and on tree trunks for arboreal gastropods.

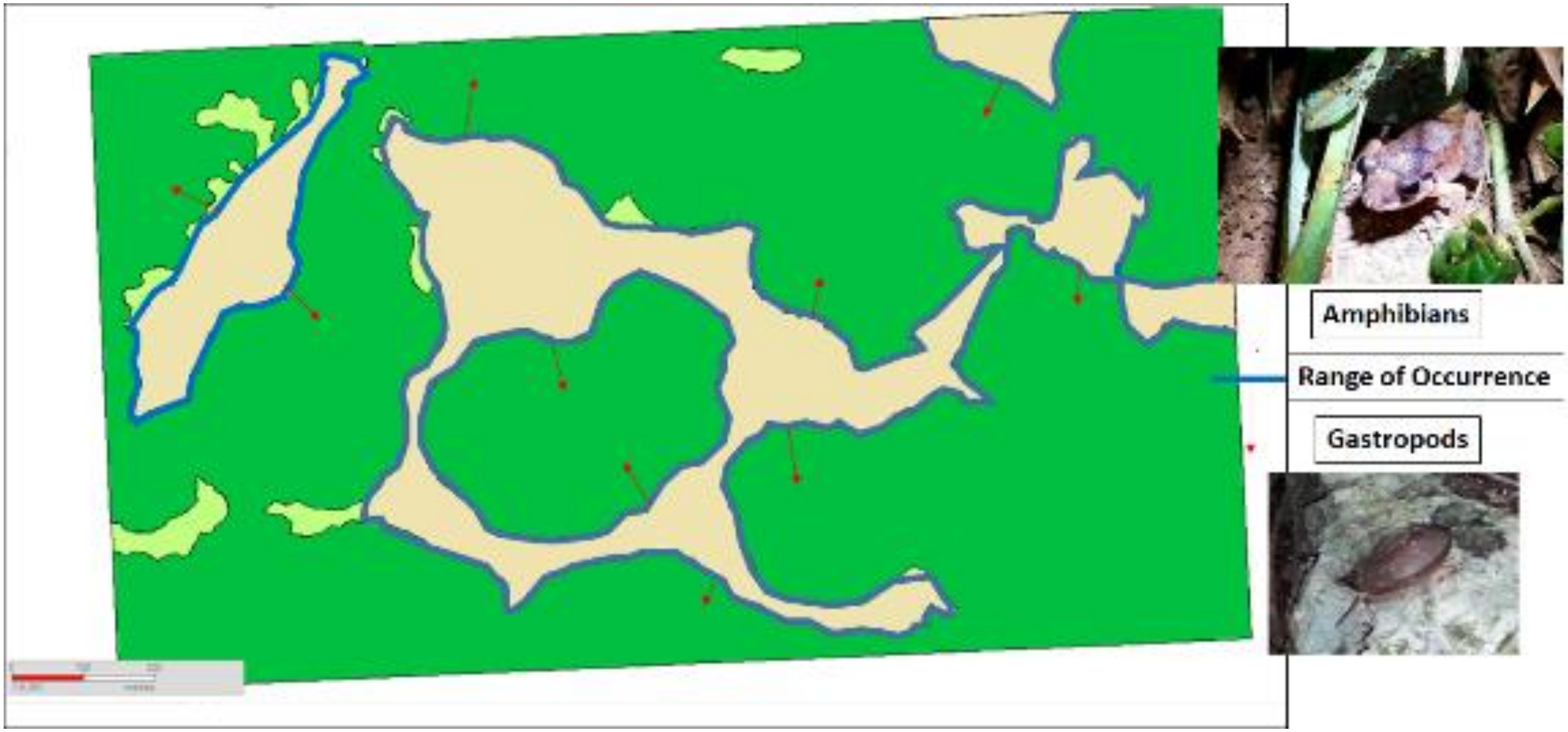

Figure 5-198: Amphibian and Gastropod Habitat/Observation Ranges Within Representation of SML Area

5.3.4.4. Delimitation of Mammal Habitats

Two mammalian habitats could be identified during surveys conducted within SML 173. The first habitats are defined on Figure 5-199 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 5-199: Ground-Based Mammal Habitat/Observation Ranges Within Representation of SML Area

The second habitats are defined for Bats on Figure 5-200 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 5-192 above). The second habitat relates to where these bats, which are believed 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, suggesting that the bats range to these habitats to feed.

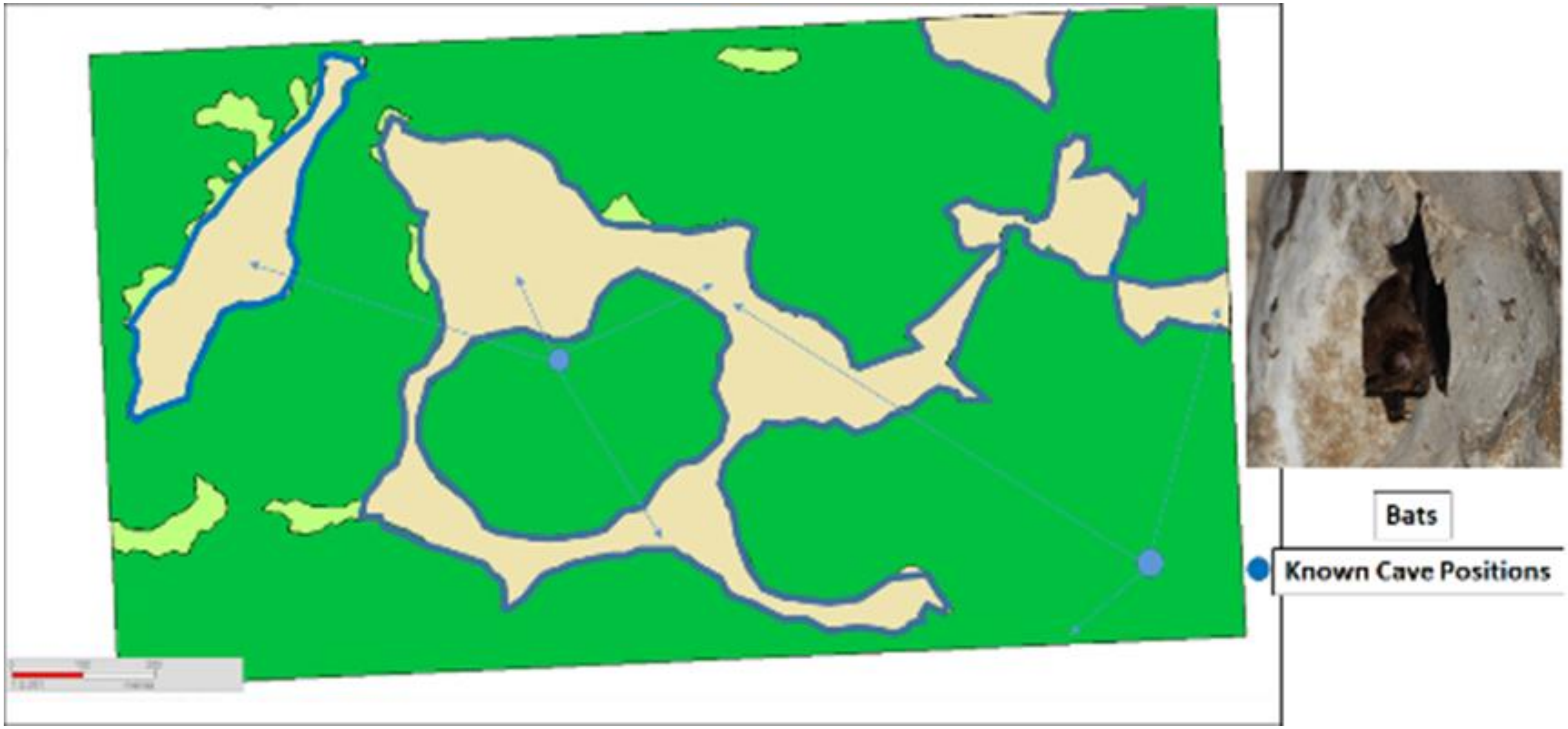

Figure 5-200: Aerial Mammal Habitat/Observation Ranges Within Representation of SML Area

5.3.4.5. Overlapping Habitats

Examining the various habitat boundaries outlined above, it was clear that, with the exception of frugivorous fauna (whose habitat ranges were apparently confined to the summits of hillocks) and, to some extent, bats (from the perspective of their roosts), there was commonality between habitats for the remaining fauna. Figure 5-201 combines habitat characteristics present within the cockpit floral environment, the transitional vegetation environment and hillock environments extending uphill for a distance of 30 meters.

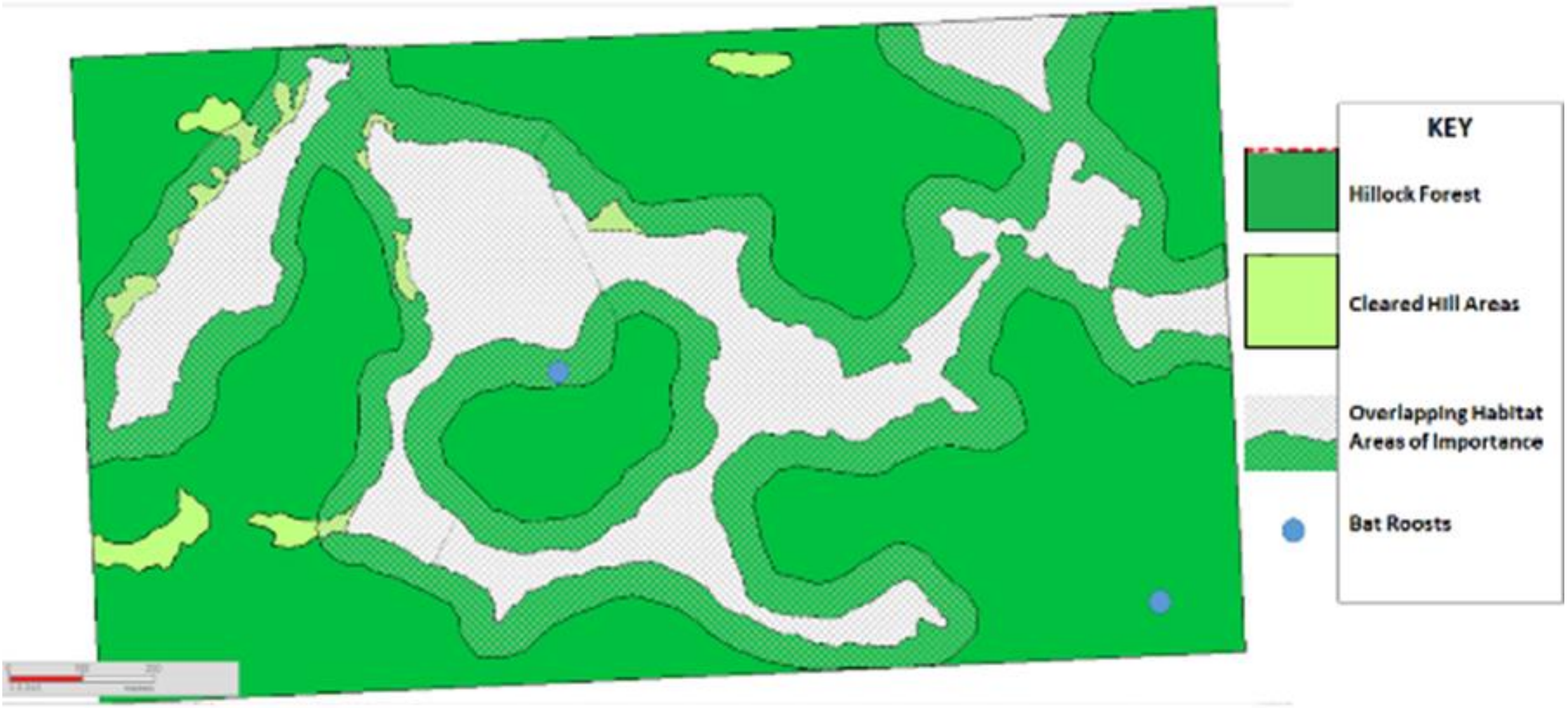

Figure 5-201: Illustration of Overlapping Habitat Areas of Importance Within SML 173

5.4. Archaeological Heritage

In keeping with the requirements of NEPA, the historical heritage of SML 173 has been assessed in detail by the Jamaica National Heritage Trust. The Archaeological Impact Assessment (AIA), is submitted as an accompanying document with this EIA, as Volume III and titled, "Archaeological Impact Assessment Proposed Bauxite Mining Operation Special Mining Lease (SML 173) Saint Ann/Trelawny Noranda Bauxite Partners II," dated October 2019.

5.5. Socio-Cultural and Economic Environment

5.5.1. Introduction

Noranda Jamaica Bauxite Partners II (NJBP II), over 10 years, has established very good relations with the communities in Western St. Ann, in which it operates. Some of these communities include:

- Alexandria
- Brown's Town
- Caledonia
- Discovery Bay
- Gibraltar
- Lime Tree Garden
- Lindale
- St. D'Acre
- Watt Town

NJPB II is, therefore, keen to gather the opinions, attitudes and views of the community members in order to ensure that the perspectives and concerns of all stakeholders are incorporated into the project. Consequently, potentially impacted communities were identified and surveyed within the context of the nature of the proposed development. This report presents the demographic and social profile of the potentially impacted communities and the findings of a socio-economic survey that was conducted in March 2019.

5.5.2. Survey Population

The Special Mining Lease 173 (SML 173) area straddles the parishes of Trelawny and St. Ann. The potential impact areas therefore include a combination of communities with a history of (and familiarity with) bauxite mining operations such as Brown's Town, Gibraltar, Madras, Alexandria (on the eastern side of the project area); and those comprising sensitive and ecologically significant areas in proximity to the proposed Cockpit Country Protected Area (CCPA) (on the western side of the project area). These areas are shown in Figure 5-202 and include, for example:

- Ulster Spring (See locations in Ulster Spring in Figure 5-203 and Figure 5-204 below),
- Alps (See locations in Alps in Figure 5-205 below),

- Sawyers (See locations in Sawyers in Figure 5-206 below)
- Clarks Town, and
- St. Vincent.

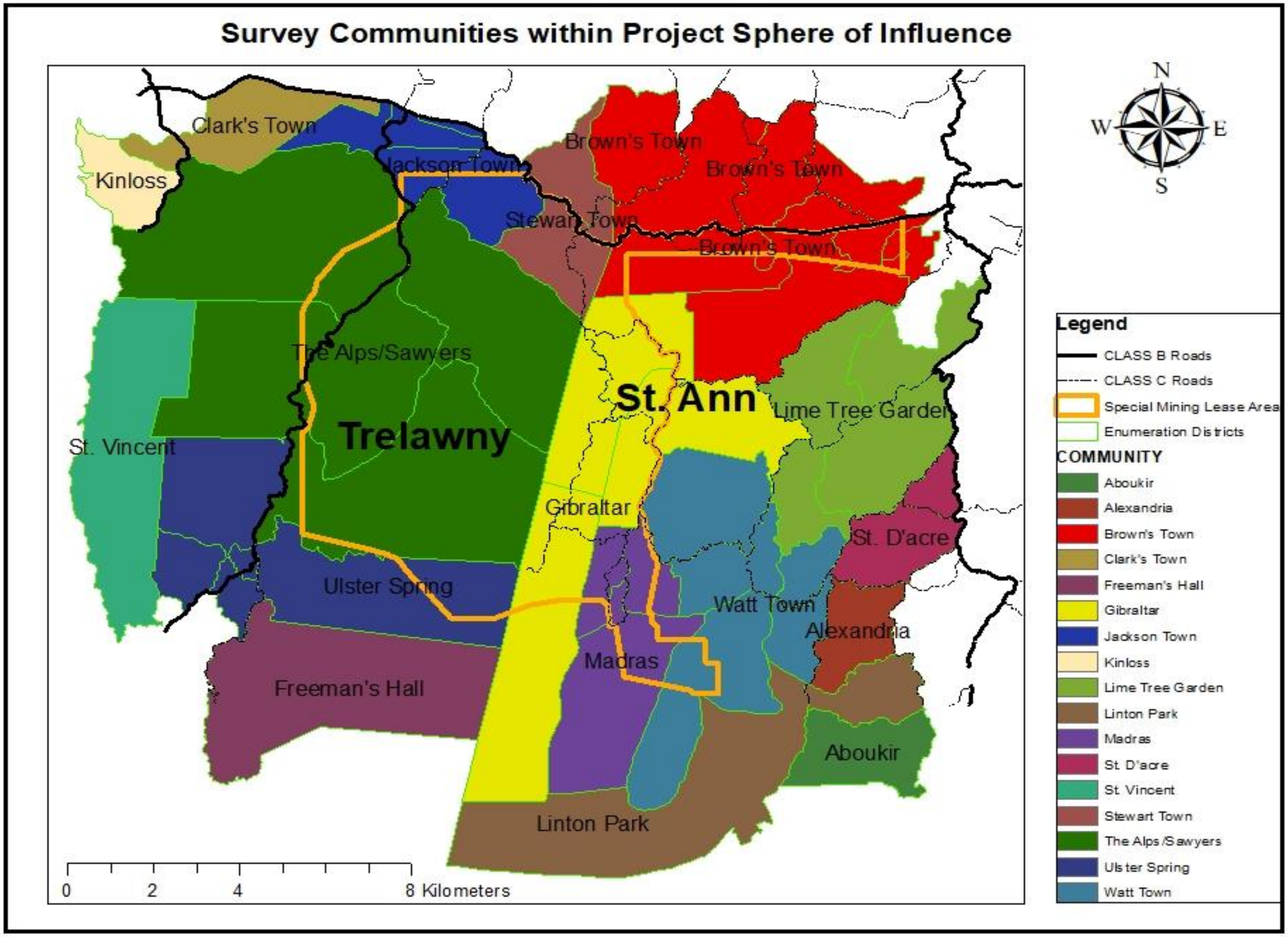

Figure 5-202: Survey Communities within the Project Sphere of Influence

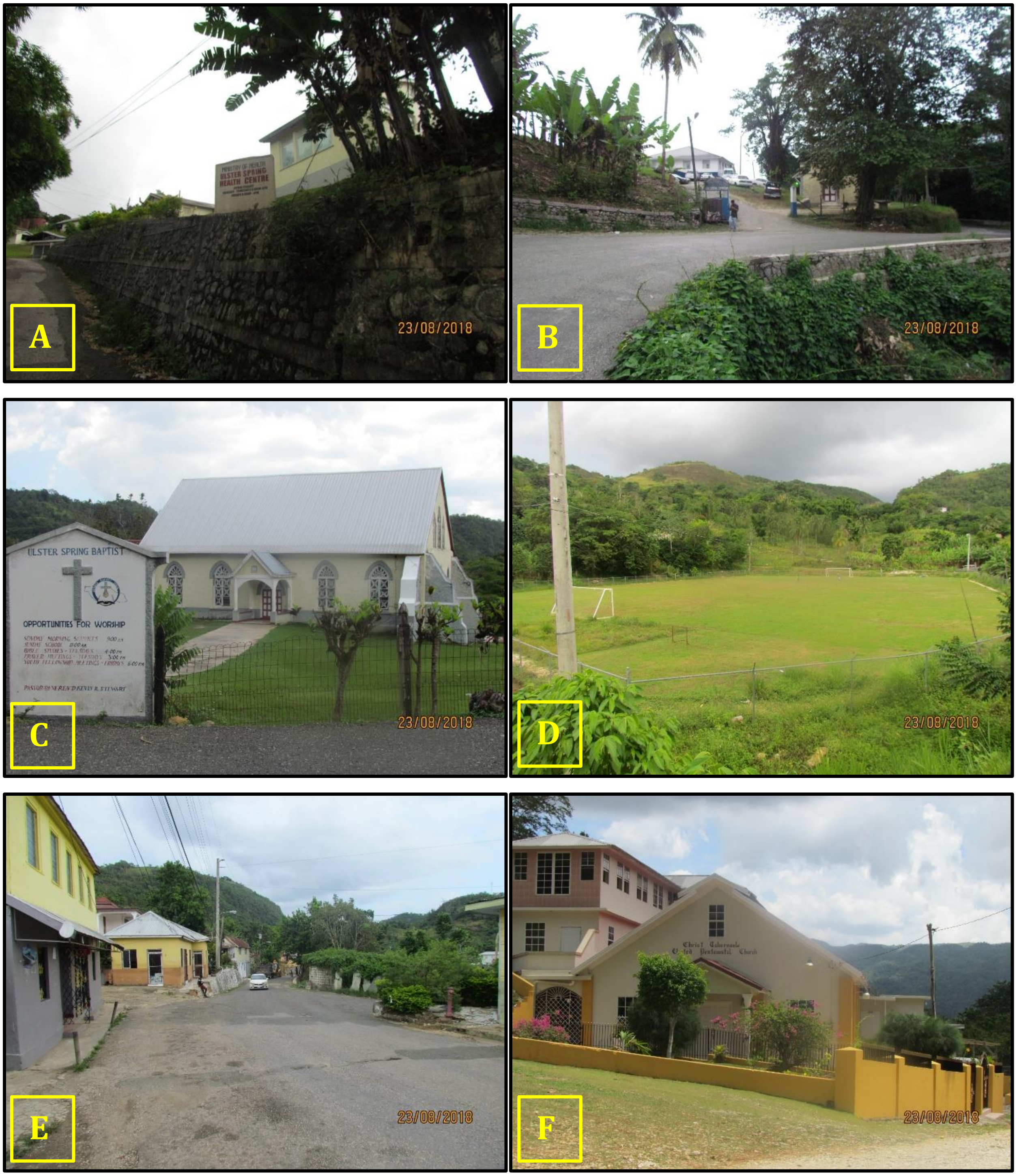

Figure 5-203: Locations in Ulster Spring Communities – [A]: Ulster Spring Health Centre (N18° 18.623' W77° 31.339', 468 meters above sea level) **[B]: Ulster Spring Police Station** (N18° 18.590' W77° 31.324', 458 meters above sea level) **[C]: Ulster Spring Baptist Church** (N18° 18.614' W77° 31.263', 458 meters above sea level) **[D]: Ulster Spring Playing Field** (N18° 18.828' W77° 31.240', 453 meters above sea level) **[E]: Ulster Spring Main**

Road (N18° 18.858' W77° 31.231', 457 meters above sea level) **[F]: Christ Tabernacle United Pentecostal Church** (N18° 18.976' W77° 31.003', 475 meters above sea level)

Figure 5-204: Locations in Ulster Spring Community – [A]: Ulster Spring Cemetery (N18° 19.145' W77° 30.940', 487 meters above sea level) **[B]: "Country Style Cuisine Restaurant"** (N18° 18.875' W77° 31.238', 448 meters above sea level)

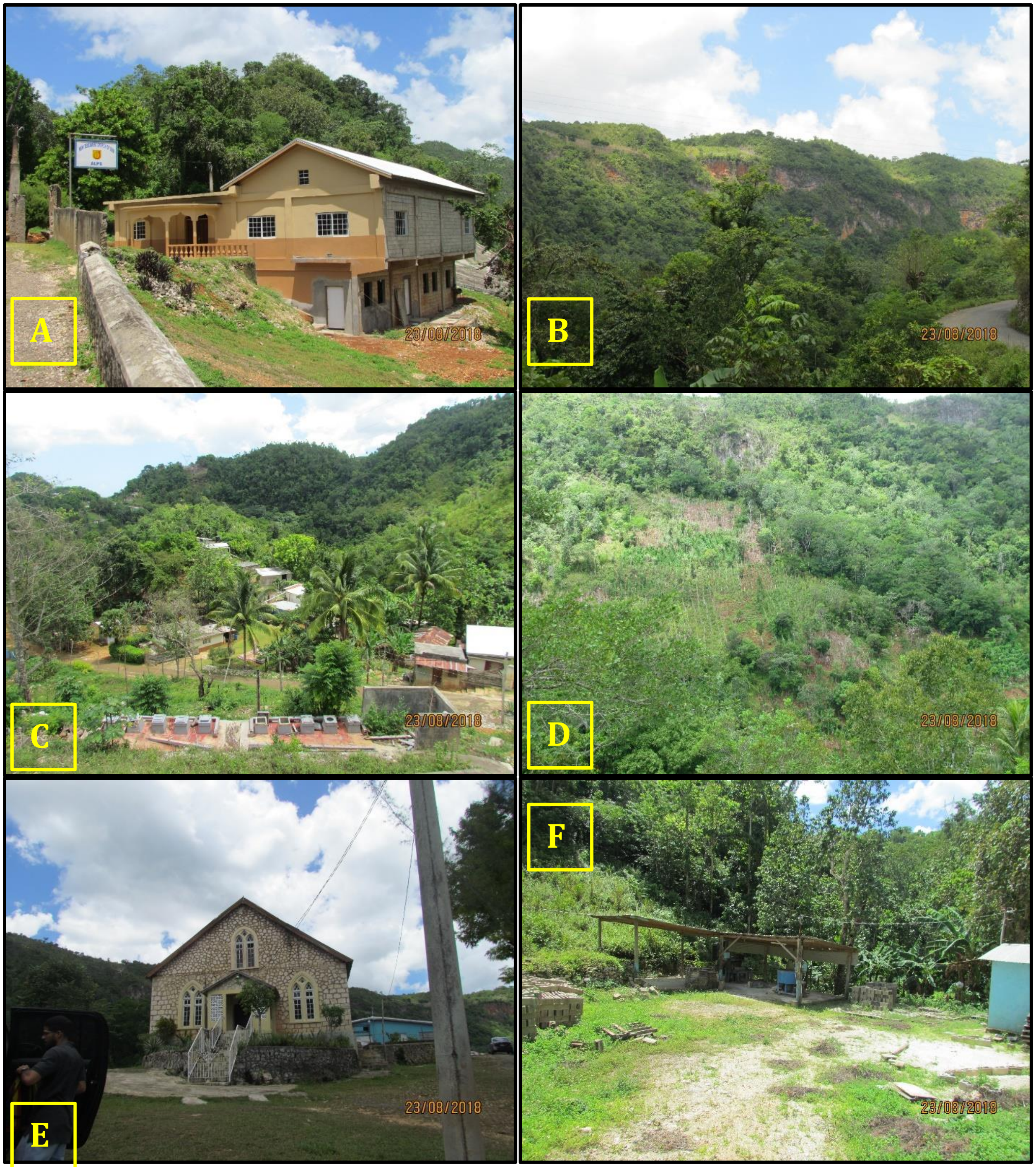

Figure 5-205: Locations in Alps Community – [A]: Alps New Testament Church of God (N18° 20.530' W77° 30.570', 395 meters above sea level) **[B]: Extensive view of the fault line** (N18° 20.114' W77° 30.732', 367 meters above sea level) **[C]: View of residential community in Alps** (N18° 20.154' W77° 30.853', 385 meters above sea level) **[D] Farming activity observed** (N18° 20.153' W77° 30.869', 388 meters above sea level) **[E]: Alps Baptist Church – Heritage Site** (N18° 20.153' W77° 30.869', 388m above sea level) **[F]: Block Making Factory**

Figure 5-206: Locations in Sawyers Community – [A]: Sawyers Primary School [B]: Sawyers Post Office (N18° 22.667' W77° 29.247', 319 m above sea level) **[C]: Banana and Yam cultivation observed in proximity to Sawyers Primary School** (N18° 22.716' W77° 29.192', 313m above sea level) **[D]: Jamaica Public Service Company Limited (JPSCo) high voltage power line observed on the hillside** (N18° 22.664' W77° 29.249', 320m above sea level)

The survey population was derived from a 1.5% sample of the total population within the area according to the 2011 Population Census. A total of 319 surveys were conducted in the Enumeration Districts (EDs) as outlined by the Statistical Institute of Jamaica (STATIN)., These surveys were conducted within and on the periphery of the project site (See Table 5-32). The selection of the areas for conducting interviews was based on EDs as defined by STATIN. However, it must be noted that it is possible for some communities to cross ED boundaries. As a result, the communities presented in this report were also defined in the field by the interviewer and the respondents.

Table 5-32: Enumeration Districts Surveyed

Parish and Enumeration District	ED Communities	Population	Sample Population (1.50%)
St. Ann			
SOUTHWEST 2, 3, 4, 6, 43	Gilbraltar	1329	20
SOUTHWEST44, 47	Linton Park	743	11
SOUTHWEST 40, 41, 42	Madras	1242	19
SOUTHWEST 5, 36, 37, 38, 39	Watt Town	1817	27
SOUTHWEST 9, 10, 11, 12	Lime Tree Garden	1357	20
SOUTHWEST 1, 7	Brown's Town	5076	76
NORTHWEST 58, 59, 60, 61, 62, 72, 73			
SOUTHWEST 13, 34	St. D'acre	1444	22
SOUTHWEST 35	Alexandria	294	4
Trelawny			
SOUTH 8, 9, 10,	Stewart Town	1382	27
SOUTH 5, 11, 12, 13, 20	Alps, Sawyers	1385	21
SOUTH 16, 17, 18, 19	Ulster Spring	1100	17
SOUTH 40	Freeman's Hall	592	9
SOUTH 21	St. Vincent	477	7
SOUTH 6, 7,	Jackson Town	1701	26
NORTH 58, 59, 60			
NORTH 109	Clark's Town	534	8
NORTH 110	Kinloss	802	12
TOTAL		**21,275**	**326**

5.5.3. Demography & Socio-Economic Profile

A total of 21,275 individuals make up the population of the impact area, of which 325 were interviewed to obtain their perspectives and opinions on the proposed mining project in the area.

The majority of the respondents have been living in the community for over twenty years as only 12% of the respondents have been residing there for less than that period. Of the remaining two hundred and eighty-six (286) respondents, 40% have lived there for up to forty years and another 20% have been residents for up to 50 years. This validates information gathered from the survey based on years of experience and familiarity with the area and will be critical for analysis of the community perception and attributes.

The age-sex pyramid depicted in Figure 5-207 illustrates the dynamics of the respondent population and suggests that a large majority (over 50%) of the respondents are of mature age (over 40 years). The majority of the respondents (60%) are between the ages of 20 and 49 years while individuals under the age of 20 years accounted for only 3% of the survey population. The males outnumber the females accounting for 52% and 48% respectively. However, it must be noted that the population structure of the survey population roughly reflects the demographic profile of Jamaica with a large economically active population (persons of working age), a contracting youthful population and an expanding ageing population.

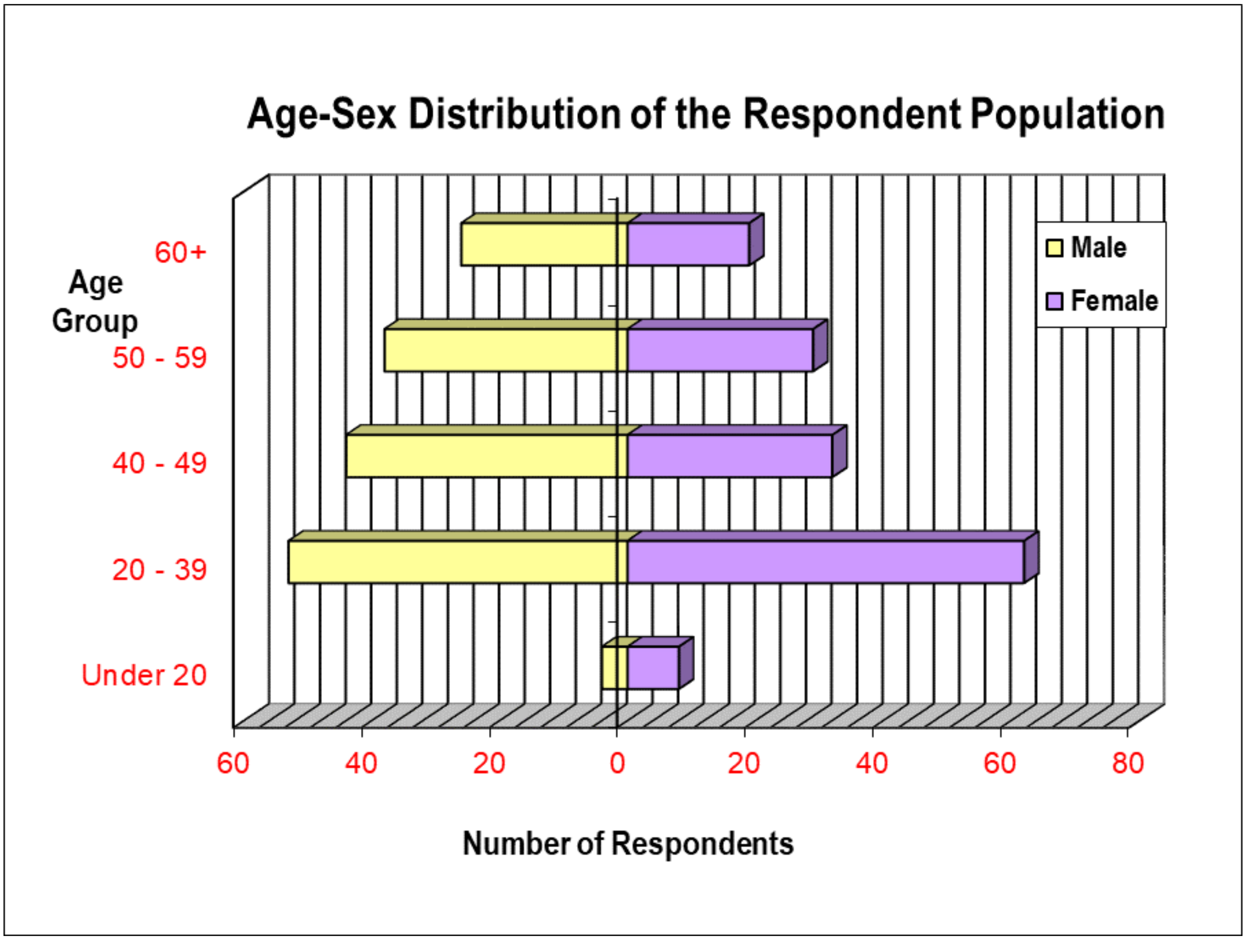

Figure 5-207: Age-Sex Pyramid of the Respondent Population

Most (60%) of the household in the area are headed by a male while forty percent (40%) of the households interviewed are headed by females. Household sizes in the survey area range from one individual to as much as fifteen individuals. Households comprising four and five individuals were the most dominant in the area, accounting for 18% of the respondents surveyed. Households with sizes exceeding ten (10) persons were evident in certain communities such as Alps, Browns Town, Gibraltar, Linton Park and Jackson Town.

Employment levels are high in the area with approximately 78% of the respondents indicating that they are currently in paid employment. The majority (60%) of these respondents are split evenly between those who enjoy full-time employment status and those who are self-employed, while the remaining 18% are employed on a part-time basis. Farming is the most popular occupation among the respondents while shop-keeping, chef, and other skilled or semi-skilled profession are present. There were a few highly trained professionals among the respondents such as doctors, teachers and sales representatives. Secondary education is the most common educational level attained, with 42% of the respondents achieving up to secondary education. Of these one hundred and thirty-seven (137) respondents, 34% were self-employed while another 20% had full-time employment status. Approximately 11% of the respondents attained tertiary level education and were outnumbered by those with only primary education (23%). Just over a third of the respondents who have only primary level education have full-time employment compared to just over fifty percent of the tertiary-educated respondents.

As indicated in Figure 5-208, a significant majority (48%) of the respondents were reluctant to give their monthly income levels in the interviews conducted. Of those who provided such information, a significant portion indicated that their monthly earnings are less than J$50,000.00. This was more evident in the communities of Alps, Jackson Town and Gibraltar, where the respondents who indicated this salary range accounted for 60%, 48%, and 45% of the respondent from the respective communities. The survey also reveals that there are tertiary educated persons and those who have received vocational training who are earning less than J$50,000.00 per month as indicated by survey results of 40% and 63%, respectively. The highest declared income range of more than $400,000.00 was earned by only 6% of the respondents. This group is comprised predominantly of those who completed up to secondary education and reside in the communities of Alps, St. D'acre and Ulster Spring.

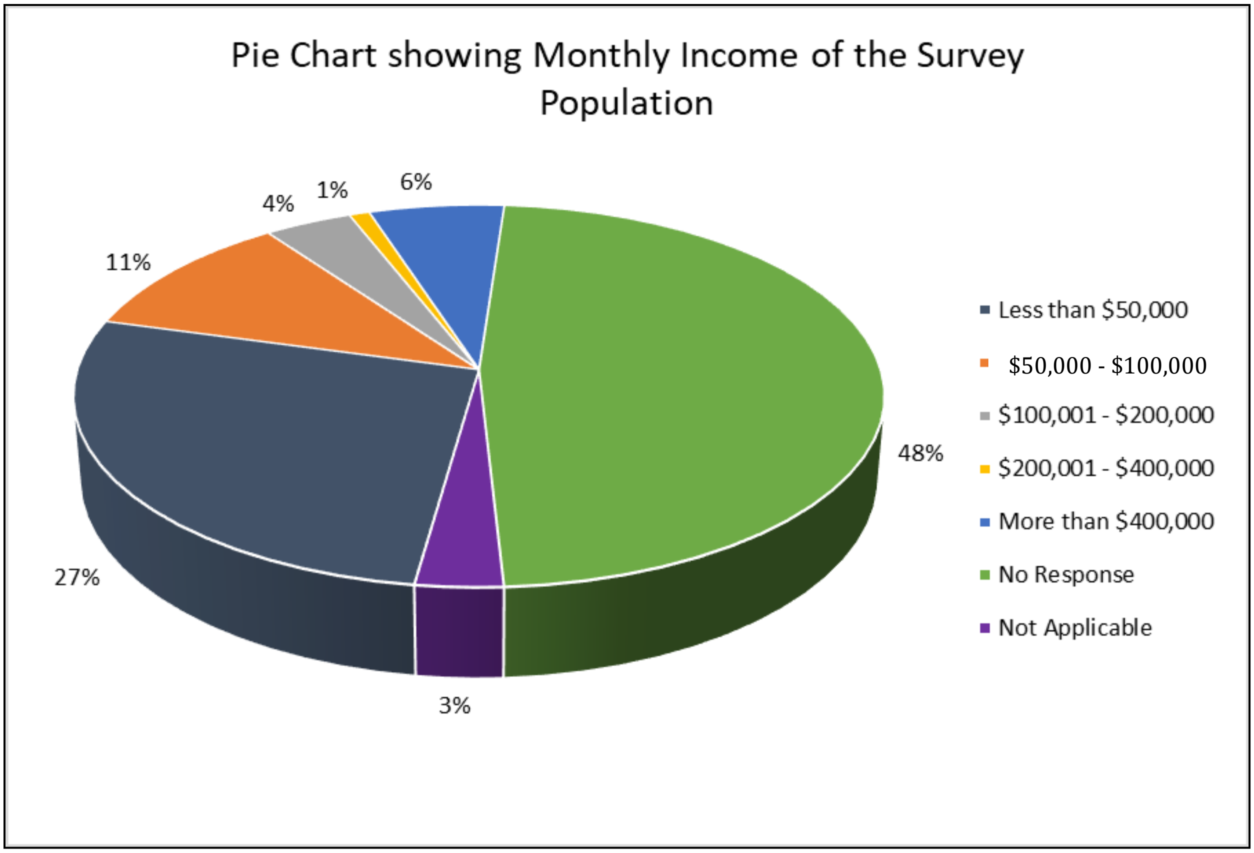

Figure 5-208: Monthly Income of Survey Population

5.5.4. Housing and Amenities Characteristics

Home ownership appears to be high in the area as a majority of respondents (74%) indicated that they owned the property while rental properties accounted for 20%. Although Brown's Town recorded the largest number of home owners (44), the percentage of home ownership among respondents was highest in Madras (100%) followed by Alps/Sawyers (86%), Lime Tree Garden (85%) and Watt Town (82%). Rented housing was most dominant in Brown's Town, with 40% of the respondents renting the property in which they currently live.

Most of the houses are serviced with electricity as most respondents (90%) indicated as their source of lighting. Kerosene lamp was the next most popular source of lighting as indicated by 6% of the respondents who were spread relatively evenly in all communities with the exception of Brown's Town, Clark's Town, Alexandria, Madras and St. D'Acre.

There is visible dissatisfaction, however, with the availability and provision of water in the area with approximately 82% rating the reliability of water 'very poor' and 'poor', while in terms of water quality 73% rated water in the area 'poorly' ('very poor' to 'poor').

According to Figure 5-210 and Figure 5-209, residents are generally discontented with water quality and reliability in all communities with the exception of Kinloss, Clark's Town, Jacksons Town and St. D'Acre. Respondents in these communities indicated that the quality and reliability of water supply in their area was of a satisfactory standard. In the southernmost communities, however, there was no positive feedback on water quality and reliability as respondents appear dissatisfied with water provision. The poor rating given to water provision in these areas may be a function of the water sources available and limited access to treated water for domestic consumption.

As illustrated in Figure 5-211, only a few respondents (36) had access to indoor tap, representing 11% of the survey population while the majority (200) indicated that rainwater was their main water source. The survey suggests that rainwater, together with trucked water, was the major water source for up to 75% of the respondents, while another 16% depended on public standpipe for water.

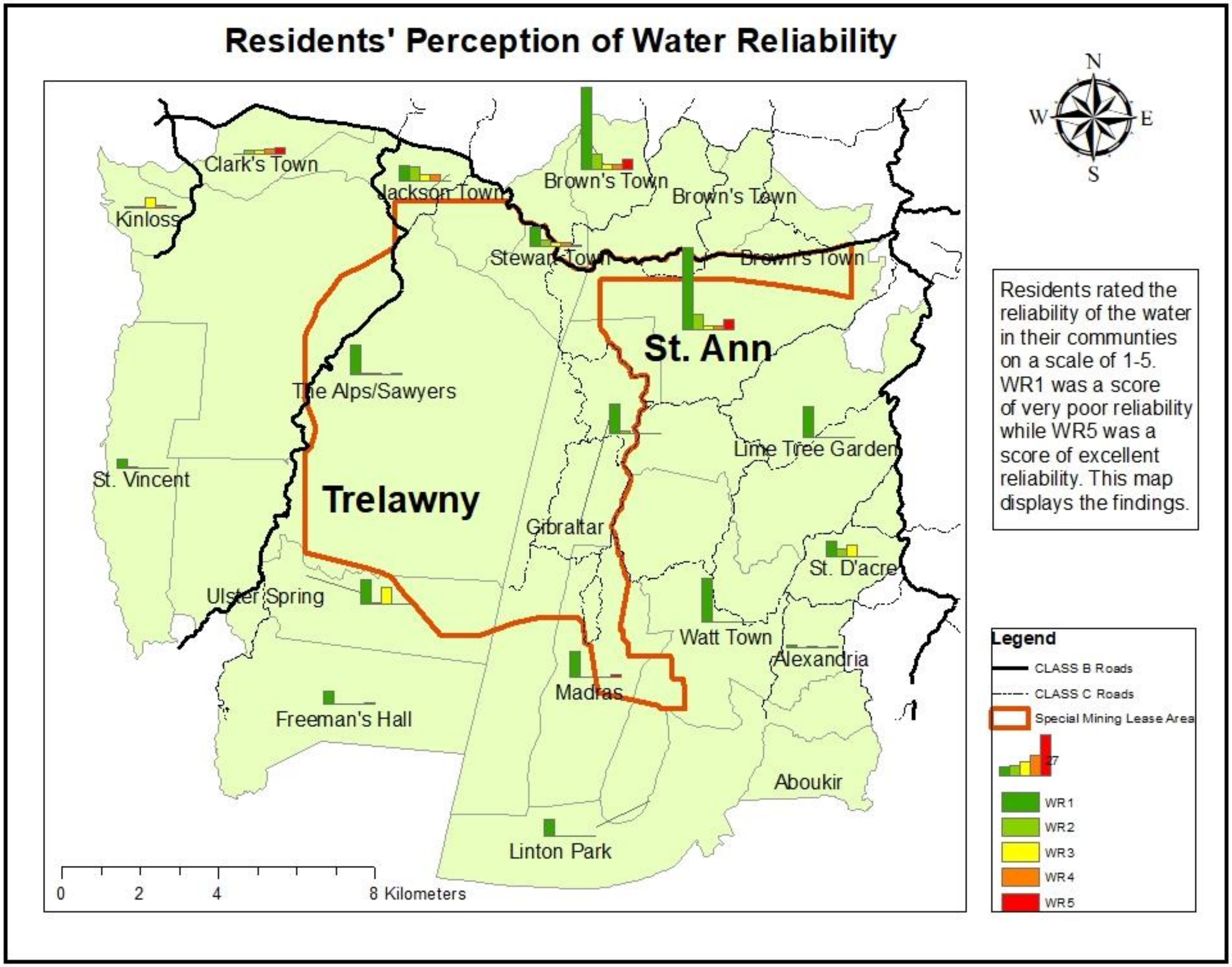

Figure 5-209: Residents' Perception of Water Reliability

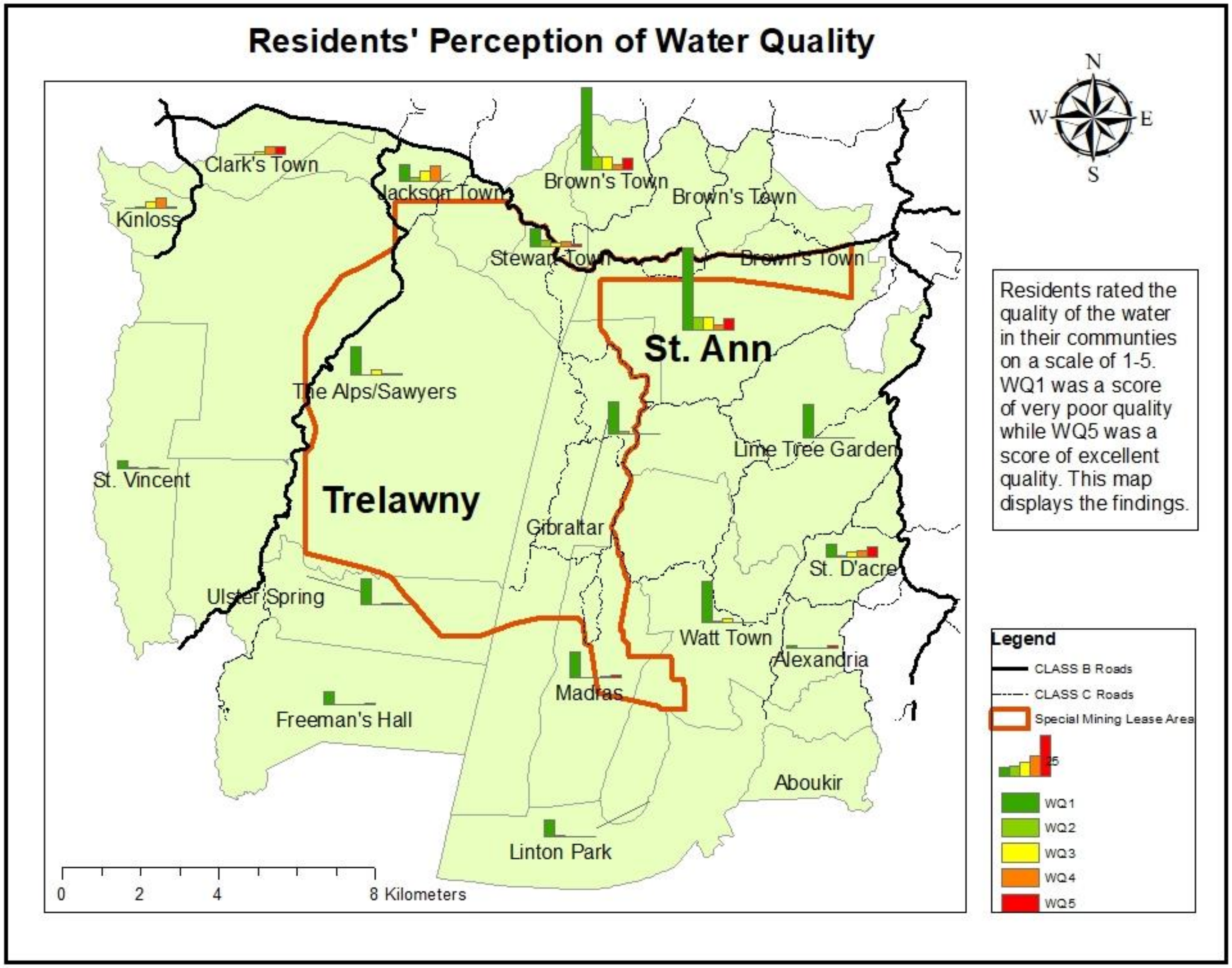

Figure 5-210: Residents' Perception of Water Quality

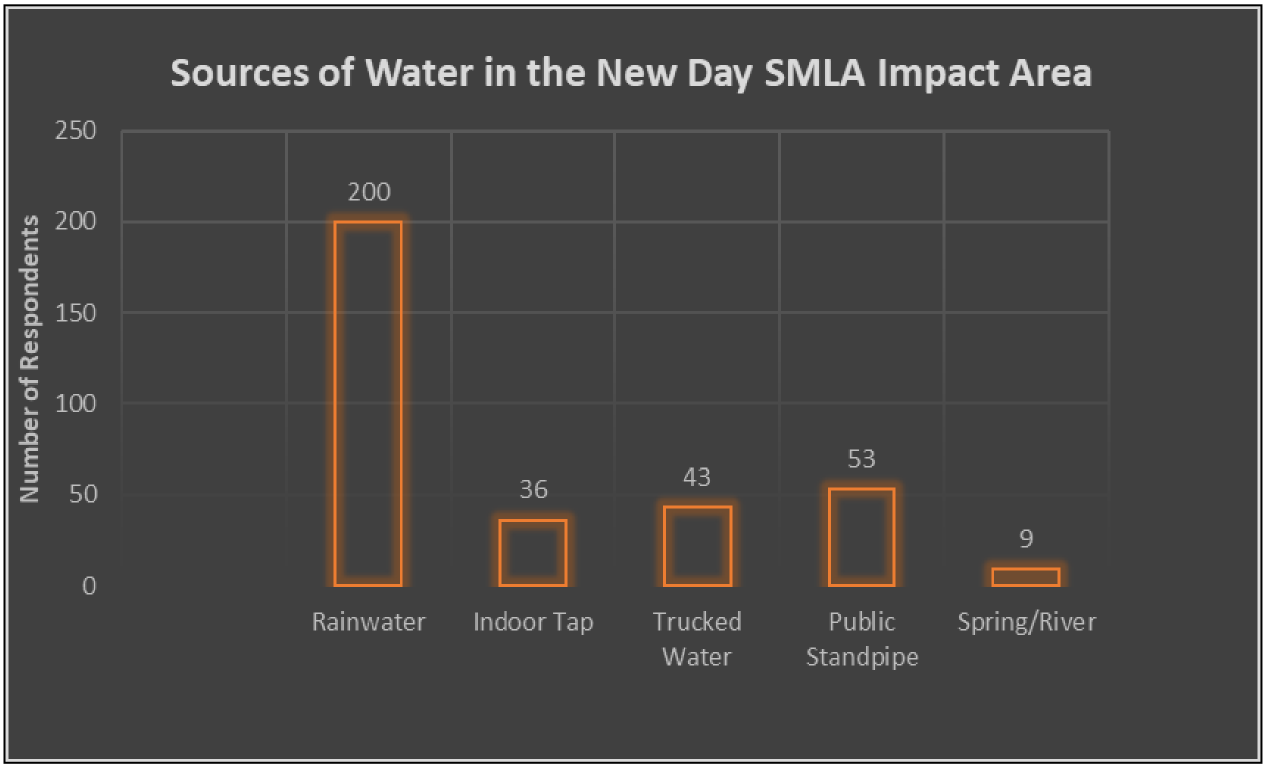

Figure 5-211: Sources of Water in the SML 173 Impact Area

5.5.5. Community Perceptions

Figure 5-212 below shows the preferred community attributes of the respondents. Friendly people and a crime-free environment are the most favoured traits identified by the respondents with as much as one hundred and sixty persons (49%) and one hundred and thirty-four persons (41%) respectively. The high safety rating suggested by the friendliness of the people and the lack of criminal activity in the area is confirmed by the very small percentage of respondents who cited crime and violence as nuisance within the communities (see Figure 5-213).

A quiet and clean environment were also among the preferred traits of several residents and together accounted for 60% of the survey population. The availability of farmland was the least popular of the liked community traits but was the most common response from residents living in Madras as it was selected by 73% of the respondents from that community, who accounted for 70% of those who highlighted farmland as a preferred trait.

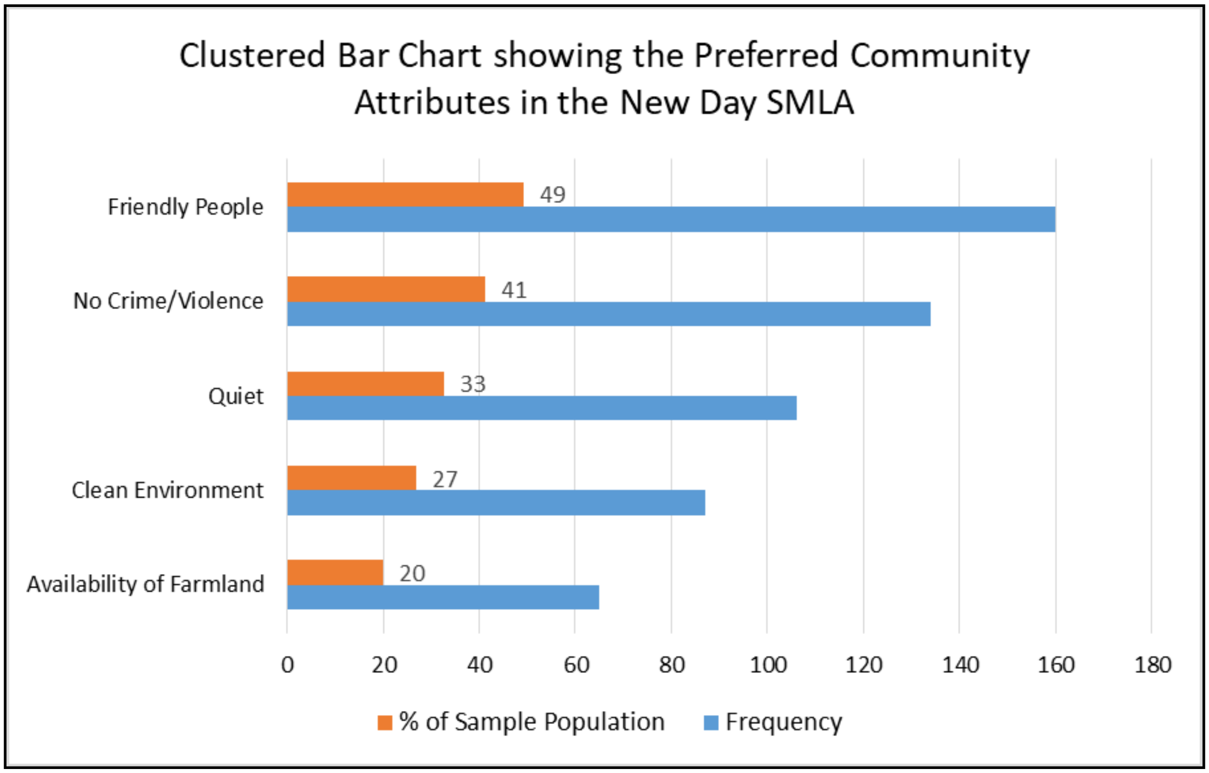

Figure 5-212: Most Liked Community Attributes

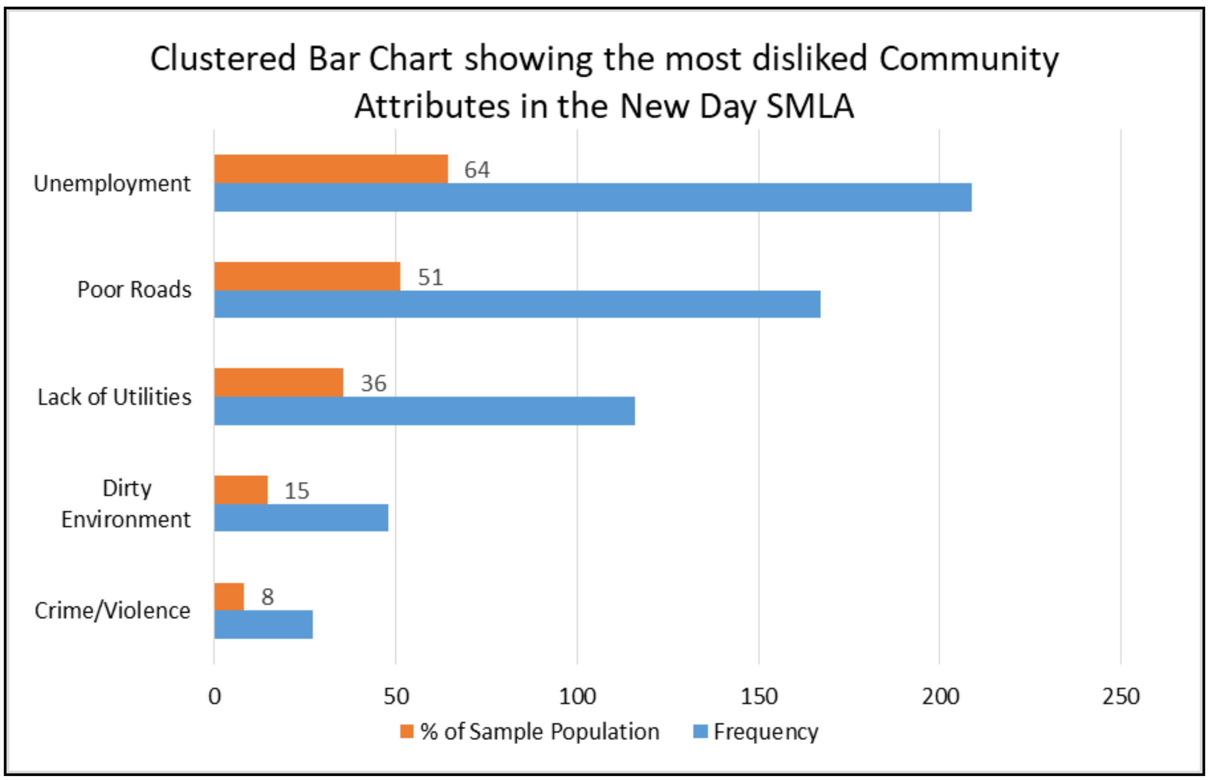

Figure 5-213: Most Disliked Community Attributes

As illustrated in Figure 5-214 below, only 8% of the survey population suggested that crime and violence was an issue in the area. The majority of these persons were residents of Brown's Town, who accounted for 41% of these twenty-seven individuals. Most residents were displeased with the level of unemployment and the poor roads in the area, which are currently the most disliked attributes of the communities. Just over half of the survey population expressed discontent with the state of the roads in their communities and applies to all with the exception of St. D'Acre, Alps/Sawyers and St. Vincent (Figure 5-215).

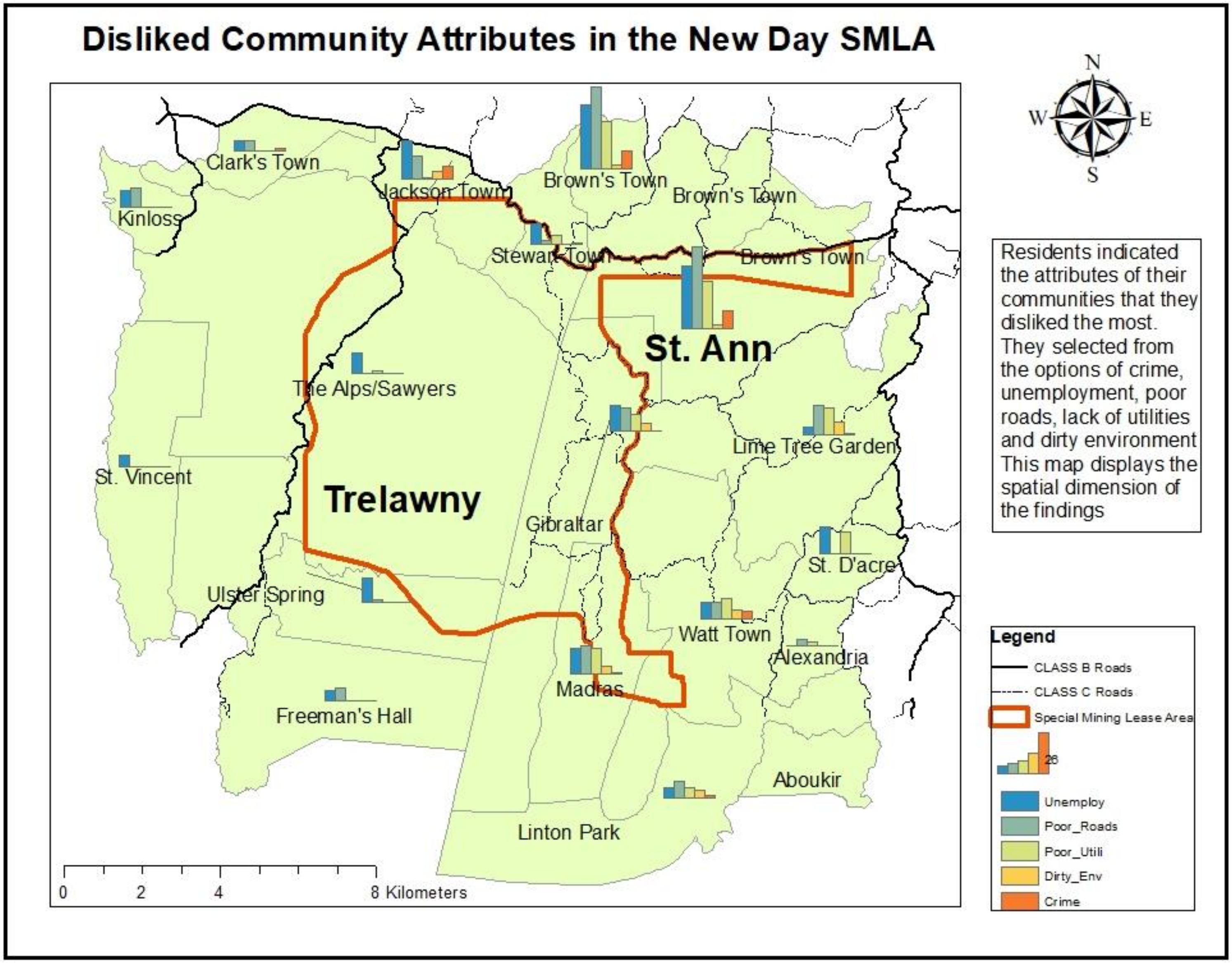

Figure 5-214: Disliked Community Attributes in the SML 173 Area

Brown's Town and Jackson Town residents dominated the residents who highlighted unemployment as their most disliked community trait, but it prevailed in all other communities and represented a larger percentage in communities such as Madras, Ulster Spring, Gibraltar and Kinloss. Although 36% of the survey population expressed a concern for the lack of utilities in the area and the largest number coming from Brown's Town, it must be noted that the largest percentage from respective communities surveyed were in Madras (89%), Lime Tree Garden (85%) and St. D'Acre (63%).

Traffic does not appear to be an issue in the communities based on the results of the survey. Cumulatively, the number of respondents that suggested that traffic was either heavy or very heavy in their communities accounted for only 18% of the survey population. Most of these respondents came from the communities of Brown's Town, Jackson Town, Stewart and St. D'Acre. The majority of the residents (48%) suggested that vehicular traffic in the area is either low or very low. Over 80% of the residents agreed, however, that when traffic does exist it is normally in the morning and/or the afternoon.

Drought appears to be a significant issue facing the communities in the proposed project area and is clearly associated with the poor water reliability rating given by the residents who are heavily dependent on rainfall for domestic water. A total of two hundred and eighty-eight residents (288) across all communities in the proposed project area, which accounts for 89% of the survey population, indicated that drought was a common hazard in the area. A small number of respondents (41) from Brown's Town, Jackson Town and Stewart Town suggested that flooding was experienced in some areas as well.

5.5.6. Knowledge, Attitudes and Perceptions towards Proposed Development

Awareness of the proposed establishment of the mining lease area in the adjacent communities is based predominantly on the survey itself (81%) and word of mouth (26%). A small number of the respondents indicated awareness prior to the survey. Most of these respondents were informed by word of mouth and/or NJBP II's representatives. However, awareness of bauxite mining in the area was the larger number (56%) and was predominantly in communities in the parish of St. Ann where precedence of bauxite mining activity exists.

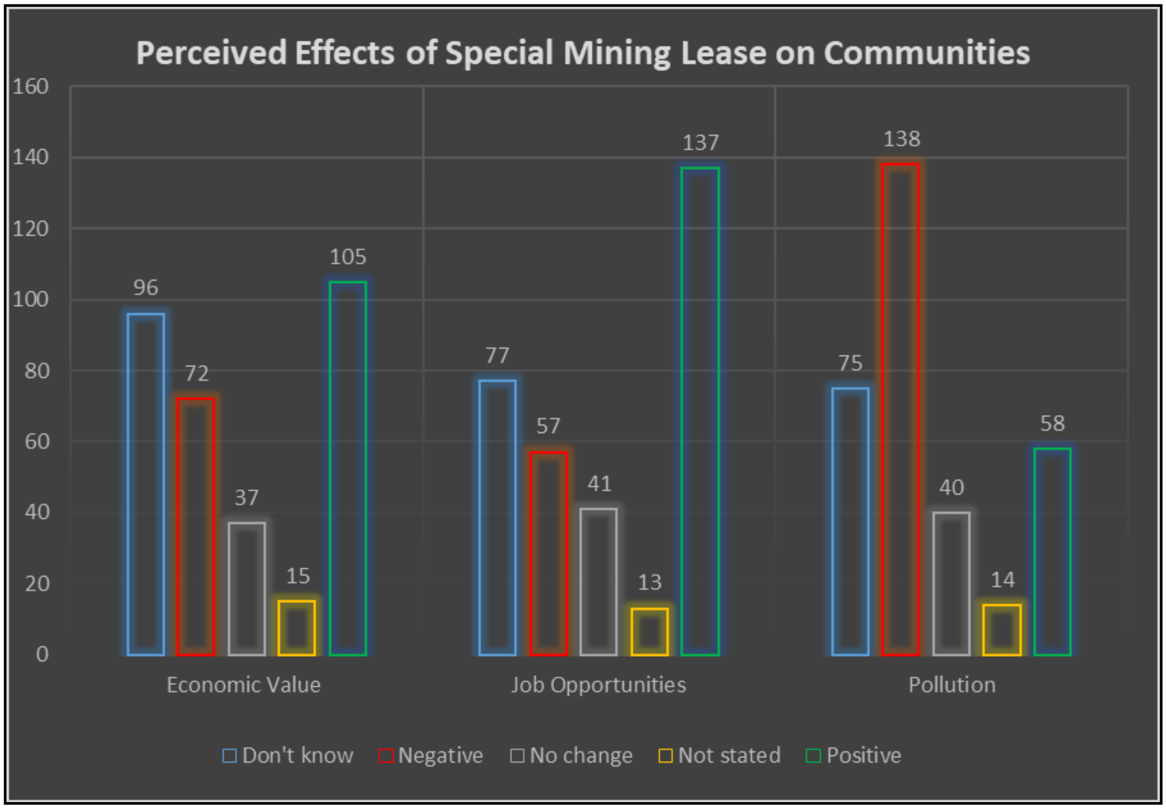

Figure 5-215: Attitude Towards Proposed SML 173 Area

While awareness among the respondents was relatively low, there were mixed sentiments in terms of the perceived impacts of the proposal on the community. As illustrated in Figure 5-215 above, a total one hundred and five (105) respondents, approximately 32% of the survey population, felt that the proposed development would increase the economic value of the community while another one hundred and thirty-seven (137), 42% of the survey population anticipate positive effects on employment opportunities.

The majority of the survey population (43%) also believe that the project will have a negative impact of pollution in the area while 12% stated it would not change anything, whether for pollution, employment opportunities or economic value. Some residents (22% of survey population), however, felt that the proposed SML 173 area would negatively affect the economic value of the community. These were predominantly residents of communities in and around existing or previous bauxite mining operations such as Gibraltar, Lime Tree Garden, Watt Town and Linton Park. Positive expectations on economic value prevailed in Brown's Town and St. D'Acre, while those who did not know came mostly from Jackson Town and Stewart Town. In terms of employment opportunities, the majority of the residents who expect positive impacts came from Brown's Town, St. D'Acre and Madras, while the least came from Lime Tree Garden, Linton Park and Alps. The large percentage of respondents who highlighted the negative impacts from pollution are mostly for the communities of Brown's Town, Gibraltar and Lime Tree Garden, where the highest percentage (95%) of residents expected the proposed mining project to have negative effects on the population.

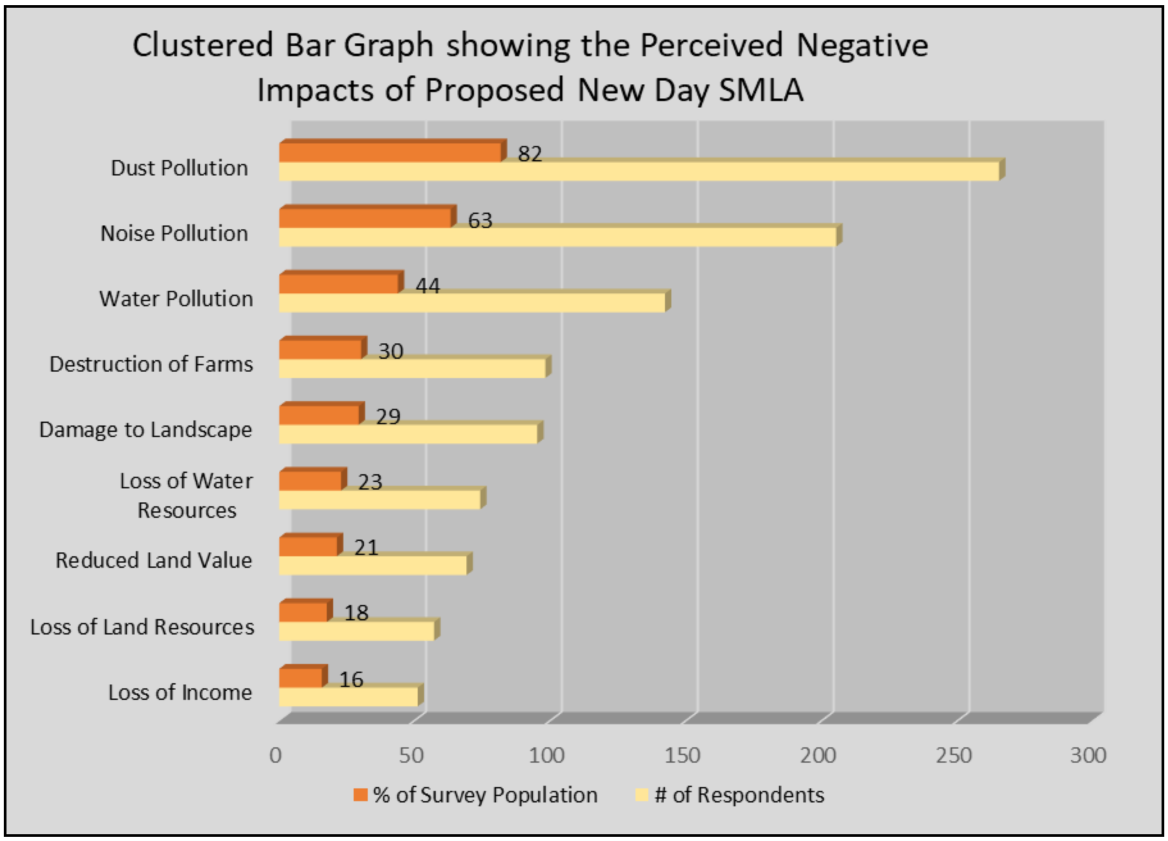

Figure 5-216: Perceived Negative Impacts of Proposed SML 73 Area

The nuisances associated with dust and noise represent the major concerns aired by the respondents. As illustrated in Figure 5-216 above, a total of two hundred and sixty-five (265) residents associated dust pollution with the proposed mining project while another two hundred and five (205) felt that noise pollution would be an impact, accounting for 82% and 63% of the survey population respectively. The majority of these respondents were from Brown's Town, Gibraltar and Lime Tree Garden (see Map 4). Concerns over water resources were expressed by a combined 67% of the survey population mostly from Gibraltar, Lime Tree Garden and Linton Park, where over 95% of the residents from these communities highlighted water pollution or loss of water resources as a negative impact. Gibraltar, Watt Town and Madras have the largest percentage of residents who see damage to farmlands as an inevitable effect of the proposed SML 173 area and directly correlates with the distribution of respondents who acknowledge the loss of income as a significant negative effect. Although the loss of income was the least common of the negative impacts, selected by only fifty-one (51) respondents (16% of the survey population). Madras, Gibraltar and Watt Town together accounted for 75% of these individuals citing this negative impact. This suggests that the persons in these communities use the areas in and near the SML 173 area for agricultural purposes. This is confirmed by all of the residents who indicated that they used areas in proximity to the proposed SML 173 area, albeit a relatively small percentage (11%) of the survey population.

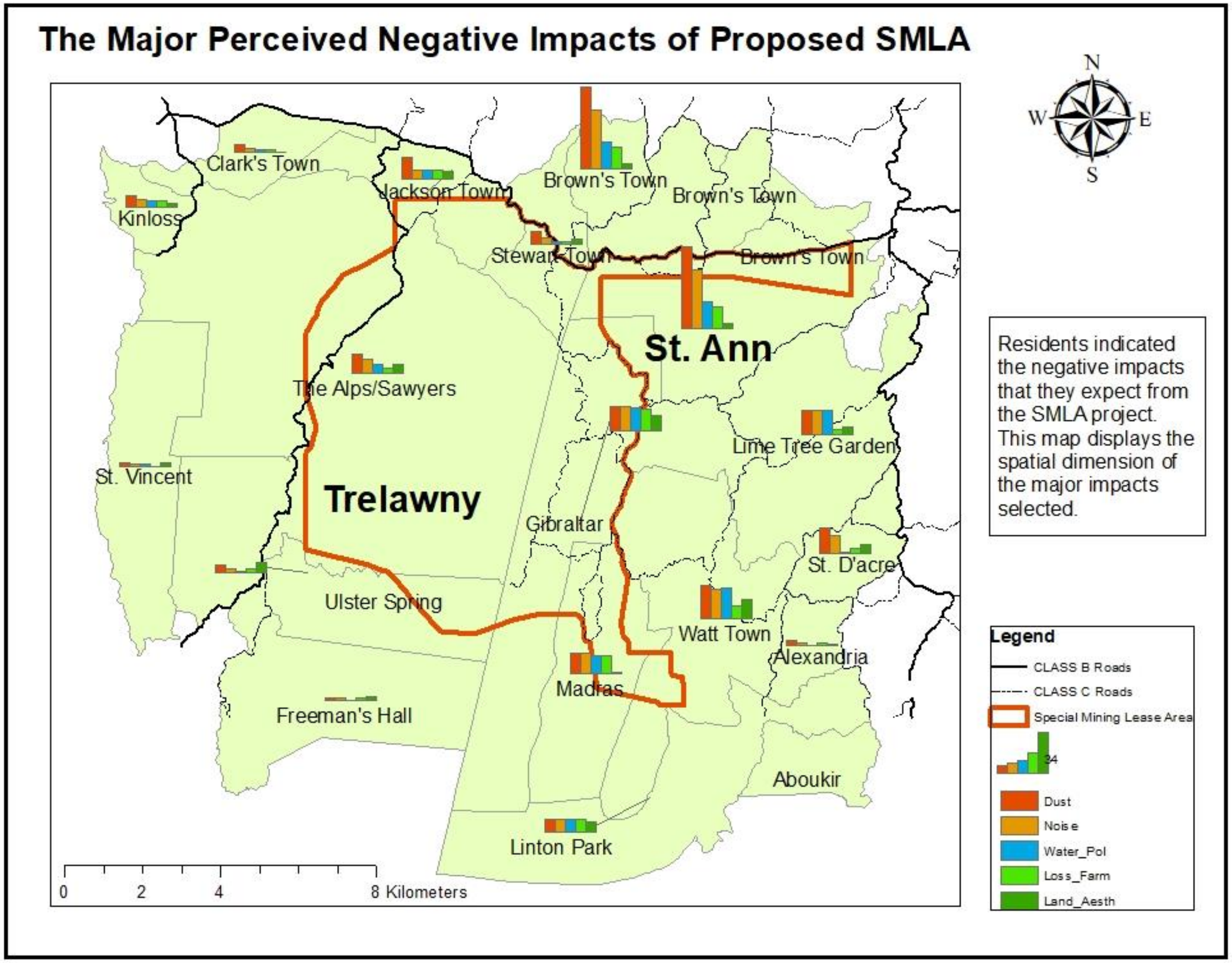

Figure 5-217: The Major Perceived Negative Impacts of SML 173 Area

Although there is a relatively even split between respondents who believe the project will affect them personally and those who do not, 35% and 34% respectively (see Figure 5-218 below), not many respondents believed that benefits would be localized. Only a combined fifty-one (51) individuals, 16% of the survey population, felt the project would translate to support for community businesses and funding for community projects. There is some uncertainty among some resident as the reasons quoted by those who thought they would be affected, personally, are dominated by nuisances related to dust, noise, water pollution, health issues and negative impacts on farming.

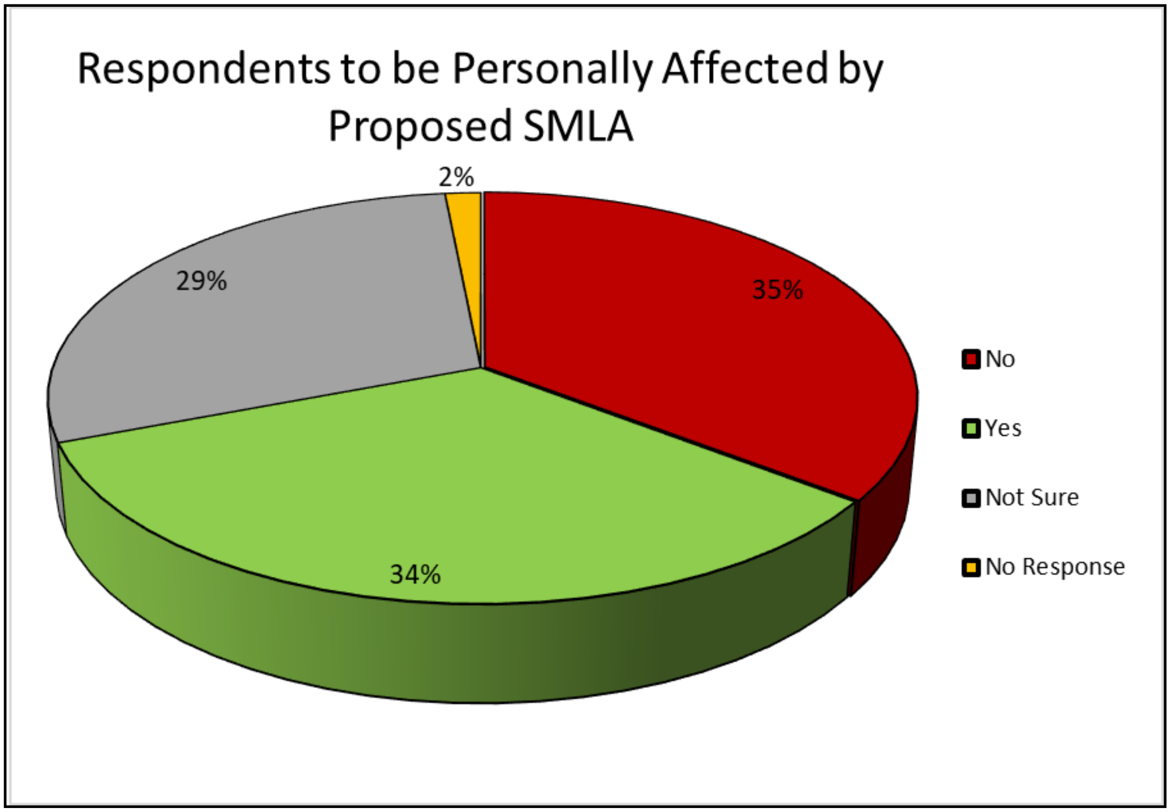

Figure 5-218: Respondents to be Personally Affected by Proposed SML

In addition, the perception of limited or no local benefit echoes from the communities of Madras, Gibraltar, Lime Tree Garden and Watt Town, where a majority of residents (no lower than 79%) believe that the project is of no significance to national or community development (see Figure 5-220). This was the opinion expressed by approximately 40% of the survey population (see Table 5-33), who gave the importance of the project the lowest ranking score. A total of one hundred and sixty (160) respondents gave the proposed mining project in SML 173 area negative rating.

Table 5-33: Respondent's Perception of the Importance of Project to National and Community Development

Parameters		# of Respondents	% of Survey Population
IMPORTANCE RANKING	Very Not Important	129	40
	Not Important	31	10
	Moderately Important	61	19
	Important	46	14
	Very Important	37	11
	No Response	21	6
	Total	**325**	**100**

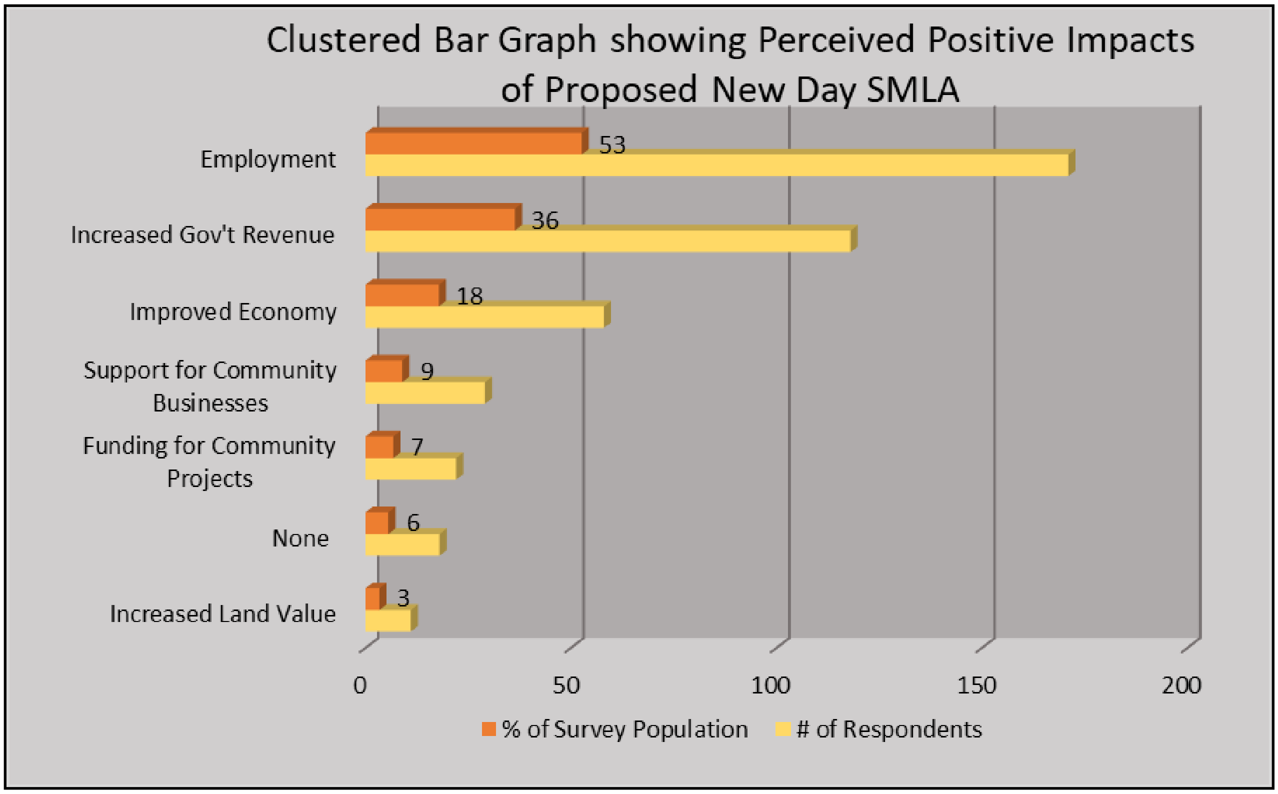

Figure 5-219: Perceived Positive Impacts of Proposed Development

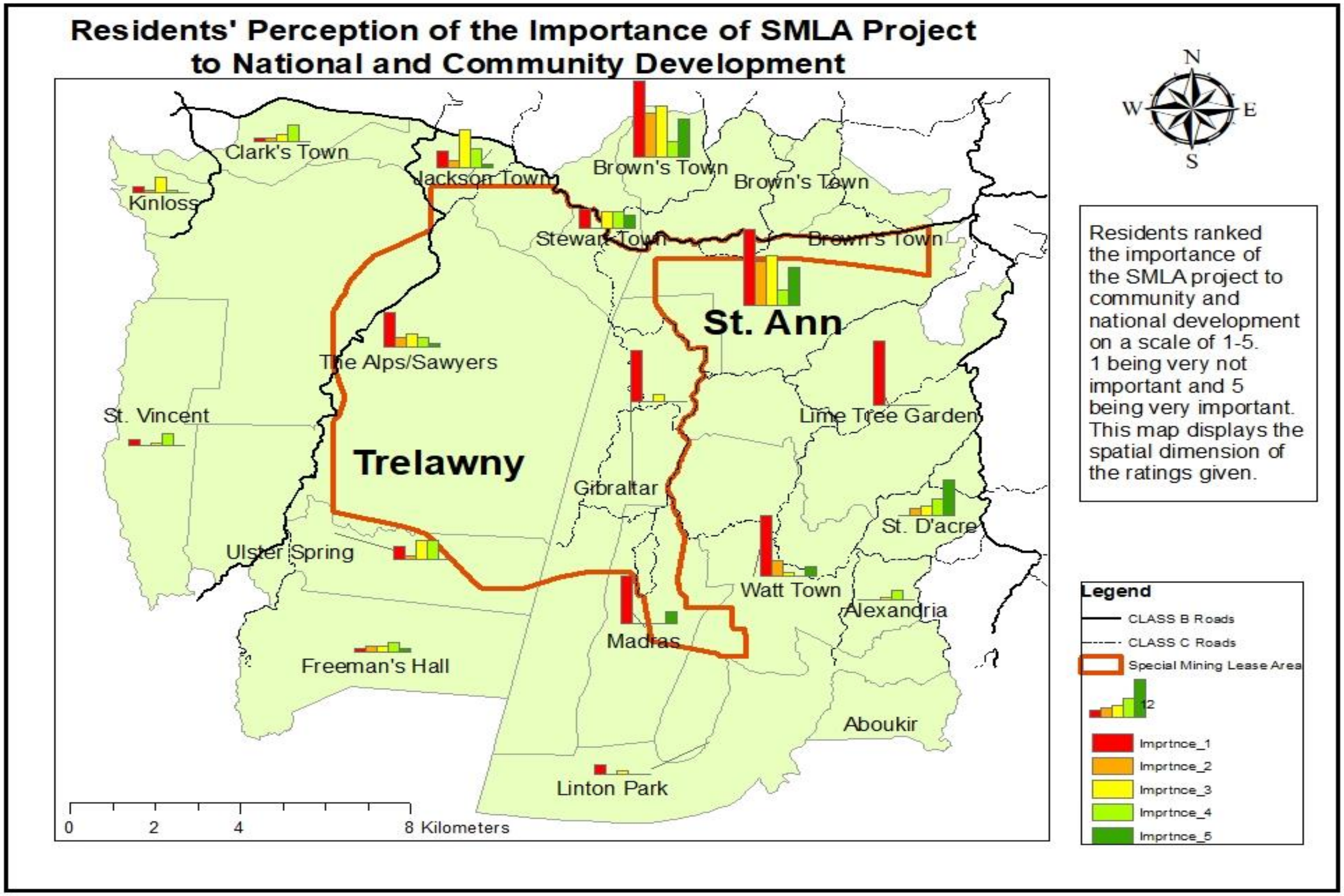

Figure 5-220: Residents Perception of the Importance of SML 173 Area Project to National and Community Development

Forty-four per cent (44%) of the survey population gave the project a positive importance rating, ranging from moderately important to very important. The largest percentage of these residents came from the communities of Jackson Town, Stewart Town and St. D'Acre, where as much as 86% of the respondents felt that the mining project would be important to community and national development. Figure 5-220 above illustrates the distribution of the opinions ranking the importance of the mining project.

As illustrated by Figure 5-219, most respondents believe that employment would be a major benefit of the mining project. A total of one hundred and seventy-one (171) residents, approximately 53% of the survey population, hold the view that employment would a positive impact of the mining proposed in SML 173 area; while another one hundred and eighteen (118), approximately 36%, also believed that the mining project would lead to an increased government revenue and another 18% expected improvement to the economy. The majority of these respondents are residents of Brown's Town, Jackson Town and St. D'Acre.

5.5.6.1. Conclusions

The opinions and perception of the residents on current situations and prospective development are critical and important in understanding the social ramifications that may be associated with the SML 173 Area. The survey covered several communities and a total of three hundred and twenty-five (325) individuals, which account for 1.5% of the population in the area defined as the sphere of influence of the proposed mining project. Interviews were conducted with a mature population within the ages group 20 to 49 years accounting for approximately 60% of the respondents with most of them living in the area for more than two decades.

The majority of the respondents are employed with the distribution between full time and self-employment being relatively even. Income levels, however, are generally low according to those residents who provided that information, with the majority 27% earning less than JA$50,000.00 monthly. There is a high home and land ownership of 74%. This is especially pronounced in the communities of Madras, Alps/Sawyers and Lime Tree Garden, while rented housing was more prevalent in Brown's Town. The provision of utilities in the area received mixed perceptions with 90% of the households surveyed having electricity but only 11% having access to water by indoor tap. Water provision was identified as a major problem in all communities with up to 75% of the survey population depending on rainwater and trucked water. Consequently, the majority 82% and 73% of the survey population rated the reliability and quality of the water in the area poorly.

Unemployment and the condition of the roads in the area are the most popular dislikes of the residents as indicated respectively by approximately 64% and 51% respectively of the residents surveyed. As such, the majority of the respondents perceived employment opportunities as a positive impact of the proposed mining project, as indicated by 53% of the respondent population. However, there is no general consensus of anticipation and approval of the mining project amongst residents with the majority of the survey population expecting negative impacts especially in terms of dust pollution, noise pollution and pollution of water resources.

Popular concerns raised by respondents was that local communities do not stand to benefit from the proposed development as 40% of the respondents gave the project the lowest possible score in terms of its importance to national and community development. The proposed sites for the proposed mining project have the potential to impact on the livelihoods of residents who use the areas, predominantly for agriculture, but is restricted to very small areas adjacent to the communities of Gibraltar, Madras and Watt Town. Generally, with the exception of Brown's Town, the communities with a history of bauxite mining activities are not expecting positive outcomes. The remaining communities are more optimistic, anticipating more employment opportunities, while expressing concerns for damage to the landscape and aesthetics, water resources and dust pollution.

5.5.7. Land-Use Analysis

5.5.7.1. Approach and Methodology

An accurate and thorough account of past and current land uses in the study area demanded a multi-faceted approach for collating land use information for the area. This included:

1. Aerial Photographs
2. Satellite Imagery of the area dating 1986, 1996 and 2016 (Google Earth)
3. Spatial analysis using Geographic Information System (GIS) and Remote Sensing
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.

Land use was examined from regional perspective with analysis of the area within the proposed SML 173 Area and communities which are adjacent to the proposed mining project area. As indicated on Figure 5-221 below, some of these communities include, but are not limited to:

1. Brown's Town
2. Stewart Town
3. Gibraltar
4. Alexandria
5. Madras
6. Linton Spring
7. Ulster Spring
8. Watt Town

An extensive area has been established as the sphere of influence of the proposed mining operations in the SML 173 Area straddling the parishes of Trelawny and St. Ann in the rugged and hilly interior, characteristic of the karst topography that constitutes the Cockpit Country. The assessment of land use for the area will typically include a general description of the current land uses in the area, changes in land cover over a forty-year period as well as an analysis of potential land use conflicts which may exist during the operational or rehabilitation phases of the proposed mining operations.

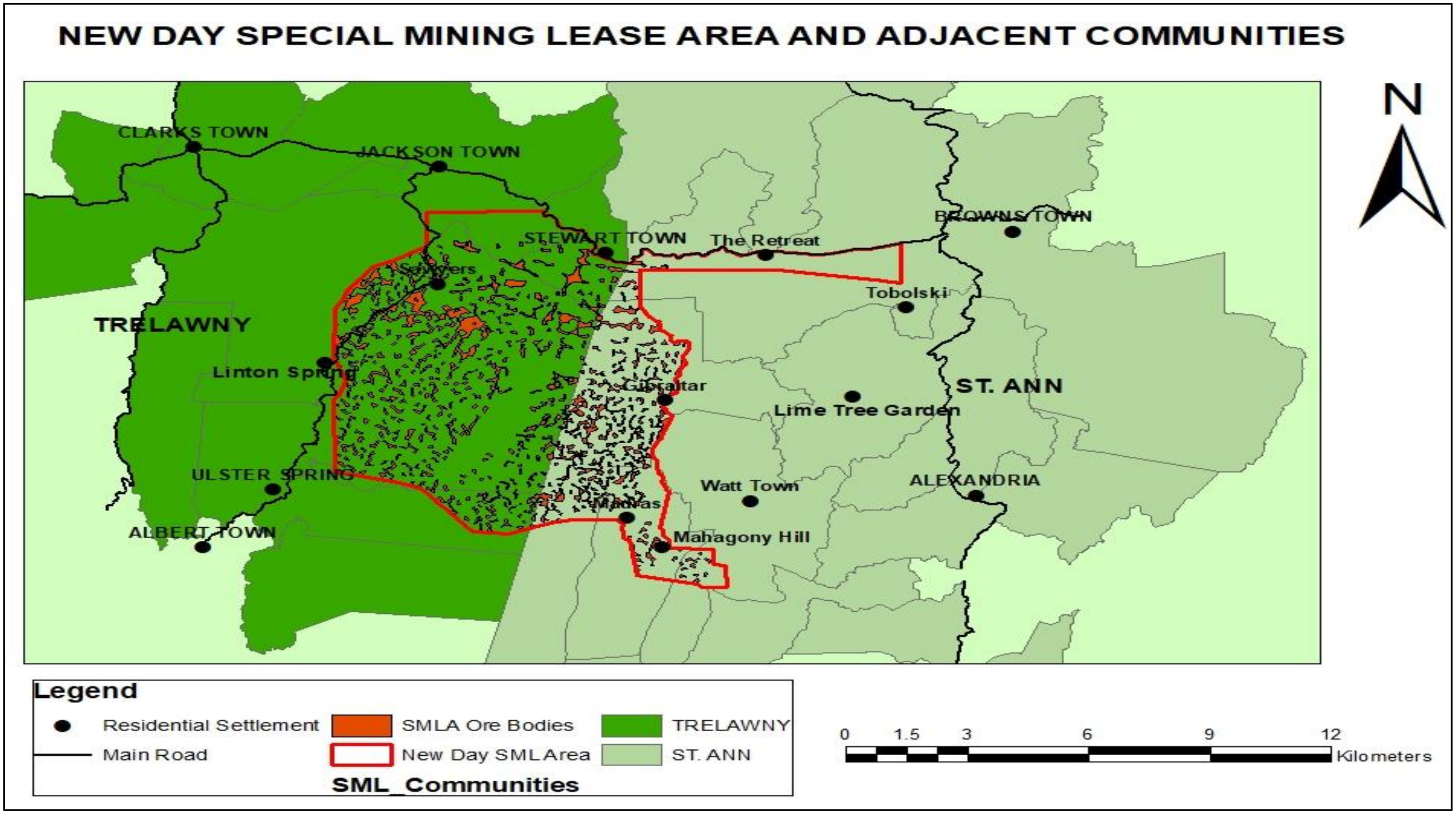

Figure 5-221: Special Mining Lease 173 Area and Adjacent Communities

5.5.7.2. <u>Historical and Existing Land Use Policy Overview</u>

Both the parishes of Trelawny and St. Ann are covered by Development Orders which stipulates land use zoning and planning policy. This falls under the Town and Country Planning Act. Each policy speaks to the terms and guidelines to which development in the respective parish must comply. This is based on their own unique (and some shared) socio-economic and physical characteristics. However, most importantly they provide stipulations directly relevant to the proposed mining operations and the associated disturbance to conservation areas and potential changes to the existing settlement patterns.

5.5.7.2.1. Trelawny

The Town and Country Planning (Trelawny Parish) Provisional Development Order, 2013 is the primary planning policy that guides development process in the parish and identifies nine (9) growth centres whose purpose are "*to achieve a rational pattern of land use and community development which will offer a guide to where it is most appropriate for receiving priority in future public and private investments*".

The SML 173 area is in close proximity to three (3) of these local planning areas, Albert Town/Ulster Spring, Jackson Town and Stewart Town. The latter is the only one which is directly intersected by the boundary. The primary concerns relevant to the proposed activities in the SML 173 area relates to the mining of bauxite ore in areas deemed to be of ecological and historical significance and the karst landscape of the Cockpit country. The Trelawny Provisional Development Order, 2013, explicitly states that the objective of the guidelines set forth for the conservation of the natural and built environment is to "*protect and preserve the unique geological features and biological communities existing in the parish especially in the Cockpit Country*". The Order stipulates that special consideration is to be given to the long term protection and conservation of areas of "*special sensitive, high conservation value and designated nature reserves*" and totally discourages any development that is "*likely to be damaging to the scientific or wildlife interest within or adjacent to the Cockpit Country.*"

The Cockpit Country was declared as a forest reserve in December 1950 (see Figure 5-222). According to the Forestry Department the forests of the Cockpit Country are one of its most important attributes as it highlights Jamaica's spectacular floral and faunal endemism with an estimated 1500 vascular plant species, of which 400 are endemic, with many individual hilltops displaying local/niche endemism. In addition, most of Jamaica's 550 native fern species are found in the Cockpit Country. More species of ferns are found in Jamaica than in any tropical forests in the world. The Cockpit Country is habitat for all 28 of Jamaica's endemic land birds and has the highest local diversity of amphibians and reptiles on the island.

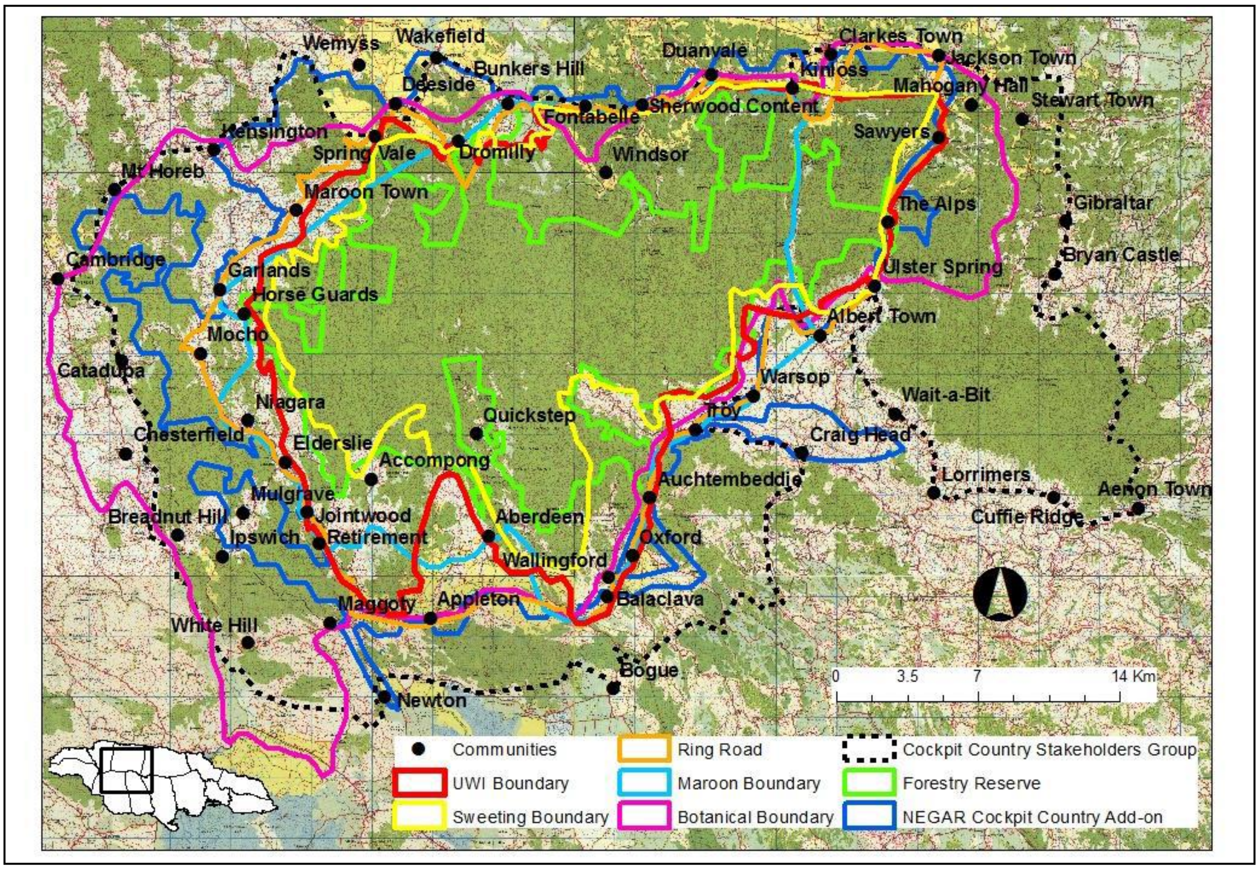

Figure 5-222: Varying Boundary Definitions for The Cockpit Country. (*Source: Technical Report on the Public Consultations on Defining the Boundaries of the Cockpit Country, 2013***)**

The Government of Jamaica had sought to protect forest areas across the island for conservation and ecological purposes, as such several areas were declared as forest reserves.

The delineation of the Cockpit Country is crucial to enforcement of these policy guidelines and has been a source of debate among stakeholders and policy makers due to the various boundary definitions put forward over the years (see Figure 5-222). As such the Government of Jamaica has taken the necessary steps to establish the legal and policy framework for the proposed Cockpit Country Protected Area (CCPA), establishing the official boundary in 2017 synonymous with that proposed by Paris Llew-Ayee in 2005 (referred to as the UWI Boundary in Figure 5-222). Although the SML 173 Area is located outside the newly proposed CCPA boundary, its proximity to the boundary and the existence of the forest reserve in the Sawyers/Linton Spring area means the activities of the proposed mining project has the potential to conflict with conservation strategies concerning renewable resources in the area. Figure 5-223 below for an overview of the interaction between the SML 173 area and the conservation policies.

However, it must also be noted that the Trelawny Parish Provisional Development Order, 2013 also acknowledges the National Minerals Policy which purports that where mineral resources are deemed to be of significant national importance efforts will be made to exploit them as long as the required management practices are put in place. As such the Development Order for the parish dictates that "*development proposals which will prevent or obstruct the extraction of minerals which is important to national development and the economy will not be supported*" but also insists that the planning authority gives due regard to the protection of natural conservation when dealing with applications which involve ore extraction within the confines of the Cockpit country.

Agricultural lands are classified as those which also require special consideration according to the development order. Areas of agricultural potential will be preserved and conserved for productive agriculture use and the intrusion of development involving these land are restricted and discourages any development which diminished the amount of productive or potentially productive lands outside of the growth centres

5.5.7.2.2. St. Ann

The Town and Country Planning (St. Ann Parish) Provisional Development Order, 1999 is the overarching policy governing planning and development in St. Ann. There are ten (10) Local Planning Areas (growth centres) established in the parish with only Brown's Town and Watt Town being the closest to the SML 173 area. St. Ann has had a long history of bauxite mining in the parish to the extent where it is acknowledged as the primary industrial activity and will result in significant negative effects on the lives of people if there is a downturn in this activity. As such, the Provisional Development Order, 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*". The policy also restricts the exploitation 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.

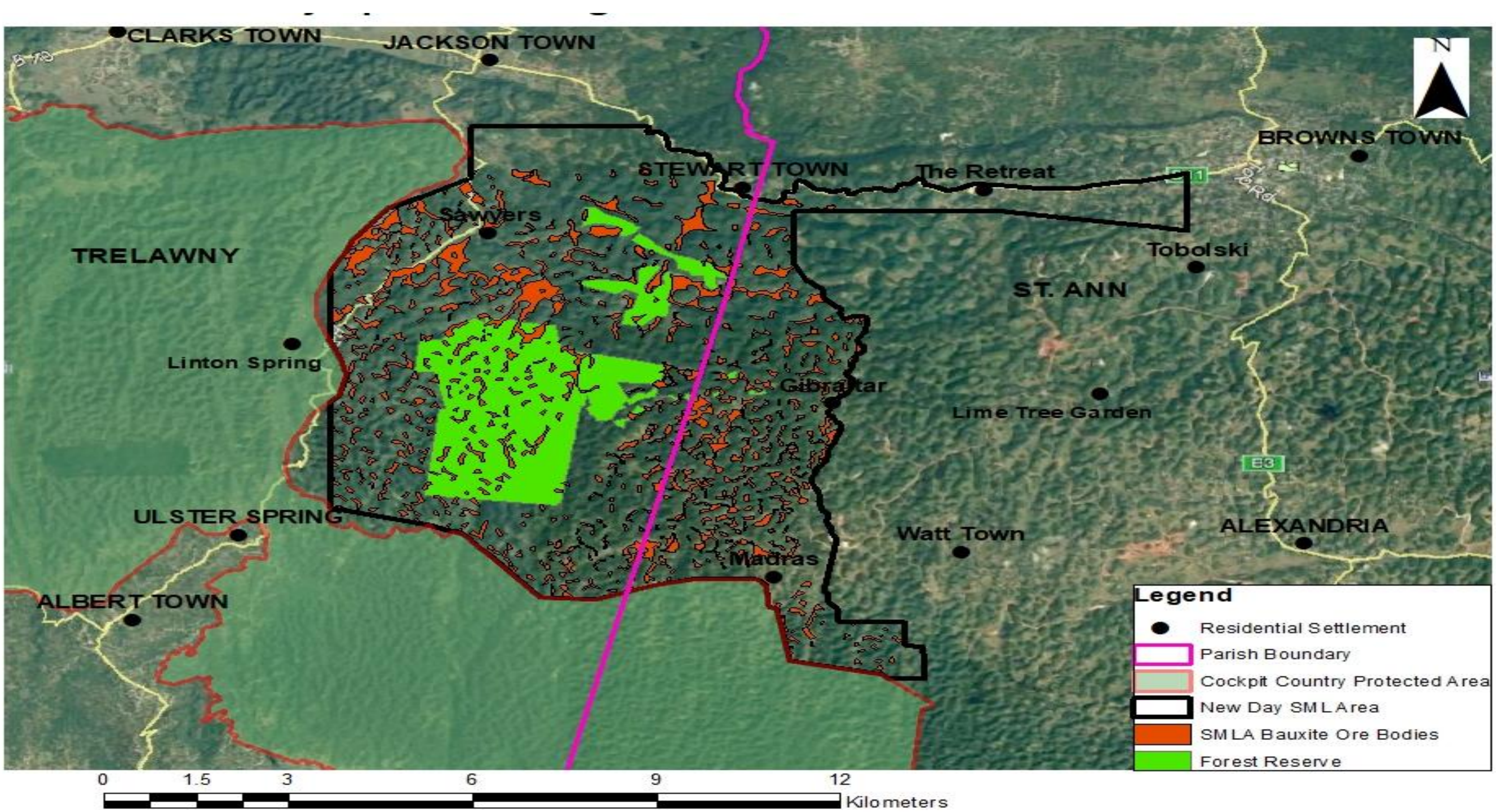

Figure 5-223: Special Mining Lease 173 Area and Conservation Areas

5.5.7.3. Current Land Use

As illustrated in Figure 5-224 below, the general land use in the area can be classified as, but not limited, to the following:

- Built-Up/Urban Areas
- Bauxite Mining and rehabilitated areas
- Forests
- Mixed Woodland/Shrubland/Grassland
- Sugar Cane Cultivation

5.5.7.3.1. Built-Up/Industrial

This land use includes planned and unplanned residential, mixed residential/commercial and industrial areas. Currently, it constitutes the smallest proportion of the study area (2%) and is approximately 9 km^2 in size. The area is comprised of both planned and unplanned settlements developing in a linear pattern along the major roadways between the major urban centres of Brown's Town and Clark's Town. Brown's Town 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 or rehabilitated bauxite mining areas. Only a few such communities are within the SML 173 Area such as Sawyers, Madras, Bryan Castle and Ashley Hall.

5.5.7.3.2. Bauxite Mining and Rehabilitated Areas

Rehabilitated bauxite lands are frequently put to residential or agricultural use once the area has been satisfactorily certified restored. The same can be observed to the east of the SML 173 area where an area of approximately 26km^2 of land is characterized by lands previously mined now occupied by scattered residential development following a liner pattern along minor road. Some of these areas have emerged into established communities such as Tobolski, Alexandria and Watt Town, while subsistence agriculture is practised on the fringes of the more developed areas. There are current mining operations taking place in areas near Gibraltar and Lime Tree Garden such as the Tobolski Loadout.

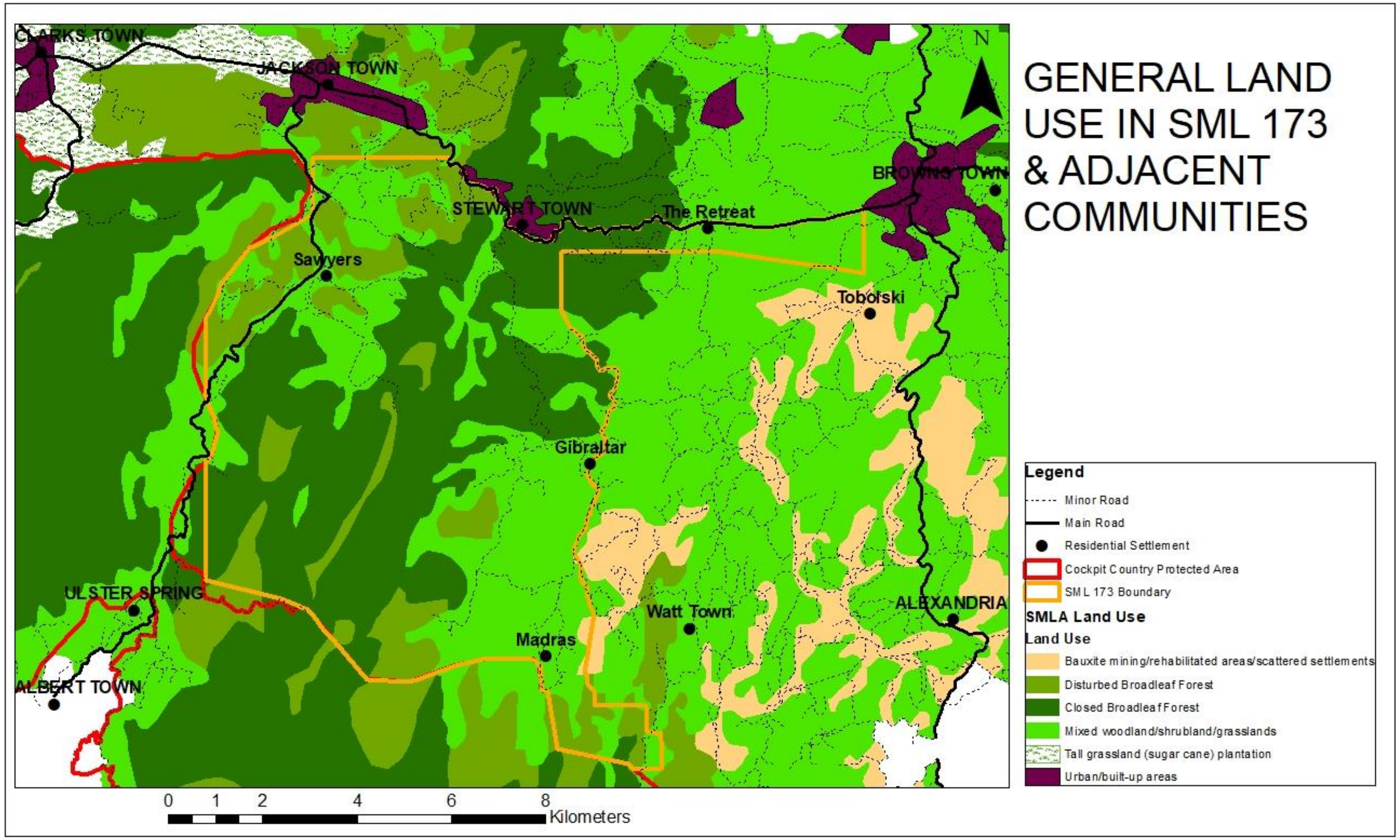

Figure 5-224: General Land Use in the Special Mining Lease 173 Area (Source: *Land Information Council of Jamaica (LICJ)*)

5.5.7.3.3. Forests

This land use dominates the SML 173 area accounting for approximately 61% of the land within the SML 173 boundary. It is made up of broadleaf forest comprising both evergreen and semi-deciduous trees in both lowland and mountainous areas, where some remain in untouched conditions (closed) while some exists in disturbed states. The disturbed forest cover 15km^2 within the SML 173 boundary and another 26km^2 in the areas outside of the SML 173 boundary, accounting for 13% of the study area. The remaining closed broadleaf forest covers an extensive 96 km^2 over the entire study area, with 38% of these broadleaf forests situated within the SML 173 boundary. They can be classified as sub-montane (transition zone) and lowland given their spatial distribution among the conical hills and enclosed depressions which prevail in the area. There is also 13 km^2 of land within the SML 173 that is classified as a forest reserve and makes up 15% of the area within the SML 173 boundary.

5.5.7.3.4. Mixed Woodland/Shrub/Grassland Vegetation

These areas include grassland/brush, shrub and woodland vegetation which dominates the areas between the forests and the settlement areas and accounts for 45% of the total land area within the sphere of influence. Dominant in the areas surrounding Madras, Gibraltar and Sawyers, it is also the most extensive land coverage within the SML 173 boundary where the near 32 km^2 of land represents 38% of the total area. Woodland vegetation is prevalent and provides a source of income for many residents in the area as the vegetation is used for charcoal production, yam sticks, and lumber. Grassland and brush areas exist on less steep slopes and depressions found among the conical hills typical of karst topography. Some subsistence agriculture also takes place in these lowland areas where the most fertile soil develop due to the weathering of limestone and the generation of clays which also typifies the wet limestone environment.

5.5.7.3.5. Sugar Cane

No sugar cane cultivation takes place within the SML 173 area boundary. There are lands under sugar cane plantation in areas around Clark's Town which provides the raw material to the Long Pond Sugar Factory and Distillery in the community. These are privately owned lands whose 13km^2 accounts for only approximately 3% of the study area.

Land use distribution within the special mining lease area is summarized in Table 1 below.

Table 5-34: General Land Use Distribution within the Special Mining Lease 173 Area

Land Use	Total Coverage within SML 173 Area (km^2)	% of Total within SML 173 Area	% of Total in Study Area
Bauxite Mining/rehabilitated areas/scattered settlements	0.2	0.2	0.1
Disturbed Forest	15	18.1	4.7
Evergreen/Semi-deciduous Forest	36	43.2	11.3
Mixed Woodland/shrubland/grassland	32	38.4	10
Urban	0.1	0.1	0.03
Total	83.3	100.0	26.1

5.5.7.4. Land Cover/Use Change

Changes in land cover in the area was assessed over a period of forty (40) years looking specifically at the years 1986, 1996 and the most recent 2016 satellite imagery (see maps below). Notable changes over the period can be summarized as follows:

1. The most notable change in land cover can be seen the growth of urban/industrial areas over the period, especially in Brown's Town, Alexandria and Clark's Town. It must be noted, however, that while changes took place in clusters with in the Browns Town area, ribbon development dominates the nature of the change in Alexandria while the clearance of lands for agriculture account for the changes observed in Clark's Town (sugar cane plantation) and it patches throughout the area (subsistence agriculture).
2. Other areas of noticeable vegetation clearance exist along minor roads where the extent of scattered and linear development, along with subsistence agriculture, has grown in areas formerly under bauxite mining or shrubland/grassland vegetation. Majority of these areas, especially to the southeast of the map, are areas which have

been rehabilitated after bauxite mining activities or established as part of resettlement strategies for communities in the mined-out areas.

3. There is an obvious decrease in the areas under active bauxite mining with the most active period visibly being in 1996. There was an increase between 1986 and 1996, with areas being mined extending further north and south of Alexandria and the north west of Watt Town. All of this activity took place outside of the SML 173 area boundary and extended easterly and south easterly direction. By 2016, much of these areas have been rehabilitated and are now occupied by subsistence agriculture, scattered residential development and brush/grassland vegetation, with the exception of an area near Lime Tree Garden (in the Tobolski area) and near Bethany (between Watt Town and Alexandria) which still has visible scarring due to either active mining or incomplete rehabilitation.

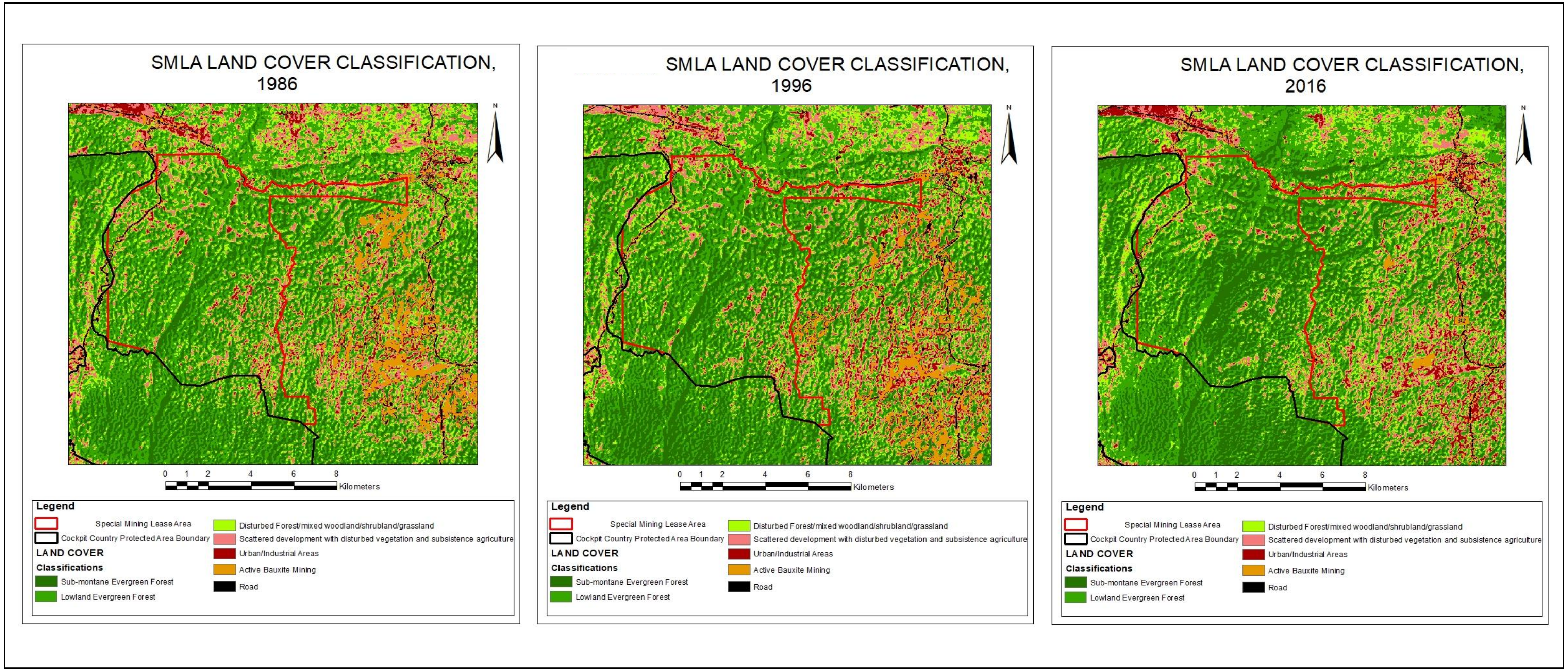

Figure 5-225: Land Cover Changes in the Study Area Over 40-Year Period

4. Increased encroachment from ribbon/scattered residential development as well as subsistence agriculture has contributed to an increase in disturbance to forested areas. Spatially, the majority of the change in disturbed forests appears to be confined to the east and south east of the SML 173 area and correlates with the expansion which took place with mining activities, scattered development and subsistence agriculture. Increased population in rehabilitated bauxite areas can understandably contribute this trend as new roads (minor) increases accessibility of the area and growing agricultural activities, critical to the rural economy in these communities, increases the demand for land.

Table 5-35. Land Cover Change in the SML 173 area between 1986 and 2016

Land Cover	Nature of Change			Magnitude of Change			Location
	Increase	Decrease	No change	Slight	Moderate	Significant	
Bauxite Mining/Bare Soil		√				√	Alexandria, Watt Town, Madras, Lime Tree Garden
Disturbed Forest	√				√		Madras, Sawyers, Ulster Spring
Evergreen/Semi-deciduous Forest		√		√			Sawyers, Gibraltar
Mixed woodland/shrubland/grassland		√		√			Madras, Sawyers, Gibraltar
Ribbon Development/ Subsistence Agriculture	√				√		Madras, Sawyers, Ulster Spring, Gibraltar, Alexandria
Urban	√					√	Brown's Town, Stewart Town

5. Evergreen Forest have not experienced any visible significant change in coverage over the period. However, what is clear is that within the SML 173 area boundary there are appears to be slight increase as the areas previously covered with disturbed vegetation, agriculture or scattered development has decreased. The extent to which

this is a product of conservation efforts and increased public awareness or in part due to the difficult topography in the area is not clear.

5.5.7.5. Potential Land Use Conflicts

Potential conflicts were identified and assessed in the context of noting conflict of interests that are likely to result from the nature, location and scale of the proposed operations and its interaction with the various land uses in the study area. The green-field nature of the development suggests that the clearing of vegetation, a major component of the mining activity, constitutes the major threat to all land uses in the area and will result in loss of vegetation in areas under evergreen forest, semi-deciduous forest, disturbed as well as woodland areas. This represent a significant source of conflict especially in areas zone for conservation or on the fringes of conservation areas such as the Cockpit Country. The multiple ecological functions of these areas such as wildlife habitats, biological diversity hotspots, carbon sinks and watershed areas, can be affected or totally compromised by improper and unsustainable mining operations.

In addition, although very few residential areas exist within the SML 173 area and in a scattered pattern, where their location intersect with mining sites, relocation of residents may be required. This can lead to intensification of population in other settlement areas and or further vegetation clearance for new housing developments. Noise and dust nuisance may be an issue for the residents in the SML 173 area or along routes between area and the plant. Subsistence farmers in the area can potentially their lands and areas of suitable topography and soil characteristics for agricultural activity can also be compromised in the short term.

However, it is the expectation that the use of state-of-the-art technology and the highest international standard for mining operations and environmental management will be keystone to the proposed activities, while maintaining strict adherence to the relevant local regulations and policies. With these factors in mind, the extent and impact of these potential risks can therefore be significantly minimized. The type and nature of potential land use conflicts arising are summarized in **Figure 5-24** below.

Table 5-36: Type and Nature of Potential Land-Use Conflicts

Phases of Operations	Affected Land Use/Area		Nature of Potential Conflicts
Land/Vegetation Clearance	Evergreen Forest	Within SML 173 area Boundary	○ Loss of forest trees and ecosystem functions (habitat, food, shelter etc) and hydrogeological functions (groundwater recharge and storage, watershed functions)
	Disturbed Forest	Within SML 173 area Boundary	○ Same as above
	Woodland/Shrub Vegetation	Within SML 173 area Boundary	○ Loss of woodland/shrub cover ○ Same as above
	Residential	Within SML 173 area Boundary	○ Displacement of residents within the SML 173 area who may be required to relocate
	Agriculture	Within SML 173 area Boundary	○ Displacement of small farmers and loss of livelihood ○ Loss of prime lands for agriculture
Mining Operation	Residential	Within SML 173 area Boundary	○ Noise and dust nuisance for heavy trucks movement and other machinery
Rehabilitation	Residential	Other towns in and around the SML 173 area	○ Increased pressure on other residential areas to accommodate relocated residents ○ Increased demand on already limited social and economic amenities.
	Agriculture	Other towns in and around the SML 173 area	○ Further encroachment from residential uses

6.0. Public Participation

6.1. Introduction

In keeping with best practices as recommended in Agenda 21 of the EIA and environmental permitting process, four Voluntary Stakeholder Consultations (in four areas) within and in proximity to SML 173 were convened.

There were differences in the level of attendance and the types and number of issues based on the location of the meetings. The locations and number of participants are presented below:

- Location of Meeting 1 – Madras, St Ann (Within the SML) – 104 participants
- Location of Meeting 2 – Retreat, St Ann (On the Boundary of SML), - 134 participants
- Location of Meeting 3 – Sawyers, Trelawny (Within the SML) – 73 participants
- Location of Meeting 4 – Ulster Spring, Trelawny (Outside the SML) – 67 participants

In general, it was found that in the St. Ann areas the issues were largely confined to:

1. dust nuisance,
2. compensation and
3. potential impacts on agriculture
4. impacts from railroad operations.

In the case of the Trelawny meetings the issues extended beyond those found in St Ann and were of a deeper socio-cultural (historical and natural heritage) nature. The participants which were vociferous were strongly in opposition to bauxite mining. This opposition to mining originated mainly from the South Trelawny Environmental Agency (STEA) in the third meeting, with added vigorous opposition from the Maroon community who were present in the fourth meeting.

It should be noted that St Ann is familiar with bauxite mining and its potential impact, while mining will be taking place in the areas close to the SML 173 in Trelawny for the first time.

The verbatim reports are being prepared, and will submitted as part of the EIA.

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 executed four meetings as part of this aspect of the project based on the population distribution within the districts comprising and surrounding SML 173. The communities to be impacted most significantly by the project were chosen to be the focus of the Voluntary Consultations. The districts with the highest population within the SML and those adjacent were chosen as the areas of interest. The resulting communities fell into four constituencies, these are:

1. St Ann South West
2. St Ann Northwest
3. Trelawny North
4. Trelawny South

Four areas emerged when this analysis was done. There is one area per constituency, these are:

1. Browns Town area – Northwestern St Ann
2. Watt Town, Gibraltar, Madras area in South Western St Ann
3. Jackson Town, Stewart Town Area in Northern Trelawny
4. Sawyers/Alps/Ulster Spring Area in Southern Trelawny

The objective was to have one voluntary public consultation at a central location in each area to effectively capture the concerns of the residents of each area of interest.

The guidelines of public consultation developed by NEPA was used for each meeting. These include:

1. using Town Criers to announce the meetings,
2. visiting the areas to find appropriate venue for the meeting,
3. using a reputable Chairman that is independent of the process.
4. And, most importantly recording the meetings ad verbatim for effective analysis of information transferred and accurate and precise re-distribution for regulators and relevant stakeholders.

Four meetings were held over the period May 15 to May 27 2017 at four (4) locations on the boundaries of the SML. The meeting locations are shown in Figure 6-1.

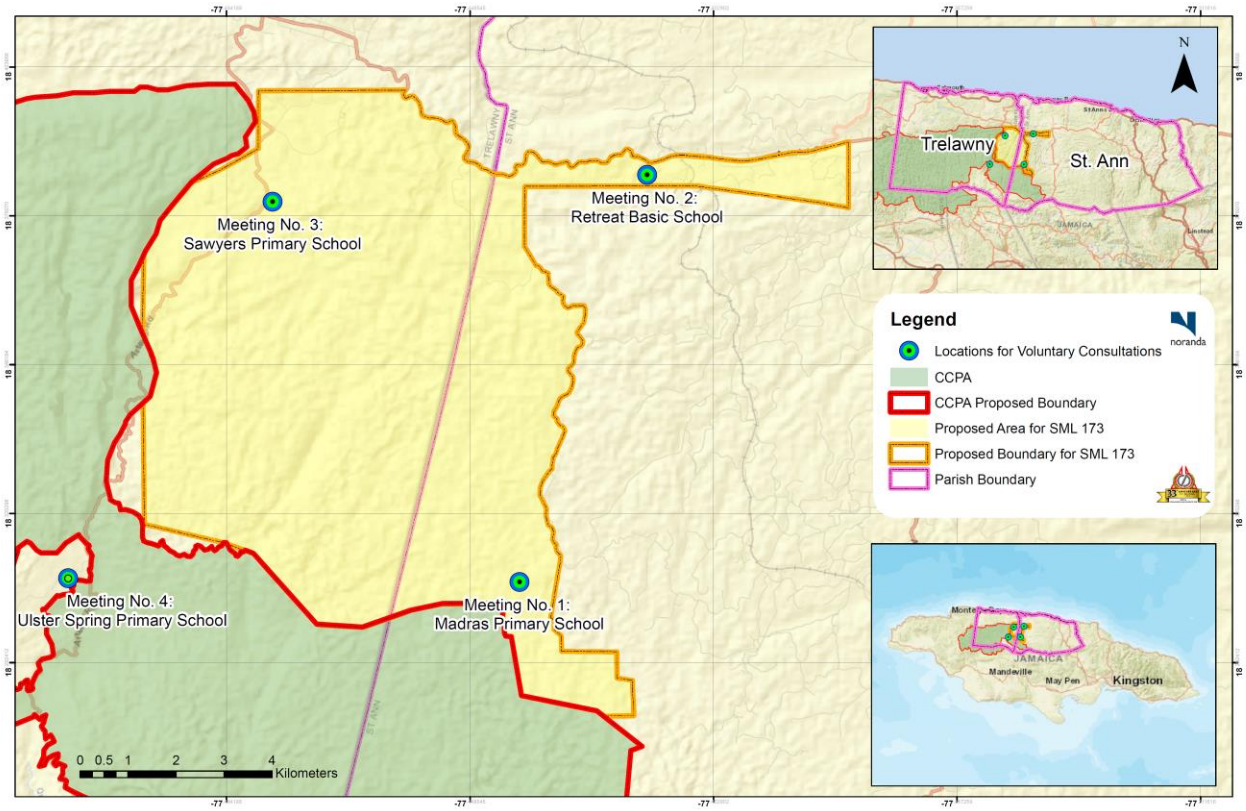

Figure 6-1. Map of the locations of Voluntary Consultation meetings for the proposed mining of Bauxite in SML 173 Area

6.3. First Meeting

The first Voluntary Public Consultation was held at the Madras All Age School, Monday May 13, 2019. This is in the southeastern tip of the SML 173 in the parish of St. Ann at its far southern region. The meeting was chaired by Mr. Keith Richards the principal of the Watt Town All Age School. The meeting was recorded ad verbatim by a Court Steno Typist.

The consultation was very well attended with 104 participants being registered. Participants represented mainly the communities of Barnstaple, Gibraltar, Caledonia, Madras and Endeavour.

A power point presentation which outlines the proposed project and the permitting process was presented to the meeting. The presentation was well received, with a very active question and answer section. The main issues that were repeatedly raised were:

1. Dust generation and its impact on the communities surrounding the existing mining areas
2. Compensation for the adverse impact of the existing mining operations
3. Mined out Pit rehabilitation being inadequate and the existing dangers to community members and drivers that use the roads in the communities surrounding the existing mined out areas.
4. Quality of land will be lost. Farming is not possible on mined out lands.
5. Unfulfilled agreements – commitments to the community not being kept.

The verbatim notes of the meeting are recorded in Volume II: Voluntary Consultation Meeting Report.

6.4. Second Meeting

The second Voluntary Public Consultation meeting that was held at the Lyndale Retreat Basic School on Wednesday May 15, 2019. This area is on the northeast edge of the SML 173 in the central part of the parish of St. Ann .

This second meeting was chaired by Mr. Keith Richards the principal of the Watt Town All Age School, he also chaired the first meeting. The meeting was recorded by a Court Stenotypist.

The consultation was very well attended with 134 participants being registered. Participants represented mainly the communities of Lyndale and Retreat. There were also a few participants from Stewart Town, Endeavour, Enfield and Browns Town.

The power point presentation outlining the project and the development plans was presented to the meeting. The presentation also included the permitting process and the progress so far. The presentation was well received, with a very active question and answer section. The main issues that were repeatedly raised were:

1. Dust impacts from Mining in proximity to Retreat and Lyndale.
2. Farming is not viable on mined out lands
3. The train impacts (noise, dust, safety, damage to homes) on the communities that it traverses.
4. Compensation for the impacts being experienced by the community members

5. Titles have not being issued on a timely basis for people who have been relocated to the area. (over 20 years have passed in some cases)
6. Rehabilitated areas should be planted with fruit trees as opposed to grass
7. Administration cost for land titling should be borne by NJBP II
8. Retreat not benefitting economically from the mining by NJBP II

The verbatim notes of the meeting are recorded in Volume II: Voluntary Consultation Meeting Report.

6.5. Third Meeting

The third Voluntary Public Consultation meeting that was held at the Sawyers Primary School on Tuesday May 21, 2019. The area is located on the northwestern edge of the SML 173 in the parish of Trelawny. The meeting commenced at 6:00 pm and ended at approximately 8 pm.

This third meeting was chaired by Mr. Keith Richards the Principal of the Watt Town All Age School, he also chaired the first and second meeting. The meeting was recorded by a Court Steno Typist

The consultation was well attended with 73 participants being registered. Participants represented mainly the community of Sawyers and its immediate surrounding. There were also a few participants from Stewart Town, Alps, Jackson Town, Biddiford and Barnstaple.

The power point presentation outlining the proposed project, was presented to the meeting. The presentation was well received, with a very active question and answer section. During the question and answer session, a member of the South Trelawny Environmental Agency (STEA) was given the opportunity to express his understanding of the project. The main issues that were repeatedly raised were:

1. Cockpit Country Protected Area boundary demarcation and the perceived errors associated with that process.
2. The concern of loss of farm lands.

    a. Land not good after mining
3. Future generation will have no land to farm on
4. What is the state of the communities in which mining is now occurring?
    a. Noranda should sponsor a visit to the existing mining areas so the community can assess.
5. Perceived conflict of interest with Noranda paying for the EIA to be done?
6. Impact of mining on water table in mining areas
7. Loss of biodiversity of the Cockpit Country.
8. Loss of ore that protects the water table.
9. Flooding in new areas of the Cockpit Country and its environs
10. No consultation with historical heritage and the social aspect of the project.
11. The opposition to mining in the Cockpit Country.

The verbatim notes of the meeting are recorded in Volume II: Voluntary Consultation Meeting Report.

6.6. Fourth Meeting

The fourth Voluntary Public Consultation meeting was held at the Ulster Spring Primary School on Monday May 27, 2019. This site is about 1 mile outside the south western edge of the SML173. The meeting commenced at 6:30 pm and ended at approximately 9 pm.

This fourth meeting was chaired by Mr. Keith Richards the Principal of the Watt Town All Age School, he also chaired the first three meetings. The meeting was recorded by a Court Steno Typist.

The consultation was well attended with 67 participants being registered. Participants represented mainly the community of Ulster Spring and its immediate environs. There were also a few participants from Albert Town, Alps, Troy, Wilson Valley, Rock Spring, Lot, Wood Grove and Freeman Hall. A number of the participants expressed that are descendants of the Maroons.

The power point presentation outlining the project, was presented to the meeting. The presentation was interrupted on several occasions. As a result, on these occasions the Chairman had to appeal for order in the meeting. There was a very lively/active question and answer section with various statements opposing mining being made. During the question and answer session, a member of the STEA was given the opportunity to express his understanding of the project as he thought the other participants were not understanding what the proposed project will involve. The main issues that were repeatedly raised were:

1. Cockpit boundary demarcation. Dissatisfaction was expressed about the way the boundary was developed. The participants indicated that there were errors associated with that process.
    a. Cockpit boundary should be expanded to include SML 173
2. The concern of loss of farm lands – communities depend on the land (Lot etc.)
3. Who owns Noranda?
4. What is the state of the communities in which mining is now occurring?
5. Perceived conflict of interest with Noranda paying for the EIA to be done.
6. Impacts of mining on water table in mining areas. Removing bauxite will reduce infiltration into the water table and flooding in other places.
7. Loss of biodiversity of the "Cockpit Country".
8. Money is not everything.
9. We are proud people – we need to speak to the Prime Minister and the Minister of Mining. A committee of stakeholders from the community should be set up and their position on all aspects of the project be stated at the meeting with the Prime Minister and the Minister of Mining.
10. How much bauxite is available in Jamaica and how long will it last?
11. The Maroons were adamant that they do not want mining to take place in the "Cockpit Country"
12. Trelawny is pristine it will not be exploited ("raped")
13. Tell Noranda to give us the money to develop the area and do not carry out mining
    a. Build hotel and golf courses. These will last for a long time as they are sustainable.

b. Mining is only for a short time

The verbatim notes of the meeting are recorded in Volume II: Voluntary Consultation Meeting Report.

6.7. Meetings with Non-Governmental Organizations

6.7.1. Forestry Boundary Meetings

Four (4) consultation meetings were convened by the Forestry Department at:

1. Clarks Town, Trelawny
2. Albert Town, Trelawny
3. Siloah, St. Elizabeth and
4. Mocho, St. James

The meetings were convened over the period November 20 – 29, 2018. All four meetings were attended by representatives of Conrad Douglas and Associates Limited (CD&A). The objective was to take note of the concerns of the residents of these four (4) communities and surrounding areas.

6.7.2. South Trelawny Environmental Agency

A meeting was convened on June 19, 2019 at the Albert Town High School with the Executives of the South Trelawny Environmental Agency (STEA). Sixteen (16) persons were in attendance at the meeting (See attendance register in Appendix XXIV). The purpose of the meeting was to provide information to STEA and obtain their feedback. The discussions were mainly on:

1. The SML 173 area and the Cockpit Country Protected Area Boundary
2. Hydrology
3. Livelihoods
4. Economic alternatives, which could generate equivalent income to bauxite revenues from exports

6.7.3. Jamaica Environment Trust

A meeting was convened on June 20, 2019 at the offices of Jamaica Environment Trust (JET). The purpose of the meeting was to provide information to JET and obtain their views and opinions and incorporate them in the EIA. The discussions were mainly on:

1. Hydrology
2. The environmental impact and history of bauxite mining, in general
3. The SML 173 area boundary and the Cockpit Country Protected Area Boundary
4. Land ownership issues
5. A recommendation for two (2) instead of one (1) Mandatory Public Meeting.

6.7.4. Windsor Research Centre

A meeting was convened on June 24th, 2019 at the Windsor Research Centre (WRC), Sherwood Content P.O. The purpose of the meeting was to provide information to WRC and obtain their views and opinions and incorporate them in the EIA. The discussions were mainly on:

1. Hydrology
2. Wildlife, with special reference to *Pterourus homerus*
3. Micro bio-physical changes in the transition zone between bauxite mining and the limestone bedrock.

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, NJBP II will avoid or mitigate any adverse impacts should they arise during all phases of this project.

The major impact may result from changes in land use. The major land use change may take place through the construction of access haul roads. Approximately 21.07 hectares could be impacted in the first five (5) years. The potential change in topography from the construction of haul roads and mining is irreversible.

The potential loss in vegetation within the orebodies and haul roads are reversible or can 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 sensitive species.

The major positive impacts are contribution to macro-economic stability through GDP growth, export income, the national economy and job creation. Also, possible improved diversity in the agricultural produce, agro-processing and the use of improved agricultural practices from rehabilitation, restoration and return of the mined-out land to agricultural production or other uses. Other potential impacts, which may result from the project are:

- 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
- Dislocation 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: 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

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
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

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 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 NJBP II. Land clearance will be limited to haul roads and orebodies. In addition, topsoil stripped during site clearance will be reused. 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.	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.	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. 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.	Minor & Irreversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						Where cuts exceed 6m, benching[57] will be implemented. Approximately 21.07 hectares of the entire 8,335 hectares of SML 173 may be used for the construction of access haul roads (0.25%) based on the 5-year mining plan.	
		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 SML 173 outline elevations and depressions and the depressions indicate the final destination of run-off within the landscape. NJBP II, 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. NJBPII 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 SML 173:	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 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 SML 173 will be protected.	Minor & Irreversible

[57] 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
Water Quality, Surface Water Hydrology and Groundwater							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	***Item WQ1*** –The impacts on groundwater of this project, if any, will be negligible as there are no chemicals, waste streams or disposal activities associated with the development that stands to affect groundwater.	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.	Minor Reversible
Operations and rehabilitation	Humans	***Item WQ2*** –There is a potential impact for 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	NJBP II 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
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.	Minor Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
						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 SML 173 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 • Wetting of roads using a chemical named 'Dust Treat' (See Appendix VIII). • Immediate removal of bauxite spillage from haul roads with the aim of reducing fugitive dusting. • Stockpiles will not be maintained in the SML 173. These will be maintained in the existing permitted locations within SML 165.	
		Item AQ 2 – There is a potential for dust generation, especially during the dry seasons, as a 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.	Low & Short-term	Local & Minor Negative	Low & Indirect	A dust suppression regime will be maintained for all active haul roads. The Air Dispersion Model commissioned by NJBP II (see Volume IV: Air Dispersion Modelling Report) has shown the following under an assumed worst-case scenario for the emission sources during mining and haulage: • No receptor in ambient air showed concentrations in excess of the Jamaican AAQS for TSP or PM_{10} within SML 173. • The proposed activities at the ore body mining sites in SML 173 could cause localized high concentrations for TSP and PM_{10} that decline by at least 80% within 100 meters of the orebody. • The proposed mining and hauling activities within SML 173 would result in ambient concentrations for TSP and PM_{10} at a maximum of 50-60% of the ambient air standards, including background concentrations, at locations outside of the ore body mining sites.	Minor Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
		Item AQ3 – There is a potential for contamination of water tanks from fugitive dust	Low & Short-term	Local & Minor Negative	Low & Indirect	NJBP II 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.	Low & Long-term	Limited & 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	Limited & 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. Sensitive species of plants identified will be removed and relocated to areas that will not be affected by the operations or at NJBP II's greenhouses.	Minor Reversible

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	NJBP II'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 SML 173 area. These are mainly Madras, Barnstaple, Enfield and Retreat. 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 SML 173 area.	Minor & Short-term	Local & Minor Negative	Low & Indirect	In the event that settlements will be impacted, NJBP II 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.	Positive & Reversible
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

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Heritage Sites							
Operations	Humans	***Item CH1*** – There are various Archaeological heritage sites in SML 173. 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 NJBP II 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, NJBP II'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 NJBP II 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. NJBP II 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
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 NJBP II's approved solid waste disposal site. NJBP II waste management policy will be fully implemented.	Minor & Reversible
Sewage Waste							
Pre-operations, operations, rehabilitation	Humans and Fauna	***Item SeW1*** – There is minimal potential for 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 minimal potential for oil spill during site activities.	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 SML 173. Neither will there be any major maintenance of equipment or machinery in SML 173.	Minor & Reversible

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
Natural Hazards							
Pre-operations, operations, decommissioning, rehabilitation	Humans, Flora and Fauna	***Item NH1*** – NJPB II's staff, machinery and equipment may be impacted by natural hazards such as hurricanes, earthquakes, landslides and flooding.	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.	Negligible & Reversible
Exclusions as a result of recommended '*Clawed Back Area*'							
Pre-operations, operations, rehabilitation	Humans, Flora and Fauna	The communities of Sawyers and Level Bottom have been excluded consequent on the '*clawed back area*' and no mining taking place. Therefore, these communities will no longer be potential impact receptors. This is beneficial to the communities as livelihoods will be maintained and export agricultural produce for the domestic and export markets will continue to be supported. Bauxite mining being undertaken in other nearby areas may result in the positive impacts or benefits to these communities through: i. Employment (job creation) ii. Contribution to the Economic Rate of Return (ERR) through statutory deductions (macro-economy). iii. Increased income to the communities through the demand for services, which the communities could supply through small business operators. iv. The formation of nearby NJBP II-organized Community Councils on which the communities would be represented as important stakeholders. v. The usual benefits that NJBP II would extend to communities such as those below could also be extended to nearby new community partners: a. development of greenhouses, b. training and employment of persons in creative conservation practices to retrieve flora and fauna from areas to be cleared	High & Long-term	Regional & Major Positive	High & Direct	No mitigation required. The communities will not be impacted by any impacts which may be caused from noise, dust and vibration that may be associated with bauxite mining. There will be no loss of livelihoods from farming.	Positive

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual & Reversible /Irreversible
		and assisting with the establishment and maintenance of greenhouses and c. support of sports facilities and sponsorship of events, and d. Scholarships from secondary up to tertiary levels					

7.4. Impact Matrices

Table 7-2: Impact Identification of the NJBP II's Mining Operation within SML 173

	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														

	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
INCREASED CRIME POTENTIAL														
HAZARD VULNERABILITY														
SEWAGE DISPOSAL														
OCCUPATIONAL HEALTH & SAFETY														

KEY

No Impact

Minor Negative

Major Negative

Minor Positive

Major Positive

7.5. Risk Analysis and Risk Assessment

7.5.1. 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[58]. For example, NJBP II has used special innocuous binding agents on

[58] 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

the surfaces of haul road and irrigation or wetting the surfaces of the haul roads and bauxite stockpiles with water. There are no plans to stockpile bauxite within SML 173.

7.5.2. 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

7.5.2.1. 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

7.5.2.2. 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

7.5.3. 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 NJBP II - *exporters of bauxite*
- various land-based commercial shops, and
- farming

In the event of a spill, NJBP II'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.

7.5.4. Risk Analysis

The major consequence to the natural and built environment in respect 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 safe guard 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	

7.5.5. Risk to Water Resources

In an island state as Jamaica with a high reliance on groundwater stored in karstic and highly permeable limestone aquifers 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 Catchment Area/Cockpit Country 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.

7.5.5.1. 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 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 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 spring that supplies Usain's Bolt community of Sherwood Content in Trelawny and 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 Catchment/sub-basin if the ore bodies within the southwest area of the SML 173 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 Catchment/sub-basin 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.

7.5.6. 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 NJBP II.

7.5.7. 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 SML 173 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 15%, or less (i.e. ~1,300 hectares), of the land area within SML 173 will be impacted over the estimated 25-years life of the project.

NJBP II's standard operating procedures ensure the protection and sustainability of these resources.

7.5.8. 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.

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 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 NJBP II. Land clearance will be limited to haul roads and orebodies. In addition, topsoil stripped during site clearance will be reused.

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.

Approximately 21.07 hectares of the entire 8,335 hectares of SML 173 area may be used for the construction of access haul roads (0.25%) based on the 5-year mining plan.

Sinkholes are at the bottom of a depression where mining will not be carried out because there are no bauxite deposits, 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 SML 173 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 SML 173 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.

There is a potential for dust generation from the road surface along the haul roads, especially during the dry seasons, as a result of movement of trucks. However, this will not significantly impact ambient air quality. A dust suppression regime will be maintained for all active haul roads. 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, 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 and a major tree planting programme of 200,000 trees.

Furthermore, NJBP II 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 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

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.

As a result of their mobility, vertebrates and invertebrates will not be impacted.

It must be stressed that NJBP II's operations are diurnal and not nocturnal. Both diurnal and nocturnal animals will move freely throughout the area, unimpeded.

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. Sensitive species of plants identified will be removed and relocated to areas that will not be affected by the operations or at NJBP II's greenhouses. This will be done in accordance with accepted methods and best practices, as is carried out by NJBP II. This includes:

- Training of staff on how to identify sensitive species of flora and fauna, as is the standard practice of NJBP II.
- Training and implementation of epiphytes retrieval in the proposed alignment and bordering where haul roads will be built and replanting activities in SML 173, as is the standard practice of NJBP II
- Others will be managed in greenhouses for replanting in SML 173 at a future date.

As far as practical, existing pathways (bridle paths/roadways/footpaths) will be mainly converted to haul roads.

NJBP II will not be engaged in any substantial fragmentation. The area is already naturally fragmented by the nature of the topography and activities in the area. NJBP II operations will temporarily impact on less than 15% of the total area inclusive of construction of haul roads. Haul roads constructed will be at a maximum width of 35 feet. This will be the distance of separation for those specific areas for which the haul roads traverse. This does not prevent any plant species that reproduces itself by any method of sexual reproduction to constrain propagation through pollen and seed dispersal.

In addition to the replanting of epiphytes, natural recolonization, in general, will also occur.

Once the haul roads have been taken out of service, they will be rehabilitated. In addition, the recommendation in the Archaeological Impact Assessment (AIA) states that haul roads may be beneficial to facilitate community development. This can be done through agreement, provided the Local Authority formally and legally accepts responsibility for the future operations and maintenance of the haul roads.

8.1.9. Employment & Worker Health & Safety

No mitigation required, though training may be essential for certain class of operations

NJBP II's Environmental Health and Safety policies and procedures will be implemented.

Proper personal protective equipment (PPE) will be issued to workers. This will 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

In the event that settlements will be impacted, NJBP II 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 NJBP II 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, NJBP II 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. Exclusions as a result of proposed '*Clawed Back Area*'

The communities of Sawyers and Level Bottom have been excluded consequent on the 'clawed back area' and no mining taking place.

Therefore, these communities will no longer be potential impact receptors. This is beneficial to the communities as livelihoods will be maintained and export agricultural produce for the domestic and export markets will continue to be supported.

Bauxite mining being undertaken in other nearby areas may result in the positive impacts or benefits to these communities through:

i. Employment (job creation)
ii. Contribution to the Economic Rate of Return (ERR) through statutory deductions (macro-economy).
iii. Increased income to the communities through the demand for services, which the communities could supply through small business operators.
iv. The formation of nearby NJBP II-organized Community Councils on which the communities would be represented as important stakeholders.
v. The usual benefits that NJBP II would extend to communities such as those below could also be extended to nearby new community partners:
    a. development of greenhouses,

b. training and employment of persons in creative conservation practices to retrieve flora and fauna from areas to be cleared and assisting with the establishment and maintenance of greenhouses
c. support of sports facilities and sponsorship of events, and
d. Scholarships from secondary up to tertiary levels

8.2. Establishment of Buffer Zones

This EIA is solely concerned with the area delineated within the boundaries of SML 173. 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:

8.2.1. 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 SML 173 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 SML 173.

8.2.2. Sinkholes

Sinkholes are features of the karst limestone topography of the SML 173 area. The mining of orebodies will not impact 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.

Avoidance of exposed sinkholes will be the first option for preventing impact on these features. All 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.

8.2.3. Historical Heritage Sites of Significance

Heritage sites have been identified within the SML 173 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. NJBP II 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 SML 173 area be demarcated and a no mining buffer zone of no less than five (5) meters be established around each site.

8.2.4. 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.

8.3. Restoration and Rehabilitation Plan

Rehabilitation will be done to the standards, and within the time frame, stipulated by the Commissioner of Mines. 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 rehabilitated by the Commissioner of Mines.

There are three main processes involved:

1. Backfilling/shaping
2. Topsoiling
3. Rehabilitation/planting

8.3.1. Backfilling

This entails the reshaping of the mined area using bulldozers. The general approach is to cut material from higher areas to fill depressions and to reduce steep gradients. The objective is to produce gentle undulating slopes capable of sustaining vegetation without the risk of erosion.

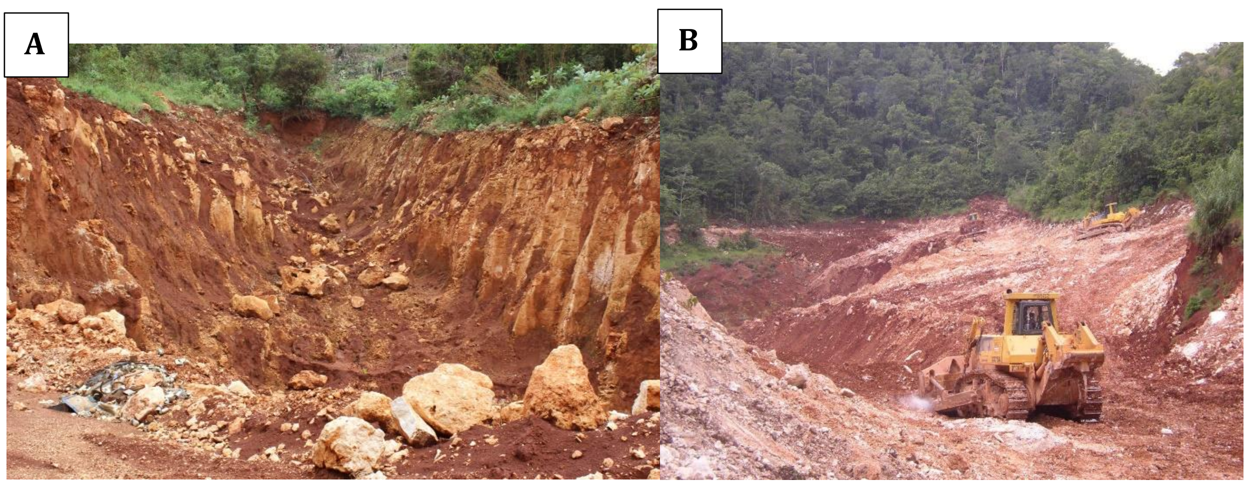

Figure 8-1: [A] Appearance of a typical mined out orebody | [B] Backfilling in progress using three bulldozers to re-profile mined out orebody by cutting and pushing material from higher margins into the main depression.

One consequence of the reshaping operations is that the area covered the shaped pit is typically larger than that of the mined-out pit before the start of reclamation. The additional area incurred is referred to as swell.

Figure 8-2: A reshaped orebody before start of topsoiling process

8.3.2. Topsoiling

This second phase of reclamation involves the replacing of topsoil that was removed prior to mining. Prior to mining the topsoil is removed from the orebody and stored in an appropriate location that is as close as possible to orebody without the risk of topsoil loss by surface run-off.

Figure 8-3: Topsoil storage pile

Scrapers and tractors are the main pieces of equipment used for relocating the stored topsoil and spreading it on the reshaped surface.

Figure 8-4: Topsoil spreading in progress using scraper and bulldozer

Figure 8-5: Topsoiled area before the start of planting

8.3.3. Rehabilitation/Planting

After replacement of the topsoil, a combination of manual labour and farm tractor are used to remove large stones and to till the soil in preparation for planting. Planting and fertilizer application are carried out manually. Grass is the preponderant vegetation cover used in rehabilitation as it allows for rapid coverage (in 3 to 6 months). Other vegetation cover types include cash crops and more rarely trees.

Figure 8-6: Grass planting in progress in topsoiled orebody

Figure 8-7: Fully grown grass in rehabilitated mined out area

Figure 8-8: Fully grown grass (approximately 12ft tall) in rehabilitated mined out area

Once the planted orebody is fully vegetated a certification exercise is arranged with representatives of the Ministry Inspectorate, JBI and the Ministry of Agriculture.

A small percentage of rehabilitated lands (less than 5%), ends up in non-agricultural use such as playfields roads or housing subdivisions. To date NJBP II has not attempted to use natural growth as a certification land cover alternative.

Generally, orebodies are certified with a single land use. However, a 2015 in-house study of land use changes in certified lands indicated that most orebodies ended with multiple land uses over time: typically pasture and crops, pasture and natural growth or a combination of all three uses. The majority 64% of the reviewed orebodies had a combination of pasture and other land uses.

Figure 8-9: Pasture and natural growth on a rehabilitated orebody

A comparative investigation was carried out between the following types of areas within or on the fringes of SML 173:

1. a mined-out area that has been rehabilitated
2. mined out area that has not been rehabilitated
3. a low-lying area or depression containing bauxite ore.

The findings of the investigation are presented below:

8.3.3.1. Transect Deployments at Control Sites - Mined Areas Outside of SML 173 Findings

Two control sites were established outside of the SML 173 study area to examine whether or not there would be floral and faunal population differences at, or adjoining rehabilitated mines or active mines. The first location was at position 18.357828° -77.402076°and represented a rehabilitated mine that had been disused in excess of 17 years. The next location was at position 18.344700° -77.425352° and represented an active mine area within SML 172.

The following represents results obtained for transects assessed outside of the SML 173 area.

8.3.3.1.1. Flora Transect Surveys

8.3.3.1.1.1. Waypoint 645 Rehabilitated Mine Area Adjoining Limestone Hillocks –

Figure 8-10 shows a Google Earth image of the location of the control transect surveyed at waypoint 046 (position 18.357828° -77.402076°) outside of the SML 173 boundary.

Figure 8-10: Location of the control transect surveyed at waypoint 645

This area can be characterized as being a heavily disturbed site with small patches of natural vegetation dispersed throughout. A transect was set up along the edge of a semi-natural forest area within the disturbed site. To the left of the transect was a recently cleared ore body that appeared to be in the process of regeneration, but showed evidence of recent impact from fire.

The species counts within the cleared area was low (total=7). The area (actual photograph shown in see Figure 8-11) was dominated mainly by grassland (80% coverage) indented by a few small perennial shrubs (*Lantana camara, Ambrosia peruviana, Eupatorium odoratum*). The area was void of any true tree species.

Figure 8-11: Re-established grassland of the ore body (foreground). A remnant of semi-natural forest which remained in the old mining area (mid-ground).

The semi natural forest appeared as a sliver of vegetation amongst the recently cleared regions. Species counted within this region were moderate (total=25). It was composed preponderantly of trees, tall shrubs, and herbaceous vines. The main tree species was *Fagara martinicensis* and at least one tree or seedling was displayed within each of the five quadrats surveyed. A fruit tree in the family Rutaceae was noted about 28 m along the transect. Shrubs species such as *Eupatorium odoratum, Lantana camara and Miconia laevigata* were observed in high abundance along the transect.

Along the forest floor were ferns (*Campyloneurum phyllitidis, Nephrolepis sp.*), grasses (*Lasciasis divaricata*) and vines (*Merremia umbellata, Triumfetta semitriloba*). One bromeliad species (*Tillandsia juncea*) was noted within forest area.

The surrounding hillocks appeared relatively undisturbed as similar stratification patterns were observed when compared to that of the previously studied natural forests. The main concern was the removal of lower shrubland area of the forest, which acts as a transition zone between the ore body and the woody forest. The removal, which occurred during the ore excavation process, created vertical cliff faces which show only a small percentage of established vegetation. (see Figure 8-13).

Figure 8-14 illustrates a zonation/profile of plant types observed on the transect at Waypoint 645. Table 8-1 supports Figure 8-14 by identifying species two-letter codes used for the zonation.

Figure 8-12: Vertical Cliff Face Formed at Mined Area

Figure 8-13: Near Vertical Collapsed Bauxite Cliff Face

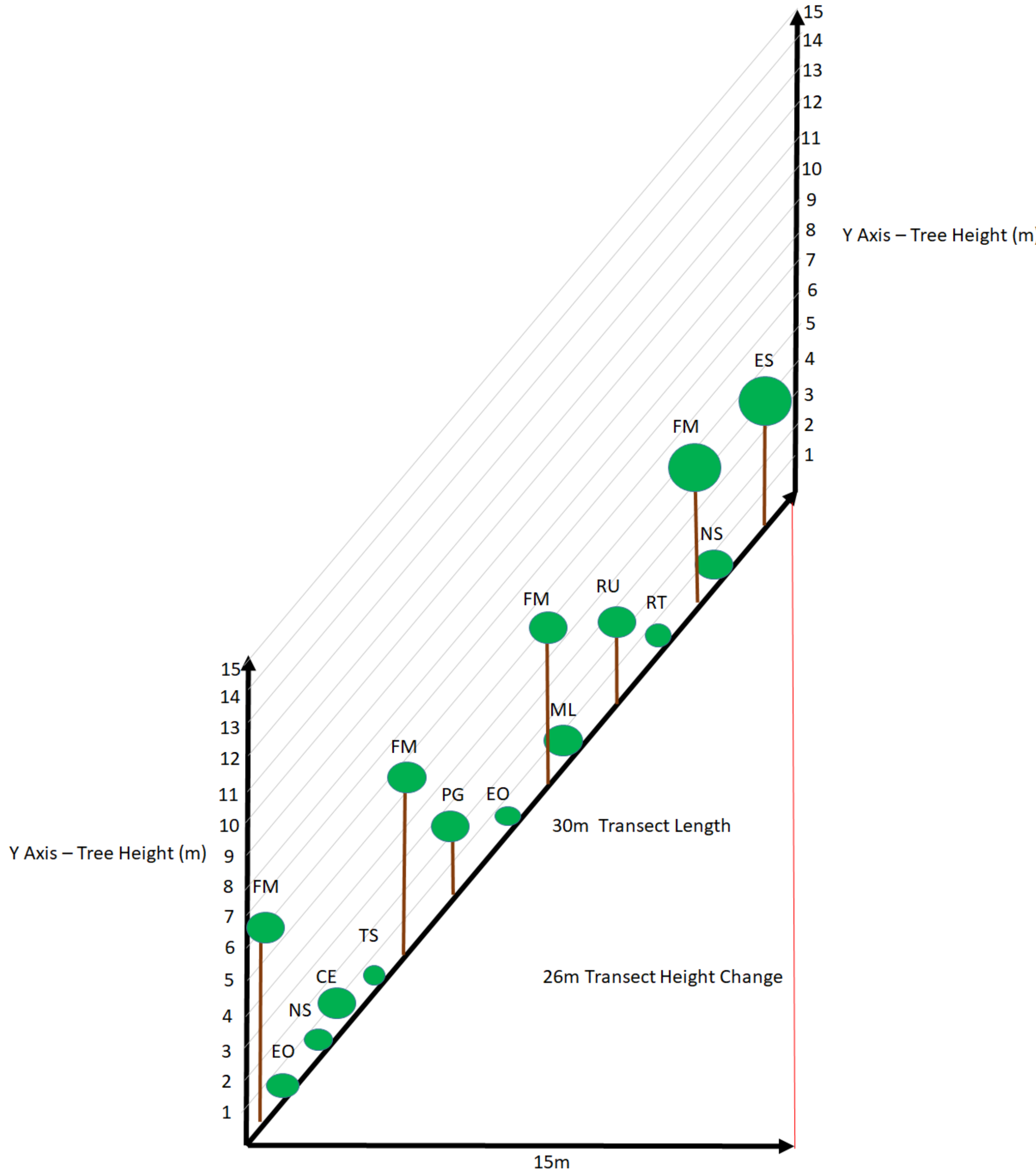

Figure 8-14: Vegetation profile showing the plants species observed along the transect at WPT 645

Table 8-1: Vegetation Profile Identification Key for WPT 645

Initials	Name	Average DBH (cm)	Average Height (m)
FM	***Fagara martinicensis***	**26**	**5.9**
EO	***Eupatorium odoratum***	**-**	**0.8**
CE	***Cassia emarginata***	**9**	**1.2**
NS	***Nephrolepis sp.***	**-**	**0.3**
TS	***Triumfetta semitriloba***	**-**	**0.4**
PG	***Psidium guajava***	**16**	**3.7**
ML	***Miconia laevigata***	**-**	**0.5**
RT	***Rhytidophyllum tomentosum***	**-**	**0.4**
ES	***Eugenia sp.***	**31**	**4.3**

8.3.3.1.1.2. Waypoint 051 Limestone Hillocks Flora Transect Survey at an Active Mine

Figure 8-15 shows the location of the control transect surveyed at waypoint 051 (position 18.344700° -77.425352°) outside of the SML 173 boundary.

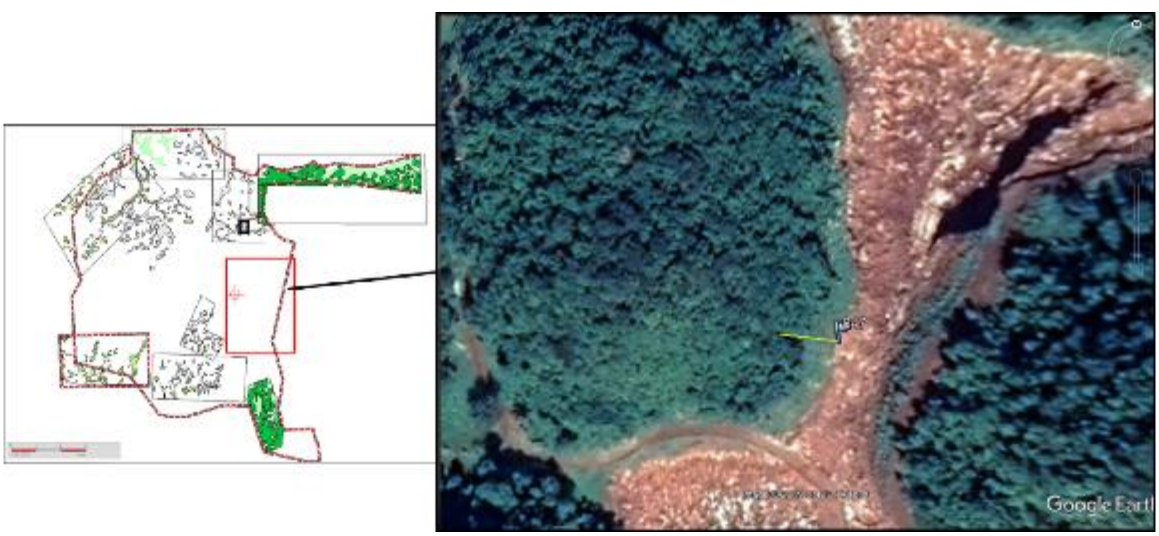

Figure 8-15: Location of the control transect surveyed at waypoint 051

This study area was present within SML 172, which was currently being mined. There was evidence of previous disturbance with the forest such as old pathways. The slope featured stratification patterns observed within other undisturbed areas where the periphery was dominated by shrubs and small herbaceous plants and ascending the slope was the woodland forest.

The shrubland comprised mainly of species such as *Bidens pilosa, Stachytarpheta cayennensis, Eupatorium odoratum and Lantana camara*. Ascending the slope, the density of the shrubs decreased and the presence of aroids increased. *Syngonium auritum* was the defining species on the forest floor (50% coverage). One bromeliad (*Hohenbergia sp.*) was observed.

Fern species (*Nephrolepis sp, Campyloneurum phyllitidis*) showed clumped distribution along rocky soils within the forest. Tree species observed included *Bauhinia divaricata*, *Calyptranthes sp., Fagara martinicensis* and *Comocladia pinnatifolia*.

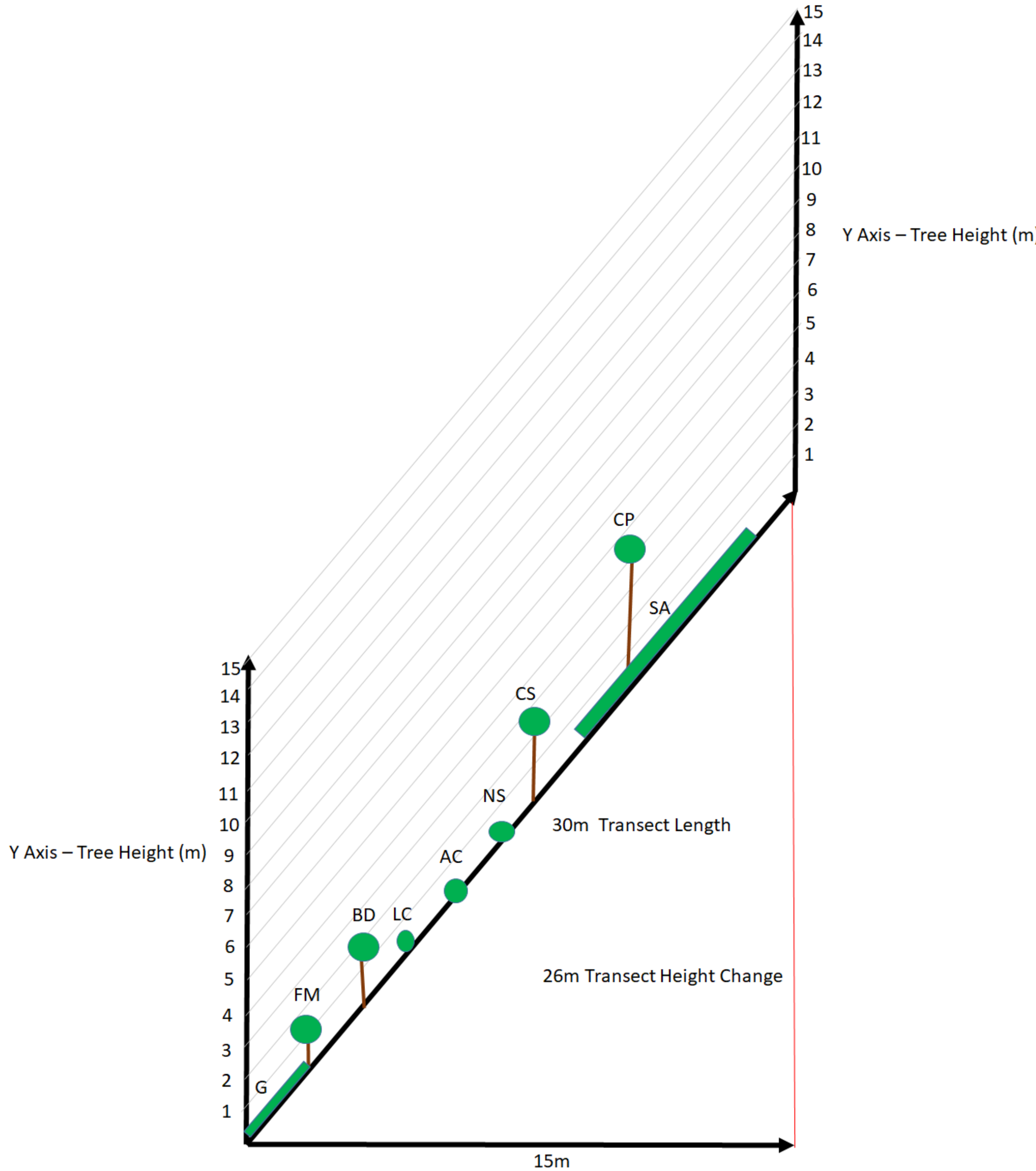

Figure 8-16: Vegetation profile of WPT 051

Table 8-2: Vegetation Profile Identification Key for WPT 051

Initials	Name	Average DBH (cm)	Average Height (m)
FM	***Fagara martinicensis***	***10***	***2.4***
BD	***Bauhinia divaricata***	***22***	***3.7***
LC	***Lantana camara***	-	***0.3***
AC	***Asclepia curassavica***	-	***0.3***
NS	***Nephrolepis sp.***	-	***0.5***
CS	***Cassia sp.***	***8***	***3.9***
CP	***Comocladia pinnatifolia***	***7***	***4***
SA	***Syngonium auritum***	-	***3.5***

8.3.3.1.2. Fauna

8.3.3.1.2.1. Avi-fauna

The site at position 18.357828° -77.402076° (rehabilitated mine) showed signs of rehabilitation. The majority of the land that had sparsely covered grasses and shrubs and a strip of undisturbed forest. The surrounding Hillock Forests appeared to be relatively undisturbed by the mining efforts. There was also evidence that the area had been used for agriculture since its rehabilitation in the form of livestock being present and rows of previously cultivated areas and an active crop of pumpkin. There was also ash residue from a bush fire that may have been initiated to clear the land for future cultivation.

The mined site at position 18.344700° -77.425352° was not yet rehabilitated and was within a mile of an active mine site. As rehabilitation had not yet been undertaken, it was observed that substrate for the establishment of plant life to support the insectivorous diet of the avifauna was not established.

Table 8-3: Species detected per site

Site	Rehabilitated Site	Mined Site
Species Detected	Jamaican Vireo	Black-faced Grassquit
	Loggerhead Kingbird	Red-billed Streamertail
	Jamaican Parakeet	Yellow-faced Grassquit
	Turkey Vulture	Jamaican Woodpecker

8.3.3.1.2.2. Anoles and Amphibians

8.3.3.1.2.2.1. Rehabilitated Area - September 14, 2019

While traversing the study transect 1 *Anolis valencienni* was seen along with a single reptile egg seen in a rock pile. An *Anolis garmani* was also seen within the low-lying canopy of a tree. An *Eleutherodactylus johnstonei* was also heard within the grass of the area.

The area was sampled over a short period of time. Based on observation the area appears to be in a suitable rehabilitated condition to support lifeform (recolonization). Anoles were observed occupying the area along with other organisms.

8.3.3.1.2.2.2. Recently Mined Area - September 14, 2019

Only a section of the transect was traversed due to inclement weather. An *Eleutherodactylus gossei* was heard in the lower grassy section of the transect.

8.3.3.1.2.3. Arthropods

At the rehabilitated area, 24 species were present that represented 9 orders, including the dragonfly *Erythrodiplax umbrata*; ticks; the butterflies *Junonia sp.*, *Dryas iulia julia* (endemic), *Eurema sp.* and members of the families *Lycaenidae and Nymphalidae*; beetles, spiders, flies, hemipterans and orthopterans. The most numerous, however, was the butterfly of the genus *Junonia*, followed by *Eurema sp*. and *Lycaenids*. The Lepidoptera were most numerous, followed afterwards by Diptera. Thirty individuals were recorded overall. Diversity of the species of this assessment was moderately low at 0.569.

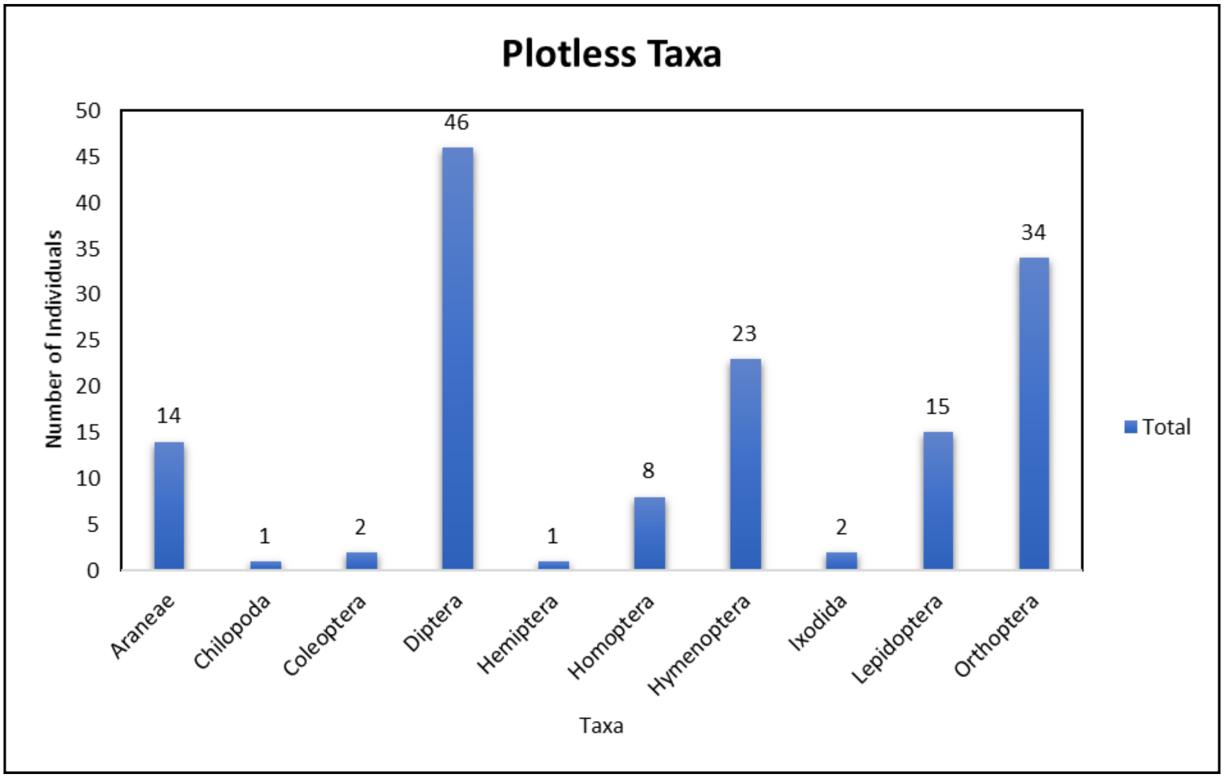

Figure 8-17: Plotless Taxa Representation

8.3.3.1.2.3.1. Plot-based Assessment

At the mined area, only 2 quadrats of the plot-based method could be completed. The traverse to the location was within an area currently being mined, thus walking was along a haul road with few fauna. Regardless, 3 species were recorded, 2 Muscids and an Orthopteran.

Within the plot-based assessment of the rehabilitated area, 146 individuals were recorded, with Diptera dominating, followed by Orthoptera. Diptera was the most dominant species, was more speciose, comprising 10 species, versus 8 for Hymenoptera and Lepidoptera. 87.5% of the Hymenoptera species were ants, including the invasive fire ant, *Solenopsis invicta*.

Of the Lepidoptera, the Arctiid was most numerous, followed by the Lycaenid. Spider diversity was also lower than in previous areas, down to only 4 species, with one particular species dominating, representing 71% of Araneae. Only 1 Chilopod was noted, but of a different species than in the previous locations. A large millipede was also sighted in the area. With reference to individuals represented, the location had a density of 0.973 arthropods per square metre.

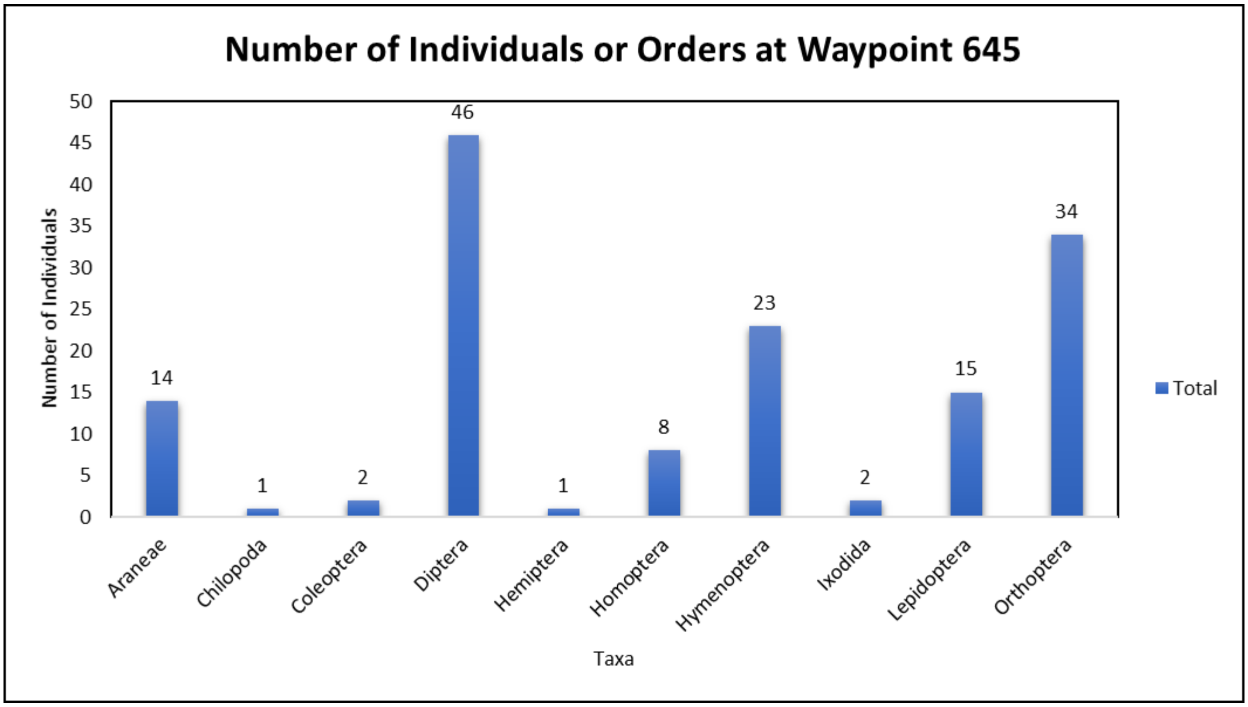

Figure 8-18: Number of Individuals of Orders at Waypoint 645

For the 2 quadrats examined at the mined area, diversity was relatively similar to the rehabilitated, but slightly higher at 0.838. Again, Diptera dominated with 17 individuals, followed by Hemiptera and Hymenoptera. Though shorter, the second location had more Hymenopteran species than the first, totaling 9, with 7 ant species. This was followed by 8 Dipteran species, then 6 Hemipteran species. The location had a density of 1.38 arthropods per square metre, higher than that of the rehabilitated area.

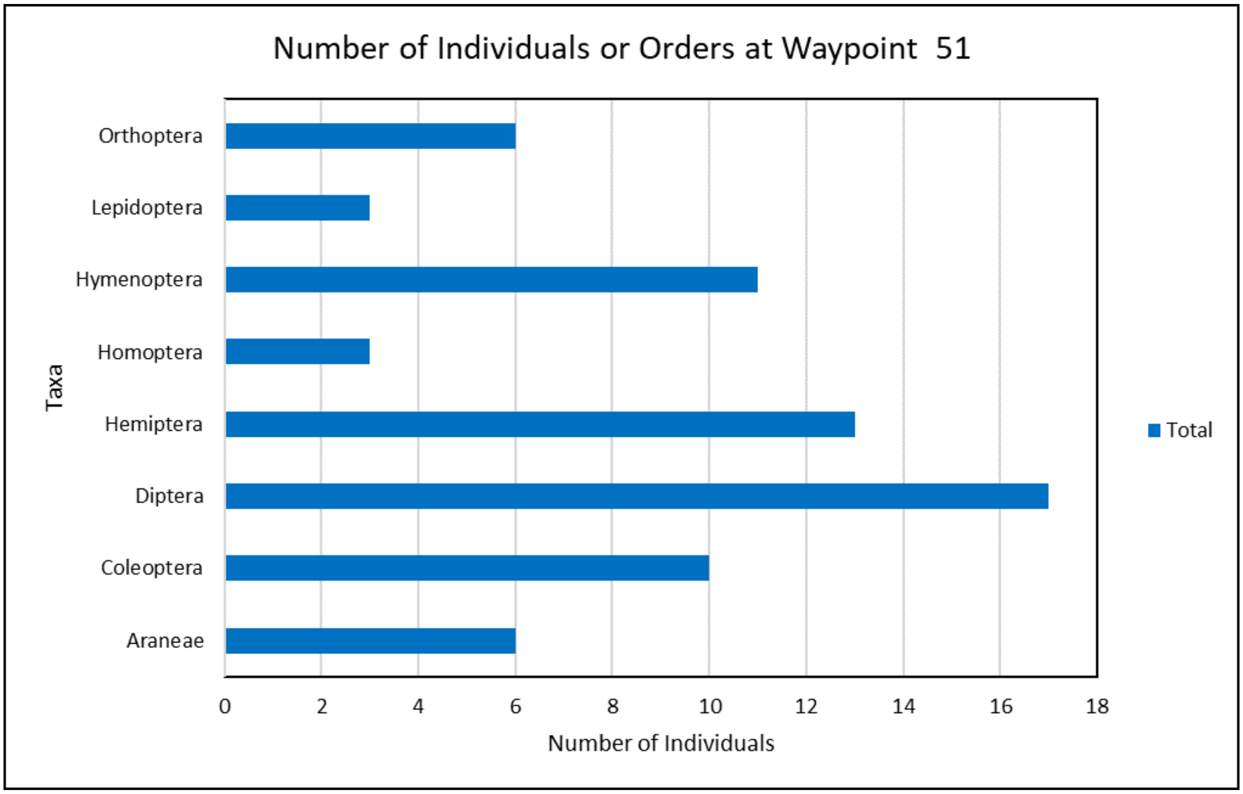

Figure 8-19: Number of Individuals of Orders at Waypoint 51

The mined area thus had the greater arthropod density, similar to that of the SML 173 study areas.

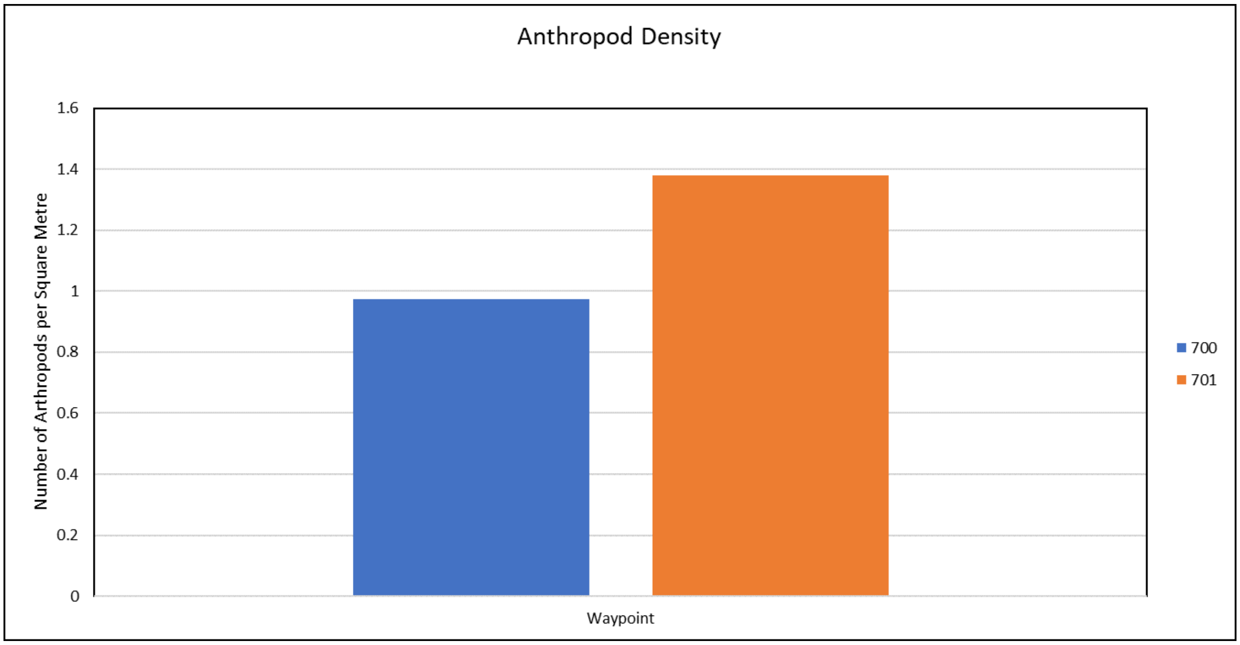

Figure 8-20: Arthropod Density per Study Area – Rehabilitated (left column) and Mined Area (right column)

8.3.3.2. Photographs at Rehabilitated Areas

Figure 8-21: Hemiptera C

Figure 8-22: Diptera A

Figure 8-23: Gryllidae A

Figure 8-24: ***Amblyomma cajennense***

Figure 8-25: Formicidae S

Figure 8-26: Formicidae B

Figure 8-27: Caterpillar A

Figure 8-28: Coleoptera A

8.3.4. NJBP II's Current Reclamation Status

Currently 2,889 hectares of the total 3,123 hectares (91%) disturbed by Kaiser/Noranda/NJBP II has been certified rehabilitated. Reclamation activities were suspended during the period of the former Noranda's bankruptcy proceedings in 2016. As a result of this the backlog of lands due for certification grew to 280 hectares. However, none of the orebodies in the backlog have passed the three-year limit. Reclamation activities were restarted in 2017 and NJBP II certification exercises have been implemented every year since then.

8.3.5. Land Use/Management Programme

NJBP II utilizes a very effective programme to assist farmers in it's new mining areas. This is done by identifying lands which are not currently required for mining activities and relocate farmers who are occupying lands required for mining. These farmers receive extensive support including land ploughing services, fertilizers, chemicals and planting materials.

Farmers in this programme are eventually accommodated on restored lands in the future. This programme reduces the wholescale displacement of farmers.

9.0. 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 9-1: 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

There are no major nor moderate residual impacts from the mining operations within the SML 173 area.

10.0. Analysis of Alternatives

10.1. Introduction

The objective of the proposed project is to provide bauxite for export to the international market for processing into alumina and subsequently aluminum. The aim is to extract the bauxite ore in as small a footprint as possible within the SML 173 area. To do this existing infrastructure such as loading areas and rail transportation facilities will be used.

Bauxite mining operations will be carried out during such hours as may be permitted by the regulatory authority. The load out areas operate on a 24-hour basis to transport bauxite to the drying plant, storage facilities and to the port. The bauxite deposits in the SML 173 area has been identified for mining for the last 60 years based on the analysis of Jamaica's available bauxite reserves in the 1950s to 1960s. Significant parcels of the lands comprising the SML 173 area were purchased from private owners by the international mining companies. The imposition of the Bauxite Levy Act of 1974, the government took position of the bauxite bearing lands and reallocated it in 40 years blocks to the mining companies. The joint venture of New Day which comprises Government of Jamaica as 51 % majority shareholder owns most of the lands to be mined in this proposed SML 173 area.

The facilities for the transportation of bauxite are located in the center of greatest mass. The objective is to achieve the greatest economy of scale for the general location. The following alternatives have been analyzed for the project:

- No Action Alternative
- The Proposed Mining Activity
- Modified Project Proposal
- Location
- Technology

10.2. 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. It means that NJBP II will not have economical access to sufficient bauxite resources to support its operations. The implications of which are stated below.

Presently, farming occurs to variable degrees on all the orebodies that have been assessed during the EIA process. The farming of yam, corn and other produce occurs on the topsoil covering the bauxite in the pits between the limestone hills within the SML 173 area. Yam farming requires the use of “yamsticks” to support the vines that generate the growth of the yam underground. These yam sticks are extracted from the vegetation on the limestone hills in and around the farming areas.

It is estimated that yam production in Jamaica uses on average 63,000,000,00 sticks per year. This results in degradation of the vegetation on hills and loss of biodiversity in the farming areas. Figure 10-1 shows one such area observed on ground truthing activities in SML 173. The degradation of the environment would therefore continue as more areas are sought after for farming.

A significant percentage of the lands within the SML 173 area are government-owned lands that are being illegally occupied.

Farming is the main economic activity within the SML 173 area. However, according to the 2012 Living Standard Report the communities in the SML 173 area have some of the highest levels of poverty in the country. The South Trelawny Environmental Agency (STEA) has over the last two decades taken a number of initiatives in an attempt to improve the economic viability of the area with the focus being on yam cultivation. The impacts on livelihoods and the standard of living have not been reflected in the government sanctioned survey. The attempts also include the development of eco-tourism within the Cockpit Country with the spin-off benefits intended to impact the communities with the SML 173 area. There is not a traditionally large amount of eco-tourism taking place in the area. This may be done independently of bauxite mining in the area. These impacts have also not been reflected in the living standard survey.

The objectives of the proposed mining project will not be achieved with the “Do Nothing Alternative”. Anthropogenic impacts will continue unabated into the future as more encroachment from farming occurs. This is likely to result in continuing degradation of the forests on the limestone hillocks. In addition, there will be no benefits to accrue from the mining of bauxite resources in the SML 173 area.

Figure 10-1: An example of removal of grass cover in preparation for farming (foreground) and yam farming underway (midground). Limestone Hillock in the SML 173 area showing deforestation from anthropogenic activity (background)

GDP growth in Jamaica's economy, which is only recently emerging from a debt to GDP ratio in excess of 150%, and which was still in a Standby Agreement with the International Monetary Fund (IMF) which ended in September 2019, has shown steady, though small positive Growth in recent times (see Figure 10-2). By not implementing this project, it may lead to closure of the company and possibly to stagnation or reversion of the economic growth of the country.

Source: STATIN

Figure 10-2: Quarterly year over year % change in Goods and Services components of real GDP

10.3. The Proposed Mining Activity

Development of the SML 173 will bring the following benefits:

- Reduction of the risk to the sustained production of bauxite and the sustainability of the micro and macro benefits to the Jamaican economy and society. The risks to the sustainably of the micro and macro economies are a result of our vulnerability to external (exogenous) shocks such as reduction in tourist arrivals, fuel prices, etc.
- NJBP II now 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.
- The proposed development will provide about (estimated) 400 jobs to be distributed as follows:
    - Construction Phases
        - Access road construction

        - Traffic Management
        - Restoration facilities
    - Operations Phase
        - 20 permanent jobs
- Improved standard of living for residents to be relocated.

10.4. Modified Project Proposal

A modification ('*clawed-back area*') to the SML 173 area has been assessed in this EIA. The following are outlined and described in the table below:

1. The original SML 173 area proposal, for which NJBP II has been issued with a mining lease, and
2. The modified ('*clawed back area*') proposal.

Table 10-1: Comparison of Entire SML 173 Area and Modified ('*clawed back*') SML 173 area – Rationale & Justification

Parameter	Entire SML 173 area	Modified ('*clawed back*') SML 173
Area (hectares)	**The entire SML 173 area** is 8,335 ha	**The area of the modified SML 173** is 6,226 ha - reduction of 25%
Exclusions	All Forest Reserves within the SML 173 area	1. All Forest Reserves within the SML 173 area, and 2. A section located north west within the SML 173 area **The aerial photographs and maps for sections of the '*clawed back area*' are shown in Appendix XXIII.**
Potential Impacts on Communities	Communities located north west within SML 173 may be impacted.	The likelihood that there will be any impact on communities located to the north west within SML 173 will be minimal to non-existent.
Potential impacts on Agriculture	The livelihoods of yam and other farmers located to the	The likelihood that there will be any impact on the livelihoods of yam and other

	north-west within SML 173 may be impacted	farmers located in the north west areas will be minimal to non-existent.

The modified *'clawed back'* SML 173 area (See Figure 10-3) is based on natural biological resource conservation. In addition, the livelihood of the farmers and export agriculture arising from farming (yam and other crops) would not be impacted in the 'clawed back area'.

The area remaining for mining activities after the modification (*'clawed back')* to the SML 173 comprises 6,226 hectares. This represents a 25% reduction of the total SML 173 area. As a result of this change, there will be a reduction in the total tonnage of bauxite reserves available for mining in the modified SML 173.

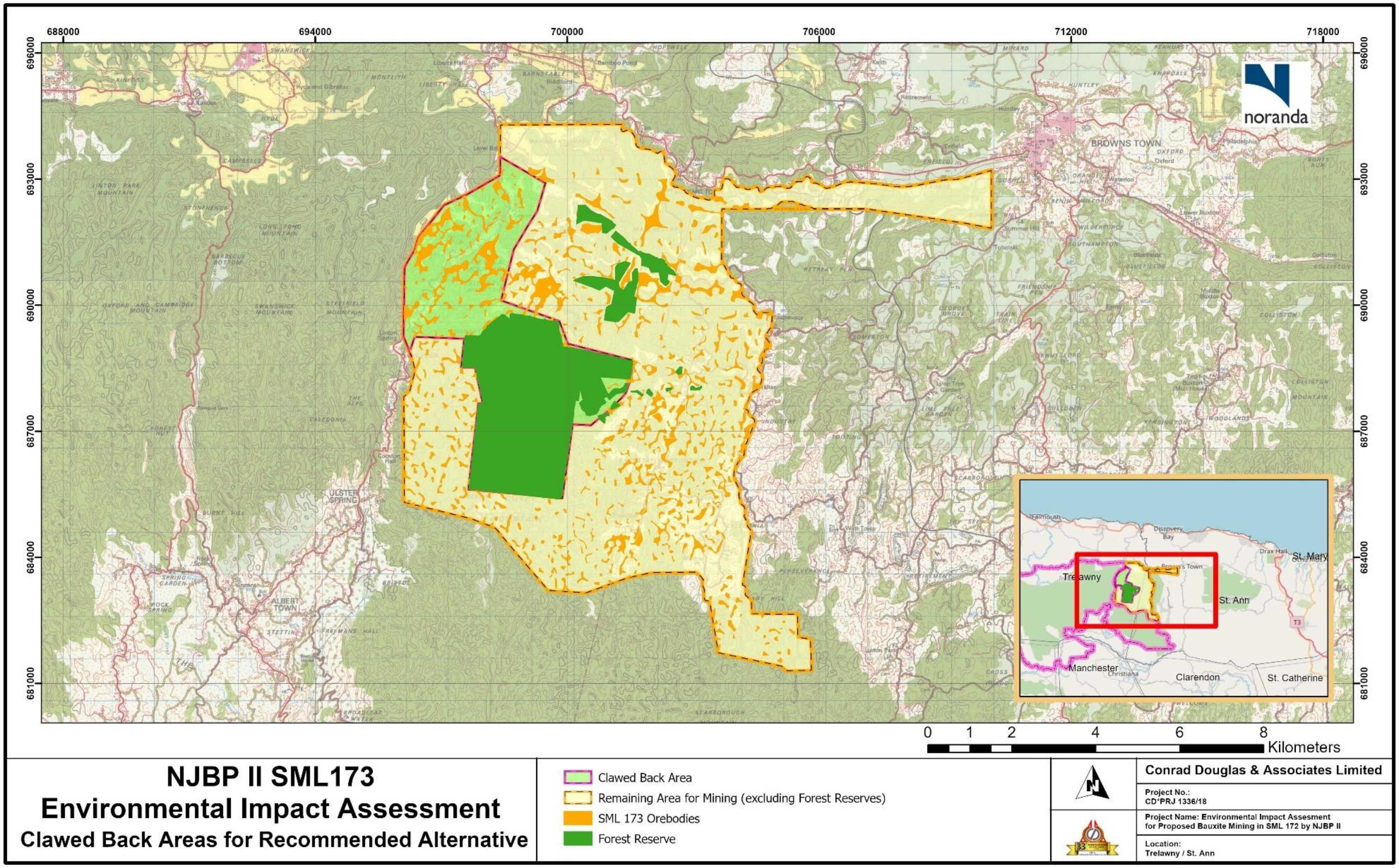

Figure 10-3: Boundaries of Entire SML 173 area and Modified '*clawed back*' SML 173

10.5. Location

The project is essentially an extension of the mining operations into an adjacent mining area. A new location would, in essence, change the philosophy and economic considerations behind the project since 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.

A new location would involve extension or reconstruction of all support services and infrastructure resulting in a much larger footprint for the project.

10.6. Conveyance Technology

10.6.1. Conveyor Beltline or Buckets

It is possible to supply bauxite to the load out areas by using conveyor systems installed above ground. The installation of these systems will require all the amenities associated with a roadway since they will have to be installed by heavy equipment and have to be maintained for the lifetime of the project.

The impacts will therefore be similar to road construction and maintenance.

11.0. Outline Environmental Monitoring & 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:

11.1. 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.

11.2. 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.

11.3. Detailed 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 11-1 below.

Table 11-1: Framework for Environmental Monitoring Plan

Monitoring	Period	Parameters	Monitoring Frequency
Noise	Baseline (1 occasion)	Leq (30 mins) GPS location	One set of measurements at selected locations (within and surrounding project site)
	Operations Phase	Leq (30 mins) GPS location	One set of measurements between 0700-1900 hours on normal weekdays once per week.
Air Quality	Baseline (1 occasion)	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurement (24-hour sampling) at selected locations once every six (6) days [59].
	Operations Phase	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (24-hour sampling) at selected

[59] Claude Davis & Associates, *NRCA Ambient Air Quality Guideline Document*, NEPA, p 4-13, November 2016

Monitoring	Period	Parameters	Monitoring Frequency
			locations once every six (6) days [60]. Selected monitoring locations will be determined on the basis of accessibility, and where the maximum TSP and PM_{10} concentrations have been predicted by the Air Dispersion Modelling Report for SML 173 (see Volume IV: Air Dispersion Modelling Report) unless otherwise required by NEPA.
Water	Baseline	BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	One set of measurements
	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	Once bi- monthly during operations.
Waste	Baseline	Visual Survey of area around proposed sites	Once
	Operations Phase	Routine supervision of mining works	As per site inspection schedule
Landscape/ Visual Resources	Baseline	Remove and relocate sensitive species (epiphytes)	Once immediately prior to operations
Chemical Waste & Control of Spills	Operations	Materials and chemicals that will be used during operations	Once per week during mining works

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 will be addressed using internationally accepted standard practices:

- Noise
- Air Quality

[60] Claude Davis & Associates, *NRCA Ambient Air Quality Guideline Document*, NEPA, p 4-13, November 2016

- Water Quality
- Waste
- Landscape and Visual
- Soil Conservation
- Chemical Waste & Control of Spills
- Traffic and Access
- Environmental Management & Monitoring Responsibilities, and;
- Reporting

11.4. Water Resource Monitoring

The Water Resources Authority (WRA) monitors ground and surface water resources in all of the hydrologic basins on a monthly basis for quantity and in some instances for quality. In many instances, the river flows are monitored using recording gauges with strip charts and more recently using digital systems that are downloaded to laptop computers in the field. The groundwater measurements are taken monthly though some wells have recently been fitted with divers that digitally record the change in the water table. The data after analysis and quality checks is stored in the WRA's hydrologic database which is available online at www.wra.gov.jm.

Analysis of this groundwater data for basins on the south coast of Jamaica where bauxite mining has taken place has not shown any continuous declining trend since the start of record keeping in the 1950s that could be attributed specifically to the mining of bauxite. The review of the groundwater levels in the Upper Rio Cobre sub-basin (Linstead-Ewarton) and the Black River basin by the Resource Monitoring Unit of the WRA for the 2014/2015 annual report showed increasing groundwater levels at several wells (Venecia Corehole-Linstead and Beacon-Treasure Beach). In fact, a review of the water levels for the period 1990 to 1999 showed declines in the water levels but between 1999 and 2005 there was a recovery. For the period 2005 to 2014 there were further declines caused by the severe droughts of 2013 and 2014, but the groundwater levels remained above the pre-2000 groundwater levels. There has been no regular analysis of water quality but there are no reports from well/spring owners and users of springs and rivers for domestic purposes in any of the basins with a history of bauxite mining that there has ever been an impact on water resources such as a red discoloration, increased turbidity of the groundwater discharge and a decline in the groundwater levels.

There are no wells close to the Cockpit Country or the SML 173 area that can be monitored for either groundwater levels or water quality. The closest wells in the north are to the west at Barnstaple (NWC) along Hampshire Lane leading to Clarkes Town, the wells at Clarkes Town owned and operated by the National Water Commission (NWC) and Long Pond Estates. All these wells have water table elevation in excess of 50metres below ground. Some of these wells have been contaminated by dunder from the distilleries at Long Pond and Hampden. These reports are in the Basil Fernandez Documentation Centre at the WRA.

In the south the NWC attempted to construct a well at Cave Valley. The well was drilled to a depth of 100metres with a water level of 15metres below ground. Yield test indicated that pumping at m^3/hr the well broke suction after 1 hour of pumping. The well tapped a perched groundwater system.

Dye tracing of groundwater was done in 1976 by a team from Bristol University. The dye tracing established a link between the Quashies and the Cave Rivers to the Rio Bueno River. The flow was underground, but the specific path was unknown but was to the north. The tracers travelled with the groundwater through the compartmentalized limestone formation via conduits and fractures/fissures developed through karstification. No further work has been done using dye tracing in the Cockpit Country or areas east.

Monitoring of water quality will have to be done at Dornoch the head of the Rio Bueno River. The monitoring of water quality should include parameters that can be done by local laboratories and should include pre-mining, operational and post mining monitoring. The parameters should be relevant to the situation and not selected just for monitoring sakes. It is noted that there are no water bodies such as river, spring or pond that can be monitored.

The use of geophysics has been suggested as one way to determine the connectivity between any sinkhole/caverns or springs in the area and the flow in the Rio Bueno. The need for cost effective methods to locate individual fractures or fracture zines in bedrock has increased in recent times and the use of surface geophysical techniques have been used in some cases successfully to describe their geometry. Surface geophysical methods are numerous and varied but all measure the response of subsurface materials and their interstitial fluids to a naturally or artificially generated signal. The interpretation of this response provides information about the subsurface materials and the fluids in them.

Use of geophysical methods in karst terrains have been limited to engineering solutions as to strength of materials for construction .and possible leakage from waste disposal sites. Usually geophysical methods are used in conjunction with drilling. In Jamaica geophysical methods have been used in alluvial formations to obtain information on thickness, type of material and water levels. These have been ground truthed by the drilling of exploratory boreholes. No geophysical method has been used in karst limestone. Attempts to use geophysical methods in the modelling of the Essex Valley Limestone Aquifer at Alpart by Schlumberger was not successful and well logs were used to determine the change in subsurface lithology.

Consensus standards for selecting surface geophysical methods to be applied to karst investigation are available and have been published as ASTM-6429. These standards identify three primary and two secondary geophysical methods as acceptable for evaluating sinkholes and voids in karst settings. Common acquisition methods and interferences have been described for each geophysical method. Each method has benefits when applied to the right scale problem in the correct setting. Each geophysical method also has limitations relative to the detail of information that can be provided by the method. When the correct geophysical method is applied in the correct setting, significant cost benefits can be realized with any karst investigation.

12.0. Conclusions and Recommendations

Based on the findings of the scientific investigations reported in this EIA using internationally accepted approaches, methodologies and best practices, the impacts identified and the mitigations proposed, we recommend that NJBP II be granted an environmental permit to implement mining operations in the SML 173 area, in compliance with all the relevant regulations, standards and guidelines and where applicable, its own internal standards. However, it is recommended that the modified 'clawed back' area be considered as the preferred option.

Jamaica's immediate to medium social, economic and sustainable development future is highly dependent on providing NJBP II with the permits to mine these bauxite resources. There are no other feasible immediate or short-term economic alternatives that have been identified that can be considered as a substitute to bring equal or greater macro and micro-economic benefits to Jamaica, at this time.

As stated by the Most Honourable Prime Minister and recognized by NJBP II, no mining will be carried out within the proposed Cockpit Country Protected Area (CCPA).

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APPENDIX

Appendix I: Agreed Terms of Reference

TERMS OF REFERENCE
for
MINING OPERATIONS
proposed by
Noranda Jamaica Bauxite Partners II (Noranda)
at
NEW DAY SPECIAL MINING LEASE (NEW DAY SML)
located in the Parishes of
St. Ann and Trelawny, Jamaica

January 29, 2019
Rev: #3

Noranda Jamaica Bauxite Partners II (Noranda)
Port Rhoades
Discovery Bay P.O.
St. Ann
Jamaica, W.I.

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Terms of Reference

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January, 2019

Terms of Reference

Table of Contents

Page Number

List of Figures

Page Number

Terms of Reference

1.0. Introduction

The St. Ann bauxite mine is operated through Noranda Jamaica Bauxite Partners II (Noranda), a Jamaican limited liability company. Noranda's bauxite mining assets consist of: (1) a concession from the Government of Jamaica to mine bauxite in Jamaica through 2030 and (2) a 49% interest in Noranda Jamaica Bauxite Partnership II, or NJBP II, which holds the physical mining assets and conducts the mining and related operations pursuant to the concession. The Government of Jamaica owns the remaining 51% of NJBP II.

Annual bauxite production is currently approximately 3.5 million dry metric tonnes of ore and Noranda Jamaica Bauxite Partners II (Noranda) wishes to improve the production to 5.2 million dry metric tonnes in the short term to improve the contribution of the local bauxite industry to the national economy in keeping with the Government of Jamaica Economic Growth and Job Creation Policy.

To achieve this the NDBJL is proposing the establishment of new mining areas and operations in a Special Mining License area spanning the western sections of the parish of St Ann and the eastern section of the parish of Trelawny. This is in keeping with the Government's major thrust for Economic Growth and Job Creation in a sustainable manner. The map of the proposed location of the specific mining area which borders the Cockpit Country (an important protected area) is shown in Figure 1 below. There are several Forest Reserves dispersed within the area of interest. Figure 2 shows the distribution of these reserves across the proposed SML. The smaller forest reserves are devoid of potential ore bodies. However the largest continuous reserve has areas that contain bauxite. Historically, bauxite bearing soils supported the growth of forests. Presently the stands of forests are located on the limestone hills, with the bauxite being located in the depressions between the hills. Figure 3 shows Google Earth image that captures the topography of the general area while Figure 4 shows an aerial photograph of a close-up of the forested hill and bauxite ore containing depression in the proposed SML.

The SML area is approximately 8,400 hectares and forms part of the bauxite reserves identified in the 1940's – 1950's and earmarked for exploitation. The major players in the explorations and mining industry at the time were all private multi-national North-American based aluminium companies. These included Kaiser, Reynolds and Alcan. These companies had large land banks containing the reserves. However, in 1974 the GOJ imposed the bauxite levy and negotiated the access rights for the mineral while implementing the Special Mining Lease system. The Special Mining Lease system resulted in a long-term arrangement/agreement in which the mining company must apply for access to the minerals and return the lands to a state that can be useful. Noranda is in the process of seeking access to lands earmarked for exploitation 60 years ago.

The project will involve the exploitation of untapped bauxite reserves in close proximity to the proposed Cockpit Country Protected Area. Figure 2 shows the orebodies distributed throughout the proposed lease area. The project will result in the mining of new orebodies and extraction and transportation of high value bauxite to existing loading areas for stockpiling followed by the use of rail facilities for ultimate processing and shipping at already existing and operational processing plants and port facilities. The distribution of ore bodies to be explored and mined over the next five years and the proposed haulage routes are shown in Figure 3 below. In addition, Figure 4 to Figure 8 show examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in SML 173.

The proposed project is concerned with the mining and transportation of bauxite and will consist of:

1. Land clearing for ore access and access road construction
2. The mining of bauxite from the ore bodies
3. The transportation of bauxite to already existing loading areas
4. The reclamation of the mined-out lands

As a result of high oil prices, Jamaica's bauxite alumina industry has been adversely affected for more than 40 years. This has resulted in this major sector of the Jamaican economy either under-performing or performing below capacity and in some instances experiencing closures. For this reason, the country's economic growth development and job creation has been negatively impacted.

Terms of Reference

Conrad Douglas & Associates Limited (CD&A) will work closely with our clients, Noranda Jamaica Bauxite Partners II (Noranda) by providing environmental consultancy services to Noranda, CD&A will work closely with the regulators for the permitting of the project and all other relevant stakeholders. This will among others, involve the preparation of a high-quality EIA report and voluntary and mandatory public consultation processes that addresses all environmental, engineering and project development issues that may be associated with the development of the new SML.

In keeping with the NRCA Act of 1991, Noranda is required to conduct an EIA on the proposed project development and its operations. This includes the land clearing, mining operations, road construction and operation, reclamation and rehabilitation of mined out lands. This terms of reference and EIA will cover all areas of the SML except those area declared under the Forest Act as forest reserves. The EIA will be submitted to the National Environment and Planning Agency (NEPA) and the public, for review and permitting in order to obtain approval for project implementation.

A detailed description of all elements of the project during the pre-operation, construction and operational phases will be prepared. The elements which will be analyzed and assessed include land clearing, mining and transportation and the associated infrastructure and equipment in the terrestrial environment inclusive of air quality. These will be assessed in relation to the bio-physical and socio-cultural baseline and setting, the regulatory framework, impact identification and risks, impact assessment for the natural and built environment, impact mitigation, and environmental monitoring requirements.

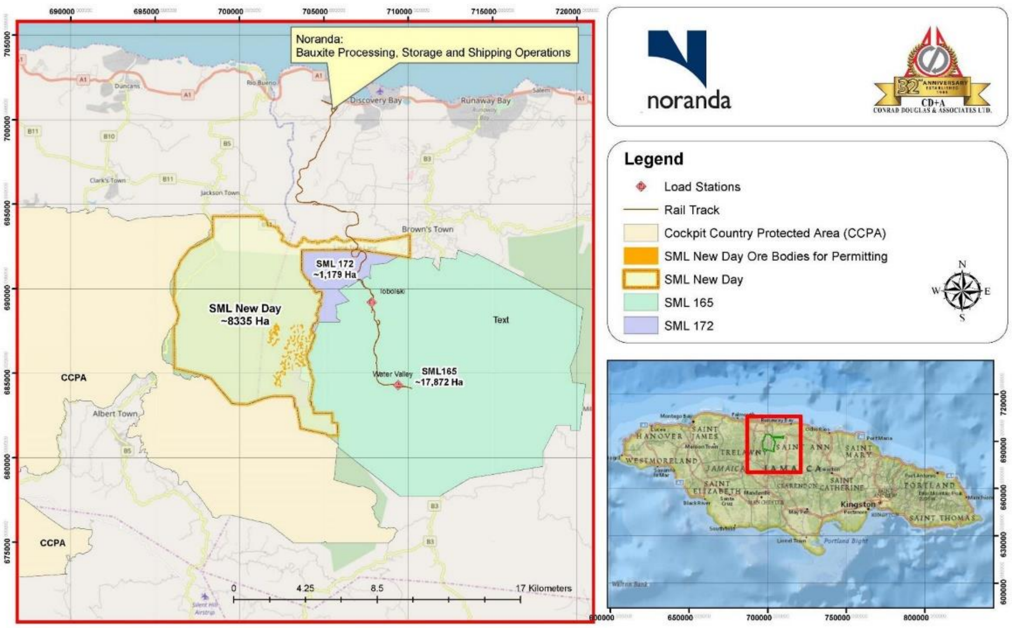

Figure 1: Location of the Proposed Project

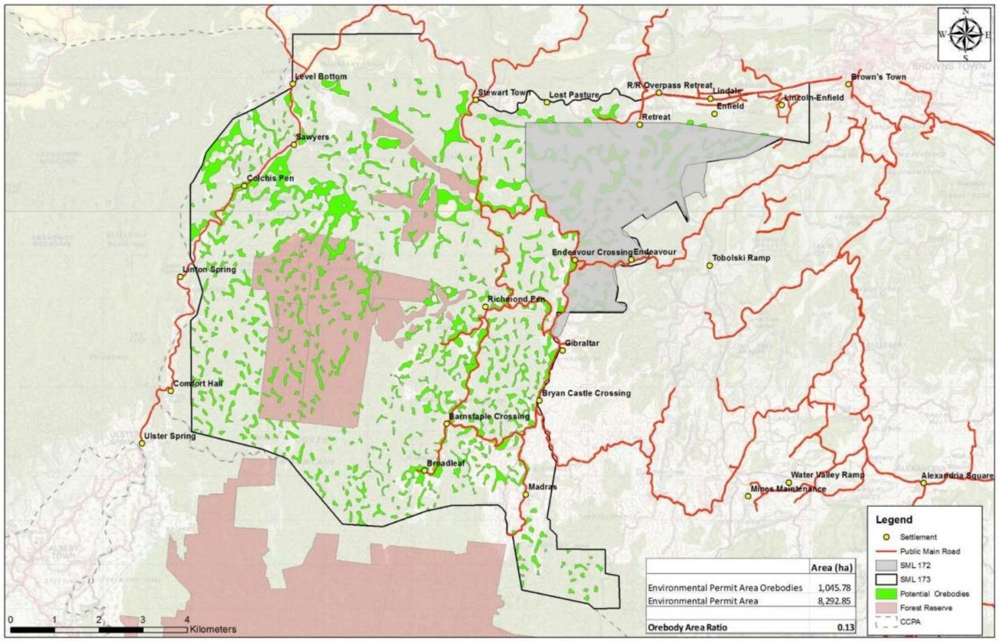

Figure 2: Ore Bodies in the Project Area overlaid on Forest Reserves

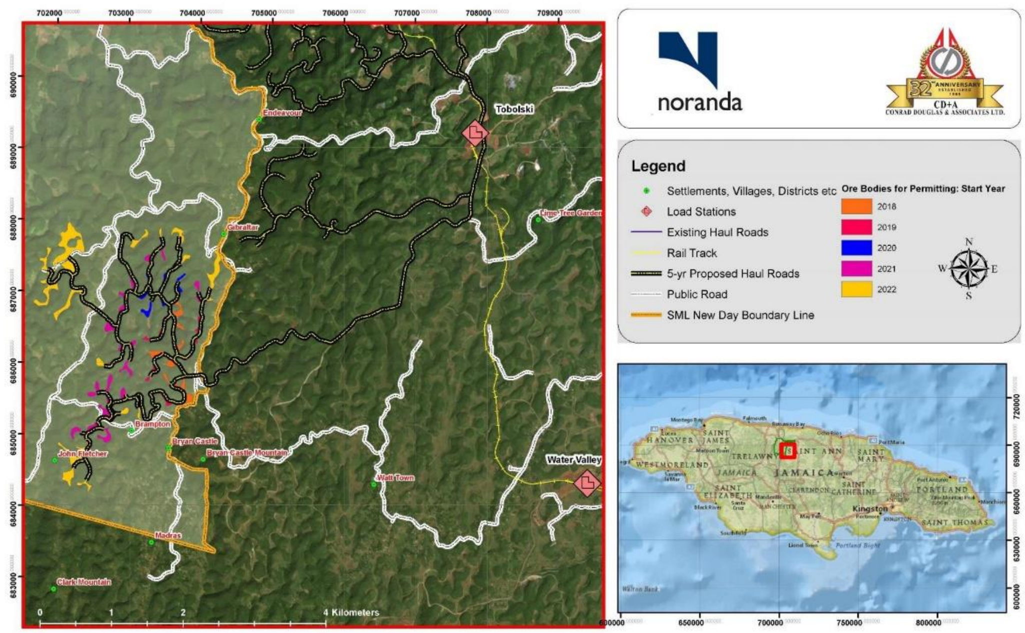

Figure 3: Proposed Ore bodies and Road Network Layout

Figure 4: Examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in SML 173

Figure 5: Examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in SML 173

Figure 6: Examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in SML 173

Figure 7: Examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in the SML 173 (Yam Cultivation Shown)F

Figure 8: Examples of Mode of Occurrence of Karstic Bauxite and Existing Land Use in SML 173 (Yam Cultivation Shown)

2.0. Executive Summary

CD&A will provide a summary of the contents of the EIA report to a maximum of ten pages. The executive summary will provide a comprehensive overview and objectives for the project proposal, natural resources and justification for the project, among others. In addition, it will include relevant background information, project description, and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses, important aspects of the environmental monitoring and management plans and the conclusions of the report.

3.0. Introduction

The Introduction will give a background, which will explain the need for and the context of the project. It will also include:

- 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 & total acreage of the land
- Profile of the project proponent, name and contact address with e-mail, implementing organization and project consultants, among others.
- Noranda will confirm that the project meets the approved Terms of Reference and environmental and planning standards applicable for the project
- Noranda 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.

4.0. Legislation and Regulatory Consideration

CD&A will outline the relevant international and national polices, legislations, regulations and standards 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 analysis of the legislation will look at but not be limited to the following:

1. Natural Resources Conservation Authority Act,
2. The Public Health Act,
3. The Town and Country Planning Act,
4. Mining Act,
5. National Solid Waste Management Act
6. Forest Act
7. Wild Life Protection Act
8. Watersheds Protection Act
9. Water Resources Act
10. Jamaica National Heritage Trust Act,
11. Building Act and Codes and Standards and any Regulations promulgated under any of the previously mentioned Acts, Development Orders and Plans and all appropriate international conventions, protocols and treaties where applicable.

CD&A will describe the traditional land use and advise on any prescriptive rights, including public access rights.

5.0. Project Description

The description will detail the elements of the project, highlighting the activities which will be involved in all the major aspects of the project. Therefore, activities which will be involved in the construction, operation, decommissioning and rehabilitation phases will be addressed. These may include, but are not limited to the following:

- ***Pre-operation***: exploration drilling and trenching; location of stockpiles, general access to site and access to extraction or dig sites, plant and accommodation and administrative office during initial development phase, duration, timing and working hours of the initial phase, drainage assessment and design, method of sewage treatment and disposal, road construction plan and methods to be employed, source(s) of potable water, electricity, solid waste disposal for site operations. Also, the identification of rescue centres/nurseries/centres for relocation of species. Noranda has an established greenhouse/nursery dedicated to the management of relocated sensitive species.

- ***Operation:*** actual mining site, mining rate, mining method, including new methodologies and best practices for mining, and to show how these will minimize the impact on forest cover during and after operations, processing methods, plant, machinery and auxiliary facilities e.g. fuel storage and generators, duration and phasing, nature and quantity of material to be extracted, estimated final depth of mining area, best practices and relevant methodologies according to the locations, storage area(s) (mining material, spoils, overburden or topsoil), dust generation and control (air quality), noise generation and control, drainage control, fuel and other chemical storage, power supply, transportation (internal and external), worker safety, fencing and security and storage and disposal of excess topsoil, waste management of extraneous materials such as rocks and boulders. Also, the identification of rescue centres/nurseries/centres for relocation of species. CD&A will describe, Noranda Partners II state of the art, cutting edge, green practices which support sustainability in its operations, in the EIA.
- ***Decommissioning:*** long term pollution potential and control of water, removal of administrative buildings, plant and machinery, monitoring and management and land use options after closure.
- ***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.

In light of the above, a comprehensive and detailed description of the proposed project will be provided. This section will provide information on the proposed project and will include but not be limited to:

- History and background of the project,
- Type of the project- new, expansion,
- Capacity of the mine and details of ancillary operations,

- Relevance of the project in the light of the existing local and national development plans and policies,
- Description of a project site, level of existing land development, slope, transport and connectivity, demographic aspects, socio, cultural and economic aspects, communities and settlements
- Comprehensive description of the use of existing public and surface infrastructure – road, railway, waterways, water supply and electrical power during construction as well as operational phases within 5 km radius of the target area.
- Type of mineral(s) to be mined.
- 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 land. A list of names and addresses of these land owners will be provided, where available.
- Clearly indicate what is the intended use for the final mined material (i.e. local market distribution and sale versus export and transportation to said destination), including destination.
- Expected project components, i.e. pre-operation, operation, decommissioning and rehabilitation (see above for details).
- Schematic plans, diagrams and drawings.
- A restoration plan highlighting grading and proposed changes in topography, as well as including proposed landscaping.
- Proposed access(es) to the site to be used for pre-construction, construction and operational phases. This description should detail all activities and features which may introduce risks or generate an impact (positive or negative) on the environment including but not limited to deforestation, soil erosion and sedimentation, slope stability and impact on biodiversity.
- Estimated life of the project and planned production rate.
- Details on infrastructure development including design plans for all components of the development including the proposed wastewater/sewage treatment system and disposal of treated effluent will be clearly outlined.

- 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. The details of the drainage for the five year development plan will be supplied in the EIA.
    - Detailed hydrostratographic maps will be used for presentation of these data

- In addition plans for providing utilities, particularly details relating to the source of potable water and electricity generation, roads and other services will be clearly stated.
- Outline Waste Management Plan which estimates expected quantities of construction waste during the construction phase, general waste arising from material consumption of the workforce, as well as, all expected waste during the operational phase will be provided. Details will also be provided for any central disposal area(s) being considered to serve the proposed project.
- 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.
- Details of workforce, including proposals for mobilization and accommodation will be indicated.
- All phases of the project will be clearly defined, the relevant time schedules provided, and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.
- The study area will be delineated and referenced. Taking into account the types of resources located in the area and the magnitude of the associated impacts, the map of the study area will be scaled to effectively illustrate all valued resources that might be significantly affected by the project.

CD&A will discuss the potential for growth or expansion with respect to the area, output or further processing. Associated or ancillary activities or developments will also be discussed. These may include machinery maintenance, haulage enterprises and the final repository of material.

These descriptions will involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate and include information on location, general layout and size, as well as pre-construction, construction, operation, decommissioning and rehabilitation plans. For projects to be done on a phased basis, all phases will be clearly defined and the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included.

Essential maps to be provided with the EIA will include but not be limited to:

- A location map at a scale of 1:12,500 (or an appropriate scale) showing regional setting.
- Site maps illustrating estimated reserves and extent of target area to be mined. It will clearly demarcate the exact location of the proposed project and will clearly identify the areas which will be used for mining, those which will be used for ore transport and those which will be used for the storage and stockpiling of material.
- A site layout plan showing the various components and design elements of the proposed development as well as the spatial allocation for the various design elements of the project.
- A map of the project area and 5 km area from the boundary of the proposed project area, delineating protected areas (forest reserves, heritage sites), parish and county boundaries.
- Land use map of the study area to [1:12,500] scale based on recent satellite imagery and other methods of remote sensing of the project area in proximity to the proposed project boundary delineating, forest area and built-up areas, water bodies, human settlement and other surface features such as railway tracks, ports, airports, roads, and major industries.
- Drainage maps showing the location of all sinkholes, caves, fault zones and other water features identified within the project area.

- Site lay out plan of the proposed development will be submitted to a scale of 1:5000, clearly marking the layout of mine, ancillary operations, roads, railway tracks, administrative and operational buildings, utilities and towns. Boundaries of the proposed port shall be shown therein with latitude and longitude.
- Area drainage contour map of the project area and 2-5 km from the proposed project area will be clearly indicated. In case of any proposed diversion of gully, river or natural drainage features, this will be shown on the map.

6.0. Description of the Environment

This section involves the generation of baseline data which is used to describe the study area as follows:

i. physical environment
ii. biological environment
iii. socio-economic and cultural environment

The methodologies employed to obtain baseline and other data will be clearly detailed in the EIA. Where applicable, the methodologies for analysis will be conducted for both the wet and dry seasons as well as diurnally. This information will form the basis upon which impacts of the project will be assessed.

The following aspects will be described in this section:

6.1. Physical Environment

6.1.1. Land

Topography - Baseline data to be given on description of existing features of the land at the proposed project area including description of slopes, inland topography and drainage features.

Soils – Baseline soil data including type, classification, characteristics, soil properties etc. Results of investigations carried out are to be provided for the project area.

Geology- Baseline data on geotechnical information including rock types, fault planes, and history of any seismic activity and associated hazards will be provided.

Geomorphology –CD&A will investigate the origin and evolution of topographic features created by physical, chemical or biological processes operating within the proposed SML. The special formations and the occurrence of the minerals within the area will be presented and discussed.

All caves and sinkholes will be geo-referenced based on the database to be developed in consultations with the WRA.

Hydrology – The hydrological regime of the proposed project area will be analysed. This will include investigations of storm water run-off, drainage patterns, potential impact on groundwater. Well data will be assessed (if available). The data will be analyzed for wet and dry periods. Available water quality and quantity of any existing rivers, ponds, or streams in the proposed SML will be analyzed for both wet and dry seasons.

Where data exists on percolation tests within the proposed SML, these will be analysed. If data exists, a test will be done in a representative site to validate the analysis.

Meteorological Data - Meteorological data covering the following will be incorporated in the EIA report. The data for at least a 30 - year period will be presented from the nearest meteorological station, except for the history of tropical cyclone event and storm surges for which 100 year data is required. The location of the nearest station will be included as well as an analysis of the relevance of the data obtained from the station. The meteorological parameters that will be considered includes:

i. Wind speed and direction
ii. Rainfall
iii. Relative humidity
iv. Temperature
v. Barometric pressures

Air quality in the area of influence including air emissions (e.g. TSP, PM_{10}, NO_x, SO_x) from stationary or mobile sources, climatic conditions inclusive of wind speed and direction, precipitation, relative humidity and ambient temperatures. (A review of the Natural Resources Conservation Authority Air Quality Regulations and the implications of the regulations on the proposed project will be conducted and ascertained).

Water Quality - parameters that will be measured for water bodies in the proposed SML include, nitrate, total suspended solid, phosphate, feacal coliform and oil and grease.

A baseline data collection exercise will be developed for the Rio Bueno with the consultation of the WRA (as this is outside of the development area). The WRA will provide the list of parameters to be included in the analysis programme as well as the location for sampling. The potential pollutants from Bauxite mining will be identified and may require special petrographic methods for analysis and may include electron microscopy, Xray fluoresce and Xray diffraction. The land use with between the SML 173 and the sampling point will be analysed to determine potential impacts on the sampling site by these activities. The frequency of monitoring will be agreed with the WRA. Evaluation of the baseline analysis data will require taking into account an evaluation of the monitoring data from the entities holding abstraction licenses issued by the WRA on Rio Bueno.

Noise levels of undeveloped site and the ambient noise in the area of influence will be measured. Vibration within the proposed SML will be assessed. There is zero vibration in the SML. CD&A will measure vibration at a point where it is expected that a haul road will be constructed.

6.2. Ecological Services

Baseline data of terrestrial flora and fauna at the project area must be collected and analyzed and will include a ranking of flora and fauna present along with their ecological importance. A statement clearly specifying whether the study area forms a part of an ecologically sensitive area or migratory corridor of any endangered fauna as well as an indication of whether or not any of the ecological services currently being offered by the site will remain or be recovered subsequent to mining must be provided. The data provided will include but not be limited to the following:

- Detailed description of the flora and fauna (terrestrial) present at the mining, reclamation, storage and disposal sites with special emphasis on rare, threatened, endangered, endemic, protected, invasive and economically important species
- Identification and description of the different ecosystem types and structure including species dominance, dependence and diversity, habitat specificity and community structure
- Possible biological loss or habitat fragmentation
- The Forestry Department's data will be used to identify the Forest Reserves within the SML as well as identifying closed broadleaf and disturbed broadleaf forests within the SML.

6.3. Natural Hazards

Vulnerability assessment of the development in relation to the following will be undertaken:

- Hurricanes,
- Earthquakes
- Natural hazard vulnerability assessment will take in account climate change projections.
- Considerations will be given to the creation/effect on microclimate within the proposed SML.

6.4. Biological Environment

CD&A will present a detailed description of the flora and fauna (terrestrial) of the area, with special emphasis on rare, endemic, protected or endangered species. In this section the emphasis is on a description of habitats, flora and fauna surveys inclusive of a species list; commentary on the ecological health, function and value in the project area, threats and conservation significance.

This will include:

- A detailed qualitative and quantitative assessment of terrestrial habitats in and around the proposed project sites and the areas of impact. This will also include flora and fauna surveys and will include species lists.
- 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.
- Species dependence, niche specificity, community structure, population dynamics, species richness and evenness (a measure of diversity) ought to be evaluated.

The field data collected will include, but not be limited to:

- Vegetation profile
- Species lists will be provided for each community
- A habitat map of the area
- Geo-referencing of all rare species identified in the course of the analysis of the proposed SML.
-

6.5. Historical Heritage

An assessment of the archaeological and historical heritage resources in the development area will be conducted in collaboration with the JNHT, taking into account the requirement of the JNHT Act. CD&A will work collaboratively with the JNHT for this assessment and will conduct joint site visits, share data on geomorphology, topography and the biological environment as well as land use survey data inclusive of aerial surveys, to facilitate efficient ground truthing.

The historical heritage resource assessment section will be compiled by the JNHT and will be incorporated in the relevant sections of the Environmental Baseline and Setting, Potential Impact Identification, Mitigation and Monitoring of the EIA by JNHT and CD&A.

6.6. Socio-economic Environment

Demography, regional setting, location assessment and current and potential land-use patterns (of neighbouring properties); description of existing infrastructure such as roadways, utilities (electricity, water and telecommunications), and public health safety; cultural peculiarities, aspirations and attitudes will be explored; and other material assets of the area will also be examined. A socio-economic survey to determine public perception of the project will also be completed and this will include but not be limited to potential impacts on social, aesthetic and historical/cultural values. This assessment will include but not be limited to: present employment and livelihood of these populations, awareness of the population about the proposed activity, information on major economic activities and sources of employment and their income.

Existing economic land use and land tenure will be analysed and discussed in relation to existing legislation, policies and development orders using a combination of secondary and primary data sources.

The historical importance of the area will also be examined including identification of culturally significant features e.g. archaeological finds. While this analysis is being conducted, an assessment of public perception of the proposed development will be conducted and the use, benefit or value of the existing site will be explored and explained. This assessment may vary with community structure and will take various forms such as public meetings or questionnaires.

7.0. Public Participation

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The instrument used to collect the information must be included in the appendix. Survey instruments to be utilized in the study will be approved by the NEPA prior to use. It may be useful and necessary to hold stakeholder meetings to inform the public of the proposed development and the possible impacts. This will also gauge the feelings or response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meetings should be held in accordance with the Guidelines for Conducting Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once the EIA is completed and submitted for consideration in keeping with NEPA's guidelines. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document will be clearly outlined to the public.

8.0. Impact Identification and Assessment and 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 impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts.

Cumulative impacts will also be evaluated taking into account previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental and public health issues should be noted and their relative importance to the design of the project and the intended activities indicated. The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts will then be ranked as major, moderate and minor and presented in separate weighted matrices for all the phases of the project (i.e. pre-construction, construction, operations and decommissioning or closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts. All impacts will be listed, ranked and assessed.

The impacts to be assessed will include but not be limited to the following:

8.1. Physical

In general, for this proposed development, the physical impacts may include the effect on soil and geology (site clearance, storm water runoff, loss of topsoil, potential erosion, change in drainage patterns, flooding risks (as it pertains to the site and the surrounding environs and communities), air, particularly in the context of the potential impact that the proposed development may have on communities such as the potential generation of dust from processing, drilling, transportation, material storage and handling and fly rock from surface workings. Possible contamination of surface and subsurface resources from improper waste disposal or storm water runoff. Loss of character of the area, impact of excavation; material assets and effects of vibration on surface structures as it pertains to the site and the surrounding environs and communities, damage to roads during transportation. The physical impacts will be explored, but not be limited to the following:

- Effects of project design and engineering;
- Impacts of construction activities such as site clearance, earthworks, access routes development on the physical features of the natural environment
- The impact of transportation networks and overburden storage for reuse, spoil disposal on major geological formation, such as sinkholes and caves.
- Impacts of accidental oil and chemical spills
- Impacts on Air Quality

- Impacts on Water Quality (pollution of potable, coastal, surface and ground waters)
- Impact of the loss of forest cover on the area
- Impact of pilferage of forest cover from non-mining areas due to the increased access
- Impacts/demands/requirements of the following must be quantified
    - ✓ Water Supply
    - ✓ 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 solution, and air quality;
- Impacts on visual aesthetics and landscape
- Noise
- Dust
- Vibration
- Change in drainage pattern
- Carrying capacity of the proposed site

8.2. Natural Hazard

Impact of natural hazards including but not limited to hurricanes, earthquakes, landslides and flooding potential.

8.3. Biological

Direct and indirect impact and associated risks on ecology of the terrestrial habitats, where relevant. Emphasis will be placed on any rare, endemic, protected or endangered species loss of biodiversity, loss of ecosystem functions, habitat loss and fragmentation, loss of niches and natural features due to construction and operation. The impact of noise, dust and vibration on floral and faunal species will also be explored.

8.4. Heritage

Loss of and damage to artefacts, archaeological, geological and paleontological features

8.5. Human/Social/Cultural

Effects of mining on the socio-economic status such as changes to public access and recreational use; impacts of the proposed mining activities on existing and potential economic activities; contribution of the development to the national economy and development of surrounding communities should be examined. Socio-economic and cultural impacts to include land use/resource effects, health and safety of the potential workers as well as the residents of the surrounding environs should be described. Public perception as it relates to loss of property value, loss of aesthetic enjoyment, loss of livelihoods among other things should be explored.

8.6. 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.

8.7. Risk Analysis and Risk Assessment

The objective of the Risk Analysis Study is to identify potential credible hazards arising from the operations

CD&A will analyze the risks to the safety of the workers and persons within the sphere of influence related to the projected impacts identified during the studies. This will include: 1) Identifying the hazards 2) and assessing the potential consequences.

9.0. Impact Mitigation

The mitigation measures will endeavour to avoid, reduce and remedy the potential negative effects while at the same time enhancing the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. This will include recommendations for the enhancement of beneficial impacts and quantify and assign financial and economic values to mitigating methods. Green technology should be examined. A statement is to be made on strategies that will be used to conserve energy and water in relation to this project.

9.1.1. Establishment of Buffer Zones

CD&A will use international and local best practices, which have been accepted for the protection of sinkholes and caves in the past, and existing legislations, including recommendations for a 100m setback, to develop and delineate buffer zones for the protection of sensitive features such as caves, sinkholes and heritage sites as applicable.

9.1.2. Restoration and Rehabilitation Plan

This plan will be prepared in a tabular form indicating the extent and quantitative coverage, plant species and timeframe for implementation. The phasing of the forest restoration will be clearly charted indicating the area to be covered and the species. The species selected for reforestation/afforestation will have significant ecological value.

10.0. Residual Impacts

Identify any residual negative impacts that potentially have no solution for mitigation, for example, change in aesthetics and habitat loss.

11.0. Analysis of Alternatives

Alternatives to the proposed project including the no-action alternative will be examined. These will be assessed according to the physical, ecological, climatic variability and socio-economic parameters of the site. This examination of alternatives will incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives will also address specific aspects of the project such as methods, locations, layouts, [costs] and technologies proposed in the execution of the project (works) that have been identified as being causes of major impacts. The scoping exercise for the analysis of alternatives will also include a description of each alternative, summary of adverse impacts of each alternative as well as a rationale for the selected project alternative.

All alternatives will be included in the document.

12.0. Outline Environmental Monitoring and Management

An outline for an environmental monitoring and management plan will be developed which will outline the requirements for construction, operational and decommissioning or closure phases of the project. This will include, but not be limited to training for staff, as well as include recommendations to ensure the implementation of mitigation measures and long-term minimization of negative impacts, compliance reporting and the responsible reporting parties.

A draft environmental monitoring programme will be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. It will also include the technical aspects of monitoring the effectiveness of mitigation measures (including measurement methodologies, data analysis, reporting schedules).

At the minimum the monitoring programme will include:

- Introduction outlining the need for a monitoring programme
- The activity(ies) being monitored and the parameters which will be monitored for each activity or implemented mitigation measure and reference standards.
- The area(s) being monitored (should incorporate a control site), the methodology, analysis and data evaluation to be employed for the monitoring of the various parameters- during construction and operational stages and frequency of sampling and monitoring recommended.

- The name and qualifications of the person(s) proposed to undertake the monitoring programme
- Frequency of monitoring reports to NEPA and other regulatory agencies including the Forestry Department, Water Resources Authority and the Jamaica National Heritage Trust.
- A sample of the report that is to be submitted
- The location of monitoring stations,
- Changes and trends with reference to baseline data and compliance with the stipulated conditions as detailed in the regulatory instruments
- the proposed format that the monitoring reports will take
- the responsible parties for the monitoring
- frequency of compliance audit reports
- responsible parties for preparing the audit report

The Monitoring report will also include, at a minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

The environmental management plan will include, at a minimum:

- Summary of potential impacts & recommended mitigation measures.
- Allocation of resources and responsibilities for plan implementation
- Administrative and technical setup for management of environment
- Institutional arrangements proposed with other organizations and government authorities for effective implementation of environmental measures proposed in the EIA

- Safe guards and mechanism to continue the assumptions and field conditions made in the EIA
- Environmental specifications for contractors should cover the required safeguards during the design and construction stage

13.0. List of References

References will be provided in the EIA.

14.0. Appendices

The appendices will include but not be limited to the following documents:

14.1. Reference documents
14.2. Photographs and maps
14.3. Data Tables
14.4. Glossary of Technical Terms used
14.5. Terms of Reference
14.6. Composition of the consulting team, team that undertook the study and assessment, including name, qualification and roles of team members
14.7. Notes of Public Consultation sessions
14.8. Instruments used in community surveys

15.0. Activities

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which may include:

15.1. Documentation Review

All documentation pertaining to the development will need to be reviewed. These will include, but not limited to, the project profile, site plan, drainage plan, vegetation clearance plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

15.2. Analysis of Alternatives

Alternatives to the site location, project design and operation conditions will be analyzed including the "no-action" alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives. This would clarify, for instance, whether the site could be used for other purposes as well as whether there are any particular aspects of the development that can be sited differently or operated differently.

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 must 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. (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), 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
- **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
- **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*
- **Ms. Jheanelle James, B.Sc. (Geography),** *Socio-economic and Public Consultation Meetings*
- **Jamaica National Heritage Trust** – Historical Heritage Resources
- **Institute of Jamaica, Natural History Division** – Natural Heritage Resources History
- **Environmental Technicians, Socio-economic interviewers, scientific laboratories**

Appendix III: Survey Instrument

Noranda

SURVEY INSTRUMENT

for
NORANDA JAMAICA BAUXITE PARTNERS II
in support of an
ENVIRONMENTAL IMPACT ASSESSMENT
for the proposed
NEW DAY SPECIAL MINING LEASE AREA (SML 173)
TRELAWNY/ST. ANN
administered by
Conrad Douglas and Associates Limited

Community Name	______________________	Community Code	☐☐☐☐☐

Background and Setting

Noranda Jamaica Bauxite Partners II (Noranda), are the applicant, for environmental permits to mine bauxite in the Special Mining Lease (SML 173). The SML 173 extends on either side of the Trelawny and St Ann border for approximately 2 miles in the easterly direction and 3.5 miles in a westerly direction.

It is bounded on the north by the Jackson Town to Browns Town main road and in the south by a line due west from Ulster Spring. Towns such as Ulster Spring, Gibraltar, Stewarts Town, Sawyers are all in close proximity to the boundaries of the SML 173.

Definition of SML: A Special Mining Lease Area (SML) is an area in which the Government of Jamaica (GoJ) has granted a Special Mining Lease of the land. This is based on the GOJ satisfaction that by reason of the difficulties and cost attending the mining in, on or under the area is necessary that such a lease be granted. (*Source: Mining Act 1947*)

SOCIAL IMPACT ASSESSMENT

Section 1: Personal Characteristics

1) Sex: **Male** ☐ **Female** ☐

2) Age Range: **Under 20** ☐ **20-39** ☐ **40-49** ☐ **50-59** ☐ **60 & over** ☐ **Not Stated** ☐

3) How many years have you been living in the community?

Under 20 ☐ **20-39**☐ **40-49** ☐ **50-59** ☐ **60 & over** ☐

Noranda

4) What is your level of educational attainment (at what level did you finish school)?

Primary ☐ Secondary/Junior High☐ Vocational/Skills ☐ Tertiary ☐ None ☐

5) What is your current occupation? ____

Section 2: Community Profile and Perceptions

6) What do you like most about the community? ***(ASK & WAIT FOR RESPONSE)***

Friendly People ☐ Clean Environment ☐ Availability of Farmland ☐ Quiet ☐ No crime/Violence ☐ Other ☐ ____________________

7) What don't you like about the community? (***ASK & WAIT FOR RESPONSE)***

Poor Roads ☐ Lack of Utilities ☐ Crime/Violence ☐ Unemployment☐ Dirty Environment ☐ Other ☐ ______________ **Not stated ☐**

8) 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)***

9) When is traffic the heaviest? **Morning ☐ Afternoon ☐ Night ☐**

10) What type of improvements are needed in your community?

____

11) What are the types of natural hazards that affect your community?

Hurricane ☐ Earthquake ☐ Fire ☐ Drought ☐ Flooding ☐

Section 3: Knowledge and Views on Proposed Special Mining Lease and Bauxite Mining in the SML 173 Area

12) Are you aware that there is a Special Mining Lease (SML) called SML 173 issued to Noranda Jamaica Bauxite Partners II in the area? **Yes ☐ No ☐**

13) If your answer [to the previous question] is yes, how did you hear about it?

Community Representation ☐ Poster/Flyer/Fact Sheet ☐ Word of mouth ☐ Noranda Representative ☐ Consultant ☐ This Survey ☐

Noranda

14) Are you aware that there is a proposal to undertake bauxite mining in the SML 173 area?

Yes ☐ **No** ☐

15) If your answer [to the previous question] is yes, how did you hear about it?

Community Representation ☐ **Poster/Flyer/Fact Sheet** ☐ **Word of mouth** ☐
Noranda Representative ☐ **Consultant** ☐ **This Survey** ☐

16) What effect do you think the proposed activities in or near your area 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** ☐ **Not Stated** ☐

ii. Job Opportunities
Positive ☐ **Negative** ☐ **No Change** ☐ **Don't Know** ☐ **Not Stated** ☐

iii. Pollution
Positive ☐ **Negative** ☐ **No Change** ☐ **Don't Know** ☐ **Not Stated** ☐

17) Which of the following **negative impacts** do you associate with the proposed SML and Bauxite Mining?

Dust Pollution ☐ **Noise Pollution** ☐ **Water Pollution** ☐ **Loss of Income** ☐
Reduced Land Value☐ **Loss of Land Resources** ☐ **Destruction of Farms** ☐
Loss of Water Resources ☐ **Damaged landscape/aesthetics** ☐ **Other**
☐____

18) Which of the following **positive impacts** do you associate with the proposed SML and Bauxite Mining?

Employment ☐ **Improved Economy** ☐ **Increased Land Value** ☐
Support for Community Businesses ☐ **Increased Government Revenue** ☐
Funding for Community Projects ☐ **Other** ☐_________

19) On a scale of 1-5 (***1 being not important and 5 being very important***), how important do you think this project is to national and community development? _________

20) Explain your answer:

____

____

____

Noranda

21) Do you think the proposed SML and Bauxite mining operations will affect you personally?

Yes ☐ **No** ☐ **Not Sure** ☐

22) If yes, explain how

____

____

____

Section 4: Housing & Economic Attributes

23) How many persons make up your household (including yourself)? ______________

24) Who is the head of the household? ________________

25) What is your current employment status?

Full-Time ☐ **Part-Time** ☐ **Self-Employed** ☐ **Other**☐

26) What is your annual income?

Less than $100,000 ☐ **$100,000 - $300,000** ☐ **$300,000 - $500,000**☐

$500,000 - $700,000 ☐ **More than $700,000** ☐ **No Response** ☐

27) 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)** ______________

28) 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 ________________________

29) What is the main source of lighting for your home?

Electricity ☐ Candles ☐ Kerosene Lamp ☐ Other ☐ ______________________

30) Do you currently **Own**☐ **Lease**☐ **Rent**☐ the property on which you live?

31) Do you rely on the areas in close proximity to the proposed SML area for your livelihood? **Yes** ☐ **No** ☐

32) If yes, explain:

What?____

____

How?____

____

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Noranda

When?____

____

Where?____

____

33) Have you or any member of your household ever worked for the Noranda Jamaica Bauxite Partners II or in the bauxite-mining industry? **Yes** ☐ **No**☐ **Not Sure** ☐

34) Are you aware of any programs or activities initiated by the Noranda Jamaica Bauxite Partners II in your community? **Yes** ☐ **No**☐ **Not Sure**☐

35) If yes, explain:

____

____

END OF QUESTIONNAIRE

Name of interviewer: ___________________________

Signature of interviewer: _______________________

Date of interview: ___________________________

Appendix IV: Statement by the Most Honourable Andrew Holness, Prime Minister to Parliament on the Delimitation of the Boundary of the Cockpit Country and the Cockpit Country Protected Area

Statement by the Most Honourable Andrew Holness, Prime Minister to Parliament

on the

Delimitation of the Boundary of the Cockpit Country and the Cockpit Country Protected Area

on

Tuesday, November 21, 2017

Mr. Speaker, for several years, the public has been actively engaged in a robust, constructive discourse on the delimitation of the boundary of the Cockpit Country. Discussions have been ongoing for decades; transcending administrations but Mr. Speaker, the wait is over, today; after extensive consultations and deliberations we are announcing the areas to be designated as the boundary of the Cockpit Country and of the Cockpit Country Protected Area.

Mr. Speaker, let me **start by defining what the Cockpit Country** is and why it is so important? The Cockpit Country is a unique geological feature. The Encyclopaedia of Jamaican Heritage' describes it '… *as steep sided valleys that alternate with conical hillocks to form a peculiar type of terrain known as karst topography. The limestone cannot retain surface water and rain water immediately percolates below ground through cracks and fissures, widening these over millions of years until the pits or valleys are formed. The conical shape of the hills comes from the effect of weathering*…'. Mr. Speaker, as we look at a picture of the Cockpit Country, **Slide showing Picture of the Cockpit Country);** we will notice the characteristic "upside down egg tray carton appearance". I am also showing a picture of other karst formation in Jamaica - **Slide Showing Picture of Other Karst Formation (St. Ann – South of Claremont)**

Mr. Speaker, the Cockpit Country is recognized nationally and internationally for its:

(i) **lush forests**, indeed, I have been advised by the Forestry Department that the Cockpit Country contains 41% of the remaining 7.7% of the island's closed broadleaf or primary forests, that is, 33,418.9 hectares, which play a critical role in the country's ability to adapt to and mitigate against the effects of climate change.

(ii) **rich biodiversity**, it is the habitat for many endemic species of flora and fauna, for example the Giant Swallowtail butterfly (*Pterourus homerus*), the largest Swallowtail butterfly in the western hemisphere, and the yellow snake;

(iii) **fresh water resources**, it is the source of 40% of western Jamaica's exploitable underground water resources; and

(iv) great **historical and cultural significance**

Mr. Speaker, the Cockpit Country has attracted the interests of the Government, academic researchers, environmentalists, community-based organizations and potential investors. Each group of stakeholders has developed comparable, opposing and complementary perspectives. However, there is agreement among stakeholders that the Cockpit Country urgently needs to be managed to ensure its sustainability for generations to come. Mr. Speaker, the Government of Jamaica started taking steps to protect the Cockpit Country by first declaring the Cockpit Country Forest Reserve almost seven decades ago. Mr. Speaker, we have not done enough since that and we cannot afford to wait any longer.

Mr. Speaker, the goal of defining the boundary is to ensure forest conservation, protection of biodiversity, preservation and improvement of traditional livelihoods and the creation of new economic opportunities from heritage, health and wellness tourism and eco-tourism.

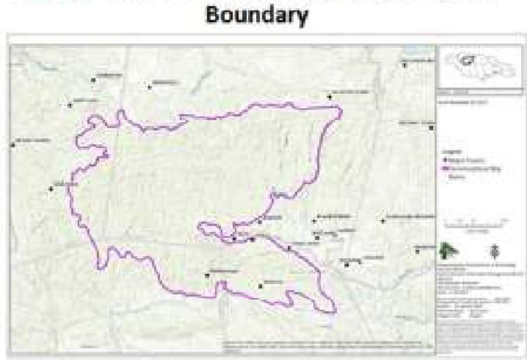
Mr. Speaker, many boundaries have been proposed over the years and each has its own criteria upon which it was defined. While we acknowledge that we may not have consensus about the ideal boundary for the Cockpit Country; we call on all stakeholders to view the Government's decision on the delimitation of the Cockpit Country as well as the area to be protected in a spirit of partnership.

Mr. Speaker, **in deliberations on the boundary of the Cockpit Country; we first sought to establish the scientific basis for defining the area**. As such, we relied on the work of researchers who would have defined the contiguous, karstic geomorphology of the area; which gives the unique conical hillocks and valleys (*the upside down egg tray appearance)*. The University of the West Indies (Mona), under the leadership of Professor Dale Webber, was engaged some years ago to undertake stakeholder consultations on the boundary of the Cockpit Country and make recommendations, accordingly. In its 2013 report, the University recommended that the Cockpit Country comprise three zones, that is, (i) a core which is represented by the contiguous karstic geomorphology of the area; represented by the boundary described by Parris Lyew-Ayee, Jnr 2005 report, (ii) a transition zone, commonly referred to as the National Ecological Gap Assessment Report (NEGAR) Cockpit Add-on Boundary, and (iii) an outer boundary or Cockpit Stakeholders' Group Boundary.

Mr. Speaker, **the Parris Lyew-Ayee Jr. (2005) boundary is being recognized by the Cabinet as the boundary of the Cockpit Country** by the State and is depicted on **Map 1.** This boundary will be declared and gazetted.

Slide Map 1 – Boundary of the Cockpit Country (geomorphological boundary)

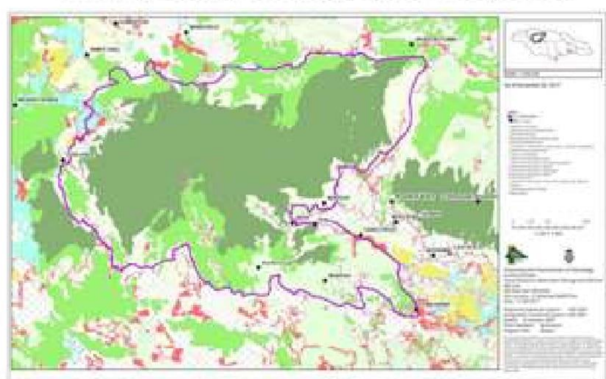
Map 1 - Cockpit Country Geomorphological Boundary



MHPM_Boundary of the Cockpit Country and the Cockpit Country Protected Area Page **4** of **14**
Please check against delivery

Mr. Speaker, while we accepted the sound basis on which this area is defined, however, in looking at the current land use, **(see Slide Map 2 – Land Use - BELOW)** we noted that the area in the vicinity of Manchester North-eastern, between Craighead in the north and Christiana in the south is severely degraded. It is sitting on degraded karst with mainly fields, degraded forest (secondary forest/ruinate), has large settlements and commercial activity. Therefore, Mr. Speaker; we are defining the section of the geomorphological boundary that excludes the above-mentioned area as the "Core Cockpit". **This is depicted on Map 3 (BELOW).**

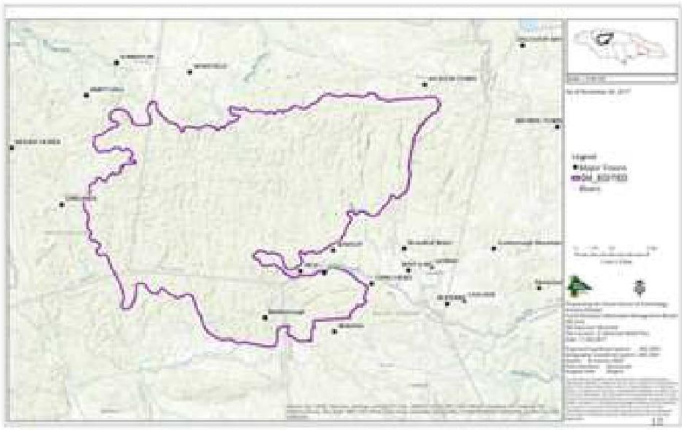
Map 2. Cockpit Country Land Use (2013)



Slide Map 3 – Core Cockpit Country

MHPM_Boundary of the Cockpit Country and the Cockpit Country Protected Area Page **5** of **14**
Please check against delivery

Map 3 - Core Cockpit Country



Mr. Speaker, let me hasten to add that there are other factors that should be taken into account in defining the areas to be protected. Mr. Speaker, we definitely took these factors into account. The Cabinet therefore in determining the boundary took into account:

- the closed broadleaf forest cover/primary forest
- the rich biodiversity
- the hydrology
- important historical, cultural sites

Mr. Speaker, therefore the area to be protected will include existing forest reserves, significant hydrological and ecological features and cultural and heritage sites. This area comprises approximately 74,726 hectares and will be referred to as the Cockpit Country Protected Area and will be protected under specific legislation as advised by the Attorney General.

Slide Map 4a – CCPA Map; Map 4b – CCPA and heritage sites

Map 4a. Cockpit Country Protected Area
(showing constituency boundaries)

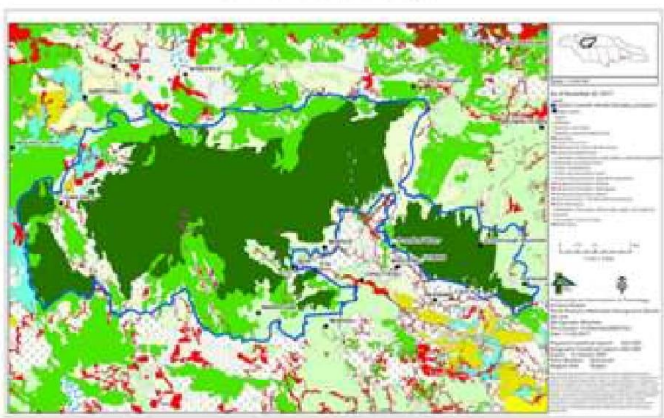
Map 4b. Cockpit Country Protected Area with Hydrological features (caves)

Mr. Speaker, let me look at each in some detail:

In relation to the **hydrological resources**, the Water Resources Authority identified and advised the Cabinet on hydrological features within the environs of the Cockpit Country which required protection. In this regard, caves in the north-east, in the Rio Bueno watershed, and in the north-west have been included in the area to be protected.

Mr. Speaker, with regards to the **forested areas**, the Cabinet has decided to extend the existing Cockpit Country, Litchfield-Matheson's Run and the Fyffe and Rankine Forest Reserves to take in the broadleaf forests which are in close proximity to these areas. These forested areas are depicted on the 2013 Land Use Map. (**see Slide Map 5 – CCPA and Land Use).**

Map 5 - Cockpit Country Protected Area with Landuse (2013)

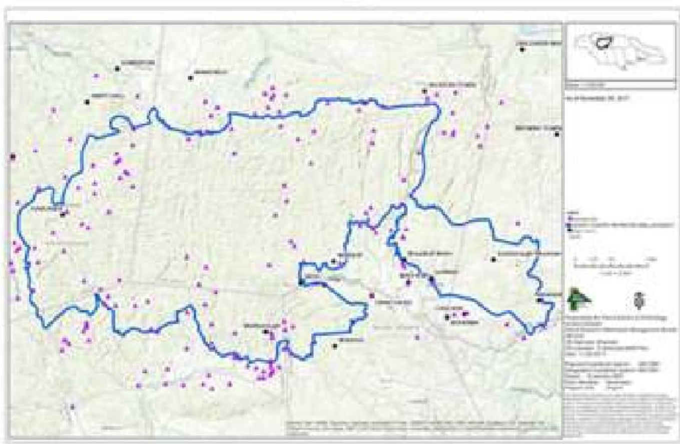


Protection of these forests play an important role in the country's climate change mitigation strategy by serving as a sink for greenhouse gases and will inform the country's Nationally Determined Contributions (NDCs) as well as assist the country in the achievement of the Sustainable Development Goals (SDGs) which reference climate change, life on land, clean water and sanitation.

In relation to the **historical and cultural sites** within the area, the Ministry with responsibility for culture and the Jamaica National Heritage Trust have advised that sufficient safeguards exist under the Jamaica National Heritage Trust Act to protect the cultural and historical sites and artefacts in the area.

(See Slide Map 6 – Historical and Cultural Sites).

Map 6 - Cockpit Country Protected Area and Heritage sites



Mr. Speaker, we have gone further to request the portfolio Ministry with responsibility for culture to fast track the identification of other important cultural/historical sites and artefacts in the area with a view to protecting them under the law. In addition, the Ministry has been asked to seek the nomination of the Cockpit Country Protected Area as a World Heritage site under UNESCO.

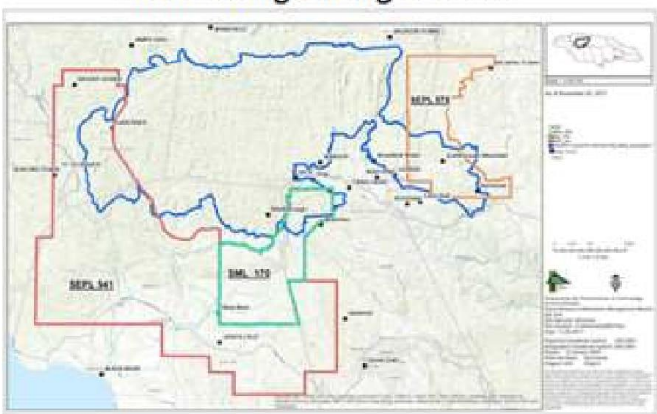
Mr. Speaker, we are therefore protecting the "Core Cockpit" i.e. the areas that have not been degraded and occupied by irreversible human activities as well as the forests flora and fauna that subsists on the core and contiguous or surround the

Mr. Speaker, to ensure the effective management of the Cockpit Country Protected Area and in recognition of the rights of private landowners, the Government intends to continue to partner with private landowners, local groups and other stakeholders, including the Accompong Maroons, in the development of a **comprehensive management plan** for the area. Implementation of this Plan will require dedicated resources from the national budget as well as donor support. This Management Plan will be subject to Cabinet approval; following which it will be tabled in Parliament.

Mr. Speaker, I would like to take this opportunity to encourage private landowners with forest, within the environs of the Cockpit Country to take advantage of the incentive of remission of property tax, provided in the Forest Act by declaring these forested lands as forest reserves or forest management areas.

Mr. Speaker, one of the major points of discussion over the Cockpit Country has been the issue of mining. Mr. Speaker, the Government is declaring that **no mining will be permitted in the Cockpit Country Protected Area.** In this regard, the Mining Act and any existing mining licences will be amended to close these areas to mining. The Government is of the view that this area is too valuable in terms of its ecological and hydrological importance and uniqueness to allow mining which may result in permanent and irreversible harm and deprive future generations of the benefit of this national asset. Mr. Speaker, while we will forgo the exploitation of millions of tonnes of high grade bauxite and limestone with potential earnings of billions of United States dollars; we cannot put a price tag on the loss to our water resources and biodiversity. **(See Slide Map 7 – Existing Mining Licences)**

Map 7 - Cockpit Country Protected Area with Existing Mining Licences



Mr. Speaker, please note that a detailed description of the boundary of the **Cockpit Country** and the **Cockpit Country Protected Area** as recognized by the State will be provided by the Forestry Department after consultations with the relevant public sector agencies and the necessary *'ground truthing' (a term used in various fields to refer to information provided by direct observation (i.e. empirical evidence)* as opposed to information provided by inference. has been undertaken.

Mr. Speaker, we cannot also deny that there are substantial mineral deposits located outside the declared boundary of the Cockpit Country which are exploitable. However, the Cabinet mandated that major development activities within the environs of the Cockpit Country will be subject to a rigorous process of decision-making including approval by Cabinet; taking into account the provisions of the relevant legislation, including the Jamaica National Heritage Trust Act, the he Water Resources Act, the Forest Act, the Natural Resources

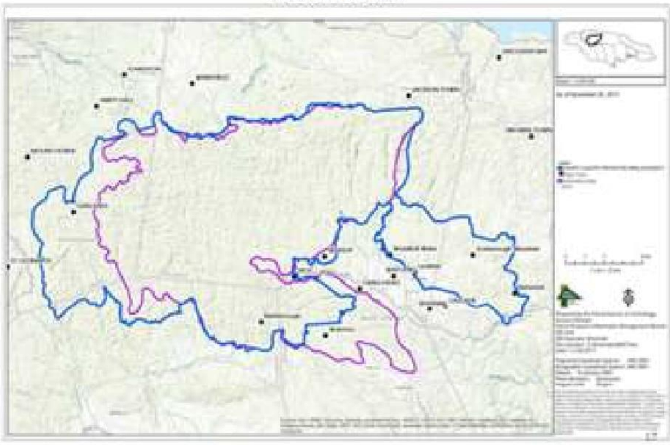
Conservation Authority Act, the Wildlife Protection Act, the Endangered Species Act and the Mining Act, prior to any decision being made. In addition, the relevant public authorities have been mandated to increase their enforcement activities within the Cockpit Country Protected Area and its environs to minimize, and ultimately eliminate, those activities that may pose a threat to the natural resources within the area, including charcoal and yam stick production, open burning, introduction of non-native species, disruption of cave ecosystems, hunting, poaching, and over-collecting of specific species. Mr. Speaker, while we will have designated protected areas; the relevant public sector agencies, including the Natural Resources Conservation Authority, as per their respective legal mandates are required to protect and conserve the natural resources within the country's jurisdiction.

Mr. Speaker, the extension services of the Ministry of Industry, Commerce, Agriculture and Fisheries have been asked to work with subsistence farmers in the Cockpit Country and its environs to ensure that best farming practices are applied in order to minimize any adverse impacts on this ecologically and hydrologically sensitive area.

The delimitation of the boundary of the Cockpit Country has long been awaited. I would like to thank every single person who contributed to the discussions. I note the interest and vigilance in ensuring that this matter is finalized. In arriving at this decision, the Government has shown its commitment to preserve this unique national treasure for the benefit of present and future generations of Jamaicans and visitors alike.

[Slides 17 and 18 – Map 8 – Boundaries of Cockpit Country and CCPA; Map 9 – Core Cockpit Country and CCPA]

Map 8. Boundaries of Cockpit Country and CCPA



Map 9. Core Cockpit Country and Cockpit Country Protected Area

Mr. Speaker, we believe that the boundary of the Cockpit Country, as I have announced today, is the one that best embraces and reflects the unique characteristics of the area. Mr. Speaker, we acknowledge that there may be differing views; however, in a true spirit of partnership to ensure that our current

MHPM_Boundary of the Cockpit Country and the Cockpit Country Protected Area Page **13** of **14**
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actions secure the future for the generations to come; we look forward to the renewed sense of responsibility and continued active participation in the sustainability of Jamaica, land we love.

Appendix V: Land Description – Volume and Folio Number and Total Acreage

Volume and Folio Number	Acres
	14.128
101/2 134/48	40.254
101/2 134/48	4.559
101/2 134/48	17.418
	1.353
	0.886
1101/136	2.121
	18.316
	11.589
1113/792	1.036
	3.856
637/121	1.584
	3.496
	1.939
712/58	1.927
564/14	3.681
	2.912
	0.859
	0.485
717/139	0.608
717/139	1.989
	0.792
	3.045
647/19	1.750
647/19	0.418
647/19	0.378
431/61	4.825
669/44	5.016
728/75	10.933
712/48	3.437
984/257	9.910
793/39	7.402
389/29	8.907
362/74	2.836
637/24	8.205
	28.474
	0.391
	35.308
	46.076

Volume and Folio Number	Acres
538/45	1.505
945/45	0.450
425/3	1.203
1138/768	20.860
1147/240	14.831
1196/760	1.853
1143/46	9.266
134/48	7.274
1095/534	6.610
662/46	17.168
	3.457
1004/668	4.114
988/518	5.319
	9.566
	8.407
	7.701
978/131	8.276
	11.701
150/38	4.716
642/11	30.417
973/11	4.233
975/377	18.950
	8.229
996/197	0.928
946/246	26.985
	37.029
	3.597
	7.177
	0.709
	5.378
	1.051
	3.172
	0.652
	0.255
	0.486
	0.601
1028/546	179.492
662/46	15.142
	7.203
	2.498
537/20	1.374

Volume and Folio Number	Acres
366/59	0.854
552/49	1.218
407/98	1.379
407/98	0.828
	0.944
	1.232
	0.167
422/69	1.000
	0.910
422/70	0.855
1042/334	7.375
976/32	2.499
	19.175
714/96	4.531
637/31	3.261
562/80	11.616
637/47	3.166
718/112	2.774
716/58	2.903
711/131	2.645
634/93	2.812
975/503	5.450
637/34	2.779
1012/671	3.988
	8.787
	3.532
726/132	4.684
717/140	3.323
	4.596
	8.675
714/98	6.574
726/102	5.616
637/45	4.096
637/42	7.747
524/17	5.053
643/8	2.620
413/79	16.781
944/452	2.377
944/451	7.624
956/529	26.908
956/529	15.879

Volume and Folio Number	Acres
409/29	0.606
	0.447
1134/436	5.191
	3.820
980/555	0.653
	5.096
	0.739
	1.249
	1.000
506/82	135.232
150/38	103.590
988/518	20.503
	2.567
	40.106
938/200	14.110
533/40	8.361
150/38	4.382
643/76	10.647
1026/254	2.151
	17.674
1150/857	8.340
	9.160
1035/396	16.317
392/50 & 999/47	13.544
476/13	21.371
	33.068
	15.341
	18.364
1420/128	100.439
534/72	9.531
744/94	23.836
662/46	397.637
810/21	16.188
826/74	5.944
	0.976
987/413	1.230
1054/328	0.814
952/531	3.861
822/28	4.245
994/29	28.946
792/92	2.363

Volume and Folio Number	Acres
990/523	202.762
	4.857
	43.639
	0.616
	0.574
1010/84	2.171
	0.238
	36.238
62/37	21.383
	0.644
	3.406
1096/506	10.677
	1.185
	0.618
990/525	77.508
542/80	9.366
	0.928
	0.702
	2.070
	2.007
	1.879
	1.397
	0.488
	2.222
	1.295
	0.681
	3.110
	7.411
	2.154
	5.205
	0.566
	0.587
	1.983
	1.743
	3.494
	6.699
267/33	5.792
267/841	25.256
	19.162
1135/966	16.357
	1.472

Volume and Folio Number	Acres
	3.300
	1.488
	6.070
	1.393
	0.864
	0.421
	1.248
	0.844
	2.543
	1.056
	2.281
	0.270
	0.308
	0.895
	8.381
	2.664
986/492	10.266
1143/341	6.827
1083/600	1.854
987/4	6.048
	1.917
	3.963
	1.393
980/639	5.427
989/613	4.389
1097/35	7.203
1012/387	6.858
1002/54	7.099
	3.827
967/351	3.109
	7.554
	2.899
	26.186
	1.106
	1.387
1001/660	5.678
	1.689
	26.553
	0.633
	3.275
	1.764

Volume and Folio Number	Acres
	22.952
	3.488
	1.286
1025/82	16.067
	2.215
	10.096
	1.856
	1.011
	1.011
	2.804
	3.435
999/67	1.086
	7.082
1140/843	0.558
	0.000
1003/355	53.787
	3.341
984/141	1.320
	1.074
1004/384	0.600
	4.125
	1.539
	9.867
	4.028
	4.606
	15.998
	6.233
	43.559
	1.066
	0.590
	0.871
	0.443
	0.305
	0.618
	1.091
	0.707
	1.091
	2.241
	1.054
	0.997
	0.786

Volume and Folio Number	Acres
	1.200
	0.607
	0.933
	1.879
	2.278
	0.614
	1.874
	2.985
	1.302
	2.757
	0.628
	0.984
	0.815
	0.680
	0.743
	0.674
	0.672
	1.148
	0.959
	0.213
	0.344
	0.136
	0.285
	1.363
	28.915
1062/997	1.212
433/28	1.836
	3.266
	3.442
399/33	1.603
398/73	1.513
405/31	1.650
576/85	7.739
405/31	2.021
436/49	1.892
436/49	0.830
541/43	13.678
788/58	16.209
830/31	4.571
538/44 & 987/210	7.387
524/12	9.231

Volume and Folio Number	Acres
964/2	3.704
591/70	1.751
739/40	11.160
	2.765
481/28	3.889
956/23	13.821
538/47	9.528
425/3	39.633
944/446	7.301
830/49	27.615
583/6	28.794
748/97	8.401
664/100	15.808
699/48	12.984
944/442	9.917
524/18	9.210
773/5	8.716
830/30	7.043
773/6	4.356
434/66	10.776
944/441	11.837
956/17	12.896
	5.779
	3.084
	5.917
717/138	6.336
	5.699
715/100	7.376
723/103	4.583
564/15	1.467
709/29	1.197
709/30	3.462
1020/362	3.235
724/62	3.267
221/112	3.146
	2.387
666/89	4.489
	3.309
637/41	4.071
	4.353
	4.240

Volume and Folio Number	Acres
610/24	1.324
610/26	1.758
610/17	0.814
610/25	1.755
413/63	10.504
944/21	7.319
944/20	5.015
956/520	11.086
830/32	10.912
610/19	8.745
571/72	8.460
524/18	5.574
956/519	7.238
	4.489
425/7	14.594
610/18	5.776
481/27	3.691
944/445	11.438
413/83	15.121
747/40	20.761
814/2	9.465
944/456	11.918
402/68	5.842
610/11	4.089
397/25	2.507
397/25	10.942
	2.110
	2.826
552/49	3.508
	0.990
	0.538
	6.734
990/552	9.012
	8.242
	2.066
1045/189	2.307
1014/392	5.317
986/319	3.036
	1.004
990/300	2.283
	3.416

Volume and Folio Number	Acres
	0.821
956/527	15.370
956/521	7.076
	11.497
944/444	7.513
956/522	18.519
577/45	26.175
	58.275
723/119	4.292
1006/109	3.258
1008/235	1.482
994/514	1.322
797/41	19.322
	2.044
	1.506
1026/659	3.849
797/41	9.147
	5.161
	0.567
	0.128
	0.259
	0.266
	0.490
	0.796
644/94	328.136
666/4	759.027
1185/613	39.140
194/14	75.444
	1630.786
	6.465
	13.949
1073/402	743.515
853/53 913/54	592.646
	12.496
101/2 134/48	96.950
	19.544
1096/250	16.821
101/2	16.671
1003/356	30.686
1096/249	23.880
1095/533	8.014

Volume and Folio Number	Acres
1003/354	19.485
	29.569
1003/353	64.253
	10.856
	2.261
	1.276
	3.428
	3.530
	6.646
	2.653
	0.785
1062/997	0.610
643/16	6.906
436/47	20.351
610/22	5.164
571/73	7.191
436/51	6.853
552/49	0.710
434/86	0.545
595/58	0.773
595/58	0.907
595/58	1.472
571/74	2.094
398/55	1.510
678/98	1.545
678/97	1.331
407/3	1.349
407/2	2.570
944/440	5.352
425/4	6.988
425/4	3.214
425/4	4.454
397/27	1.503
394/28	1.155
397/26	1.409
397/26	1.246
944/440	0.805
944/454	1.287
425/4	1.772
425/5	1.008
541/43	4.485

Volume and Folio Number	Acres
434/87	1.917
1003/625	2.223
	1.146
944/464	1.282
944/463	1.364
944/456	2.579
413/32	1.237
402/7	2.133
625/29	1.448
945/47	4.091
945/49	2.632
538/45	4.123
945/46	2.439
945/45	1.415
425/3	3.753
433/28	1.096
433/27	1.204
405/30	1.116
608/63	1.177
608/64	2.132
597/21	1.881
391/87	1.606
413/32	1.670
413/32	2.375
402/6	1.897
944/462	2.813
944/461	2.900
944/460	4.333
944/459	3.535
944/458	2.961
944/457	2.682
552/47	2.870
610/20	6.599
481/29	3.148
422/93	5.071
610/10	5.648
945/42	5.042
434/67	7.170
945/43	14.871
538/46	8.135
956/515	16.523

Volume and Folio Number	Acres
956/514	6.886
610/23	5.927
576/83	6.598
830/33	12.739
830/33	7.475
434/47	3.693
381/81	4.941
876/11	9.141
945/34	5.162
944/447	9.645
576/81	12.974
956/526	16.577
436/50	8.524
422/67	2.991
945/33	6.123
583/11	6.930
605/86	7.591
422/95	27.116
643/15	5.832
648/40	7.476
436/52	11.138
945/35	10.829
655/46	3.695
324/52	33.651
324/52	3.258
324/53	4.747
	13.362
597/18	7.982
524/13	16.135
324/52	11.625
643/19	5.715
697/94	14.271
945/36	5.322
	6.655
610/27	1.154
	1.886
773/7	5.419
398/72	1.828
368/34	13.929
948/201	21.131
944/448	11.643

Volume and Folio Number	Acres
552/46	5.381
956/525	16.583
903/56	20.090
956/524	18.419
583/9	22.141
814/3	6.507
608/62	7.980
956/18	20.277
956/16	7.762
944/440	21.853
655/50	9.297
944/439	7.637
408/12	10.445
	3.927
	1.245
583/7	1.632
324/52	1.624
771/5	0.503
	0.000
422/92	9.429
481/26	8.543
945/48	11.297
583/10	4.812
	5.448
478/67	6.438
621/6	4.790
945/44	2.088
	0.001
422/71	9.834
577/57	12.872
524/16	4.406
422/68	8.237
422/94	9.067
576/86	2.780
436/48	5.193
	1.416
	0.166
	0.176
	0.187
1085/794	2.662
	2.717

Volume and Folio Number	Acres
	10.401
	4.789
	0.915
	0.375
	1.229
	0.745
977/485	3.761
	10.441
	68.920
	2.031
637/40	3.490
560/83	4.419
714/99	3.244
723/7	6.526
713/84	3.090
864/61	2.661
1026/430	3.330
1004/196	3.109
1009/265	2.438
659/78	2.891
709/111	2.786
637/49	6.494
631/19	2.416
637/39	4.886
	38.050
934/95	5.670
	5.125
637/38	4.948
	4.702
	3.402
1208/478	4.219
726/6	4.562
631/13	3.619
631/18	3.594
	5.807
	3.368
631/20	3.093
	8.627
637/121	2.554
634/88	4.414
717/142	4.099

Volume and Folio Number	Acres
	7.197
716/57	1.571
993/521	3.600
	1.884
1076/347	4.321
	5.135
1151/693	2.913
706/134	3.076
864/60	3.308
	2.927
558/50	2.460
998/555	0.904
631/15	1.208
1165/943	8.614
995/348	2.900
	3.429
	1.015
	0.983
	1.410
	1.054
714/97	3.504
	0.953
	1.330
	0.478
	0.522
	1.764
719/113	3.478
	2.814
	0.712
	12.448
	3.300
	8.572
638/30	2.334
	5.263
	2.342
724/64	3.177
	4.288
721/12	4.554
714/73	2.606
724/63	2.612
563/12	3.376

Volume and Folio Number	Acres
	18.992
	3.591
	3.900
	3.169
	13.770
	2.484
	14.433
	7.160
549/145	10.532
717/136	14.130
	7.898
	3.380
466/104	3.424
547/82	3.616
	2.494
637/35	3.362
1056/650	3.603
	2.573
504/16	2.736
709/32	2.604
634/90	3.415
	3.446
724/65	3.384
706/133	3.421
	3.049
713/122	2.638
	4.795
	4.354
939/413	3.930
712/71	5.925
	3.459
	3.061
	5.779
864/43	4.033
	3.381
560/13	4.251
865/68	3.811
1395/289	3.373
853/32	3.070
722/19	2.634
	10.975

Volume and Folio Number	Acres
	3.267
634/93	3.082
	5.754
	5.616
722/92	3.764
709/28	3.770
	3.290
563/15	2.225
709/31	2.195
	2.985
547/12	3.678
	6.433
	5.413
	4.460
	3.738
705/89	4.117
	3.265
982/484	2.986
	2.916
	3.564
712/70	2.523
709/33	3.185
637/30	3.489
1004/651	3.679
564/13	2.883
661/41	6.491
	3.333
	3.253
	8.787
563/13	5.614
504/89	3.796
	3.381
	6.247
	9.201
	3.943
504/89	2.470
	2.682
717/137	5.777
	2.582
	3.638
713/74	3.665

Volume and Folio Number	Acres
637/28	5.479
	2.398
635/88	3.076
854/26	3.037
718/116	3.688
547/15	3.285
722/40	2.272
	4.788
	3.792
716/59	2.473
	4.174
	15.014
	3.721
	7.731
	145.986
	6.657
631/17	2.761
854/27	2.460
	6.674
	3.083
	7.824
	6.152
	2.058
855/43	7.381
637/37	6.633
934/167	3.925
	5.570
564/23	2.947
996/384	3.861
634/91	4.044
	3.084
713/85	16.450
	11.303
	3.820
	3.276
637/48	3.533
	1.965
	6.193
	8.109
956/528	8.836
956/528	3.045

Volume and Folio Number	Acres
944/450	4.226
944/450	4.120
	9.260
	3.630
1127/548	1.865
	0.879
	0.234
	5.250
1003/138	11.159
992/645	5.511
	13.945
826/73	5.873
150/38	7.970
63/76	134.917
431/63	4.996
346/94	20.668
548/99	6.161
325/85	15.767
	5.103
361/149	8.009
325/89	3.439
729/144	3.557
	6.777
882/66	0.763
361/149	10.379
431/37	5.634
865/41	6.372
361/19	5.843
1339/315	5.847
445/50	5.630
361/36	5.375
501/113	13.502
445/51	4.560
	5.372
431/39	5.308
431/38	4.847
418/11	1.697
325/89	4.747
389/41	10.623
500/110	8.357
431/40	5.286

Volume and Folio Number	Acres
1495/627	3.368
	3.408
	8.328
	0.534
	1.036
	0.001
986/498	2.267
986/498	2.725
	2.632
	3.708
	1.137
	5.421
990/179	1.780
	2.244
1493/119	2.009
666/4	44.868
	1.013
	191.666
1419/453	10.765
1042/593	24.654
990/523	29.212
1054/328	0.561
826/73	1.531
1131/813	0.717
	6.781
	8.362
	10.144
637/27	20.029
362/80	3.912
361/7	15.789
432/9	9.726
304/36	10.864
	6.652
361/8	11.141
	0.415
325/86	13.239
988/221	7.138
854/45	18.767
987/411	15.299
856/25	7.225
499/140	11.355

Volume and Folio Number	Acres
	10.581
619/33	496.212
	68.000
	6.664
1099/592	24.706
	8.421
1003/654	1.225
	2.950
1003/405	8.679
990/523	75.848
	0.516
	0.092
	0.494
	0.691
	5.986
	2.155
	0.405
	0.585
	0.565
	1.331
	4.829
	0.454
	0.908
	1.282
	0.929
	0.491
	0.669
	3.038
	0.517
	1.523
	1.998
	0.310
	1.066
	7.400
	0.824
	0.172
	1.975
	0.387
	0.627
	1.860
	0.010

Volume and Folio Number	Acres
	9.257
	0.548
	0.545
	0.563
	6.872
	0.812
	0.313
	0.444
	0.354
	0.664
	0.579
	0.431
	6.599
	0.604
	13.551
	15.523
	1.790
	3.510
	3.132
	14.065
	0.947
	0.470
	4.596
	2.820
	0.739
	4.197
	1.612
	1.274
	1.062
	0.881
	8.180
	5.506
	0.085
	3.089
	1.283
	1.619
	0.172
	7.521
	0.441
	1.610
	1.154

Volume and Folio Number	Acres
	0.204
	1.510
	2.686
	1.476
	0.577
	1.004
	0.163
	0.420
	0.348
	0.461
	0.614
	0.617
	5.139
	4.235
	0.448
	0.319
	1.540
	0.576
	0.208
	0.311
	0.594
	0.834
	0.565
	0.377
	0.539
	0.327
	0.599
	0.981
	0.730
	0.979
	0.430
	0.533
	2.308
	0.400
	1.046
	4.315
101/2 134/48	150.911
	3.405
101/2 134/48	179.921
	0.554
	0.650

Volume and Folio Number	Acres
	5.995
	3.853
	0.899
	1.623
	7.030
	4.470
	3.005
	4.374
	4.207
	4.716
	5.750
	3.015
	6.968
	11.153
	9.266
	5.096
	5.556
	4.661
	5.274
	4.862
	6.574
	5.488
	5.549
	5.063
	2.972
	4.582
	4.995
	5.483
	4.605
	5.089
	5.153
	5.574
	7.482
	6.097
	4.096
	4.033
	4.181
	9.248
	5.210
	5.044
	5.626

Volume and Folio Number	Acres
	5.747
101/2 134/48	11.140
101/2 134/48	19.368
1003/138	11.159
992/645	5.511
	13.945
	40.417
	3.114
	42.856
	11.283
	5.641
	18.978
	13.717
	33.667
	20.970
	11.096
	8.977
	17.734
	19.311
	15.416
	12.584
	85.633
	5.644
	4.189
	8.360
	4.788
	10.407
	8.792
	22.088
	21.191
	7.119
	4.952
	17.598
	1.308
	1.554
	1.178
	7.126
	4.807
	6.081
	3.897
	1.964

Volume and Folio Number	Acres
	2.174
	3.732
	6.952
	4.084
	4.114
	2.382
	1.765
	1.282
	2.558
	33.025
	0.879
	0.854
	1.207
	0.724
	0.479
	0.867
	0.692
	3.139
	0.611
	19.067
	3.843
	3.434
	5.743
	2.216
	17.770
	5.179
	23.594
	9.059
	11.180
	11.952
	6.467
	0.413
	0.637
	4.696
	2.009
	5.101
	6.081
	3.101
1003/138	9.036
	29.593
	2.249

Volume and Folio Number	Acres
	28.895
	6.079
	10.635
1002/53	15.400
	5.400
	27.424
	4.381
992/645	4.191
	9.276
	5.842
	18.274
	7.443
	13.751
	3.017
	0.057
	0.000
	0.041
	198.611
	2.046
	6.062
	1.694
	3.030
	1.287
	7.853
	2.495
1006/572	0.996
	16.759
	10.047
	14.389
	2.102
1128/638	3.653
	1.842
	0.765
	3.573
	0.001
	0.000
	0.000
	0.001
	0.000
	0.002
	0.000

Volume and Folio Number	Acres
	187.818
945/48	2.877
538/44 & 987/210	0.557
	0.000
	1.758
	0.002
	0.487
	0.000
	0.633
	0.000
	0.442
	58.625
	0.002
1073/402	8.028
1073/402	281.057
1073/402	19.078
1073/402	12.692
	0.600
	0.203
	0.308
	0.274
	0.899
	0.287
	1.703
	1.573
	0.070
1073/402	280.824
	0.399
	0.288
	0.059
	0.049
	0.000
	0.000
	0.001
1137/822	5.197
	6.134
	2.340
	0.849
	0.658
	0.524
	0.344

Volume and Folio Number	Acres
	1.368
	0.086
	0.465
	2.327
1004/535	1.969
	2.545
	2.017
1004/532	2.637
	4.361
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	0.000
	26.553
	26.553
	0.825
	187.818
	3.271

Appendix VI: The Wild Life Protection (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*

2

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 VII: Jamaica Gazettes for the Estates in the SML 173 supplied by the Forestry Department – Highlighted in Red Box

The Jamaica Gazettes below for the estates in SML 173, supplied by the Forestry Department, illustrates the boundaries of the Forest Reserves as printed between 1950 and 1964. It was made clear by the Forestry Department at the beginning of the EIA & Permitting process that bauxite mining will not be permitted in the Forest Reserves.

FIRST SCHEDULE

DISCOVERY FOREST RESERVE

All that parcel of Crown Lands known as Discovery Mountain, formerly known as Nightingale Grove situate in the parish of Trelawny and containing by estimation 368 acres more or less butting

Northerly on Unity Hall and Vale Royal Mountain, called Mount Plenty
Easterly on Hyde Hall Mountain or Cedar Spring
Southerly on part of the same land in the possession of small settlers
Westerly on Cedar Hill

or however otherwise the same may be butted, bounded, known, distinguished or described.

DOLPHIN HEAD FOREST RESERVE

Bath Mountain Block (Block A)

All that parcel of Crown Land known as Dolphin Head situate in the parish of Westmoreland containing by estimation 300 acres more or less butting

Northerly on Quasheba Mountain
Easterly on Quasheba Mountain and Midgham Pen
Southerly on Blackness and Bulstrode
Westerly on Geneva Mount

or however otherwise the same may be butted, bounded, known, distinguished or described.

Baulk Pen Block (Block B)

All that parcel of Crown Lands known as Baulk Pen situate in the parishes of Hanover and Westmoreland and containing by estimation 265½ acres more or less butting

Northerly on Retirement in the possession of S. W. Aguilar and on the remainder of the same lands in the possession of small settlers
Easterly on Belle Isle Mountain (formerly known as James Watkins Patent) in the possession of West India Sugar Co. and on Mount Cromwell Pen in the possession of M. H. Segree
Southerly on Mount Cromwell Pen in the possession of M. H. Segree
Westerly on Glasgow Estate in the possession of P. Meany

or however otherwise the same may be butted, bounded, known, distinguished or described.

BURNT SAVANAH FOREST RESERVE

Block A

All that parcel of Crown Land known as Burnt Savanah situate in the parish of Westmoreland and containing by estimation 97 acres more or less butting

Northerly on Fontabelle Mountain
Westerly on Coote Mountain
Southerly on Burnt Savanah Land Settlement
Easterly on James Virgo Dunn Patent

or however, otherwise the same may be butted, bounded, known, distinguished or described.

Block B

All that parcel of Crown Land known as part of Burnt Savanah and formerly in the possession of Maria Johnson situate in the parish of Westmoreland and containing by estimation 100 acres more or less butting

Northerly on Belvedere Mountain
Southerly on Hogg Mountain

Land Settlement, on lands known as Sweeny Land in the possession of Henry Sweeny *et al*, save and except all that portion of a road reserved 50 links wide passing through the area above described.

Block B

containing by survey 146 acres 1 rood and 34 perches butting

Northerly on lot 49 of Pennants Land Settlement and on lands known as Christians in the possession of the Estate of John Newman (deceased)

Easterly on lands known as Condia Hill in the possession of the Estate of John Newman (deceased) and on land in the possession of David Needham

Southerly on lands known as Teak Pen in the possession of the Hon. Colonial Secretary and on lots 55, 54 and 53 of Pennants Land Settlement

Westerly on the Parochial road from Beckford Kraal to Smoky Hole save and except all that portion of road reserved 18 links wide passing through the above described area

or however otherwise the same may be butted, bounded, known, distinguished or described.

PENNANTS (DOUCES) FOREST RESERVE

All those portions of Crown Lands forming part of Pennants Land Settlement in the parish of Clarendon.

Block A

containing by survey 65 acres 1 rood and 6 perches butting

Northerly on lands known as Bunker's Hill in the possession of Mary May, Richard May, Hubert Walters, Robert May, Richard Lewis, Stephen Lynch, Arthur Fearon, Abraham Cain, Leonard Fearon, Clarence Ricketts, James Beacher, Zepheniah Goode

Easterly on lands known as Bull Head in the possession of Zachariah Bonnick and Jarvis Bonnick and on lands known as Douces in the possession of Richard Lewis and Henry Howe

Southerly on lots 245, 244, 242, 238, 237, 236, 235 and 234 of Pennants Land Settlement

Westerly on lands known as Rickford in the possession of James Campbell, Philemon Fearon and Hubert Walters.

Block B

containing by survey 7 acres 2 roods and 12 perches butting

Northerly and *Easterly* on a road reserved

Southerly on lots 240 and 241 of Pennants Land Settlement

Westerly on lot 239 of Pennants Land Settlement.

Block C

containing by survey 6 acres 1 rood and 9 perches butting

Northerly, *Westerly* and *Southerly* on a road reserved

Easterly on lots 239 and 240 of Pennants Land Settlement

or howsoever otherwise the same may be butted, bounded, known, distinguished or described.

HYDE HALL MOUNTAIN FOREST RESERVE

All that portion of Crown Land known as Hyde Hall Mountain situate in the parish of Trelawny and containing by survey 1,635 acres 3 roods 34.4 perches, butting

Northerly on Vale Royal Mountain in possession of L. S. Martin part of Friendship Mountain in possession of Jemima Hawthorne, part of Friendship in Mtn. in possession of Abdel Amith, part of Friendship Mtn. in possession of the Crown, part of Friendship Mtn. in possession of Phillip West, part of Friendship Mountain in possession of C. Ingram, part of Friendship Mtn. in possession of C. Ferguson, and part of Friendship in possession of the Crown

Easterly on part of Richmond Pen in possession of Alfred Hylton, a portion of Richmond Pen cut up as a Government Land Settlement and part of Richmond Pen in possession of J. A. Dickenson

Southerly on Mosquito Cove in possession of Ernest Stewart

Westerly on Tisdale or Brislington Mountain in possession of L. S. Martin, part of Wiltshire in possession of Johnathan Gibbs, part of Wiltshire in possession of Norman Brown, part of Wiltshire in possession of J. Anderson, part of Wiltshire in possession of Andrew Warp, part of Wiltshire in possession of Keturah Bailey

or howsoever otherwise the same may be butted, bounded, known, distinguished or described.

PIKE AND RAVENS FOREST RESERVE

All that portion of Crown Lands situate in the parish of Trelawny forming part of Pike and Ravens and containing by survey 201 acres 3 roods 22.2 perches and bounded

Northerly by remaining portions of Pike and Ravens in the possession of Josiah Edwards, Adolphus Mendes, Victor Hanson, Cornelius Hanson, Cecil Nation, Henry Blake and by a portion of John Ebdons Patent in the possession of Henry Powell

Easterly by a portion of John Ebdons Patent in the possession of Henry Powell, by portions of Lowe River in the possession of Mrs. R. White, Nathaniel Stethford and by Crown Lands in the possession of the Forest Department

Southerly by a portion of Dobson's Run in the possession of Geo. Dunwell Jeremiah Brown and by Crown Land in the possession of the Forest Department

Westerly by remaining portions of Pike and Ravens in the possession of James Samms, Sylvester Myers, David Williams, Othniel Gilbert, Cecil Montague, Uriah Dobbs, Justin Murray, Uriah Rose, John Coley, Victoria Daley, Stanley Bailey, Lawrence Mason, Theophillus Powell, James Powell, Hubert Dunwell, and Charlotte Hewitt

or however otherwise the same may be bounded, butted, known or described.

TEAK PEN FOREST RESERVE

Block A

All that piece or parcel of Crown Land forming part of Teak Pen Land Settlement in the parish of Clarendon and containing by estimation 1,317 acres butting

Northerly on Pennants Land Settlement in possession of small settlers and remaining portion of Teak Pen Land Settlement in possession of small settlers

Easterly on parochial road from Jacobs Hut to Chapelton and Lillian Coote Dawkins

Southerly on Denbeigh Estate in possession of G. W. Muirhead, John Hayles' land in possession of Vernal Coleman and James Henry

Westerly on Smoky Hole in possession of James Henry, Pearl Louise Alexander, Dr. A. G. McKinley, Mortimer Bennett, James Archer, David Fuller, Wm. Sweeny, Wilfred Cowan, Jane Elliott and Wilfred Cowan and Pennants Land Settlement in possession of small settlers

or however otherwise the same may be butted, bounded, known, distinguished or described.

364 PROCLAMATIONS, RULES AND REGULATIONS [JULY 21, 1955

Dover Forest Reserve

All that parcel of land known as Lot 33 part of Dover Land Settlement in the parish of St. Mary, containing by estimation 62 acres 2 roods and butting

Northerly, on Lot 21 part of Dover Land Settlement, parochial road, Lot 22 of the said Settlement and reserved track.
Easterly, on Vinery.
Southerly, on Endeavour.
Westerly, on Lots 46, 47, 48, 49, 50 and 51 part of Dover Land Settlement,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Nutfield Forest Reserve

All that parcel of land known as Lot 174 part of Nutfield Land Settlement in the parish of St. Mary containing by area on plan 24 acres 2 roods 34.8 perches, and butting

Northerly, on Lot 163 of Nutfield Land Settlement and Sheerness track.
Easterly, on Sheerness.
Southerly, on Lots 187, 186 and 184 of Nutfield Land Settlement and Reserved Land Settlement road 33.
Westerly, on Lots 179, 177 and 175 part of Nutfield Settlement and Land Settlement road,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Richmond Pen Forest Reserve—Block A

All that parcel of land part of Richmond Pen Land Settlement in the parish of St. Ann containing by survey 147 acres 34 perches, and butting

Northerly, on part of Hyde Hall Mountain and Lot 198, Land Settlement Reserved Road, Lots 199 and 200 part of Richmond Pen Land Settlement.

Easterly, on Lot 197 part of Richmond Pen Land Settlement.

Southerly, on Lots 183, 185, 186, 187 and 191 part of Richmond Pen Land Settlement.

Westerly, on Lot 201 part of Richmond Pen Land Settlement, Land Settlement Reserved Road and part of Hyde Hall Mountain,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block B

All that parcel of land part of Richmond Pen Land Settlement in the parish of St. Ann known as Lot 184 and containing by survey 11 acres 12.1 perches and butting

Northerly, on Lot 185 of Richmond Pen Land Settlement.

Easterly, on Land Settlement reserved road.

Southerly, on Lot 182 of Richmond Pen Land Settlement.
Westerly, on Lot 183 of Richmond Pen Land Settlement,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block C

All that parcel of land known as Lot 188 forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 7 acres 1 rood 23.9 perches and butting

Northerly, on Lot 187 part of Richmond Pen Land Settlement.
Easterly, on Lot 189 part of the Settlement and reserved road.
Southerly, on reserved road.
Westerly, on Lot 187 and reserved road,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block D

All that parcel of land known as Lot 194 forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 5 acres 03.8 perches and butting

Northerly, on Lot 195 Land Settlement reserved road and Lot 196 part of Richmond Pen Land Settlement.
Easterly, on reserved road.
Southerly, on Lots 192 and 193 part of Richmond Pen Land Settlement.
Westerly, on Lot 197,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block E

All that parcel of land known as Lot 208 forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 5 acres 09.6 perches and butting

Northerly, on reserved road.
Easterly, on Lot 209 part of Richmond Pen Land Settlement.
Southerly, on Lots 113 and 114 part of Richmond Pen Land Settlement.
Westerly, on Lot 207 part of Richmond Pen Land Settlement,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block F

All that parcel of land known as Lot 253B forming part of the Richmond Pen Lant Settlement in the parish of Trelawny and that of St. Ann and containing by survey 36 acres 36 perches and butting

Northerly, partly on reserved road and partly on Lots 220, 221, 222, 223 and 253A part of Richmond Pen Land Settlement.
Easterly, on Lot 224 part of Richmond Pen Land Settlement.
Southerly, on reserved road and partly on Lots 253 and 253C.
Westerly, on reserved road,

or however otherwise the same may be butted, bounded, known, distinguished or described.

Block G

All that parcel of land known as Lot 109 forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 3 acres and butting

Northerly, on Lot 105 part of Richmond Pen Land Settlement.
Easterly, on reserved road.
Southerly, on Lot 99 part of Richmond Pen Land Settlement.
Westerly, partly on Lot 100 and partly on Lot 106,
or however otherwise the same may be butted, bounded, known, distinguished or described.

Block H

All that parcel of land known as Lot 232 forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 6 acres 2 roods 16.5 perches and butting
Northerly, on Belmont.
Easterly, on Lot 253 part of Richmond Pen Land Settlement.
Southerly, on reserved road.
Westerly, on Lot 231 part of Richmond Pen Land Settlement,
or however otherwise the same may be butted, bounded, known, distinguished or described.

Block I

All that parcel of land known as Lots 9, 10 and 11, forming part of Richmond Pen Land Settlement in the parish of St. Ann and containing by survey 5 acres 3 roods 11.3 perches and butting
Northerly, on reserved road.
Easterly, partly on Lot 8 and partly on Lot 62 part of Richmond Pen Land Settlement.
Southerly, on Lots 32 and 34 part of Richmond Pen Land Settlement.
Westerly, on Lot 12 part of Richmond Pen Land Settlement,
or however otherwise the same may be butted, bounded, known, distinguished or described.

New Ground Forest Reserve

All that parcel of land being Lot 135 forming part of New Ground Land Settlement in the parish of St. Ann and containing by survey 14 acres 3 roods 08.3 perches and butting
Northerly, on Lots 63 and 60 part of New Ground Land Settlement.
Easterly, partly on Lot 60 and partly on Land Settlement road.
Southerly, on Lots 61 and 62 part of New Ground Land Settlement.
Westerly, on Lot 62 and Content in possession of Florence Coxe,
or however otherwise the same may be butted, bounded, known, distinguished or described

Troy Forest Reserve—Block A

All that parcel of land forming part of Troy Land Settlement in the parish of Trelawny containing by survey 604 acres 2 roods 09.0 perches and butting
Northerly, on George Davis Patent Forest Reserve.
Easterly, partly on Block B part of this Reserve on parochial road leading from Troy and partly on lands possessed by Rachael Brissett, James Brown and Edward Peart.
Southerly, on lands possessed by Clement Angel, John Patrick and E. P. Domville.
Westerly, partly on Crown Lands and partly on land occupied by Clement Angel,

AND WHEREAS I have deemed it expedient to bring the said Act into operation on the 5th day of February, 1964:

NOW, THEREFORE, I CLIFFORD CLARENCE CAMPBELL, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Governor-General of Jamaica, DO HEREBY APPOINT the 5th day of February, one thousand nine hundred and sixty-four as the day on which the said Act shall come into operation.

Given under my hand and the Broad Seal of Jamaica at King's House this 3rd day of February in the year of Our Lord one thousand nine hundred and sixty-four, in the Twelfth Year of the Reign of Her Majesty Queen Elizabeth II.

GOD SAVE THE QUEEN

No. 40

THE FOREST LAW

(Cap. 134)

THE FOREST (CROWN LANDS) (NO. 2) ORDER, 1963

In exercise of the powers conferred upon the Minister by section 4 of the Forest Law, the following Order is hereby made:—

1. This Order may be cited as the Forest (Crown Lands) (No. 2) Order, 1963.

2. The several parcels of Crown Lands described in the Schedule to this Order are hereby declared to be Forest Reserves.

SCHEDULE (Paragraph 2)

Llandaff Forest Reserve

FIRSTLY: All that piece or parcel of land known as part of Llandaff formerly part of ARCADIA MOUNTAIN situate in the parish of TRELAWNY appearing as Section (1) on plan prepared by H. P. Abrikian, Commissioned Land Surveyor, and attached to Certificate of Title registered at Volume 990 Folio 523 containing by survey Seventy-seven Acres and Two Roods and said to belong to the Commissioner of Lands butting and bounding as follows:

NORTHERLY partly on part of MAHOGANY HALL registered at Volume 823 Folio 84 of the Register Book of Titles and said to belong to Kaiser Bauxite Company and partly on part of LLANDAFF formerly part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

SOUTHERLY and EASTERLY on part of LLANDAFF formerly Part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

WESTERLY Partly on part of ASHLEY HALL registered at Volume 644 Folio 94 of the Register Book of Titles and said to belong to Kaiser Bauxite Company and partly on MAHOGANY HALL registered at Volume 823 Folio 84 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

SECONDLY: All that piece or parcel of land known as part of LLANDAFF formerly part of ARCADIA MOUNTAIN situate in the parish of TRELAWNY appearing as section (2) on plan prepared by H. P. Abrikian, Commissioned Land Surveyor, and attached to Certificate of Title registered at

Volume 990 Folio 523 containing by survey Thirty-one Acres and Twenty-one Perches and said to belong to the Commissioner of Lands butting and bounding as follows:

NORTHERLY, SOUTHERLY and WESTERLY on LLANDAFF formerly part of ARCADIA MOUNTAIN Registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

EASTERLY on MANCHESTER PEN registered at Volume 104 Folio 14 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

THIRDLY: All that piece or parcel of land known as part of LLANDAFF formerly part of ARCADIA MOUNTAIN situate in the Parish of TRELAWNY appearing as Section (3) on plan prepared by H. P. Abrikian, Commissioned Land Surveyor, and attached to Certificate of Title registered at Volume 990 Folio 523 containing by survey Two Hundred and Four Acres Two Roods and Two Perches and said to belong to the Commissioner of Lands butting and bounding as follows:

NORTHERLY on part of LLANDAFF formerly part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

SOUTHERLY partly on part of LLANDAFF formerly part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company and partly on FRIENDSHIP MOUNTAIN said to belong to William Clarke.

EASTERLY partly on part of LLANDAFF formerly part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company and partly on part of BELMONT and said to belong to Stewart Town Peoples Co-operative Bank Limited.

WESTERLY partly on part of LLANDAFF formerly part of ARCADIA MOUNTAIN registered at Volume 662 Folio 46 of the Register Book of Titles and said to belong to Kaiser Bauxite Company and Partly on HARMONY HALL MOUNTAIN said to belong to Mauritius Baillie.

Stonehenge Forest Reserve

FIRSTLY: All that piece or parcel of land known as part of STONEHENGE situate in the Parish of TRELAWNY appearing on Section (1) on plan prepared by H. P. Abrikian, Commissioned Land Surveyor, and attached to Certificate of Title registered at Volume 990 Folio 522 containing by Survey Four Hundred and Eighty-five Acres One Rood and Thirty-one Perches and said to belong to the Commissioner of Lands butting and bounding as follows:

NORTHERLY on part of STONEHENGE registered at Volume 700 Folio 62 of the Register Book of Titles and said to belong to Kaiser Bauxite Company.

SOUTHERLY partly on part of OXFORD AND CAMBRIDGE MOUNTAINS said to belong to Joseph Kerr and partly on lands known as ROBERT MCGHIES PATENT said to belong to the Commissioner of Lands.

EASTERLY partly on Part of LONG POND MOUNTAIN said to belong to Sheriff and Company Limited and partly on SWANSWICK MOUNTAIN said to belong to VALE ROYAL ESTATES LIMITED.

WESTERLY on the Parochial Road leading from ALBERT TOWN to CLARKS TOWN.

Appendix VIII: MSDS for Dust Treat

GE
Water & Process Technologies

Material Safety Data Sheet

Issue Date: 14-SEP-2010
Supercedes: 26-JUL-2010

DUSTREAT DC9112T

1 Identification

Identification of substance or preparation
DUSTREAT DC9112T

Product Application Area
Material handling treatment

Company/Undertaking Identification
GE Betz, Inc.
4636 Somerton Road
Trevose, PA 19053
T 215 355-3300, F 215 953 5524

Emergency Telephone
(800) 877-1940

Prepared by Product Stewardship Group: T 215-355-3300 Prepared on: 14-SEP-2010

2 Hazard(s) identification

****
EMERGENCY OVERVIEW

CAUTION

Non-hazardous to skin. May cause slight or mechanical irritation to the eyes. Mists/aerosols cause irritation to the upper respiratory tract.

DOT hazard is not applicable
Odor: Mild; Appearance: Brown-Black, Liquid

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water
****

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; Non-hazardous to skin.

ACUTE EYE EFFECTS:
May cause slight or mechanical irritation to the eyes.

ACUTE RESPIRATORY EFFECTS:
Mists/aerosols cause irritation to the upper respiratory tract.

INGESTION EFFECTS:
No evidence of adverse effects from available information.

TARGET ORGANS:
No evidence of potential chronic effects.

MEDICAL CONDITIONS AGGRAVATED:
Not known.

SYMPTOMS OF EXPOSURE:
May cause redness or itching of skin.

3 Composition / information on ingredients

Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

This product is not hazardous as defined by OSHA regulations.

No component is considered to be a carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, or the Occupational Safety and Health Administration at OSHA thresholds for carcinogens.

4 First-aid measures

SKIN CONTACT:
Wash thoroughly with soap and water. Remove contaminated clothing. Get medical attention if irritation develops or persists.
EYE CONTACT:
Remove contact lenses. Hold eyelids apart. Immediately flush eyes with plenty of low-pressure water for at least 15 minutes. Get immediate medical attention.
INHALATION:
If nasal, throat or lung irritation develops - remove to fresh air and get medical attention.
INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 2-8 fluid ounces (60-240 mL) of milk or water.
NOTES TO PHYSICIANS:
No special instructions

5 Fire-fighting measures

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).
EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water
HAZARDOUS DECOMPOSITION PRODUCTS:
oxides of carbon and sulfur
FLASH POINT:
> 213F > 101C P-M(CC)

6 Accidental release measures

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.
DISPOSAL INSTRUCTIONS:
Water contaminated with this product may be sent to a sanitary sewer treatment facility,in accordance with any local agreement,a permitted waste treatment facility or discharged under a permit. Product as is - Incinerate or land dispose in an approved landfill.

7 Handling and storage

HANDLING:
Normal chemical handling.
STORAGE:
Keep containers closed when not in use. Do not freeze. If frozen, thaw and mix completely prior to use. Atmospheric exposure should be minimized. Do not store at elevated temperatures. Shelf life 270 days.

8 Exposure controls / personal protection

EXPOSURE LIMITS

This product is not hazardous as defined by OSHA regulations.

ENGINEERING CONTROLS:
adequate ventilation
PERSONAL PROTECTIVE EQUIPMENT:
Use protective equipment in accordance with 29CFR 1910 Subpart I
RESPIRATORY PROTECTION:
A RESPIRATORY PROTECTION PROGRAM THAT MEETS OSHA'S 29 CFR 1910.134 AND ANSI Z88.2 REQUIREMENTS MUST BE FOLLOWED WHENEVER WORKPLACE CONDITIONS WARRANT A RESPIRATOR'S USE.
USE AIR PURIFYING RESPIRATORS WITHIN USE LIMITATIONS ASSOCIATED WITH THE EQUIPMENT OR ELSE USE SUPPLIED AIR-RESPIRATORS.
If air-purifying respirator use is appropriate, use any of the following particulate respirators: N95, N99, N100, R95, R99, R100, P95, P99 or P100.
SKIN PROTECTION:
rubber, butyl, viton or neoprene gloves -- Wash off after

each use. Replace as necessary.
EYE PROTECTION:
splash proof chemical goggles

9 Physical and chemical properties

Spec. Grav.(70F,21C)	1.242	Vapor Pressure (mmHG)	~ 18.0
Freeze Point (F)	23	Vapor Density (air=1)	< 1.00
Freeze Point (C)	-5		
Viscosity(cps 70F,21C)	810	% Solubility (water)	100.0

Odor		Mild
Appearance		Brown-Black
Physical State		Liquid
Flash Point	P-M(CC)	> 213F > 100C
pH As Is (approx.)		7.8
Evaporation Rate (Ether=1)		< 1.00
Percent VOC:		0.0

NA = not applicable ND = not determined

10 Stability and reactivity

CHEMICAL STABILITY:
Stable under normal storage conditions.
POSSIBILITY OF HAZARDOUS REACTIONS:
No known hazardous reactions.
INCOMPATIBILITIES:
May react with strong oxidizers, acids, and alkaline materials.
DECOMPOSITION PRODUCTS:
oxides of carbon and sulfur

11 Toxicological information

Oral LD50 RAT: 20,000 MG/KG

12 Ecological information

AQUATIC TOXICOLOGY
Ceriodaphnia 48 Hour Static Renewal Bioassay
LC50= 2297; No Effect Level= 1000 mg/L
Ceriodaphnia 7 Day Chronic Bioassay
Reproduction NOEL= 500; Reproduction LOEC= 1000 mg/L
Daphnia magna 48 Hour Static Renewal Bioassay
LC50= 2732; No Effect Level= 2000 mg/L
Fathead Minnow 7 Day Chronic Bioassay
Growth NOEL= 250; Growth LOEL= 500 mg/L
Fathead Minnow 96 Hour Static Renewal Bioassay
LC50= 557; No Effect Level= 250 mg/L
Rainbow Trout 96 Hour Static Renewal Bioassay
LC50= 748; No Effect Level= 560 mg/L

BIODEGRADATION
BOD-28 (mg/g): 74
BOD-5 (mg/g): 50
COD (mg/g): 479

13 Disposal considerations

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is :
Not applicable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

14 Transport information

Transportation Hazard: Not Applicable
DOT: Not Regulated

DOT EMERGENCY RESPONSE GUIDE #: Not applicable
Note: Some containers may be DOT exempt, please check BOL for exact container classification
IATA: Not Regulated

IMDG: Not Regulated

15 Regulatory information

TSCA:
All components of this product are included on or are in compliance with the U.S. TSCA regulations.
CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):
No regulated constituent present at OSHA thresholds
NSF Registered and/or meets USDA (according to 1998 Guidelines):
Registration number: Not Registered
SARA SECTION 312 HAZARD CLASS:
Product is non-hazardous under Section 311/312
SARA SECTION 302 CHEMICALS:
No regulated constituent present at OSHA thresholds
SARA SECTION 313 CHEMICALS:
No regulated constituent present at OSHA thresholds
CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65):
No regulated constituents present
MICHIGAN REGULATORY INFORMATION

No regulated constituent present at OSHA thresholds

16 Other information

HMIS vII		CODE TRANSLATION
Health	0	Minimal Hazard
Fire	1	Slight Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	B	Goggles,Gloves

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

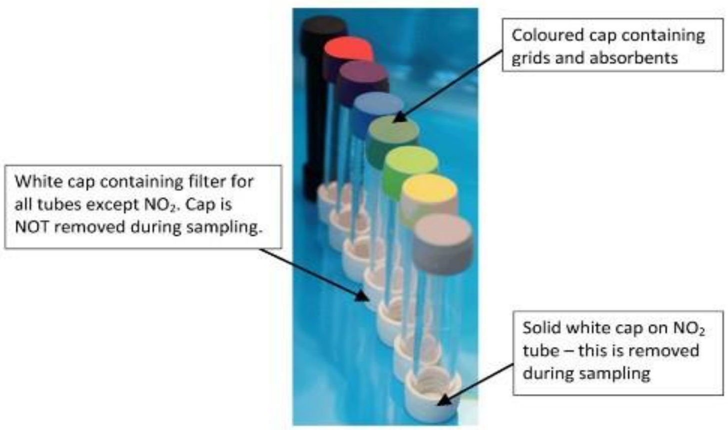
	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	08-AUG-2007		** NEW **
	16-JUL-2009	12	08-AUG-2007
	26-MAY-2010	12	16-JUL-2009
	26-JUL-2010	12	26-MAY-2010
	14-SEP-2010	12	26-JUL-2010

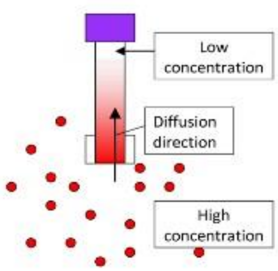
Appendix IX: Gradko – "*How do Palmes Diffusion Tubes Work?*"

gradko environmental

How do Palmes diffusion tubes work?

Plastic monitoring tubes for inorganic compounds – Nitrogen dioxide, Nitric oxide, Sulphur dioxide, Hydrogen sulphide, Acid gases, Ozone, Ammonia. Tubes are 7 cm tall and 1.5 cm wide.





Diffusion tubes work by a process called molecular diffusion. During molecular diffusion, compounds will move from an area of high concentration to an area of low concentration.

The compounds in the air are at a higher concentration than those in the tube, so the compounds diffuse into the tube and collect on the absorbent at the end of the tube.

Because the compounds are absorbed, the low concentration in the tube is maintained, and therefore diffusion continues. The rate that the compounds move into the tube is called the uptake rate. This is a known rate and is used in the calculations during analysis.

Many of the tubes are clear as light is required during the absorption process. Hydrogen sulphide tubes are black as light would affect the storage of the compounds.

+44 (0)1962 860 331 diffusion@gradko.com www.gradko.com

gradko environmental

Using diffusion tubes

Benefits of passive monitoring:
- No power supply required
- Inexpensive
- Can be used over a wide area
- Long-term monitoring

Diffusion tubes are designed for long-term monitoring so that a sufficient concentration of compounds is absorbed on to the tubes to be detected during the analysis.

The tube should be placed in the required monitoring location and left there for between 2 and 4 weeks.

Once the sampling period is over, the tubes are sealed and returned to the laboratory for analysis.

Various analysis techniques are used for the different diffusion tubes. The lab determines the concentration of compounds on the tube. This is then used in a calculation with the uptake rate to calculate the average concentration of compounds that were present in the air over the monitoring period.

The results are reported in parts per billion (ppb) and micrograms per metre cubed (ugm^{-3}) to allow comparison with health guideline levels. Reports are emailed to the customer within 10 working days of receipt of the samples.

Technical tips

- An acid gases tube can be used to measure six different gases simultaneously.
- Always position the tube vertically, with the open end or the filter pointing downwards.
- Spacers should be used to position the tube away from the fixing surface.

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Appendix X: Gradko – Combined Nitrogen Dioxide and Sulphur Dioxide Diffusion Tube - Technical Data Sheet

gradko environmental

Technical Data Sheet: TDS 3

DIF 500 RTU-RA - COMBINED NITROGEN DIOXIDE (NO_2) AND SULPHUR DIOXIDE (SO_2) DIFFUSION TUBE

Description: Acrylic tube fitted with a green and white thermoplastic rubber caps. The green cap contains the absorbent and the white cap is fitted with a filter to prevent the ingress of particulates. This tube is designed to simultaneously passively monitor gaseous NO_2 and SO_2. Analysis of exposed tubes is carried out by Ion Chromatography (UKAS Accredited Methods).

This tube is suitable for carrying out spatial or localised assessments for NO_2 / SO_2 in ambient air. It can be used for co-location projects alongside an automatic analyzer **but it is not recommended for bias comparison measurements**. For this application separate NO_2 and SO_2 diffusion should be employed.

Clips and straps are not included and must be ordered separately.

Tube Dimensions: 71.0mm length x 11.0mm internal diameter.

Recommended Exposure Periods: 2 – 4 weeks.

Air Velocity: Influence of wind speed: Sampling rate does not vary between 1.0 and 4.5 $msec^{-1}$ (*based on original data).

Storage: Store in a dark, cool environment preferably between 5-10°C.

Shelf Life: 12 weeks from preparation date.

Desorption Efficiency: d = 0.98 (determined using N.I.S.T. Standard Analytes).

Limit of detection:
- NO2: Less than 0.5 ugm^{-3} over a 4-week exposure period.
- SO2: Less than 1.5 ugm^{-3} over a 4-week exposure period.
- Specific values available upon request.

Analytical Expanded Measurement Uncertainty: available upon request.

Relevant Standards: BS EN 13528 Parts 1-3: 2002/3.

Special Factors: Potential interference from nitrous acid, peroxy acetyl nitrate, and sub-micron sulphur loaded particulates, which could increase levels of nitrate and sulphate.

TDS 3:V1 March 2012

Appendix XI: Gradko – Combined NO_2 and SO_2 Instructions

gradko environmental

Combined NO_2 and SO_2 Tube Instructions

Shelf life: This tube has a shelf life of 12 weeks. Tubes must be exposed and returned for analysis within this period.

Tube storage: Tubes should be refrigerated before exposure. Do not exceed the shelf life. If using a blank tube, do not remove the tube from the screw top container. Store in the same conditions as the sampling tubes.

Fixing tubes: It is important that the end of the tube is in an area with a free circulation of air. Certain surfaces may act as absorbers leading to reduced atmospheric concentrations immediately adjacent to the tube. For this reason tubes should not be mounted directly onto a surface. Ideally a spacer of at least 5cm should be used between the surface and the tube. The spacer should not be placed in any form of recess (to avoid the possibility of sampling stagnant air). To avoid sampling in an area of higher than usual turbulence, tubes should not be located on the corner of a building.

Exposure:

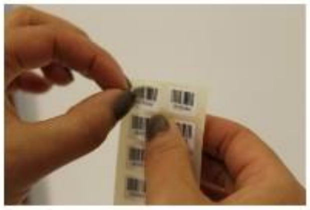
1. Remove tube from screw top container. Keep container in a safe place.
2. Position tube vertically with the cap containing the filter facing downwards during required sampling period (2-4 weeks).
3. **Label the tube and the exposure sheet clearly with the supplied barcode labels (see below).** After sampling put the tube back into the screw top container.

Returning tubes: Tubes should be returned as soon as possible after exposure. Fill in exposure sheet including **exposure time**. Tubes should be returned in a sealed container, such as the plastic bag that they are received in.

Return address:
Gradko International Ltd, St Martins House, 77 Wales Street, Winchester, Hampshire, SO23 0RH.
Tel: +44 (0) 1962 860 331
Email: diffusion@gradko.com or enquiries@gradkolab.com

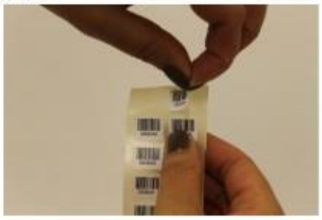
New Barcoding for Tubes

On receiving your delivery, you should find enclosed
A copy of an exposure sheet
A strip of bar codes
Your tubes



We recommend that you label your tubes (and sheets) at the point of placing the tubes on site.

Simply take the 1st of the duplicate labels (1.) and stick it to the appropriate location on the exposure sheet (2.).



1.

2.

Then take the 2nd matching label (3.) and stick it to the tube exposed at the same location (4.).

Please take care to make sure the label is securely fixed to the tube (5.).
These labels are treated to deal with the weather conditions.

3.

4.

5.

Appendix XII: Laboratory Analysis Report - GRADKO

gradko environmental
(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

DETERMINATION OF ACID GASES IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER M04929R
BOOKING IN REFERENCE No M04929
DESPATCH NOTE No 43379

CUSTOMER Mark Richards
1 Shalimar Close
Kingston 3
Jamaica

DATE SAMPLES RECEIVED 12/07/2018
JOB REFERENCE

Location	Bar Code	Date On	Date Off	Exposure (hrs)	NITROGEN DIOXIDE µg NO_2 Total	µgNO_2 - Blank	NO_2 µg/m^{3*}	NO_2 ppb*
AQMS 6	1142348	31/05/18	14/06/18	338.17	0.09	0.09	3.74	1.95
AQMS 7	1142340	31/05/18	14/06/18	337.72	0.12	0.11	4.55	2.37
AQMS 7	1142349	31/05/18	14/06/18	337.72	0.09	0.09	3.73	1.94
AQMS 7	1142350	01/06/18	14/06/18	312.83	0.09	0.09	3.94	2.05
AQMS 7	1142351	01/06/18	14/06/18	312.83	0.10	0.09	4.08	2.12
AQMS 3	1142352	12/06/18	28/06/18	383.03	0.09	0.08	2.97	1.55
AQMS 3	1142353	12/06/18	28/06/18	383.03	0.08	0.08	2.86	1.49
AQMS 5	1142354	12/06/18	28/06/18	382.50	0.11	0.11	3.96	2.06
AQMS 5	1142355	12/06/18	28/06/18	382.50	0.09	0.09	3.15	1.64
AQMS 4	1142357	12/06/18	28/06/18	380.63	0.11	0.10	3.70	1.93
AQMS 4	1142339	12/06/18	28/06/18	380.63	0.11	0.11	3.75	1.95
AQMS 2	1142374	09/05/18	31/05/18	525.52	0.12	0.12	3.18	1.65
AQMS 2	1142375	09/05/18	31/05/18	525.52	0.12	0.12	3.13	1.63
AQMS 6	1142370	08/05/18	31/05/18	549.53	0.11	0.11	2.60	1.35
AQMS 6	1142371	08/05/18	31/05/18	549.53	0.10	0.09	2.33	1.21
AQMS 1	1142368	08/05/18	31/05/18	549.58	0.20	0.19	4.76	2.47
AQMS 1	1142369	08/05/18	31/05/18	549.58	0.20	0.20	4.96	2.58
AQMS 3	1142376	29/05/18	12/06/18	333.87	0.09	0.09	3.74	1.94
AQMS 3	1142358	29/05/18	12/06/18	333.87	0.09	0.09	3.70	1.92
AQMS 4	1142359	29/05/18	12/06/18	335.35	0.10	0.10	3.97	2.06
AQMS 4	1142360	29/05/18	12/06/18	335.35	0.10	0.10	4.01	2.09
AQMS 5	1142361	29/05/18	12/06/18	331.37	0.10	0.10	3.97	2.07
AQMS 5	1142362	29/05/18	12/06/18	331.37	0.08	0.08	3.25	1.69
AQMS 2	1142364	31/05/18	14/06/18	340.67	0.08	0.08	3.03	1.58
AQMS 2	1142363	31/05/18	14/06/18	340.67	0.07	0.07	2.67	1.39
AQMS 1	1142365	31/05/18	14/06/18	338.87	0.13	0.13	5.04	2.62
AQMS 1	1142366	31/05/18	14/06/18	338.87	0.14	0.13	5.34	2.78

Samples have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures. Data provided by the client and any subsequent calculations shall be indicated by an asterisk (*), these calculations and results are not within the scope of our UKAS accreditation. The results within this report relate only to the items tested. Any queries concerning data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

Form LQF32b Issue 8 – June 2018 Report Number: M04929R Page 1 of 3

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ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

AQMS 6	1142367	31/05/18	14/06/18	339.17	0.11	0.10	4.15	2.16
Unlabelled	1094190			549.58	<0.05	<0.05	<1.13	<0.59
Unlabelled	1094191			549.58	<0.05	<0.05	<1.13	<0.59
Unlabelled	1094192			549.58	0.06	0.06	1.39	0.72
Unlabelled	1094193			549.58	<0.05	<0.05	<1.13	<0.59
Unlabelled	1156390			549.58	<0.05	<0.05	<1.13	<0.59
Lab Blank					0.001			

(RESULTS ARE BLANK CORRECTED)

Tubes 1094190, 1094191, 1094192, 1094193 & 1156390 were received but not listed on the exposure sheet. Maximum exposure times were used.

Results reported as <0.05µg NO_2^- are below the reporting limit.

OVERALL M.U. ±14.9% **REPORTING LIMIT** 0.05µg NO_2^-

Analysed on Dionex ICS1100 ICU10

ANALYST NAME C. Fraser **REPORT CHECKED BY** S. Minns

DATE OF ANALYSIS 24/07/2018 **DATE OF REPORT** 26/07/2018

ANALYSIS HAS BEEN CARRIED OUT IN ACCORDANCE WITH IN-HOUSE METHOD GLM3

DETERMINATION OF ACID GASES IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

Location	Bar Code	Date On	Date Off	Exposure (hrs)	SULPHUR DIOXIDE µg S Total	µgS - Blank	SO_2 µg/m³*	SO_2 ppb*
AQMS 6	1142348	31/05/18	14/06/18	338.17	<0.03	<0.03	<3.16	<1.18
AQMS 7	1142340	31/05/18	14/06/18	337.72	<0.03	<0.03	<3.16	<1.19
AQMS 7	1142349	31/05/18	14/06/18	337.72	<0.03	<0.03	<3.16	<1.19
AQMS 7	1142350	01/06/18	14/06/18	312.83	<0.03	<0.03	<3.41	<1.28
AQMS 7	1142351	01/06/18	14/06/18	312.83	<0.03	<0.03	<3.41	<1.28
AQMS 3	1142352	12/06/18	28/06/18	383.03	<0.03	<0.03	<2.79	<1.05
AQMS 3	1142353	12/06/18	28/06/18	383.03	<0.03	<0.03	<2.79	<1.05
AQMS 5	1142354	12/06/18	28/06/18	382.50	<0.03	<0.03	<2.79	<1.05
AQMS 5	1142355	12/06/18	28/06/18	382.50	<0.03	<0.03	<2.79	<1.05
AQMS 4	1142357	12/06/18	28/06/18	380.63	<0.03	<0.03	<2.81	<1.05
AQMS 4	1142339	12/06/18	28/06/18	380.63	<0.03	<0.03	<2.81	<1.05

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2187

LABORATORY ANALYSIS REPORT

AQMS 2	1142374	09/05/18	31/05/18	525.52	<0.03	<0.03	<2.03	<0.76
AQMS 2	1142375	09/05/18	31/05/18	525.52	<0.03	<0.03	<2.03	<0.76
AQMS 6	1142370	08/05/18	31/05/18	549.53	<0.03	<0.03	<1.94	<0.73
AQMS 6	1142371	08/05/18	31/05/18	549.53	<0.03	<0.03	<1.94	<0.73
AQMS 1	1142368	08/05/18	31/05/18	549.58	<0.03	<0.03	<1.94	<0.73
AQMS 1	1142369	08/05/18	31/05/18	549.58	<0.03	<0.03	<1.94	<0.73
AQMS 3	1142376	29/05/18	12/06/18	333.87	<0.03	<0.03	<3.20	<1.20
AQMS 3	1142358	29/05/18	12/06/18	333.87	<0.03	<0.03	<3.20	<1.20
AQMS 4	1142359	29/05/18	12/06/18	335.35	<0.03	<0.03	<3.18	<1.19
AQMS 4	1142360	29/05/18	12/06/18	335.35	<0.03	<0.03	<3.18	<1.19
AQMS 5	1142361	29/05/18	12/06/18	331.37	<0.03	<0.03	<3.22	<1.21
AQMS 5	1142362	29/05/18	12/06/18	331.37	<0.03	<0.03	<3.22	<1.21
AQMS 2	1142364	31/05/18	14/06/18	340.67	<0.03	<0.03	<3.14	<1.18
AQMS 2	1142363	31/05/18	14/06/18	340.67	<0.03	<0.03	<3.14	<1.18
AQMS 1	1142365	31/05/18	14/06/18	338.87	<0.03	<0.03	<3.15	<1.18
AQMS 1	1142366	31/05/18	14/06/18	338.87	<0.03	<0.03	<3.15	<1.18
AQMS 6	1142367	31/05/18	14/06/18	339.17	0.03	0.03	3.30	1.24
Unlabelled	1094190			549.58	<0.03	<0.03	<1.94	<0.73
Unlabelled	1094191			549.58	<0.03	<0.03	<1.94	<0.73
Unlabelled	1094192			549.58	<0.03	<0.03	<1.94	<0.73
Unlabelled	1094193			549.58	<0.03	<0.03	<1.94	<0.73
Unlabelled	1156390			549.58	<0.03	<0.03	<1.94	<0.73

Lab Blank 0.004

(RESULTS ARE BLANK CORRECTED)

Tubes 1094190, 1094191, 1094192, 1094193 & 1156390 were received but not listed on the exposure sheet. Maximum exposure times were used.

Results reported as <0.03µg S are below the reporting limit.

OVERALL M.U. ±14.9% **REPORTING LIMIT** 0.03µg S

Analysed on Dionex ICS1100 ICU10

ANALYST NAME C. Fraser **REPORT CHECKED BY** S. Minns

DATE OF ANALYSIS 24/07/2018 **DATE OF REPORT** 26/07/2018

ANALYSIS HAS BEEN CARRIED OUT IN ACCORDANCE WITH IN-HOUSE METHOD GLM3

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L. Gates, Laboratory Manager

Appendix XIII: Flora Species List for SML 173 Area

Trees Observed in Hillock Areas:

Common Name	Scientific Name
Trumpet Tree	***Cecropia peltata***
Sweetwood	***Nectandra spp,***
Sweetwood	***Nectandra coriacea***
Sweetwood	***Nectandra hihua***
Sweetwood	***Nectandra antillana***
Bulletwood	***Dipholis sp.***
Red Bullet	***Dipholis nigra***
Black Bullet	***Dipholis salicifolia***
Bullet Tree	***Bumelia nigra***
Trumpet Tree	***Bursera simaruba***
Pigeon Plum	***Coccoloba spp.***
Salt Wood	***Neea nigricans***
Bitter Wood	***Picrasma excelsa***
Oil Nut	***Pyrularia pubera***
Broadleaf	***Terminaria latifolia***
Rose Apple	***Syzygium jambos***
Cobnut	***Omphalea triandra***
Santa Maria	***Calophyllum calaba***
Cedar	***Cedrela odorata***
Herringwood	***Guapira fragrans***
Silk Cotton Tree	***Ceiba pentandra***
Flame of the Forest	***Spathodea campanulata***
Fig Tree	***Ficus spp***
Red Birch	***Bursera simaruba***
Bull Hoof tree	***Bauhinia divaricata***
Dogwood	***Piscidia piscipula***
Lead Tree	***Lucina leucocephala***
Bastard Cedar	***Guazuma ulmifolia***
Blue Mahoe	***Hibiscus elatus***
West Indian Cedar	***Cedrela odorata***
Burnwood	***Metopium brownei***
Maiden Plum	***Commocladia pinnetifolia***

Agricultural Produce Observed in Lowlands:

Common Name	Scientific Name
Carrot	*Daucus carota*
Callaloo	*Amaranthus viridis*
Escallion	*Allium fistulosum*
Mango Tree	*Magnifera indica*
Coco	*Colocasia esculenta*
Spanish needle	*Bidens cynapiifolia*
Cabbage	*Brassica oleracea*
Pak choi	*Brassica rapa*
Pineapple	*Ananas comosus*
Cactus	*Hylocereus triangularis*
Sweet Potato	*Ipomoea batats*
Leaf of Life	*Byrophyllum pinnatum*
Pumpkin	*Curcurbita pepo*
Pasture Grass	*Sporobolus sp*

Transition Zone Plants:

Common Name	Scientific Name
Lantana	***Lantana camara***
Bitterbush	***Eupatorium villosum***
Spanish Needle	***Bidens pilosa***
Duppy Gun	***Ruellia tuberosa***
Wild Frangipani	***Plumeria obtusa***
Snake Plant	***Sansevieria trifasciata***
Shame Me Lady	***Mimosa pudica***
Cockspur	***Pisonia acculeata***
Wild Hop	***Moghania stribilifera***
Ram Goat Dash along	***Turnera ulmifolia***
	Piper amalgo
	Piper arboreum
Vervine	***Stachytarpheta jamaicensis***

Aroids:

3. *Anthurium grandiflora*
4. *Philodendron lacerum*
5. *Merremia peltata*

Epiphytes:

1. *Tillansia fasciculata*
2. *Hohenbergia antillana*
3. *Hylocelereus triangularis* (God Okra – endemic)
4. *Aechmea paniculigera*

Ferns:

1. *Thelypteris sp* (various varieties)
2. *Polypodium sp*
3. *Ctenitis effusa*

Appendix XIV: 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 XV: 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 richardsonii***
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 XVI: 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 XVII: 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 XVIII: 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 XIX: 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. parnellii either will be endemic to Jamaica or restricted to Jamaica and Cuba [i.e., the subspecies P.p.parnelii 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 XX: Fauna Species List for SML 173 Area

Table 13-1: Birds

No.	Species List (endemic*)	4-Letter Code
1.	American Kestrel (*Falco sparverius*)	AMKE
2.	Antillean Palm Swift (*Tachornis phoenicobia*)	ANPS
3.	Arrow-headed Warbler (*Setophaga pharetra*)*	ARRW
4.	Bananaquit (*Coereba flaveola*)	BANA
5.	Barn Owl (*Tyto alba*)	BANO
6.	Black-Faced Grassquit (*Melanospiza bicolor*)	BFGR
7.	Black-whiskered Vireo(*Vireo altiloquus*)	BWVI
8.	Cattle Egret (*Bubulcus ibis*)	CAEG
9.	Cave Swallow (*Petrochelidon fulva*)	CASW
10.	Chestnut-bellied Cuckoo (*Coccyzus pluvialis*)*	CBCU
11.	Common Ground Dove (*Columbina passerina*)	COGD
12.	Gray Kingbird(*Tyrannus dominicensis*)	GRAK
13.	Greater Antillean Bullfinch (*Loxigilla violacea*)	GABU
14.	Greater Antillean Grackle (*Quiscalus niger)*	GAGR
15.	Green Rumped Parrotlet (*Forpus passerines*)	GRUP
16.	Jamaican Becard (*Pachyramphus niger*)*	JABE
17.	Jamaican Crow(*Corvus jamaicensis*)*	JACR
18.	Jamaican Euphonia (*Euphonia Jamaica*)*	JAEU
19.	Jamaican Mango (*Anthracothorax mango*)*	JAMA
20.	Jamaican Lizard Cuckoo (*Saurothera vetula*)*	JALC
21.	Jamaican Owl (*Pseudoscops grammicus*)*	JAOW
22.	Jamaican Peewee (*Contopus pallidus*)*	JAPE
23.	Jamaican Spindalis (*Spindalis nigricephala*)*	JAMS
24.	Jamaican Tody (*Todus todus*)*	JATO
25.	Jamaican Vireo (*Vireo modestus*)*	JAVI
26.	Jamaican Woodpecker(*Melanerpes radiolatus*)*	JAWO
27.	Loggerhead Kingbird (*Tyrannus caudifasciatus*)	LOKI
28.	Northern Mocking Bird (*Mimus polyglottos*)	NOMO
29.	Northern Potoo (*Nyctibius jamaicensis*)	NORP
30.	Jamaican Parakeet (*Epusitulla nana*) Formerly, Olive-throated Parakeet (*Aratinga nana*)	OTPA
31.	Orangequit (*Euneornis campestris*)*	ORAN
32.	Prairie Warbler(*Setophaga discolour*)	PRAW
33.	Red-Billed Streamertail (*Trochilus polytmus)**	RBST

34.	Rufous-tailed Flycatcher (*Myiarchus validus*)*	RFTF
35.	Sad Flycatcher(*Myiarchus barbirostris*)	SAFL
36.	Saffron Finch (*Sicalis flaveola*)	SAFI
37.	Shiny Cowbird (*Molothrus bonariensis*)	SHCO
38.	Smooth-billed Ani (*Crotophaga ani*)	SBAN
39.	Stolid Flycatcher (*Myiarchus stolidus*)	STOF
40.	Turkey Vulture (*Cathartes aura*)	TUVU
41.	Vervain Hummingbird (*Mellisuga minima*)	VEHU
42.	White-chinned Thrush(*Turdus aurantius*)*	WCTH
43.	White-Crowned Pigeon (*Patagioenas leucocephala*)	WCPI
44.	Yellow-Billed Parrot (*Amazona collaria*)*	YBPA
45.	Yellow-faced Grassquit (*Tiaris olivaceus*)	YFGR
46.	Zeneida Dove (*Zenaida aurita*)	ZEDO

Table 13-2: Table showing Species list per site

Study Block	1	1	4	3	7	8
Site Name	East of Barsnatple	Western Border of SML 173*	Dunn's Hole	Ulster Spring	Broadleaf	Madras
Transect/PC and Traverse point	1	2	3	4	5	6
Species per site, 4-Letter Alpha Codes	AMKE	GRKI	ANPS	BANA	ANPS	BFGR
	ANPS	JACR	COGD	BFGR	BANA	COGD
	BANA	OTPA	GRPA	CGDO	BFGR	JACR
	BFGR	JAPE	JACR	JAEU	BWVI	JAOR
	CAEG	LOKI	JAVI	JAPE	CBCU	JAPE
	COGD	RBST	JAWO	JATO	CGDO	JAVI
	JACR	SAFL	LOKI	JAVI	GRKI	OTPA
	JAEU	YFGR	PRAW	JAWO	JACR	RBST
	JAVI	ZEDO	RBST	LOKI	JAPE	SAFL
	JAWO		SAFL	OTPA	JATO	SBAN
	LOKI		TUVU	RBST	JAVI	VEHU
	NOMO		YBPA	RTFL	JAWO	YFGR
	OTPA		YFGR	SBAN	LOKI	
	RBST			STOF	AMKE	
	SAFL			TUVU	ORAN	
	SBAN			WCTH	OTPA	
	SHCB			YFGR	RBST	
	TUVU			ZEDO	SAFL	
	WCTH				SBAN	
	YBPA				TUVU	
	YFGR				VEHU	
	ZEDO				WCPI	
					YBPA	
					YFGR	
					ZEDO	

Table 13-3: Reptiles: (Windsor Research Centre, 2014)

No.	Common Name	Scientific Name
1	Limestone Galliwasp	*Celestus barbourin*
2	Common Galliwasp	*Celestus crusculus*
3	Red-spotted Galliwasp	*Celestus hewardii*
4	Giant anole	*Anolis garmani*
5	Turquoise anole	*Anolis grahami*
6	Gray anole	*Anolis lineatopus*
7	Opal Bellied anole	*Anolis opalinus*
8	Twig anole	*Anolis valencienni*
9	Cuban brown anole	*Anolis sagrei*
10	Croaking lizard	*Aristelliger praesignis*
11	Stippled Shpaero/Polly lizard	*Sphaerodactylus argus*
12	Forest Sphaero	*Sphaerodactylus goniorhynchus*
13	Sharp noise Sphaero	*Sphaerodactylus oxyrhinus*
14	Jamaican Boa	*Epicrates Red-spotted*
15	Red racer	*Hypsirhynchus callilaemus*
16	Black racer proxy	*Hypsirhynchus funereus*
17	Eyespot Trope	*Tropidophis stejnegeri*
18	Blind Snake	*Typhlops jamaicensis*
19	Jamaican Slider	*Trachemys terrapen*
20	Limestone Galliwasp	*Celestus barbourin*

Insects:

- Jamaican Monarch (*Danaus cleophile*)
- Cramer's Little Sulphur (*Eurema nise*)
- Mimosa Yellow (*Pyrisitia nise*)
- Antillean Great White (*Ascia monuste*)
- West Indian Buckeye (*Precis evarete zonalis*)
- Tropical Fritillary (*Euptoieta hegesia hegesia*),
- Jamaican Zebra (*Heliconius charitonius simulator*)
- *Pyrisitia nise*
- Dragonfly *(Erythrodiplax sp.*)
- Grasshoppers (*Orphulella punctata*)

Amphibians:

1. Cane Toad *(Rhinella marina*)
2. Jamaican Snoring Treefrog *(Osteopilus crucialis*)
3. Jamaican Laughing Tree Frog *(Osteopilus ocellatus*)
4. Jamaican Yellow Treefrog *(Osteopilus marianae*)
5. Jamaican Green Treefrog *(Osteopilus wilderi*)
6. *Eleutherodactylus cundalli*
7. Jamaican Ear-spot Frog *(Eleutherodactylus fuscus)*
8. Jamaican Forest Frog *(Eleutherodactylus gossei*)
9. Jamaican Pallid Frog *(Eleutherodactylus grabhami*)
10. Jamaican Bromeliad Frog *(Eleutherodactylus jamaicensis*)
11. Lesser Antillean Frog *(Eleutherodactylus johnstonei*)
12. Rock Pocket Frog *(Eleutherodactylus junori*)
13. Jamaican Masked Frog *(Eleutherodactylus luteolus*)
14. Jamaican Yellow-bellied Frog *(Eleutherodactylus pantoni*)
15. Cuban Flathead Frog *(Eleutherodactylus planirostris*)
16. BullFrog *(Lithobates catesbianus*)

(Windsor Research Centre, 2016)

Gastropods:

- *Thelidomus cognate,*
- *Pleurodonte peracutissima*
- *Sagda foremaniana*.

Appendix XXI: Fauna Species List for Ecological Assessment provided by the Institute of Jamaica (IOJ), Natural History Museum of Jamaica Division (NHMJ)

Table 13-4: Fauna - Stewart Town

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	Stewart Town	0°00'00"S	0°00'00"W	*Anolis sp.*	Reptilia	Dachyloidae

Table 13-5: Fauna - Ulster Spring

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	Ulster Spring	0°00'00"S	0°00'00"W	*Dysdercus mimulus*	Hemiptera	Pyrrhocoridae
Trelawny	Ulster Spring	0°00'00"S	0°00'00"W	*Oedancala sp.*	Hemiptera	Pachygronthidae
Trelawny	Ulster Spring	0°00'00"S	0°00'00"W	*Diatraea saccharlis*	Lepidoptera	Crambidae

Table 13-6: Fauna - Spring Garden

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	Spring Gardens	0°00'00" S	0°00'00" W	*Bufo marinus*	Amphibia	Bufonidae
Trelawny	Spring Garden	0°00'00" S	0°00'00" W	*Conocephalus sp.*	Orthoptera	Tettigoniidae
Trelawny	Spring Garden	0°00'00" S	0°00'00" W	*Aphidophagous sp.*	Diptera	Cecidomyiidae
Trelawny	Spring Garden	0°00'00" S	0°00'00" W	*Sciapus sp.*	Diptera	Dolichopodidae
Trelawny	Spring Garden	0°00'00" S	0°00'00" W	*Pelastoneurus sp.*	Diptera	Dolichopodidae

Table 13-7: Fauna - Troy

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	Troy	0°00'00"S	0°00'00"W	*Hyla wilderi*	Amphibia	Hylidae
Manchester	Troy	18°13'00"N	77°37'00"W	*Hyalurga vinosa*	Lepidoptera	Arctiidae
Manchester	Troy	0°00'00"S	0°00'00"W	*Toxomerus arcifer*	Diptera	Syrphidae
Manchester	Troy	0°00'00"S	0°00'00"W	*Toxomerus floralis*	Diptera	Syrphidae

Manchester	Troy	0°00'00"S	0°00'00"W	*Ornidia obessa*	Diptera	Syrphidae
Manchester	Troy	18°13'00"N	77°37'00"W	*Strialuna diminuta*	Gastropoda	Sagdidae
Trelawny	Troy	0°00'00"S	0°00'00"W	*Helicobia rapax*	Diptera	Sarcophagidae

Table 13-8: Fauna - Quickstep

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	Quickstep	0°00'00"S	0°00'00"W	*Myodocha unispinosa*	Hemiptera	Rhyparochromidae
St. Elizabeth	Quickstep	0°00'00"S	0°00'00"W	*Leucauge argyura*	Arachnida	Tetragnathidae
St. Elizabeth	Quickstep	0°00'00"S	0°00'00"W	*Araneus sp.*	Arachnida	Araneidae
St. Elizabeth	Quickstep	0°00'00"S	0°00'00"W	*Eustala nadleri*	Arachnida	Araneidae
St. Elizabeth	Quickstep	0°00'00"S	0°00'00"W	*Eustala fuscavittata*	Arachnida	Araneidae
St. Elizabeth	Quickstep Paynes Patent	0°00'00"S	0°00'00"W	*Eustala fuscavittata*	Arachnida	Araneidae

Table 13-9: Fauna - Maroon Town

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
St. James	Maroon Town	0°00'00"S	0°00'00"W	*Parasarcolites*	Bivalvia	Antillocaprinidae

Table 13-10: Fauna -Windsor

Region Name	Site Name	Latitude	Longitude	Full Name	Order	Family
Trelawny	WindsorMarta Brae River	0°00'00"S	0°00'00"W	*Trachemys terrapen*	Reptilia	Cheloniidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Eurytides(Protographium) marcellinus*	Lepidoptera	Papilionidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Eurema nise nise*	Lepidoptera	Pieridae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Eurema lisa euterpe*	Lepidoptera	Pieridae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Calisto zangis*	Lepidoptera	Sattridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Anartia jatrophae jamaicensis*	Lepidoptera	Nymphalidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Siproeta stelenes stelenes*	Lepidoptera	Nymphalidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Euptoieta hegesia hegesia*	Lepidoptera	Nymphalidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Leptotes cassius theonus*	Lepidoptera	Lycaenidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Phocides lincea perkinsi*	Lepidoptera	Hesperiidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Proteides mercurius jamaicensis*	Lepidoptera	Hesperiidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Polygonus leo hagar*	Lepidoptera	Hesperiidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Aguna asander jasper*	Lepidoptera	Hesperiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Urbanus proteus proteoides*	Lepidoptera	Hesperiidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Opharus elota*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Horama panthalon grotei*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Uraga haemorrhoa*	Lepidoptera	Arctiidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Dione vanillae insularis*	Lepidoptera	Heliconidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Precis evarete zonalis*	Lepidoptera	Nymphalidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Cincia ap.*	Lepidoptera	Arctiidae

Trelawny	Windsor	0°00'00"S	0°00'00"W	*Agratie sp.*	Lepidoptera	Noctuidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Tuerta sp.*	Lepidoptera	Noctuidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Falco sparverius*	Aves	Falconidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Xylophanes chironnechus*	Lepidoptera	Sphingidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Enyo lugubris latipennis*	Lepidoptera	Sphingidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Pholus satellitia*	Lepidoptera	Sphingidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Cocytius duponchel*	Lepidoptera	Sphingidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Idalus delicata*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Pareuchaetes insulata*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Symphlebia jamaicensis*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Carathis palpalis*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Calidota strigosa*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Ametris nitocris*	Lepidoptera	Geometridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Condica mobilis*	Lepidoptera	Noctuidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Hemeroplanes parce*	Lepidoptera	Sphingidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Amplypterus gannascus jamaicensis*	Lepidoptera	Sphingidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Madoryx oiclus*	Lepidoptera	Sphingidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Xylophanes sp.*	Lepidoptera	Sphingidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Leptocella cubana*	Trichoptera	Leptoceridae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Helicopsyche cubana*	Trichoptera	Helicopsychidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Diapherodes jamaicensis*	Phasmida	Phasmatidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Gonotista grisea*	Mantodea	Liturgusidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Conocephalus*	Orthoptera	Tettigoniidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Ischyra vigans*	Orthoptera	Tettigoniidae

Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Osmilia flavolineata*	Orthoptera	Acrididae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Stenacris caribaea*	Orthoptera	Acrididae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Orphulella punctata*	Orthoptera	Acrididae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Neoconocephalus afinis*	Orthoptera	Tettigoniidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Thyreodon sp.*	Hymenoptera	Ichneumonidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Limonette meridionalis*	Hymenoptera	Ichneumonidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Enicospilus spp.*	Hymenoptera	Ichneumonidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Ophion flavidula*	Hymenoptera	Ichneumonidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Pseudomethoca cargilli*	Hymenoptera	Mutillidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Timulla trimaculosa*	Hymenoptera	Mutillidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Sphex jamaicensis*	Hymenoptera	Sphecidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Centris crassipes*	Hymenoptera	Apidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Selenophorus pyritosus*	Coleoptera	Carabidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Thermonectus circumscripta*	Coleoptera	Dytiscidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Thonalmus bicolor*	Coleoptera	Lycidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Pyrophorus plagiophthalmus*	Coleoptera	Elateridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Oniticellus gazella*	Coleoptera	Scarabaeidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Phyllophaga jamaicensis*	Coleoptera	Melolonthidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Cyclocephala tetrica*	Coleoptera	Dynastidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Stenocrates davisorum*	Coleoptera	Dynastidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Strongylaspis corticarius*	Coleoptera	Cerambycidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Chlorida festiva*	Coleoptera	Cerambycidae
Trelawny	Windsor Estate,About 12 miles S of Falmouth	0°00'00"S	0°00'00"W	*Phylloieus farri*	Coleoptera	Calamoceratidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Neoclytus longipes*	Coleoptera	Cerambycidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Metamasius ritchiei*	Coleoptera	Dryophthoridae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Limonia domestica*	Diptera	Limoniidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Limonia basistylata*	Diptera	Limoniidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Rhabdomastix parvula*	Diptera	Limoniidae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Merosarqus sp.*	Diptera	
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Psephiocera sp.*	Diptera	Stratiomyidae

Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Microchrysa sp.*	Diptera	Stratiomyidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Cyphomyia sp.*	Diptera	Stratiomyidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Tabanus vittiger (guatemalanus)*	Diptera	Tabanidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Cerotainia jamaicensis*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Phellopteron farri*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Andrenosoma lewisi*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Ommatius saccas*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Ommatius alexanderi*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Psilonyx arawak*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Schildia jamaicensis*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Efferia caudex*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Efferia gossei*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Efferia sp.*	Diptera	Asilidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Poecilanthrax lucifer*	Diptera	Bombyliidae
Trelawny	Windsor Cave	0°00'00"S	0°00'00"W	*Drapetis sp.*	Diptera	EmpidiDdae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Pseudodorus clavatus*	Diptera	Syrphidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Ocyptamus sagittems*	Diptera	Syrphidae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Allograpta sp.*	Diptera	Syrphidae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Aphidophagous sp.*	Diptera	Syrphidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Meromacrus ruficrus*	Diptera	Syrphidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Copestylum pallens*	Diptera	Syrphidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Toxomerus dispar*	Diptera	Syrphidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Taeniaptera lasciva*	Diptera	Micropezidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Taeniaptera sp.*	Diptera	Micropezidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Physogenua vittara*	Diptera	Lauxaniidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Sapromyza sp.*	Diptera	Lauxaniidae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Trigonometopus sp.*	Diptera	Lauxaniidae
Trelawny	Windsor Hotel	0°00'00"S	0°00'00"W	*Pherebellia guttata*	Diptera	Sciomyzidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Sepedomerus macropus*	Diptera	Sciomyzidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Pyrrharctia (Isia) isabella*	Lepidoptera	Erebidae

Trelawny	Windsor Cave	0°00'00"S	0°00'00"W	*Ploiaria rufoannulata*	Hemiptera	Reduviidae
Trelawny	Windsor Cave	0°00'00"S	0°00'00"W	*Ploiaria umbrarum*	Hemiptera	Reduviidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Doru lineare*	Dermaptera	Forficulidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Zicca taeniola*	Hemiptera	Coreidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Spartocera batatus*	Hemiptera	Coreidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Liorhyssus hyalinus*	Hemiptera	Rhopalidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Jadera aeola*	Hemiptera	Rhopalidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Dysdercus jamaicensis*	Hemiptera	Pyrrhocoridae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Dysdercus andreae*	Hemiptera	Pyrrhocoridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Dysdercus mimulus*	Hemiptera	Pyrrhocoridae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Myodocha unispinosa*	Hemiptera	Rhyparochromidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Loxa viridis*	Hemiptera	Pentatomidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Euschistus thoracicus*	Hemiptera	Pentatomidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Nezara viridula*	Hemiptera	Pentatomidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Edessa bifida* (Say)	Hemiptera	Pentatomidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Podisus sagitta*	Hemiptera	Pentatomidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Prosapia basalis*	Hemiptera	Cercopidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Ehagua cruenta* (Gmelin)	Hemiptera	Cicadellidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Poeciloscarte laticeps* M. & B.	Hemiptera	Cicadellidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Hortensia similis* Walker	Hemiptera	Cicadellidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Agalliopsis norella jamaicensis*	Hemiptera	Cicadellidae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Metapaulias depressus*	Decapoda	Sesarmidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Patalene sp.*	Lepidoptera	Noctuidae
Trelawny	Windsor	0°00'00"S	0°00'00"W	*Eriophora edax*	Arachnida	Araneidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Dichorda rhodocephala*	Lepidoptera	Geometridae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Thyrinteina unicornis*	Lepidoptera	Geometridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Cydosia nobilitella*	Lepidoptera	Noctuidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Syngamia florella*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Pilocrocis tripunctata*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Pilocrocis lauralis*	Lepidoptera	Crambidae

Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Mapeta xanthomelas*	Lepidoptera	Pyralidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Agathodes designalis*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Diaphania costata*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Diaphania costata*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Schistocera nitens*	Orthoptera	Acrididae
Trelawny	Windsor Estate	0°00'00"S	0°00'00"W	*Polistes crinitus*	Hymenoptera	Eumenidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Stenognatha toddi*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Epimecis scolopaia*	Lepidoptera	Geometridae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Heterochroma insignis*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Aclytia heber*	Lepidoptera	Arctiidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Polygrammodes elevata*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Hymenia perspectalis*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	18°21'22"N	77°38'48"W	*Pangaeus bilineatus*	Hemiptera	Cydnidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Sematura sp.*	Lepidoptera	Sematuridae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Spodoptera (Prodenia) ornithogalli*	Lepidoptera	Noctuidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Megastes brunnealis*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Desmia ploralis*	Lepidoptera	Crambidae
Trelawny	Windsor Great House	0°00'00"S	0°00'00"W	*Amplicencia pallida*	Lepidoptera	Arctiidae
Trelawny	Windsor EstateWindsor Great Cave	0°00'00"S	0°00'00"W	*Modisimus sp.*	Arachnida	Araneidae

Appendix XXII: Flora Species List for Ecological Assessment provided by the Institute of Jamaica (IOJ), Natural History Museum of Jamaica Division (NHMJ)

Table 13-11: Flora – Browns Town, St. Ann

Taxon	Family	Locality Name	Full Name of Parish
Anoda acerifolia DC.	Malvaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Asclepias nivea L.	Apocynaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Bidens pilosa L.	Asteraceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Brosimum alicastrum Sw.	Moraceae	c. 1.5 mile north of Browns Town.	Jamaica, Parish of Saint Ann
Calyptranthes zuzygium (L.) Sw.	Myrtaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Campylocentrum micranthum (Lindl.) Maury	Orchidaceae	Road from Endeavour to Browns Town, Tolboski bauxite mine area, ca. 200m northeast of railroad crossing.	Jamaica, Parish of Saint Ann
Clusia rosea Jacq.	Clusiaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Condea verticillata (Jacq.) Harley & J.F.B.Pastore	Lamiaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Cyperus odoratus L.	Cyperaceae	Knutsford, 2.7 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Diospyros tetrasperma Sw.	Ebenaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Duranta erecta L.	Verbenaceae	Browns Town	Jamaica, Parish of Saint Ann
Guzmania monostachya (L.) Rusby ex Mez	Bromeliaceae	Tobolski district, 3 miles southwest of Browns Town	Jamaica, Parish of Saint Ann
Lucya tetrandra (L.) K.Schum.	Rubiaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann

Nama jamaicensis L.	Hydrophyllaceae	Knutsford, 2.7 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Pavonia spinifex (L.) Cav.	Malvaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Picrasma excelsa (Sw.) Planch	Simaroubaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Psychotria pubescens Sw.	Rubiaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Rousselia humilis Urb.	Urticaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Salvia serotina L.	Lamiaceae	Vicinity of Browns Town	Jamaica, Parish of Saint Ann
Sida javensis Cav.	Malvaceae	Minard Pen, c. 1 mile south of Browns Town	Jamaica, Parish of Saint Ann
Sudamerlycaste barringtoniae Archila	Orchidaceae	Knutsford estate, 3 miles due south of Browns Town	Jamaica, Parish of Saint Ann
Teucrium vesicarium Mill.	Lamiaceae	Browns Town	Jamaica, Parish of Saint Ann
Tillandsia balbisiana Schult.f.	Bromeliaceae	Tobolski district, 3 miles southwest of Browns Town	Jamaica, Parish of Saint Ann
Tillandsia juncea (R. & P.) Poir.	Bromeliaceae	Tobolski district, 3 miles southwest of Browns Town	Jamaica, Parish of Saint Ann
Ximenia americana L.	Ximeniaceae	Knutsford house, 2.7 miles due south of Browns Town.	Jamaica, Parish of Saint Ann

Table 13-12: Flora – Stewart Town

Taxon	Family	Locality Name	Full Name of Parish
Antirrhinum antirrhiniflorum (Humb. & Bonpl. ex Willd.) *Hitchc.*	Plantaginaceae	Westwood, near Stewart Town	Jamaica, Parish of Trelawny
Campylocentrum jamaicense (Rchb.f. & Wullschl.) *Benth. ex Fawc.*	Orchidaceae	Woodlands, near Stewart Town	Jamaica, Parish of Trelawny
Casasia longipes Urb.	Rubiaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny

Celtis trinervia Lam.	Cannabaceae	Westwood School, near Stewart Town	Jamaica, Parish of Trelawny
Cionosicys pomiformis Griseb.	Cucurbitaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
Cyclopogon elatus (Sw.) Schltr.	Orchidaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
Cyperus tenuifolius (Steud.) Dandy	Cyperaceae	Near source of Dornock River (Rio Bueno) near Stewart Town	Jamaica, Parish of Saint Ann
Dichromena ciliata Vahl	Cyperaceae	Near source of Dornock River, (Rio Bueno) near Stewart Town	Jamaica, Parish of Saint Ann
Habenaria quinqueseta (Michx.) Eaton	Orchidaceae	Vicinity of Stewart Town	Jamaica, Parish of Trelawny
Liparis nervosa (Thunb.) Lindl.	Orchidaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
Lucya tetrandra (L.) K.Schum.	Rubiaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
*Najas guadalupensis (*Spreng.*) Morong*	Hydrocharitaceae	Woodlands, near Stewart Town	Jamaica, Parish of Trelawny
Peperomia amplexicaulis (Sw.) A.Dietr.	Piperaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
Potamogeton illinoensis Morong	Potamogetonaceae	Just below source of Dornock River (Rio Bueno) near Stewart Town.	Jamaica, Parish of Saint Ann
Teucrium vesicarium Mill.	Lamiaceae	Vicinity of Westwood High School, near Stewart Town	Jamaica, Parish of Trelawny
Tillandsia juncea (R. & P.) *Poir.*	Bromeliaceae	Near "Bird Haven", along main road 1 1/4 miles norhwest of Stewart Town	Jamaica, Parish of Trelawny
Tillandsia recurvata (L.) L.	Bromeliaceae	Along track leading to Woodlands, opposite Westwood, 1 mile northwest of Stewart Town	Jamaica, Parish of Trelawny
Tolumnia guttata (L.) Nir	Orchidaceae	Woodtown-Stewart road, ca. 1.5 km north of Stewart Town	Jamaica, Parish of Trelawny
Urena sinuata L.	Malvaceae	By source of Dornock River (Rio Bueno) near Stewart Town	Jamaica, Parish of Saint Ann

Wedelia gracilis Pers.	Asteraceae	By source of Dornock River (Rio Bueno), near Stewart Town	Jamaica, Parish of Saint Ann

Table 13-13: Flora –Jackson Town

Family	Taxon	Locality Name	Full Name of Parish
Solanaceae	*Solanum nigrum L.*	Along main road 1 1/4 miles east south east of Jackson Town	Jamaica, Parish of Trelawny

Table 13-14: Flora – Alps

Family	Taxon	Locality Name	Full Name of Parish
Asteraceae	Chromolaena DC. odorata	The Alps district, c. 2 miles north by north west of Ulster Spring.	Jamaica, Parish of Trelawny

Table 13-15: Flora – Linton Spring

Family	Taxon [Formatted]	Locality Name	Full Name of Parish
Apocynaceae	Funastrum clausum Schltr.	Dry River district, c. 1 mile north north east of Linton Spring	Jamaica, Parish of Trelawny
Asteraceae	Youngia japonica (L.) Benth.	Dry River district, c. 1 mile north north east of Linton Spring	Jamaica, Parish of Trelawny
Convolvulaceae	Ipomoea mauritiana Jacq.	Dry River district, c. 1 mile north,north,east of Linton Spring	Jamaica, Parish of Trelawny
Cyperaceae	Cyperus swartzii (Dietr.) Boeck. & Kuk.	Dry River district, c. 1 mile north, north,east of Linton Spring	Jamaica, Parish of Trelawny
Cyperaceae	Cyperus ochraceus Vahl	Dry River district, c. 1 mile North North East of Linton Spring	Jamaica, Parish of Trelawny
Lamiaceae	Leonurus sibiricus L.	Dry River district, c. 1 mile north, north,east of Linton Spring	Jamaica, Parish of Trelawny
Lamiaceae	Teucrium vesicarium Mill.	Dry River district, c. 1 mile north, north, east of Linton Spring	Jamaica, Parish of Trelawny

Lythraceae	Cuphea parsonsia R.Br. ex Steud.	Dry River district, c. 1 mile north north east of Linton Spring	Jamaica, Parish of Trelawny
Poaceae	Lithachne pauciflora (Sw.) Beauv.	Dry River district, c. 1 mile north north east of Linton Spring	Jamaica, Parish of Trelawny
Primulaceae	Wallenia subverticillata Ekman ex Urb.	Dry River district, c. 1 mile north,north,east of Linton Spring	Jamaica, Parish of Trelawny

Table 13-16: Flora – Ulster Spring

Taxon	Family	Locality Name	Full Name of Parish
Begonia sp.	Begoniaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny
Bletia sp.	Orchidaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village.	Jamaica, Parish of Trelawny
Chromolaena odorata	Asteraceae	The Alps district, c. 2 miles north by north west of Ulster Spring.	Jamaica, Parish of Trelawny
Campylocentrum fasciola (Lindl.) Cogn.	Orchidaceae	0.5 mile south of Ulster Spring	Jamaica, Parish of Trelawny
Cyperus tenuis Sw.	Cyperaceae	0.5 mile south of Ulster Spring	Jamaica, Parish of Trelawny
Eugenia sp.	Myrtaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny
Ionopsis satyrioides Rchb.f.	Orchidaceae	0.5 mile south of Ulster Spring	Jamaica, Parish of Trelawny
Lagetta lagetto (Sw.) Nash	Thymelaeaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny
Piper arboreum Aubl.	Piperaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny
Piper sp.	Piperaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny
Sida javensis Cav.	Malvaceae	Along track to Dry River from road between Sawyers & Ulster Spring	Jamaica, Parish of Trelawny
Smilax ornata Lem.	Smilacaceae	Berlin Estate, 4.5 miles due east of Ulster Spring Village	Jamaica, Parish of Trelawny

Table 13-17: Flora – Maroon Town

Taxon	Family	Locality Name	Full Name of Parish
Anathallis sertularioides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Casearia odorata Macf.	Salicaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Cyclopogon elatus (Sw.) Schltr.	Orchidaceae	Chat sworth district, 1.5 miles north north west Maroon Town	Jamaica, Parish of Saint James
Eugenia eperforata Urb.	Myrtaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Hedychium coronarium J.Koenig	Zingiberaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Hillia tetrandra Sw.	Rubiaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Rhynchospora polyphylla Vahl	Cyperaceae	Chatsworth, near Maroon Town	Jamaica, Parish of Saint James
Rhynchospora pusilla Griseb.	Cyperaceae	Ca. 1 mile South of Spring Vale, on road to Maroon Town	Jamaica, Parish of Saint James
Specklinia tribuloides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James
Tillandsia pruinosa Sw.	Bromeliaceae	0.5 mile northwest of Maroon Town	Jamaica, Parish of Saint James

Table 13-18: Flora – Windsor

Taxon	Family	Locality Name	Full Name of Parish
Acroceras zizanioides (Kunth) Dandy	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Amphitecna latifolia (Mill.) A.H.Gentry	Bignoniaceae	Windsor Castle district, west of Buff Bay	Jamaica, Parish of Portland

Axonopus compressus (Sw.) Beauv.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Bacopa repens Wettst.	Plantaginaceae	Windsor estate	Jamaica, Parish of Trelawny
Boehmeria jamaicensis Urb.	Urticaceae	South of Windsor House, on trail to Troy.	Jamaica, Parish of Trelawny
Brassavola subulifolia Lindl	Orchidaceae	Windsor estate.	Jamaica, Parish of Trelawny
Calophyllum jacquinii F. & R.	Calophyllaceae	Windsor estate	Jamaica, Parish of Trelawny
Cardiospermum grandiflorum Sw.	Sapindaceae	Along road to Windsor.	Jamaica, Parish of Trelawny
Casearia odorata Macf.	Salicaceae	Windsor estate	Jamaica, Parish of Trelawny
Casearia sylvestris Sw.	Salicaceae	Windsor estate	Jamaica, Parish of Trelawny
Catopsis berteroniana (Schult. & Schult.f.) Mez	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Ceiba pentandra (L.) Gaertn.	Malvaceae	Windsor estate	Jamaica, Parish of Trelawny
Cenchrus echinatus L.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Chrysophyllum cainito L.	Sapotaceae	Windsor estate	Jamaica, Parish of Trelawny
Clidemia erythropogon DC.	Melastomataceae	Windsor estate	Jamaica, Parish of Trelawny
Clidemia hirta D.Don	Melastomataceae	Vicinity of Windsor Cave	Jamaica, Parish of Trelawny
Clinopodium brownei (Sw.) Kuntze	Lamiaceae	Windsor eastate	Jamaica, Parish of Trelawny
Cochleanthes flabelliformis (Sw.) R.E.Schult. & Garay	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Cordia laevigata Lam.	Ehretiaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Cuscuta obtusiflora H.B.K var. glandulosa Engelm.	Convolvulaceae	Windsor estate	Jamaica, Parish of Trelawny
Cynodon dactylon (L.) Pers.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Cyperus brevifolius (Rottb.)Hassk.	Cyperaceae	Windsor estate	Jamaica, Parish of Trelawny
Cyperus flavus (Vahl)Nees	Cyperaceae	Windsor estate	Jamaica, Parish of Trelawny
Dichromena ciliata Vahl	Cyperaceae	Windsor estate	Jamaica, Parish of Trelawny
Digitaria horizontalis (L.) Scop.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny

Digitaria sanguinalis (L.) Scop.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Disocactus ramulosus (Salm-Dyck) Kimnach	Cactaceae	Windsor estate	Jamaica, Parish of Trelawny
Dorstenia fawcettii Urb.	Moraceae	Windsor Cave	Jamaica, Parish of Trelawny
Elleanthus longibracteatus (Lindl. ex Griseb.) Fawc.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Epidendrum anceps Jacq.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Epidendrum difforme Jacq.	Orchidaceae	Windsor estate.	Jamaica, Parish of Trelawny
Epidendrum diffusum Sw.	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny
Epidendrum nocturnum Jacq.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor.	Jamaica, Parish of Trelawny
Epidendrum rigidum Jacq.	Orchidaceae	Windsor estate.	Jamaica, Parish of Trelawny
Epidendrum strobiliferum Rchb.f.	Orchidaceae	Cockpit country along track between Windsor and Tyre	Jamaica, Parish of Trelawny
Erechthites hieracifolia (L.) Raf.	Asteraceae	Windsor estate	Jamaica, Parish of Trelawny
Eugenia disticha DC.	Myrtaceae	Windsor estate	Jamaica, Parish of Trelawny
Eugenia monticola DC.	Myrtaceae	Cockpit county along track between Windsor & Tyre, north of Troy	Jamaica, Parish of Trelawny
Faramea occidentalis (L.) A.Rich.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Faramea occidentalis (L.) A.Rich.	Rubiaceae	Cockpit County, WIndsor to Troy Trail, ca. 5.5 miles in Jamaica Parrot Project Camp, disturbed area on hilltop, common throughout trail	Jamaica, Parish of Trelawny
Ficus maxima Mill.	Moraceae	Along trail to Windsor Cave.	Jamaica, Parish of Trelawny
Guzmania monostachya (L.) Rusby ex Mez	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Habenaria repens Nutt.	Orchidaceae	1 mile north of Windsor Cave	Jamaica, Parish of Trelawny
Hamelia axillaris Sw.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Hylocereus triangularis Britton & Rose	Cactaceae	Windsor estate	Jamaica, Parish of Trelawny

Ichnanthus nemorosus (Sw.) Doell.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Ionopsis satyrioides Rchb.f.	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny
Ionopsis utricularioides (Sw.) Lindl.	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny
Ipomoea horsfalliae Hook.	Convolvulaceae	Windsor estate	Jamaica, Parish of Trelawny
Jacquiniella globosa (Jacq.) Schltr.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Lasiacis divaricata (L.) Hitchc.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Lithachne pauciflora (Sw.) Beauv.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Lobelia fawcettii Urb.	Campanulaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Mammea americana L.	Calophyllaceae	Windsor estate	Jamaica, Parish of Trelawny
Maxillaria parviflora (Poepp. & Endl.) Garay	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny
Nidema ottonis Britton & Millsp.	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Oeceoclades maculata Lindl.	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Oplismenus setarius (Lam.) R. & S.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Ossaea microphylla (Sw.)Triana	Melastomataceae	Windsor estate	Jamaica, Parish of Trelawny
Palicourea domingensis DC.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Panicum fasciculatum Sw.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Panicum laxum Sw.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Panicum pilosum Sw.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Paspalum conjugatum Berg.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Paspalum filiforme Sw.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Paspalum notatum Fluegge	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Paspalum paniculatum L.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny

Paspalum plicatulum Michx.	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Passiflora foetida L.	Passifloraceae	Windsor estate	Jamaica, Parish of Trelawny
Passiflora rubra L.	Passifloraceae	Windsor estate	Jamaica, Parish of Trelawny
Paullinia jamaicensis Macf.	Sapindaceae	Windsor estate	Jamaica, Parish of Trelawny
Peperomia cordifolia A.Dietr.	Piperaceae	Windsor estate	Jamaica, Parish of Trelawny
Peperomia serpens (Sw.) Loudon	Piperaceae	Windsor estate	Jamaica, Parish of Trelawny
Petitia domingensis Jacq.	Lamiaceae	Windsor estate	Jamaica, Parish of Trelawny
Pharus latifolius L.	Poaceae	Source of the Martha Brae River, Windsor estate	Jamaica, Parish of Trelawny
Phoradendron dipterum Eichler	Santalaceae	Windsor estate.	Jamaica, Parish of Trelawny
Physalis angulata L.	Solanaceae	Windsor estate	Jamaica, Parish of Trelawny
Physalis cordata Mill.	Solanaceae	Windsor estate	Jamaica, Parish of Trelawny
Physalis pubescens L.	Solanaceae	Windsor estate	Jamaica, Parish of Trelawny
Picramnia antidesma Sw.	Picramniaceae	South of Windsor House, on trail to Troy.	Jamaica, Parish of Trelawny
Picrasma excelsa (Sw.) Planch	Simaroubaceae	Windsor estate	Jamaica, Parish of Trelawny
Pilea sp.	Urticaceae	Windsor estate.	Jamaica, Parish of Trelawny
Pilea sp.	Urticaceae	Cockpit country 1 mile south south east of Windsor.	Jamaica, Parish of Trelawny
Pilea brevistipula Urb.	Urticaceae	Cockpit country along track between Windsor & Tyre	Jamaica, Parish of Trelawny
Pilea grandifolia Blume	Urticaceae	Windsor estate	Jamaica, Parish of Trelawny
Pilea inaequalis Wedd.	Urticaceae	Windsor estate	Jamaica, Parish of Trelawny
Pilea lucida Blume	Urticaceae	Path to Windsor Cave	Jamaica, Parish of Trelawny
Pilea maxonii Britton	Urticaceae	Windsor estate, north side of Cockpit Country	Jamaica, Parish of Trelawny
Pilea reticulata Wedd.	Urticaceae	Cockpit country along track between Windsor and Tyre	Jamaica, Parish of Trelawny
Piper sp.	Piperaceae	Windsor Caves, on trail leading to Quick Step (via Rest and Be Thankful), between Windsor Caves and Mosquito Hill	Jamaica, Parish of Trelawny

Piper amalago var. nigrinodum (C.DC.) Yunck.	Piperaceae	Windsor estate	Jamaica, Parish of Trelawny
Piper arboreum Aubl.	Piperaceae	Windsor estate	Jamaica, Parish of Trelawny
Plumeria obtusa L.	Apocynaceae	Windsor estate	Jamaica, Parish of Trelawny
Pouteria multiflora (A.DC.) Eyma	Sapotaceae	Windsor estate	Jamaica, Parish of Trelawny
Pseudorhipsalis alata (Sw.) Britton & Rose	Cactaceae	Windsor estate	Jamaica, Parish of Trelawny
Psychotria marginata Sw.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Psychotria nervosa Sw.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Psychotria pubescens Sw.	Rubiaceae	Windsor estate	Jamaica, Parish of Trelawny
Psychotria uliginosa Sw.	Rubiaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Renealmia aromatica Griseb.	Zingiberaceae	Windsor estate	Jamaica, Parish of Trelawny
Rhynchospora pusilla Griseb.	Cyperaceae	Windsor estate	Jamaica, Parish of Trelawny
Rousselia humilis Urb.	Urticaceae	Windsor estate	Jamaica, Parish of Trelawny
Sacoila lanceolata (Aubl.) Garay	Orchidaceae	Adam Brandons Patent, Windsor disitrict, 1 1/2 miles due north of Moore Town	Jamaica, Parish of Portland
Schlegelia parasitica Griseb.	Schlegeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Solanum mammosum L.	Solanaceae	Windsor estate	Jamaica, Parish of Trelawny
Specklinia corniculata (Sw.) Mutel	Orchidaceae	Vicinity of Windsor Cave	Jamaica, Parish of Trelawny
Specklinia tribuloides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny
Stenotaphrum secundatum (Walter) Kuntze	Poaceae	Windsor estate	Jamaica, Parish of Trelawny
Tillandsia balbisiana Schult.f.	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Tillandsia juncea (R. & P.) Poir.	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Tillandsia pruinosa Sw.	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Tillandsia variabilis Schltdl.	Bromeliaceae	Windsor estate	Jamaica, Parish of Trelawny
Tolumnia triquetra (Sw.) Nir	Orchidaceae	Windsor estate	Jamaica, Parish of Trelawny

Tournefortia angustiflora Ruiz & Pav.	Heliotropiaceae	Windsor estate	Jamaica, Parish of Trelawny
Tournefortia glabra L.	Heliotropiaceae	South of Windsor House, on trail to Troy.	Jamaica, Parish of Trelawny
Turpinia occidentalis (Sw.) G. Don	Staphyleaceae	Along trail to Windsor Cave	Jamaica, Parish of Trelawny
Urena sinuata L.	Malvaceae	Windsor estate	Jamaica, Parish of Trelawny

Table 13-19: Flora – Kinloss

Taxon	Family	Locality Name	Full Name of Parish
Anathallis sertularioides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 5.2 miles (8.3 km) from Burnt Hill intersection.	Jamaica, Parish of Trelawny
Bletia purpurea DC.	Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 5.2 miles (8.3 km) from Burnt Hill intersection.	Jamaica, Parish of Trelawny
Calyptranthes chytraculia (L.) Sw.	Myrtaceae	Two miles south of Kinloss at Stone Henge.	Jamaica, Parish of Trelawny
Campylocentrum micranthum (Lindl.) Maury	Orchidaceae	Cockpit Country, Spring Garden-Kinloss Rd, 6.8 miles (10.9 km) north of Burnt Hill intersection	Jamaica, Parish of Trelawny
Epidendrum anceps Jacq.	Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 6.8 miles (10.9 km) north of Burnt Hill intersection.	Jamaica, Parish of Trelawny
Liparis nervosa (Thunb.) Lindl.	Orchidaceae	Ramgoat Cave, along road between Albert Town and Kinloss	Jamaica, Parish of Trelawny
Lobelia acuminata Sw.	Campanulaceae	Along road between Kinloss & Barbecue Bottom.	Jamaica, Parish of Trelawny
Passiflora penduliflora Bertero ex DC.	Passifloraceae	Cockpit Country, Kinloss to Barbeque Bottom Road	Jamaica, Parish of Trelawny
Smilax sp.	Smilacaceae	Stonehenge, south of Kinloss	Jamaica, Parish of Trelawny
Smilax domingensis Willd.	Smilacaceae	About 1 1/2 miles above Kinloss	Jamaica, Parish of Trelawny
Stachytarpheta x adulterina Urb & Ekman	Verbenaceae	Along road between Kinloss and Stonehenge, cockpit country	Jamaica, Parish of Trelawny
Tillandsia balbisiana Schult.f.	Bromeliaceae	South West of Clarks Town along the road to Kinloss	Jamaica, Parish of Trelawny

Trichocentrum undulatum (Sw.) Ackerman & M.W.Chase	Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 5.2 miles (8.3 km) from Burnt Hill intersection.	Jamaica, Parish of Trelawny

Table 13-20: Flora – Albert Town

Taxon	Family	Locality Name	Full Name of Parish
Arthrostema fragile Lindl.	Melastomataceae	Along road between Burnt Hill & Albert Town	Jamaica, Parish of Trelawny
Calophyllum jacquinii F. & R.	Calophyllaceae	Albert Town	Jamaica, Parish of Trelawny
Ficus citrifolia Mill.	Moraceae	Burnt Hill between Albert Town and Troy.	Jamaica, Parish of Trelawny
Guazuma ulmifolia Lam.	Malvaceae	Near Albert Town	Jamaica, Parish of Trelawny
Ipomoea cairica (L.) Sweet	Convolvulaceae	Albert Town	Jamaica, Parish of Trelawny
Liparis nervosa (Thunb.) Lindl.	Orchidaceae	Ramgoat Cave, along road between Albert Town and Kinloss	Jamaica, Parish of Trelawny
Manilkara sideroxylon (Hook.) Dubard	Sapotaceae	Albert Town	Jamaica, Parish of Trelawny
Morella cerifera Small	Myricaceae	2.8 miles by road south of Albert Town P.O.	Jamaica, Parish of Trelawny
Paspalum virgatum L.	Poaceae	Albert Town	Jamaica, Parish of Trelawny
Pimenta dioica (L.) Merr.	Myrtaceae	Albert Town	Jamaica, Parish of Trelawny
Piper sp.	Piperaceae	Burnt Hill between Albert Town and Troy	Jamaica, Parish of Trelawny
Pouteria multiflora (A.DC.) Eyma	Sapotaceae	Albert Town	Jamaica, Parish of Trelawny
Sapindus saponaria L.	Sapindaceae	Albert Town	Jamaica, Parish of Trelawny
Schlegelia parasitica Griseb.	Schlegeliaceae	Burnt Hill between Albert Town and Troy	Jamaica, Parish of Trelawny
Themeda arguens (L.) Hack.	Poaceae	Albert Town	Jamaica, Parish of Trelawny
Tolumnia guttata (L.) Nir	Orchidaceae	Near Albert Town	Jamaica, Parish of Trelawny

Triumfetta hispida A.Rich.	Tiliaceae	Albert Town	Jamaica, Parish of Trelawny

Table 13-21: Flora – Spring Garden

Family	Locality Name	Full Name of Parish
Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 5.2 miles (8.3 km) from Burnt Hill intersection.	Jamaica, Parish of Trelawny
Orchidaceae	Near Spring Garden.	Jamaica, Parish of Trelawny
Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 5.2 miles (8.3 km) from Burnt Hill intersection.	Jamaica, Parish of Trelawny
Scrophulariaceae	c. 1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Myrtaceae	0.6-1 mile north of Spring Garden.	Jamaica, Parish of Trelawny
Orchidaceae	Cockpit Country, 0.7 miles (1.1 km) south of Burnt Hill on road to Spring Garden.	Jamaica, Parish of Trelawny
Orchidaceae	Cockpit Country, Spring Garden-Kinloss Rd, 6.8 miles (10.9 km) north of Burnt Hill intersection	Jamaica, Parish of Trelawny
Rubiaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Rhizophoraceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Bromeliaceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Clusiaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Euphorbiaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Sapindaceae	Spring Garden	Jamaica, Parish of Westmoreland
Orchidaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Loranthaceae	0.6-1 mile north of Spring Garden.	Jamaica, Parish of Trelawny

Ebenaceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 6.8 miles (10.9 km) north of Burnt Hill intersection.	Jamaica, Parish of Trelawny
Orchidaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Myrtaceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Myrtaceae	0.6-1 mile north of Spring Garden.	Jamaica, Parish of Trelawny
Myrtaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Sapindaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Rubiaceae	0 . 6 - 1 mile of north of spring garden	Jamaica, Parish of Trelawny
Salicaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Orchidaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Campanulaceae	c. 1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Orchidaceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Urticaceae	Spring Garden district.	Jamaica, Parish of Westmoreland
Urticaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Urticaceae	0.6-1 mile north of Spring Garden	Jamaica, Parish of Trelawny
Myrtaceae	Spring Garden	Jamaica, Parish of Westmoreland
Piperaceae	Spring Garden district.	Jamaica, Parish of Westmoreland
Orchidaceae	Cockpit Country, 0.7 miles (1.1 km) south of Burnt Hill on road to Spring Garden.	Jamaica, Parish of Trelawny
Orchidaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden.	Jamaica, Parish of Trelawny
Sapotaceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny

Melastomataceae	0.6-1 mile north of Spring Garden.	Jamaica, Parish of Trelawny
Heliotropiaceae	"Mango Tree Hill", along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny
Orchidaceae	Cockpit Country, Spring Garden-Kinloss Road, 6.8 miles (10.9 km) north of Burnt Hill intersection.	Jamaica, Parish of Trelawny
Moraceae	Mango Tree Hill, along road between Burnt Hill & Spring Garden	Jamaica, Parish of Trelawny

Table 13-22: Flora – Quickstep

Taxon	Family	Locality Name	Full Name of Parish
Begonia glabra Aul.	Begoniaceae	Paynes Patent district, c. 4 miles west north west of Quick Step	Jamaica, Parish of Trelawny
Bixa orellana L.	Bixaceae	Me No Sen You No Come, near Quick Step	Jamaica, Parish of Trelawny
Blakea trinervia L.	Melastomataceae	Belmore Castle, 1 mile north of Quick Step	Jamaica, Parish of Trelawny
Boehmeria jamaicensis Urb.	Urticaceae	Paynes Patent district, 31/2 miles west north west of Quick Step.	Jamaica, Parish of Trelawny
Cardiospermum sp.	Sapindaceae	Belmore Castle, Taylor's Property. Above Quick Step, District of Look Behind	Jamaica, Parish of Trelawny
Chionanthus domingensis Lam.	Oleaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Chromolaena odorata	Asteraceae	Along trail west north west of Quick Step	Jamaica, Parish of Trelawny
Cinnamodendron corticosum Miers	Canellaceae	Cockpit Country north of Quick Step	Jamaica, Parish of Trelawny
Cionosicys pomiformis Griseb.	Cucurbitaceae	Paynes Patent district, c. 4 miles west north west of Quick Step	Jamaica, Parish of Trelawny

Cissus microcarpa Vahl	Vitaceae	Belmore Castle, Tayor's Property. Quick step village	Jamaica, Parish of Trelawny
Cordia laevigata Lam.	Ehretiaceae	Paynes Patent district, c. 4 miles west north west of Quick Step	Jamaica, Parish of Trelawny
Cranichis muscosa Sw.	Orchidaceae	Cockpit county c. 5 miles north of Quick Step	Jamaica, Parish of Trelawny
Cryptarrhena lunata R.Br.	Orchidaceae	Cockpit County c. 8 miles north of Quick Step	Jamaica, Parish of Trelawny
Cupania glabra Sw.	Sapindaceae	Belmore Castle, north of Quick Step	Jamaica, Parish of Trelawny
Cuphea parsonsia R.Br. ex Steud.	Lythraceae	Belmore Castle, Taylor's Property. Above Quick Step, District of Look Behind	Jamaica, Parish of Trelawny
Dendrophylax funalis (Sw.) Benth. ex Rolfe	Orchidaceae	Cockpit country c. 8 miles north of Quick Step	Jamaica, Parish of Trelawny
Dioscorea cordata (L.) Raz	Dioscoreaceae	Along road north to Quick Step	Jamaica, Parish of Trelawny
Dioscorea polygonoides Humb. & Bonpl. ex Willd.	Dioscoreaceae	Along road north of Quick Step	Jamaica, Parish of Trelawny
Dorstenia fawcettii Urb.	Moraceae	Cockpit country c. 8 miles north of Quick Step.	Jamaica, Parish of Trelawny
Epidendrum anceps Jacq.	Orchidaceae	Belmore Castle, Taylor's Property. Above the village of Quick Step, District of Look Behind.	Jamaica, Parish of Trelawny
Eugenia sp.	Myrtaceae	Along road north of Quick Step	Jamaica, Parish of Trelawny
Eugenia axillaris Willd.	Myrtaceae	Cockpit hill above Belmore Castle, Taylor's Property. Near Quick Step village	Jamaica, Parish of Trelawny
Eugenia disticha DC.	Myrtaceae	Paynes Patent district, c. 4 miles west north west of Quick Step	Jamaica, Parish of Trelawny
Eugenia websteri Proctor	Myrtaceae	Cockpit Country c. 5 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Ionopsis utricularioides (Sw.) Lindl.	Orchidaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny

Ipomoea phyllomega (Vell.) House	Convolvulaceae	5.1 miles by road north of Quick Step P.A.	Jamaica, Parish of Trelawny
Krugiodendron ferreum (Vahl) Urban	Rhamnaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Laetia thamnia L.	Salicaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Lagetta lagetto (Sw.) Nash	Thymelaeaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Lepanthes sp.	Orchidaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Liparis nervosa (Thunb.) Lindl.	Orchidaceae	Along road north of Quick Step	Jamaica, Parish of Trelawny
Macradenia lutescens R.Br.	Orchidaceae	Belmore Castle district, c. 1 mile north of Quick Step	Jamaica, Parish of Trelawny
Mammea americana L.	Calophyllaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Manilkara zapota (L.) P.Royen	Sapotaceae	Quick Step	Jamaica, Parish of Trelawny
Microchilus hirtellus D.Dietr.	Orchidaceae	Cockpit Country c. 5 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Mikania micrantha H.B.K.	Asteraceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Mitranthes glabra Proctor	Myrtaceae	5.3 miles by road north of Quick Step P.A.	Jamaica, Parish of Trelawny
Mouriri myrtilloides (Sw.) Poir.	Melastomataceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Muscarella delicatula (Lindl.) Luer	Orchidaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pavonia rosea Schlecht.	Malvaceae	Dyer's Patent, near Quick Step	Jamaica, Parish of Trelawny
Pentalinon luteum (L.) B.F.Hansen & Wunderlin	Apocynaceae	Along road between Quick Step and Belmore Castle, cockpit country	Jamaica, Parish of Trelawny
Peperomia glabella A.Dietr.	Piperaceae	School-house Hill, Quick Step	Jamaica, Parish of Saint Elizabeth
Peperomia serpens (Sw.) Loudon	Piperaceae	Along trail west north west of Quick Step	Jamaica, Parish of Trelawny

Petitia domingensis Jacq.	Lamiaceae	Hill behind schoolhouse Quick Step	Jamaica, Parish of Saint Elizabeth
Pharus latifolius L.	Poaceae	Along trail west,north,west of Quick Step, cockpit country	Jamaica, Parish of Trelawny
Picramnia antidesma Sw.	Picramniaceae	On hill behind school, Quick Step	Jamaica, Parish of Saint Elizabeth
Pilea sp.	Urticaceae	Along road north of Quick Step.	Jamaica, Parish of Trelawny
Pilea sp. 2	Urticaceae	Along road north of Quick Step.	Jamaica, Parish of Trelawny
Pilea brevistipula Urb.	Urticaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pilea crassifolia Blume.	Urticaceae	Cockpit Country, 1 - 2 miles northwest of Quick Step School	Jamaica, Parish of Trelawny
Pilea impressa Urb.	Urticaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pilea inaequalis Wedd.	Urticaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pilea maxonii Britton	Urticaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pilea reticulata Wedd.	Urticaceae	Cockpit country 5.3 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Pilea rotundata Griseb.	Urticaceae	Cockpit Country, 1 - 2 miles northwest of Quick Step School	Jamaica, Parish of Trelawny
Pilea silvicola Fawc. & Rendle	Urticaceae	Cockpit Country, 1 - 2 miles northwest of Quick Step School	Jamaica, Parish of Trelawny
Piper sp.	Piperaceae	Windsor Caves, on trail leading to Quick Step (via Rest and Be Thankful), between Windsor Caves and Mosquito Hill	Jamaica, Parish of Trelawny
Piper aduncum L.	Piperaceae	Hilltop above Mouse Hole, along trail west north west of Quick Step	Jamaica, Parish of Trelawny
Piper amalago var. nigrinodum (C.DC.) Yunck.	Piperaceae	School-house Hill, Quick Step.	Jamaica, Parish of Saint Elizabeth

Piper amalgo L.	Piperaceae	School-house Hill, Quick Step.	Jamaica, Parish of Saint Elizabeth
Piper arboreum Aubl.	Piperaceae	5.2 miles north of Quick Step, Cockpit Country	Jamaica, Parish of Trelawny
Piper arboreum subsp. arboreum	Piperaceae	Along trail west north west of Quick Step	Jamaica, Parish of Trelawny
Piper arboreum var. falcifolium (Trel.) Yunck.	Piperaceae	Paynes Patent district, 31/2 miles west north west of Quick Step.	Jamaica, Parish of Trelawny
Pleurothallis sp.	Orchidaceae	Cockpit Country c. 5 miles by road north of Quick Step	Jamaica, Parish of Trelawny
Podocarpus purdieanus Hook.	Podocarpaceae	Cockpit country W.N.W. of Quick Step.	Jamaica, Parish of Trelawny
Ponthieva racemosa C.Mohr	Orchidaceae	Along trail between Quick Step and Accompong	Jamaica, Parish of Saint Elizabeth
Pouteria multiflora (A.DC.) Eyma	Sapotaceae	Along trail west,north,west of Quick Step, cockpit country	Jamaica, Parish of Trelawny
Prosthechea fragrans (Sw.) W.E.Higgins	Orchidaceae	Cockpit country c. 8 miles north of Quick Step.	Jamaica, Parish of Trelawny
Sacoila lanceolata (Aubl.) Garay	Orchidaceae	Along trail between Quick Step and Accompong	Jamaica, Parish of Saint Elizabeth
Schlegelia parasitica Griseb.	Schlegeliaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Solanum acropterum Griseb.	Solanaceae	Paynes Patent, 2 miles west,north,west of Quick Step	Jamaica, Parish of Trelawny
Solanum torvum Sw.	Solanaceae	Cockpit Country, 1 - 2 miles northwest of Quick Step School	Jamaica, Parish of Trelawny
Stenostomum coriaceum (Vahl) Griseb.	Rubiaceae	5.3 miles by road north of Quick Step P.A.	Jamaica, Parish of Trelawny
Tolumnia guttata (L.) Nir	Orchidaceae	Along road north of Quick Step	Jamaica, Parish of Trelawny
Tolumnia pulchella Raf.	Orchidaceae	Belmore Castle area, north of Quick Step	Jamaica, Parish of Trelawny
Tournefortia angustiflora Ruiz & Pav.	Heliotropiaceae	Quick step district of Look behind	Jamaica, Parish of Trelawny

Tournefortia glabra L.	Heliotropiaceae	Cockpit Coutry, beyond Belmore Castle, 1-2 miles northwest of Quick Step school	Jamaica, Parish of Trelawny
Trichocentrum luridum (Lindl.) M.W.Chase & N.H.Williams	Orchidaceae	Along trail between Quick Step and Accompong	Jamaica, Parish of Saint Elizabeth
Trichosalpinx dura (Lindl.) Luer	Orchidaceae	Cockpit country c. 8 miles north of Quick Step.	Jamaica, Parish of Trelawny
Turnera ulmifolia L.	Turneraceae	Hill behind scchool-house. Quick Step	Jamaica, Parish of Saint Elizabeth
Turpinia occidentalis (Sw.) G. Don	Staphyleaceae	Quick Step	Jamaica, Parish of Trelawny
Urera expansa Griseb.	Urticaceae	Cockpit Country c. 1-2 miles northwest of Quick Step school.	Jamaica, Parish of Trelawny

Table 13-23: Flora - Elderslie

Taxon	Family	Locality Name	Full Name of Parish
Blakea trinervia L.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Clidemia erythropogon DC.	Melastomataceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Clidemia hirta D.Don	Melastomataceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Clidemia strigillolosa (Sw.) DC.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Eleocharis geniculata (L.) R. & S.	Cyperaceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Eugenia disticha DC.	Myrtaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Fimbristylis complanata (Retz.) Link	Cyperaceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Hamelia scabrida Britton	Rubiaceae	Along road between Mulgrave & Elderslie	Jamaica, Parish of Saint Elizabeth
Heterotrichum umbellatum (Mill.)Urban	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Lobelia fawcettii Urb.	Campanulaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Miconia albicans (Sw.) Triana	Melastomataceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Miconia ciliata (L.Rich.) DC.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth

Miconia impetiolaris (Sw.) D. Don ex DC.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Miconia laevigata (L.) DC.	Melastomataceae	Cocks Bottom, east of Elderslie.	Jamaica, Parish of Saint Elizabeth
Miconia prasina (Sw.) DC.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Miconia serrulata (DC.) Naud.	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Ossaea microphylla (Sw.)Triana	Melastomataceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Paspalum virgatum L.	Poaceae	1/2 mile southeast of Elderslie	Jamaica, Parish of Saint Elizabeth
Pavonia troyana Urb.	Malvaceae	Along road between Mulgrave & Elderslie	Jamaica, Parish of Saint Elizabeth
Peperomia cordifolia A.Dietr.	Piperaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Pilea brevistipula Urb.	Urticaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Pilea inaequalis Wedd.	Urticaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Pilea lucida Blume	Urticaceae	Cocks Bottom, east of Elderslie.	Jamaica, Parish of Saint Elizabeth
Pilea reticulata Wedd.	Urticaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Scleria cubensis Boeckl.	Cyperaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Solanum grandiflorum Ruiz & Pav.	Solanaceae	Cooks Bottom, east of Elderslie	Jamaica, Parish of Saint Elizabeth
Tournefortia maculata Vahl	Heliotropiaceae	Along road between Mulgrave & Elderslie	Jamaica, Parish of Saint Elizabeth

Table 13-24: Flora - Troy

Taxon	Family	Locality Name	Full Name
Acianthera hirsutula (Fawc. & Rendle) Pridgeon & M.W.Chase	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Allophylus cominia Sw.	Sapindaceae	Cockpit Country c. 3 miles N of Troy	Jamaica, Parish of Trelawny
Anathallis sertularioides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Angadenia lindeniana Miers	Apocynaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Boehmeria jamaicensis Urb.	Urticaceae	South of Windsor House, on trail to Troy.	Jamaica, Parish of Trelawny

Bourreria venosa (Miers) Stearn	Ehretiaceae	End of Crown Lands Road from near Troy	Jamaica, Parish of Trelawny
Bourreria venosa (Miers) Stearn	Ehretiaceae	End of Crown Lands Road from near Troy	Jamaica, Parish of Trelawny
Brachiaria brizantha stapf	Poaceae	Along Crown Lands road extension 4.5-6 miles NW. of Troy	Jamaica, Parish of Trelawny
Brassia caudata (L.) Lindl.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Buchenavia capitata (Vahl) Eichl.	Combretaceae	Crown Lands road extension c. 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Calyptranthes chytraculia (L.) Sw.	Myrtaceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Campylocentrum fasciola (Lindl.) Cogn.	Orchidaceae	Bridge End, near Troy. (Trelawny)	Jamaica, Parish of Manchester
Campylocentrum micranthum (Lindl.) Maury	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Carex polystachya Sw.	Cyperaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Chloris ekmanii Hitchc.	Poaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Citharexylum caudatum L.	Verbenaceae	Cockpit Country, Crown Lands 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Clethra occidentalis Kuntze	Clethraceae	Woods at the end of crown lands from near Troy	Jamaica, Parish of Trelawny
Clidemia hirta D.Don	Melastomataceae	1/2 miles north of Troy.	Jamaica, Parish of Trelawny
Clinopodium brownei (Sw.) Kuntze	Lamiaceae	Near Troy	Jamaica, Parish of Trelawny
Clusia flava Jacq.	Clusiaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Cochleanthes flabelliformis (Sw.) R.E.Schult. & Garay	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Cordia laevigata Lam.	Ehretiaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Crinum zeylanicum L.	Amaryllidaceae	Bridge End near Troy (Trelawny)	Jamaica, Parish of Manchester

Cyclopogon elatus (Sw.) Schltr.	Orchidaceae	Boothe district, c. 3 miles north of Troy	Jamaica, Parish of Trelawny
Cymbidium vestitium (Sw.) Sw.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Digitaria horizontalis Willd.	Poaceae	West Indies: Troy	Jamaica, Parish of Trelawny
Disocactus ramulosus (Salm-Dyck) Kimnach	Cactaceae	Troy	Jamaica, Parish of Trelawny
Dorstenia fawcettii Urb.	Moraceae	Cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Elleanthus linifolius C.Presl	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Elleanthus longibracteatus (Lindl. ex Griseb.) Fawc.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Encyclia angustifolia Schltr.	Orchidaceae	Crown Lands area, 4 - 5 miles northwest of Troy.	Jamaica, Parish of Trelawny
Epidendrum anceps Jacq.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Epidendrum difforme Jacq.	Orchidaceae	Bridge End, near Troy (Trelawny)	Jamaica, Parish of Manchester
Epidendrum diffusum Sw.	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Epidendrum nocturnum Jacq.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Epidendrum rigidum Jacq.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Epidendrum rivulare Lindl.	Orchidaceae	Boothe district, c. 3 miles north of Troy	Jamaica, Parish of Trelawny
Eugenia sp.	Myrtaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Eugenia axillaris Willd.	Myrtaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Eugenia disticha DC.	Myrtaceae	1/2 mile southwest of Troy	Jamaica, Parish of Manchester
Eugenia monticola DC.	Myrtaceae	1/2 mile southwest of Troy	Jamaica, Parish of Manchester
Eulophia alta Fawc. & Rendle	Orchidaceae	Cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Faramea occidentalis (L.) A.Rich.	Rubiaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny

Ficus citrifolia Mill.	Moraceae	Burnt Hill between Albert Town and Troy.	Jamaica, Parish of Trelawny
Fimbristylis dichotoma (L.) Vahl	Cyperaceae	Cockpit County, Crown Lands 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Fischeria crispiflora K.Schum.	Apocynaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Garcinia humilis (Vahl) C.D.Adams	Clusiaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Gonzalagunia brachyantha Urb.	Rubiaceae	End of Crown Lands Road from near Troy	Jamaica, Parish of Trelawny
Guettarda argentea Lam.	Rubiaceae	Limestone cliffs near Troy	Jamaica, Parish of Trelawny
Heterotrichum umbellatum (Mill.)Urban	Melastomataceae	Cockpit country 4 miles nortwest of Troy.	Jamaica, Parish of Trelawny
Hydrolea spinosa L.	Hydrophyllaceae	Vicinity of Troy	Jamaica, Parish of Trelawny
Hypoxis decumbens L.	Hypoxidaceae	Bridge End, near Troy (Trelawny)	Jamaica, Parish of Manchester
Ionopsis utricularioides (Sw.) Lindl.	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Jacquiniella globosa (Jacq.) Schltr.	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Krugiodendron ferreum (Vahl) Urban	Rhamnaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Laelia lyonsii (Lindl.) L.O.Williams	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Leochilus labiatus (Sw.) Kuntze	Orchidaceae	Bridge End near Troy (Trelawny)	Jamaica, Parish of Manchester
Lepanthes sp.	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Lepanthes sp. 2	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Lepanthes sp. 3	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Lepanthes convexa Hespenheide	Orchidaceae	5 1/2 miles northwest of Troy	Jamaica, Parish of Trelawny
Lepanthes multiflora C.D.Adams & Hiespenheide	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny

Lobelia fawcettii Urb.	Campanulaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Malaxis spicata Sw.	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Matayba apetala Radlk.	Sapindaceae	Troy	Jamaica, Parish of Trelawny
Maxillaria parviflora (Poepp. & Endl.) Garay	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Melanthera aspera (Jacq.)Rendle.	Asteraceae	1/2 miles north of Troy.	Jamaica, Parish of Trelawny
Miconia impetiolaris (Sw.) D. Don ex DC.	Melastomataceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Miconia laevigata (L.) D. Don	Melastomataceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Miconia prasina (Sw.) DC.	Melastomataceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Mitranthes sp. 1	Myrtaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Mitranthes clarendonensis (Proctor) Proctor	Myrtaceae	Ca. 5 miles northwest of Troy Bridge on Crown Lands road extension, past the settlement of Headings	Jamaica, Parish of Trelawny
Mitranthes macrophylla Proctor	Myrtaceae	Near Crown Lands road extension 4.5-5 miles northwest of Troy	Jamaica, Parish of Trelawny
Mitranthes sp. 2	Myrtaceae	Troy, near Crown Lands road extension in forest reserve	Jamaica, Parish of Trelawny
Mitranthes sp. 3	Myrtaceae	Troy, near Crown Lands road extension in forest reserve	Jamaica, Parish of Trelawny
Muscarella delicatula (Lindl.) Luer	Orchidaceae	5 1/2 miles northwest of Troy	Jamaica, Parish of Trelawny
Myrsine coriacea (Sw.) R.Br. ex Roem. & Schult.	Primulaceae	Cockpit Country, Crown Lands 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Nidema ottonis Britton & Millsp.	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Oeceoclades maculata Lindl.	Orchidaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny

Oplismenus setarius (Lam.) R. & S.	Poaceae	End of Crown Lands Road from near Troy	Jamaica, Parish of Trelawny
Oryctanthus occidentalis Eichler	Loranthaceae	1/2 mile north of Troy.	Jamaica, Parish of Trelawny
Ossaea microphylla (Sw.)Triana	Melastomataceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Paspalum notatum Fluegge	Poaceae	Near Troy	Jamaica, Parish of Trelawny
Paspalum plicatulum Michx.	Poaceae	Near Troy	Jamaica, Parish of Trelawny
Passiflora rubra L.	Passifloraceae	Cockpit County, WIndsor to Troy Trail, ca. 5.5 miles in Jamaica Parrot Project Camp, disturbed area on hilltop, common throughout trail	Jamaica, Parish of Trelawny
Passiflora tacsonioides	Passifloraceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Pavonia troyana Urb.	Malvaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Peperomia amplexicaulis (Sw.) A.Dietr.	Piperaceae	Cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Peperomia barbata C.DC.	Piperaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Peperomia cordifolia A.Dietr.	Piperaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Phaius tancarvilleae (L'Her.) Blume	Orchidaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Pharus latifolius L.	Poaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Picramnia antidesma Sw.	Picramniaceae	South of Windsor House, on trail to Troy.	Jamaica, Parish of Trelawny
Pilea sp.	Urticaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy.	Jamaica, Parish of Trelawny
Pilea flavicaulis Urb. & Britton ex Urb.	Urticaceae	Road from Troy to Crown Lands, about 5 mile northwest of Troy bridge	Jamaica, Parish of Trelawny
Pilea impressa Urb.	Urticaceae	Cockpit Country, Crown Lands 4 miles northwest of Troy	Jamaica, Parish of Trelawny

Pilea laurae C.D.Adams	Urticaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Pilea rufescens Fawc. & Rendle	Urticaceae	Cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Piper sp.	Piperaceae	Burnt Hill between Albert Town and Troy	Jamaica, Parish of Trelawny
Piper amalago var. nigrinodum (C.DC.) Yunck.	Piperaceae	1/2 mile north of Troy	Jamaica, Parish of Trelawny
Pleurothallis sp.	Orchidaceae	Near Crown Lands road extension 4.5 - 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Podocarpus purdieanus Hook.	Podocarpaceae	Edge of cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Polystachya foliosa (Hook.) Rchb.f.	Orchidaceae	Near Troy	Jamaica, Parish of Trelawny
Prosthechea cochleata (L.) W.E.Higgins	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Pseudolmedia spuria Griseb.	Moraceae	Tyre district, 2 miles north of Troy.	Jamaica, Parish of Trelawny
Pseudorhipsalis alata (Sw.) Britton & Rose	Cactaceae	Boothe district, c. 3 miles north of Troy	Jamaica, Parish of Trelawny
Psychotria nervosa Sw.	Rubiaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Psychotria uliginosa Sw.	Rubiaceae	Cockpit country along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Rhynchospora pusilla Griseb.	Cyperaceae	Cockpit County, Crown Lands 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Schlegelia parasitica Griseb.	Schlegeliaceae	Troy	Jamaica, Parish of Trelawny
Solanum grandiflorum Ruiz & Pav.	Solanaceae	Bridge End, near Troy (Trelawny)	Jamaica, Parish of Manchester
Specklinia corniculata (Sw.) Mutel	Orchidaceae	Cockpit country 4 miles northwest of Troy	Jamaica, Parish of Trelawny
Specklinia tribuloides (Sw.) Pridgeon & M.W.Chase	Orchidaceae	Troy	Jamaica, Parish of Trelawny

Stachytarpheta mutabilis Vahl	Verbenaceae	Ca. midway between Troy and Warsop	Jamaica, Parish of Trelawny
Stelis scabrida Lindl.	Orchidaceae	5 1/2 miles northwest of Troy	Jamaica, Parish of Trelawny
Stenostomum coriaceum (Vahl) Griseb.	Rubiaceae	End of Crown Lands Road from near Troy	Jamaica, Parish of Trelawny
Tillandsia fasciculata Sw.	Bromeliaceae	Near Crown Lane road extension 4.5-5 miles northwest of Troy	Jamaica, Parish of Trelawny
Tillandsia pruinosa Sw.	Bromeliaceae	Troy	Jamaica, Parish of Trelawny
Tillandsia selleana Harms	Bromeliaceae	Crown Lands road c.4 miles West North West of Troy	Jamaica, Parish of Trelawny
Tillandsia variabilis Schltdl.	Bromeliaceae	Troy	Jamaica, Parish of Trelawny
Tolumnia triquetra (Sw.) Nir	Orchidaceae	Cockpit Country, along trail from Troy to Windsor	Jamaica, Parish of Trelawny
Tournefortia glabra L.	Heliotropiaceae	Crown Lands road extension c. 5 miles northwest of Troy	Jamaica, Parish of Trelawny
Tournefortia maculata Vahl	Heliotropiaceae	Tyre district, 2 miles north of Troy	Jamaica, Parish of Trelawny
Trichocentrum undulatum (Sw.) Ackerman & M.W.Chase	Orchidaceae	Troy	Jamaica, Parish of Trelawny
Trophis racemosa Urb.	Moraceae	Crown Lands road extension c. 5 mile northwest of Troy.	Jamaica, Parish of Trelawny

Appendix XXIII: Aerial Photographs and Maps for the 'C*lawed Back Area*'

Figure 13-1 to Figure 13-2 are aerial photographs and maps for the '*clawed back area*', which includes the communities of Sawyers and Level Bottom. These aerial photographs and maps illustrate the following:

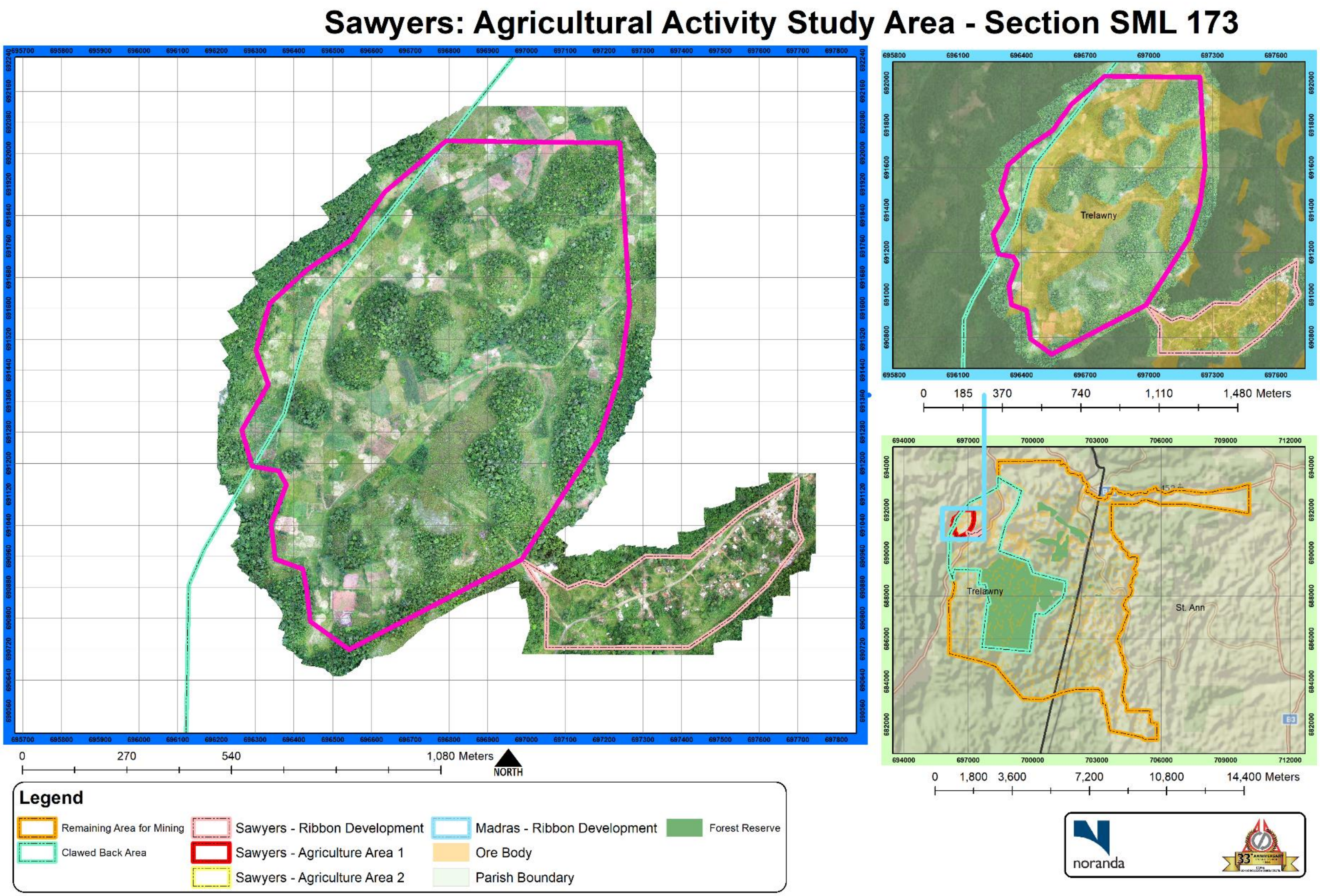
1. The area is relatively developed, with modern physical infrastructure (roadways)
2. Human settlements with residences made of reinforced concrete and modern materials
3. Mixed settlements/agriculture/grasslands on variable terrain
4. Agricultural areas in depressions
5. Cleared hillsides (Hillsides cleared to facilitate agricultural activities and for obtaining yam sticks)
6. Grass-covered depressions
7. Remnant forests on the hillocks

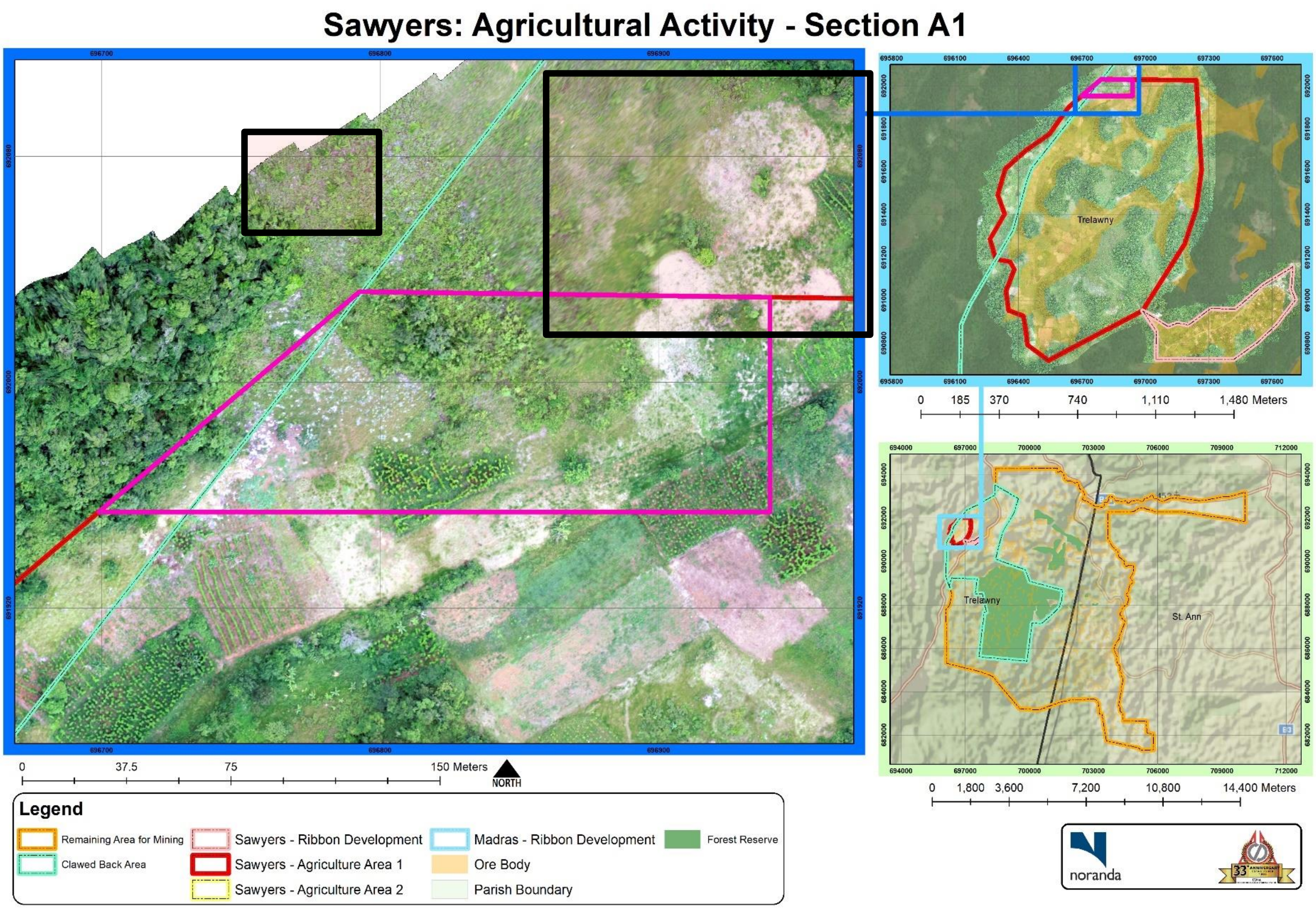
This shows an existing high level of natural fragmentation and fragmentation resulting from human activities. The '*clawed back area*' will not be impacted by bauxite mining. Farming will therefore be continued in the communities, and the livelihoods of the residents will be sustained.

The remnant forests on the elevated parts of the hillocks show a high level of floral biodiversity. In general, these remnant forests will continue to perform their natural services of providing habitats for flora and fauna, as well as carrying out their natural services of carbon sequestration, air cleansing, in general, generating oxygen (carbon neutrality) and perform evapotranspiration services. It is important to note that even if bauxite mining were to be carried out in the '*clawed back area*', it will not impact on these remnant forests, which are in the elevated areas of the hillocks.

Avoidance of this area represents a significant impact mitigation strategy, which will bear socio-economic and natural benefits.

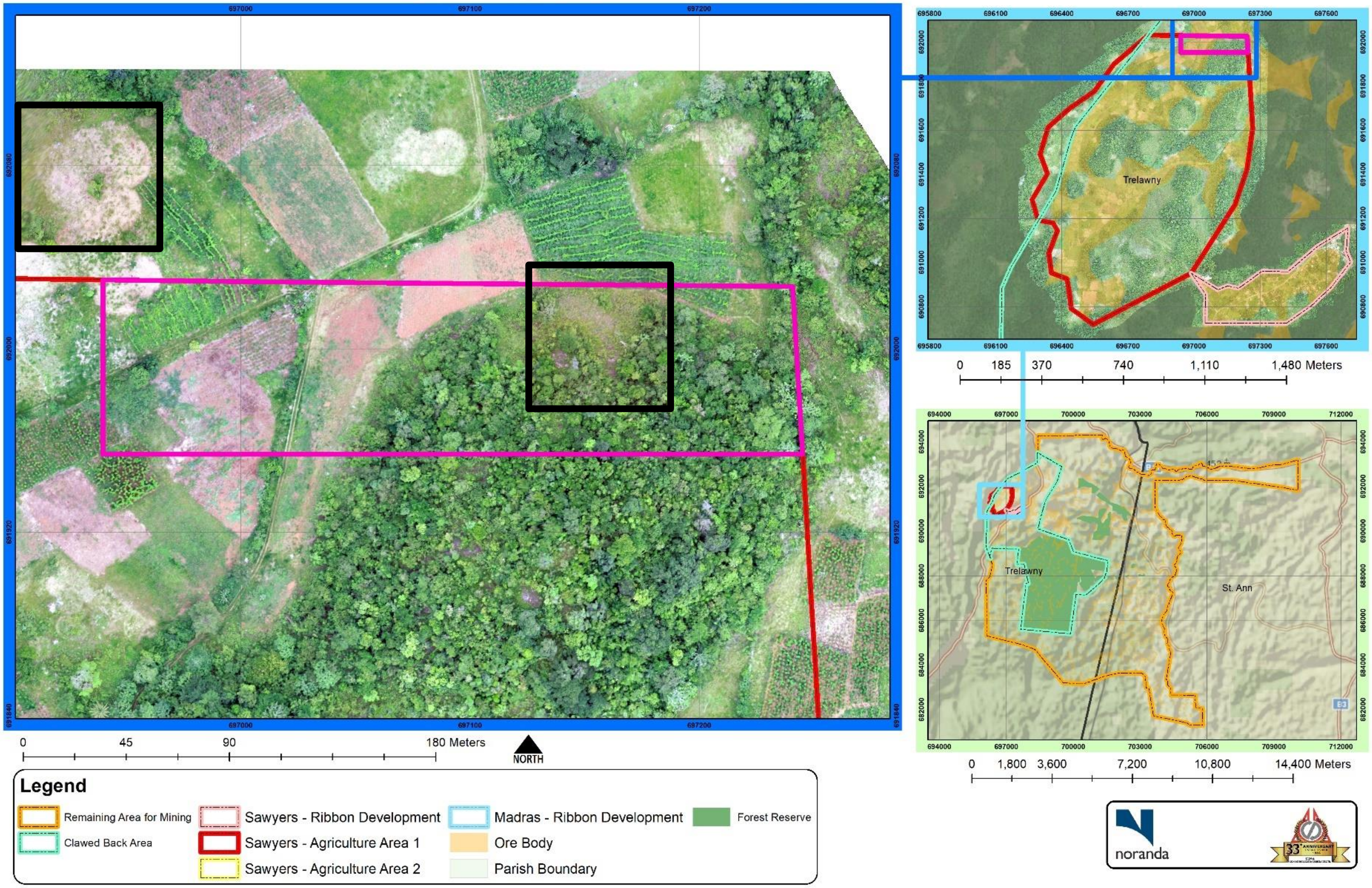
Figure 13-1: Sawyers Agricultural Activity (Area 1) – Section of SML 173





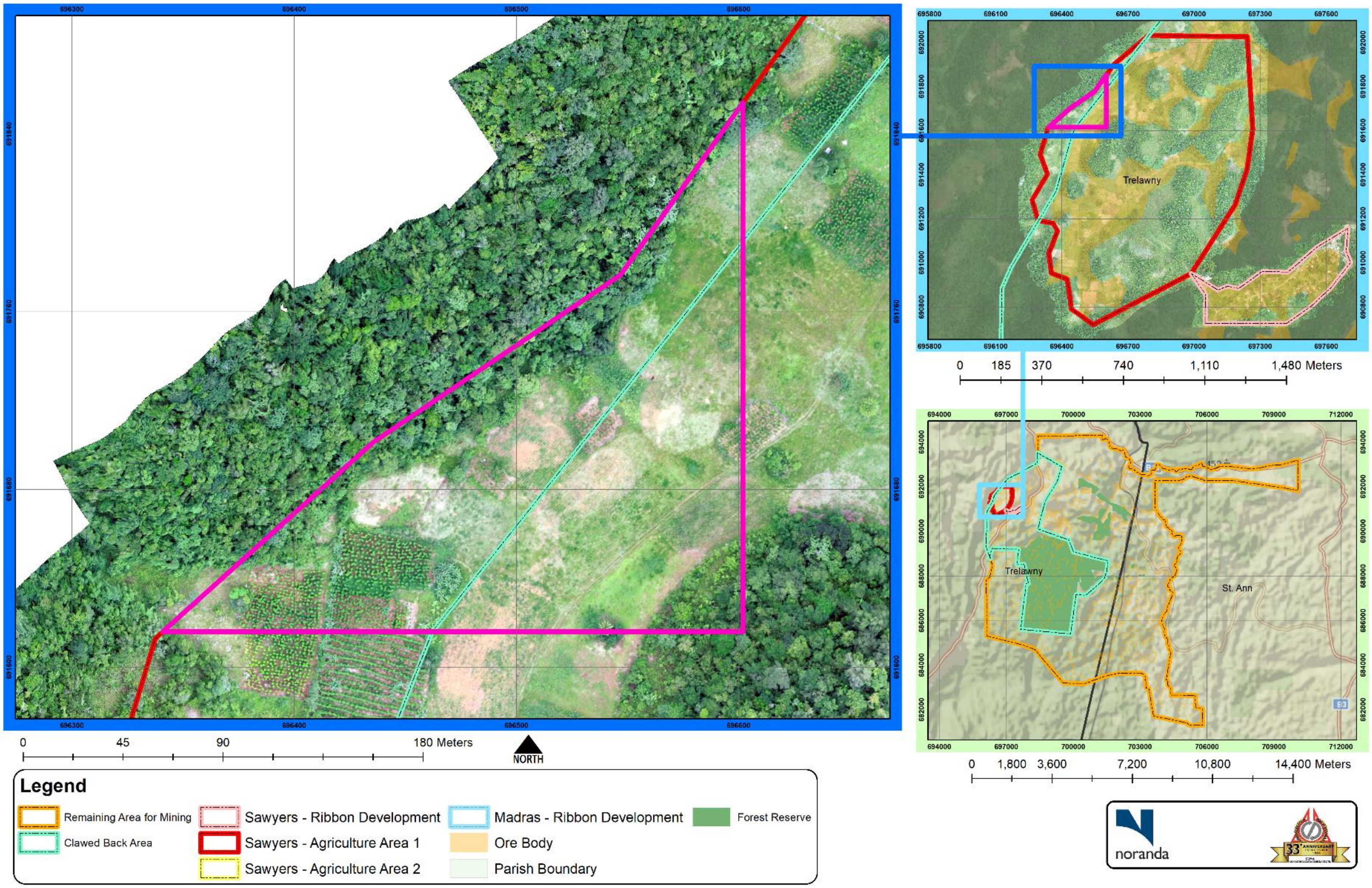
Agricultural activities and high floral biodiversity in the remnant hillocks (Shown in black boxes – vegetation stripped exposing limestone base rock).

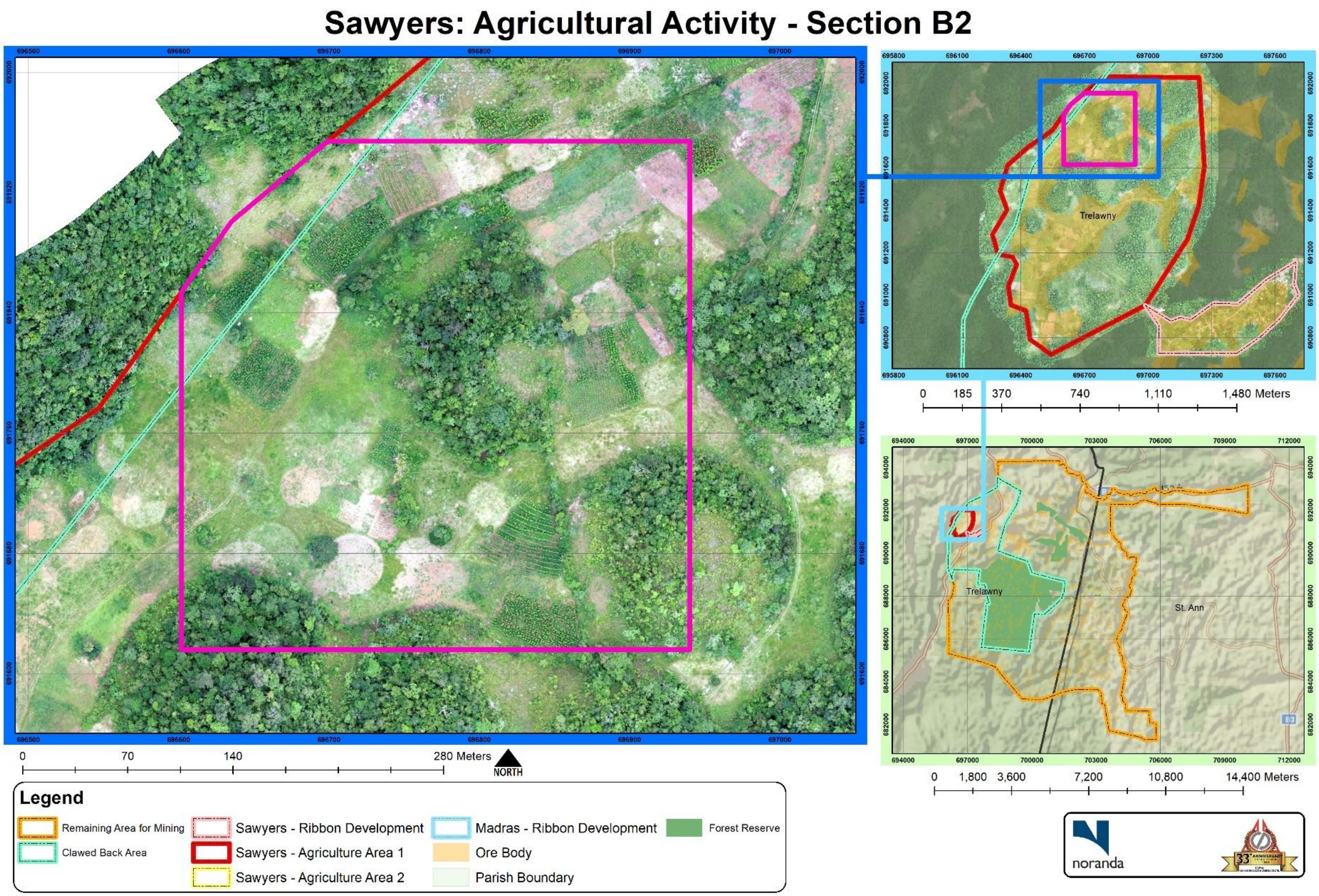
Sawyers: Agricultural Activity - Section A2



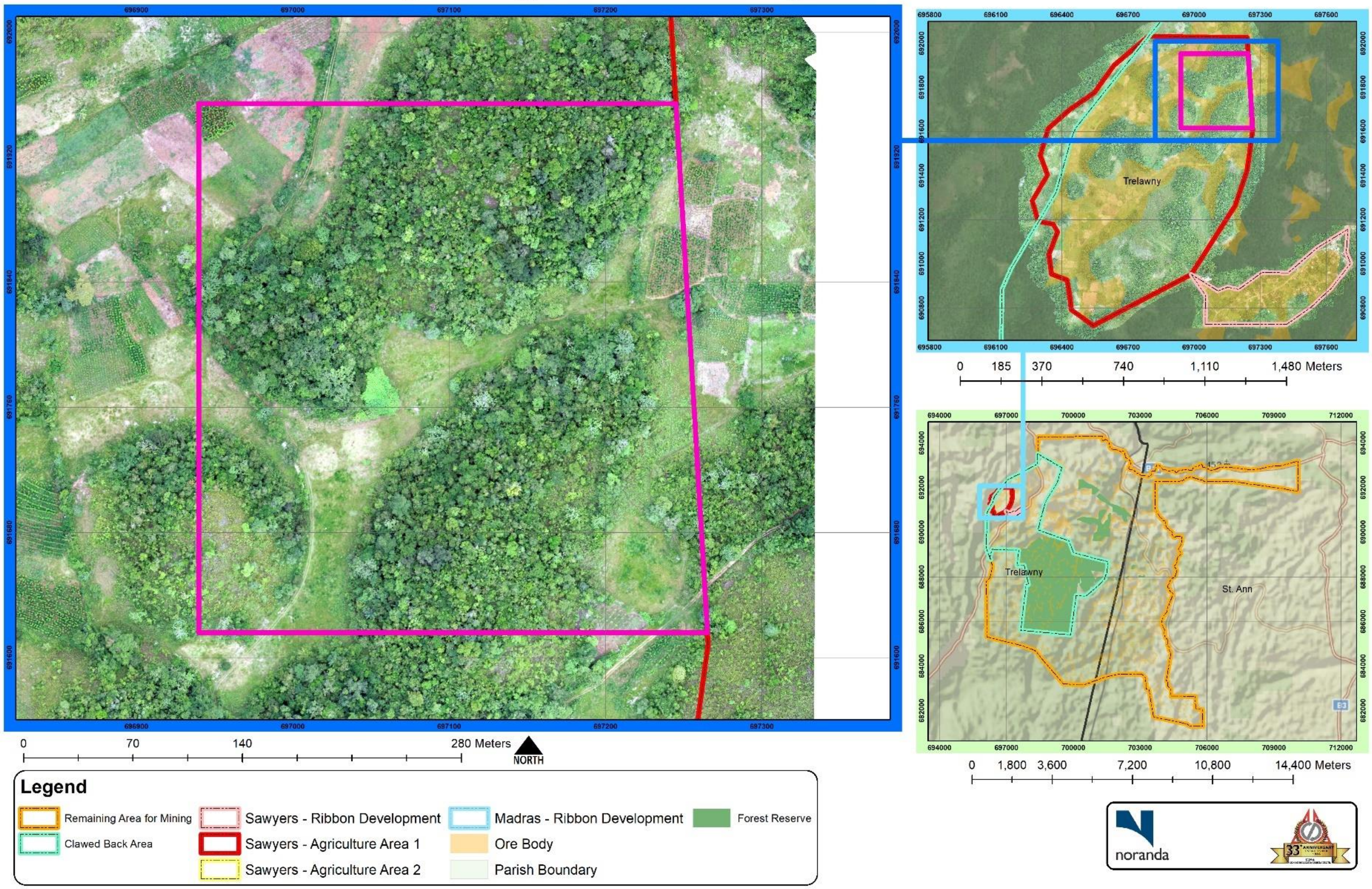
Agricultural activities and high floral biodiversity in the remnant hillocks (Shown in black box – vegetation stripped exposing limestone base rock).

Sawyers: Agricultural Activity - Section B1

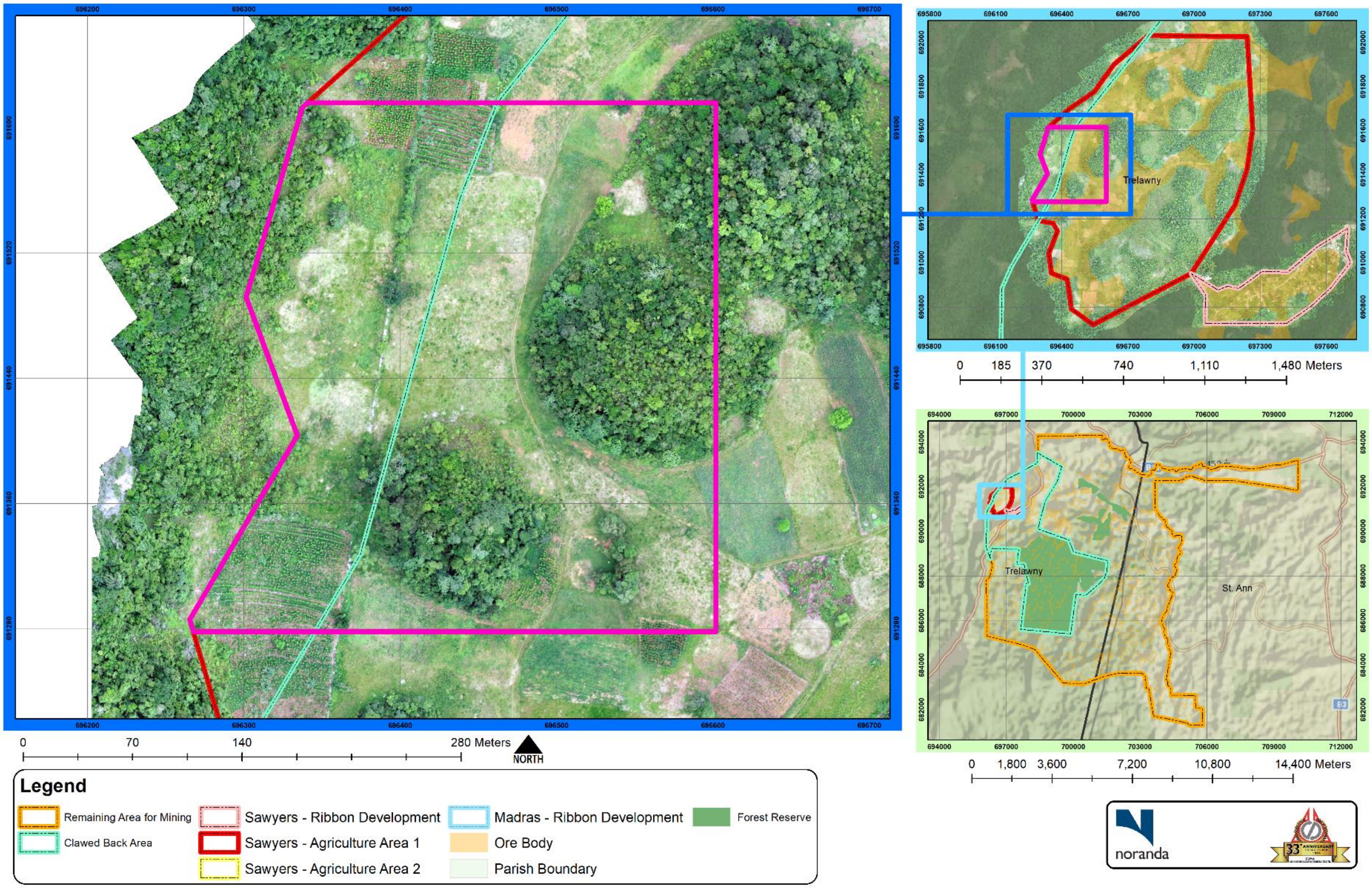



Sawyers: Agricultural Activity - Section B2
0
70
140
280 Meters
NORTH
Trelawny
0 185 370 740 1,110 1,480 Meters
Trelawny
St. Ann
0 1,800 3,600 7,200 10,800 14,400 Meters
Legend
Remaining Area for Mining
Clawed Back Area
Sawyers - Ribbon Development
Sawyers - Agriculture Area 1
Sawyers - Agriculture Area 2
Madras - Ribbon Development
Ore Body
Parish Boundary
Forest Reserve
noranda

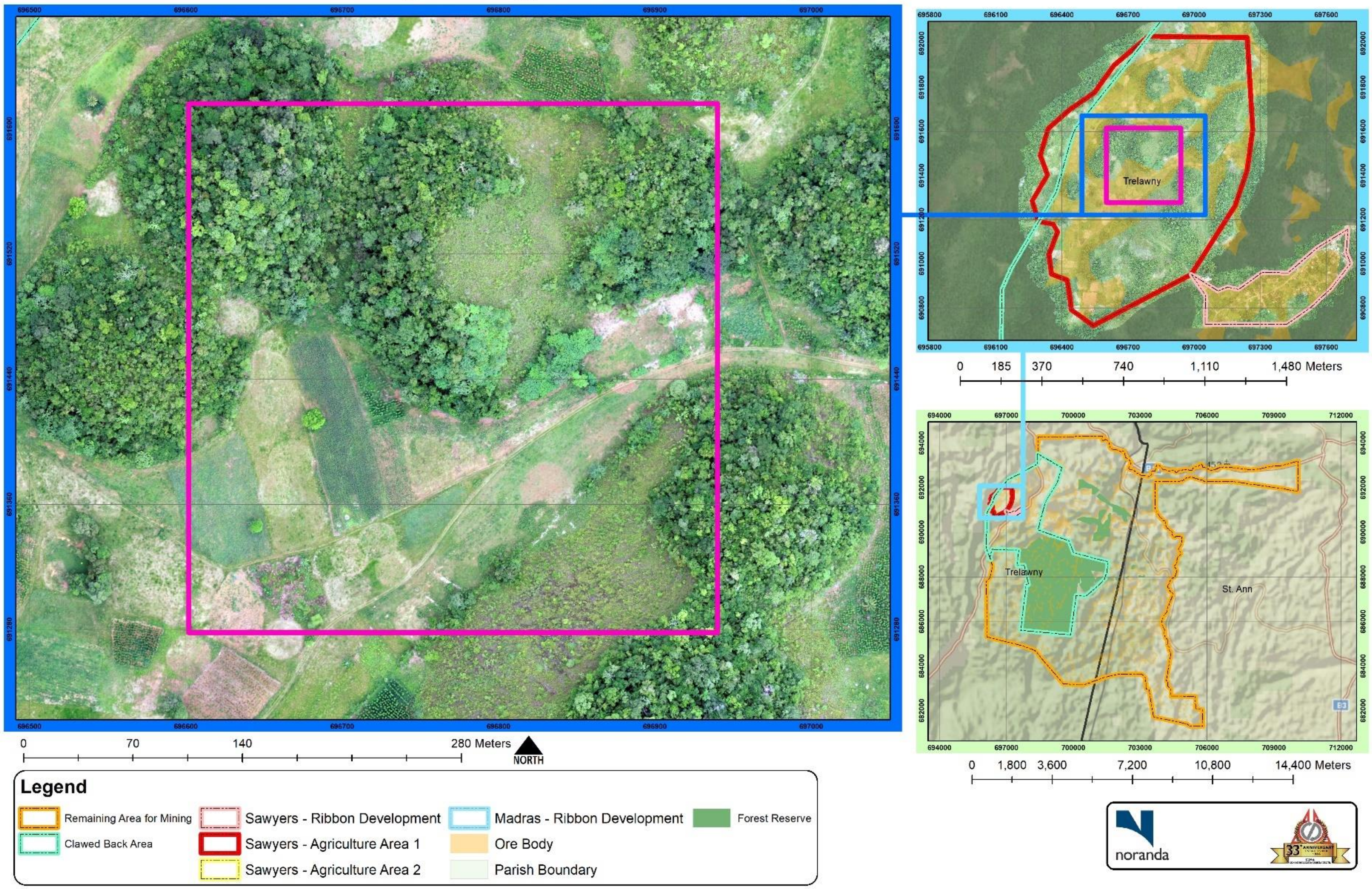
Sawyers: Agricultural Activity - Section B3



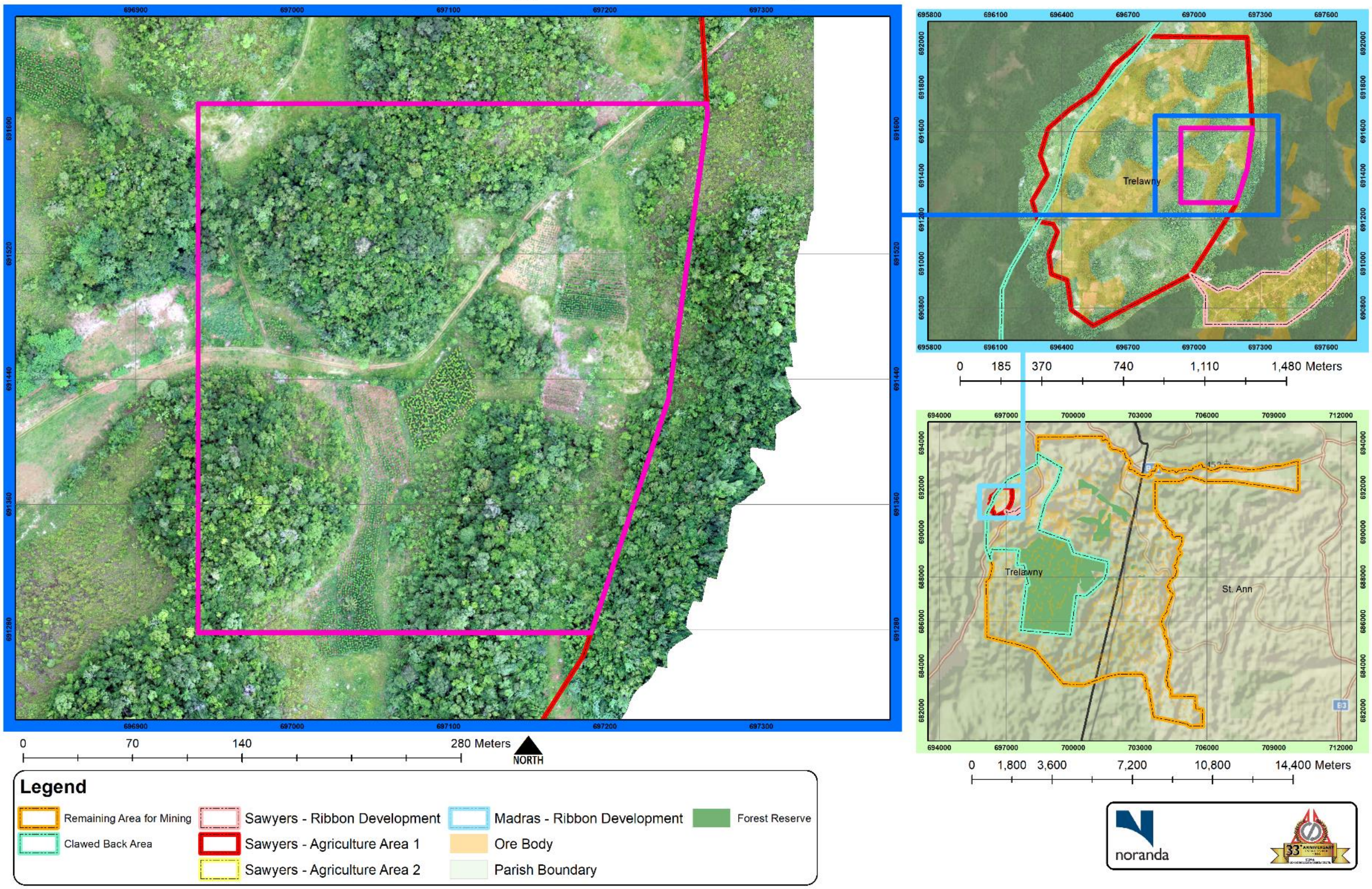
Sawyers: Agricultural Activity - Section C1



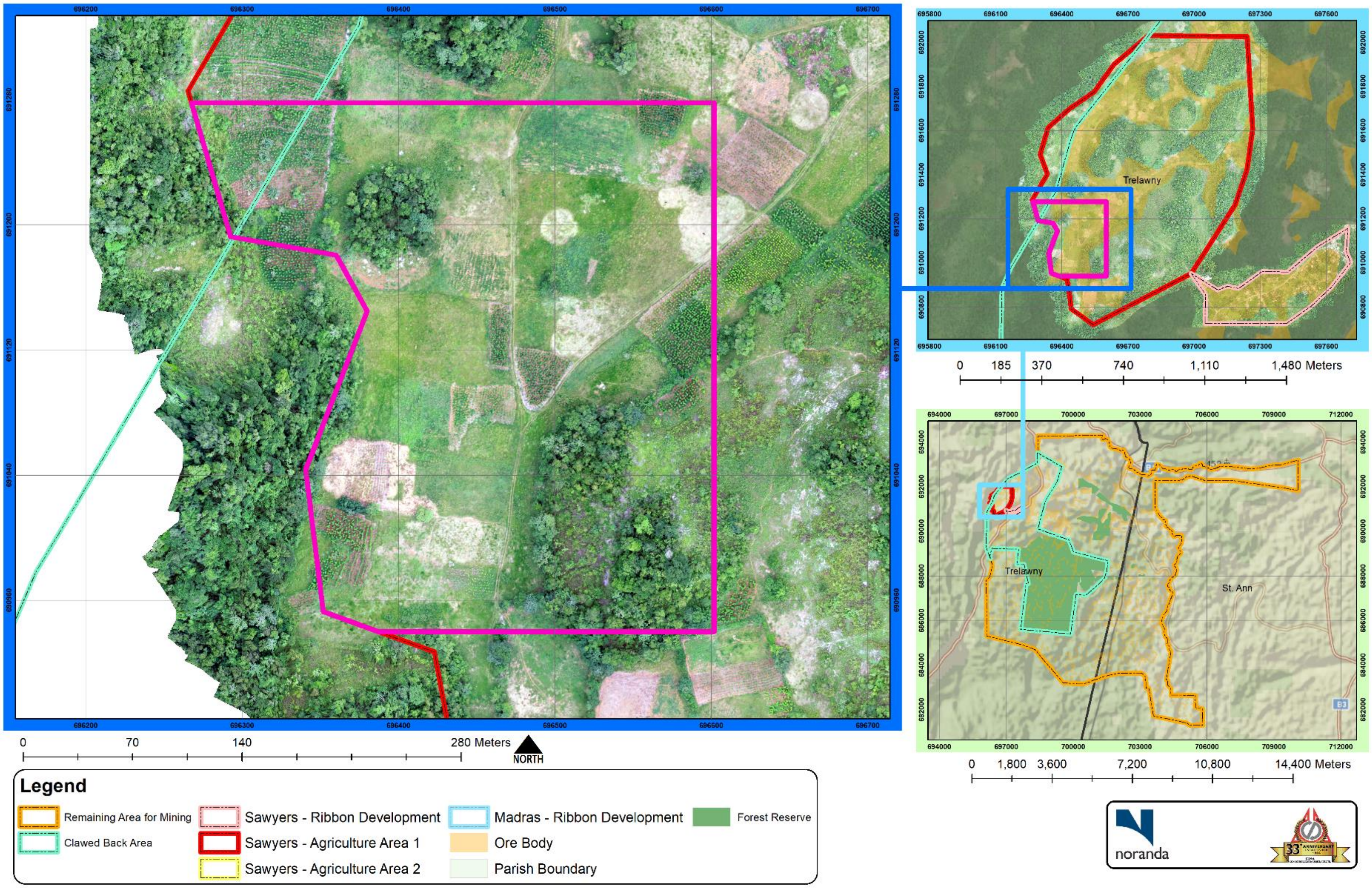
Sawyers: Agricultural Activity - Section C2



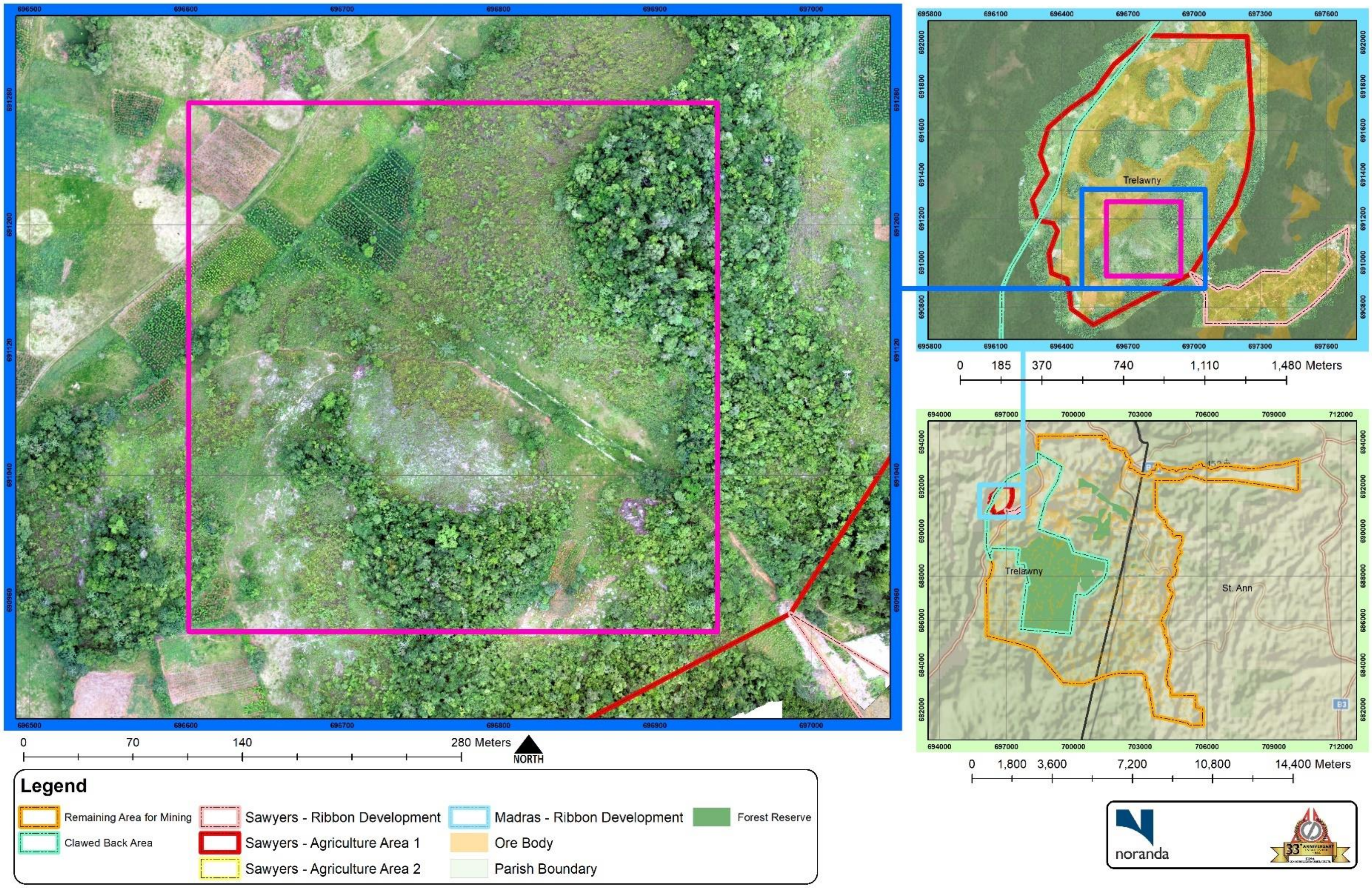
Sawyers: Agricultural Activity - Section C3

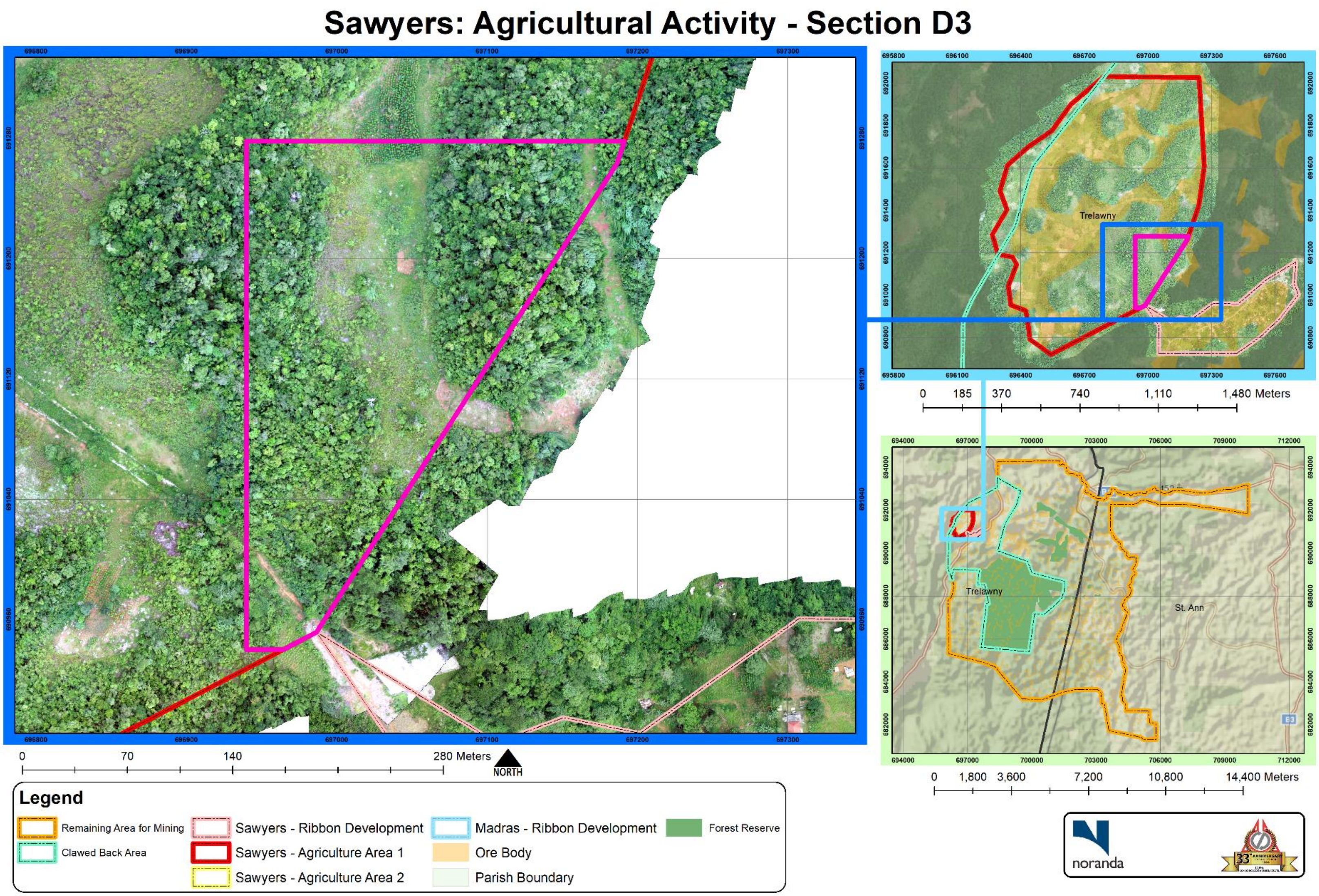


Sawyers: Agricultural Activity - Section D1

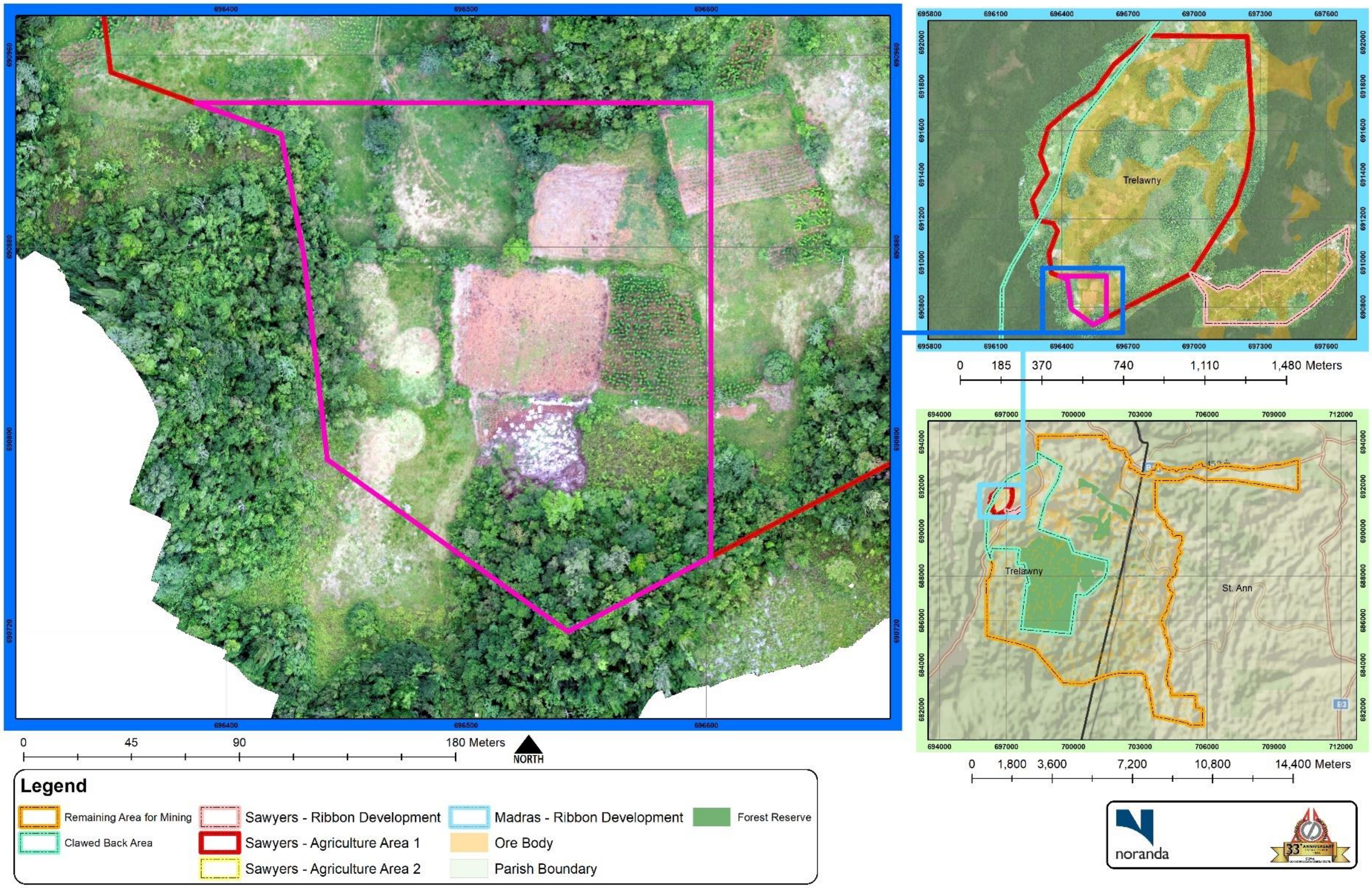


Sawyers: Agricultural Activity - Section D2

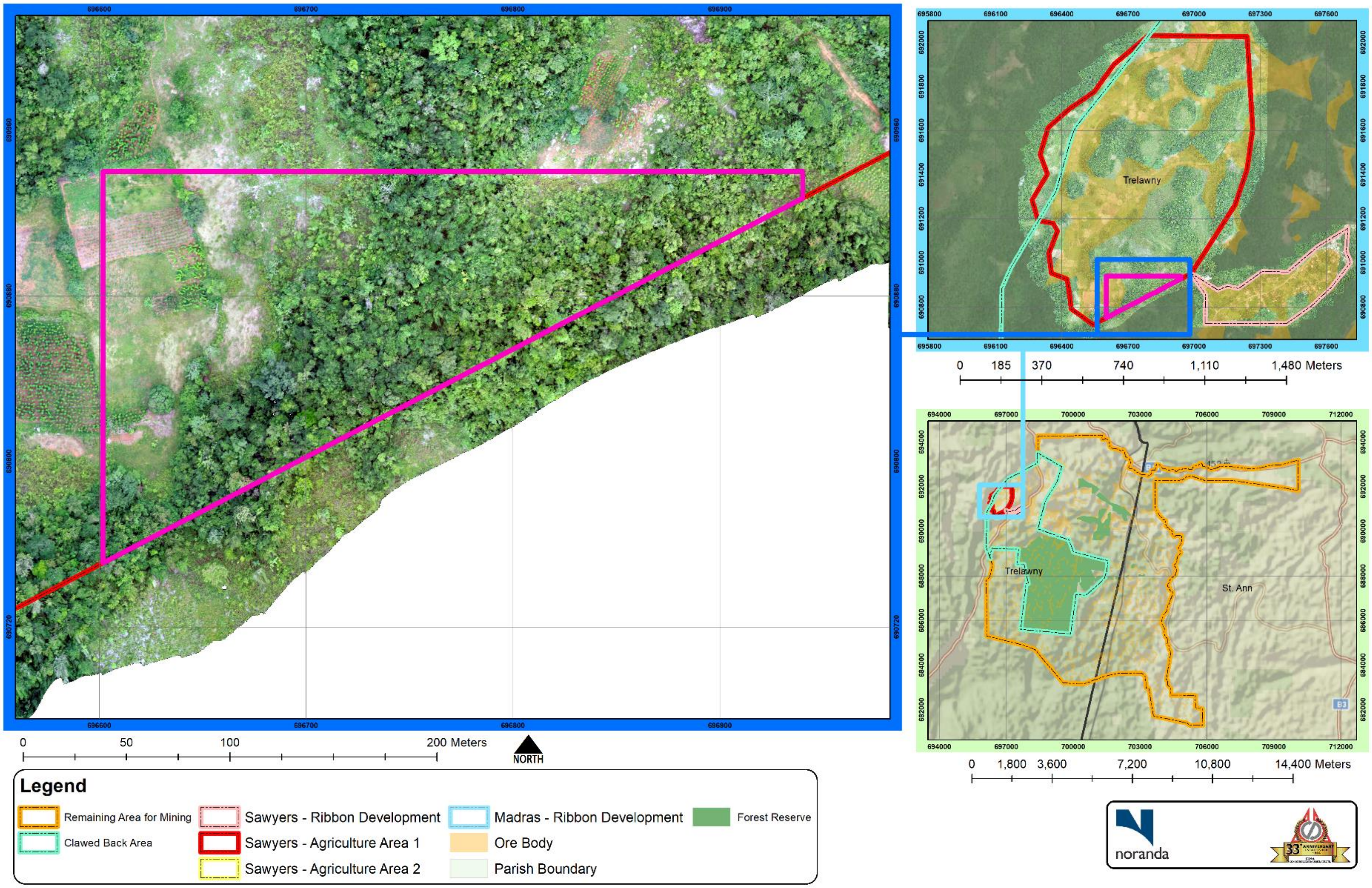



Sawyers: Agricultural Activity - Section D3
0 70 140 280 Meters
NORTH
Trelawny
0 185 370 740 1,110 1,480 Meters
Trelawny
St. Ann
0 1,800 3,600 7,200 10,800 14,400 Meters
Legend
Remaining Area for Mining
Clawed Back Area
Sawyers - Ribbon Development
Sawyers - Agriculture Area 1
Sawyers - Agriculture Area 2
Madras - Ribbon Development
Ore Body
Parish Boundary
Forest Reserve
noranda

Sawyers: Agricultural Activity - Section E1



Sawyers: Agricultural Activity - Section E2



Sawyers: Agricultural Activity - Section E3

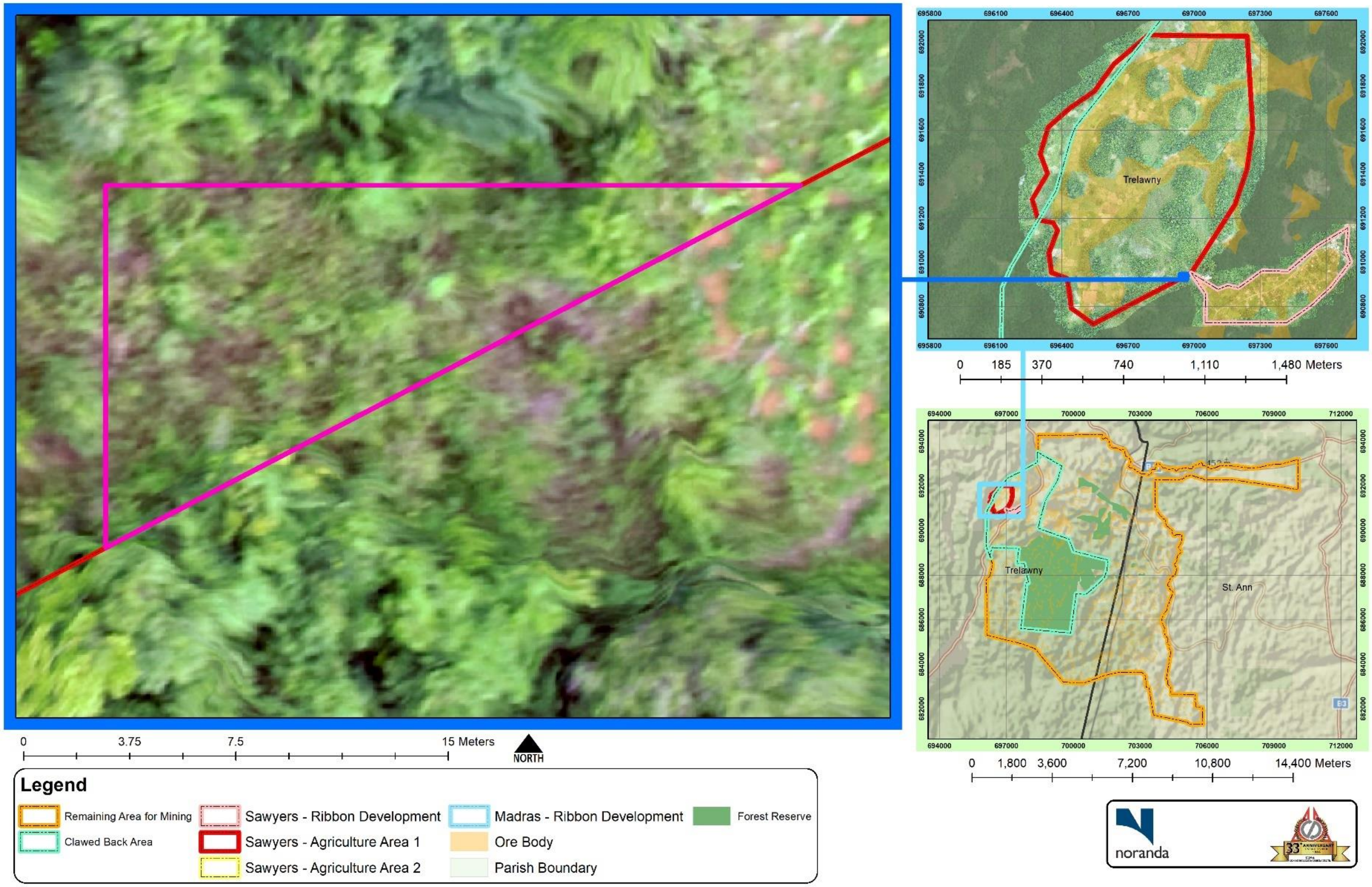
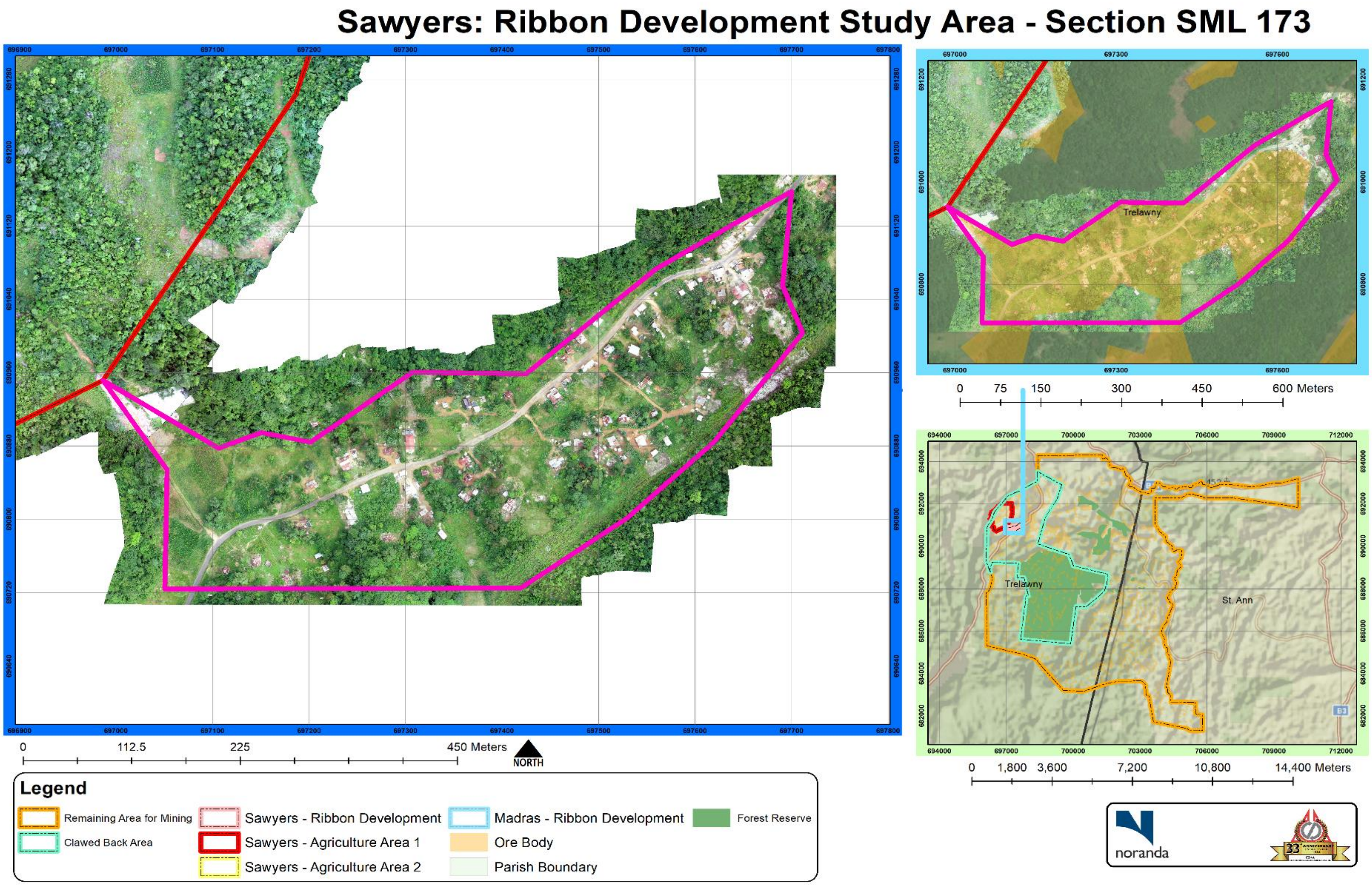
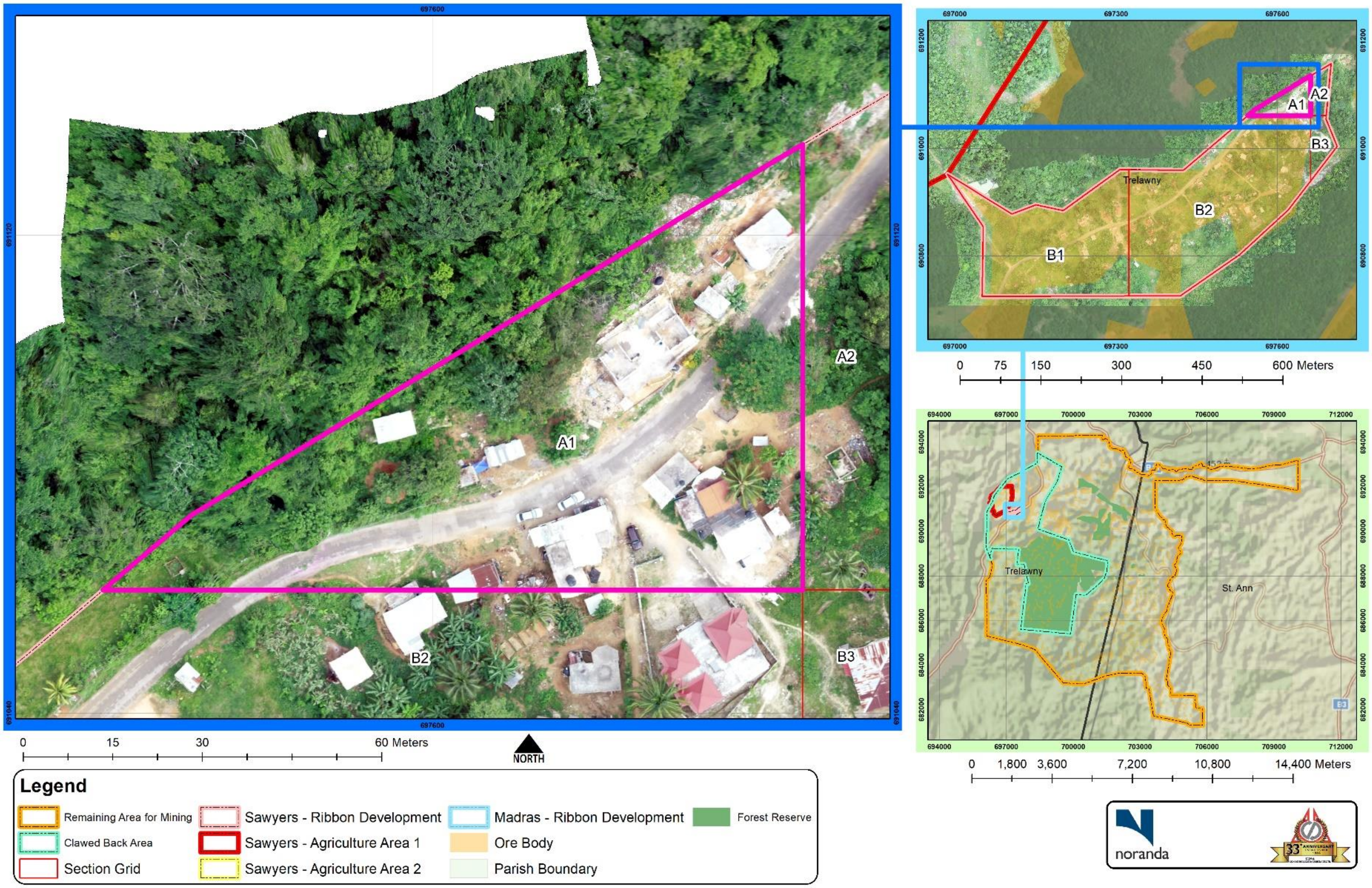


Figure 13-2: Sawyers Ribbon Development – Section of SML 173



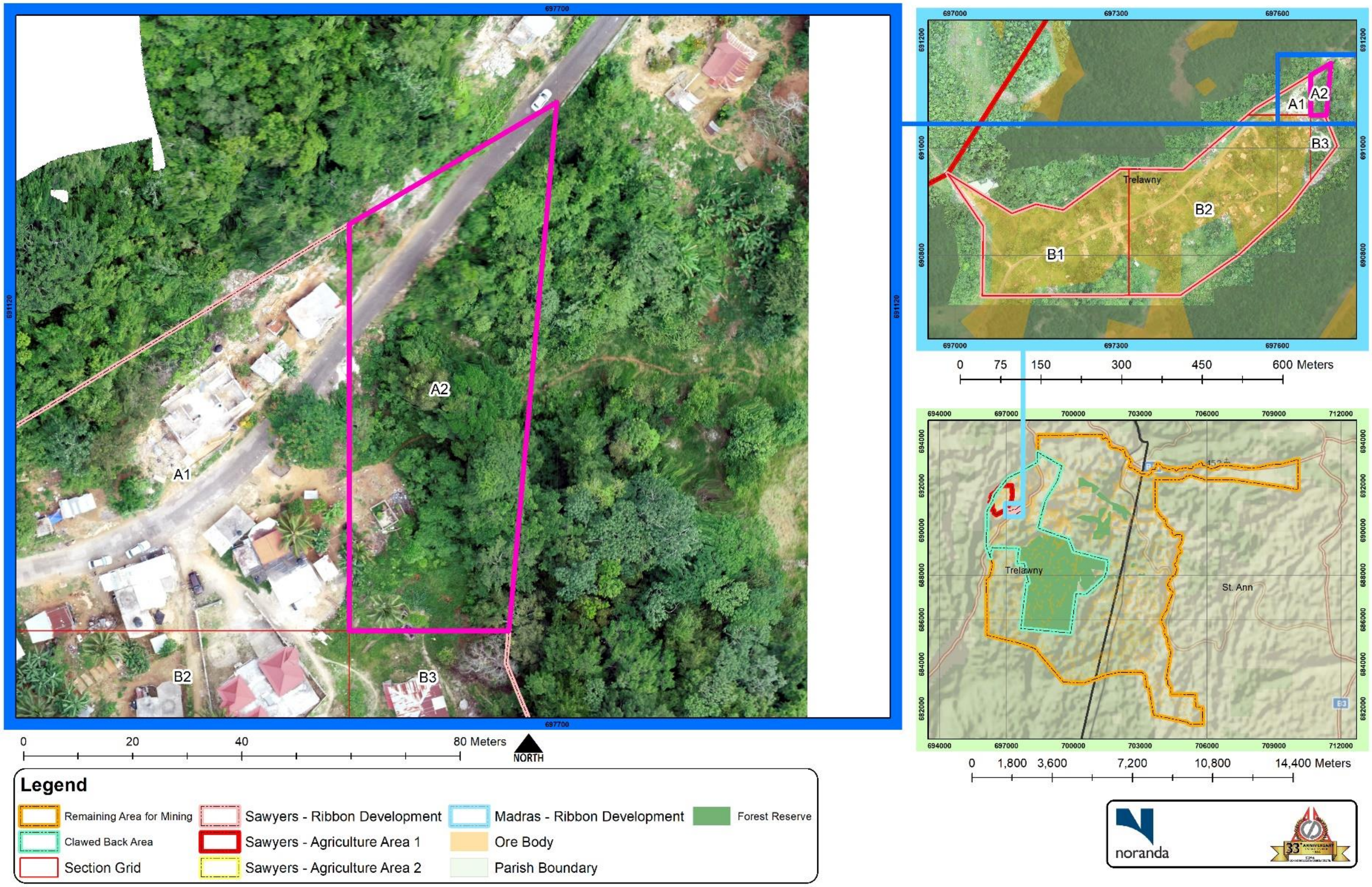
Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities

Sawyers: Ribbon Development - Section A1



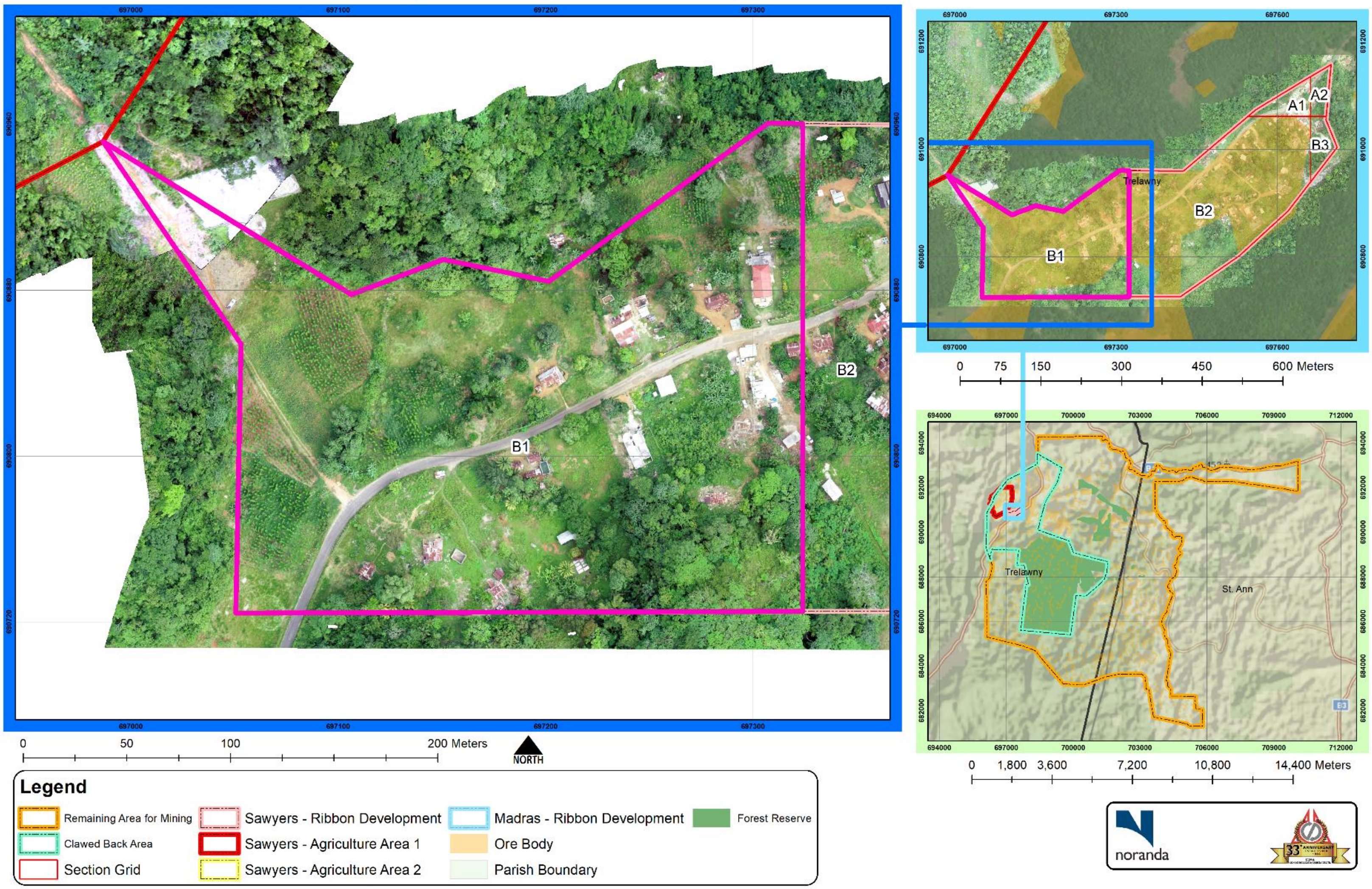
Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities

Sawyers: Ribbon Development - Section A2



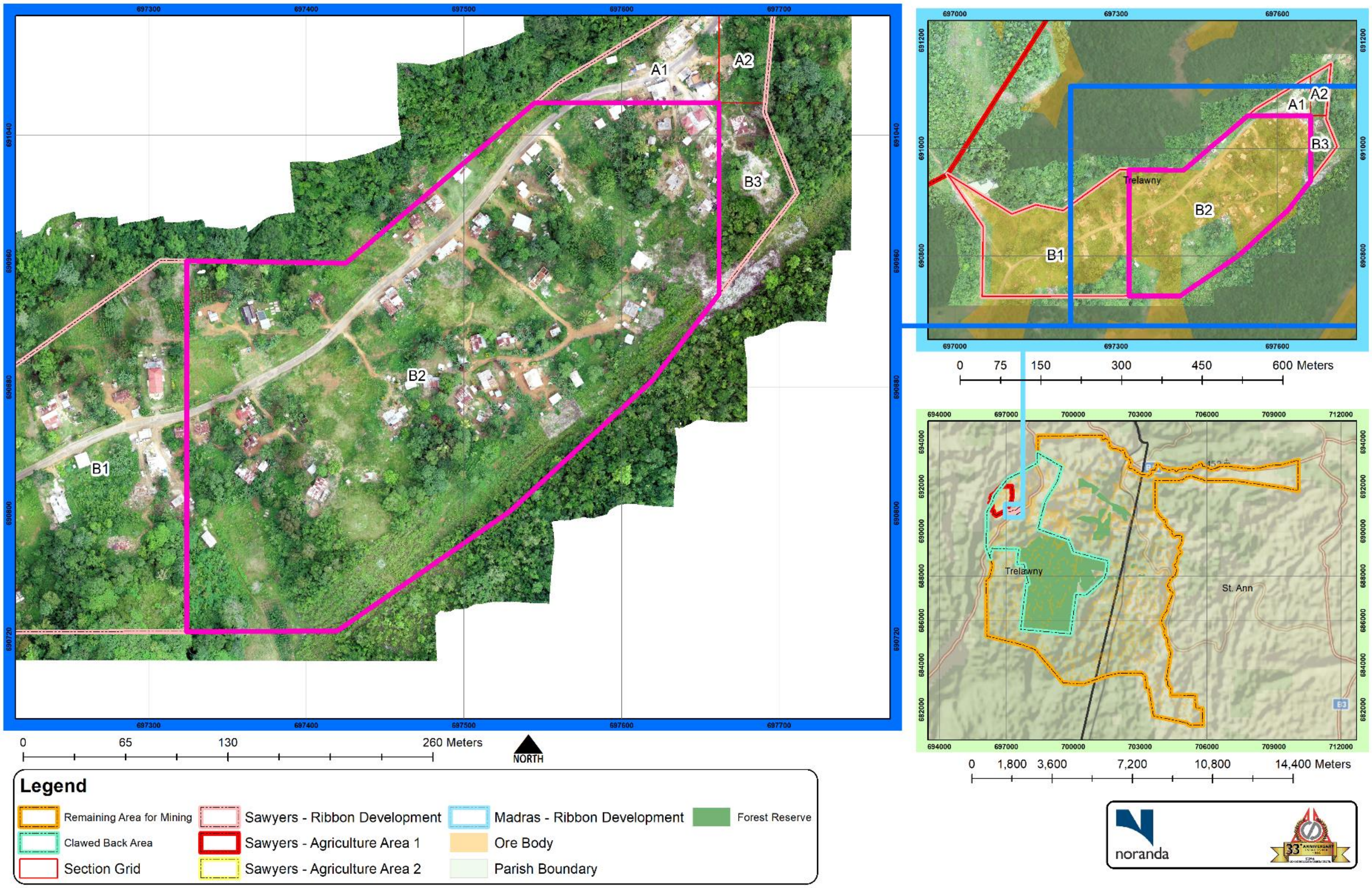
Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities. Hillsides partially cleared to facilitate settlements.

Sawyers: Ribbon Development - Section B1



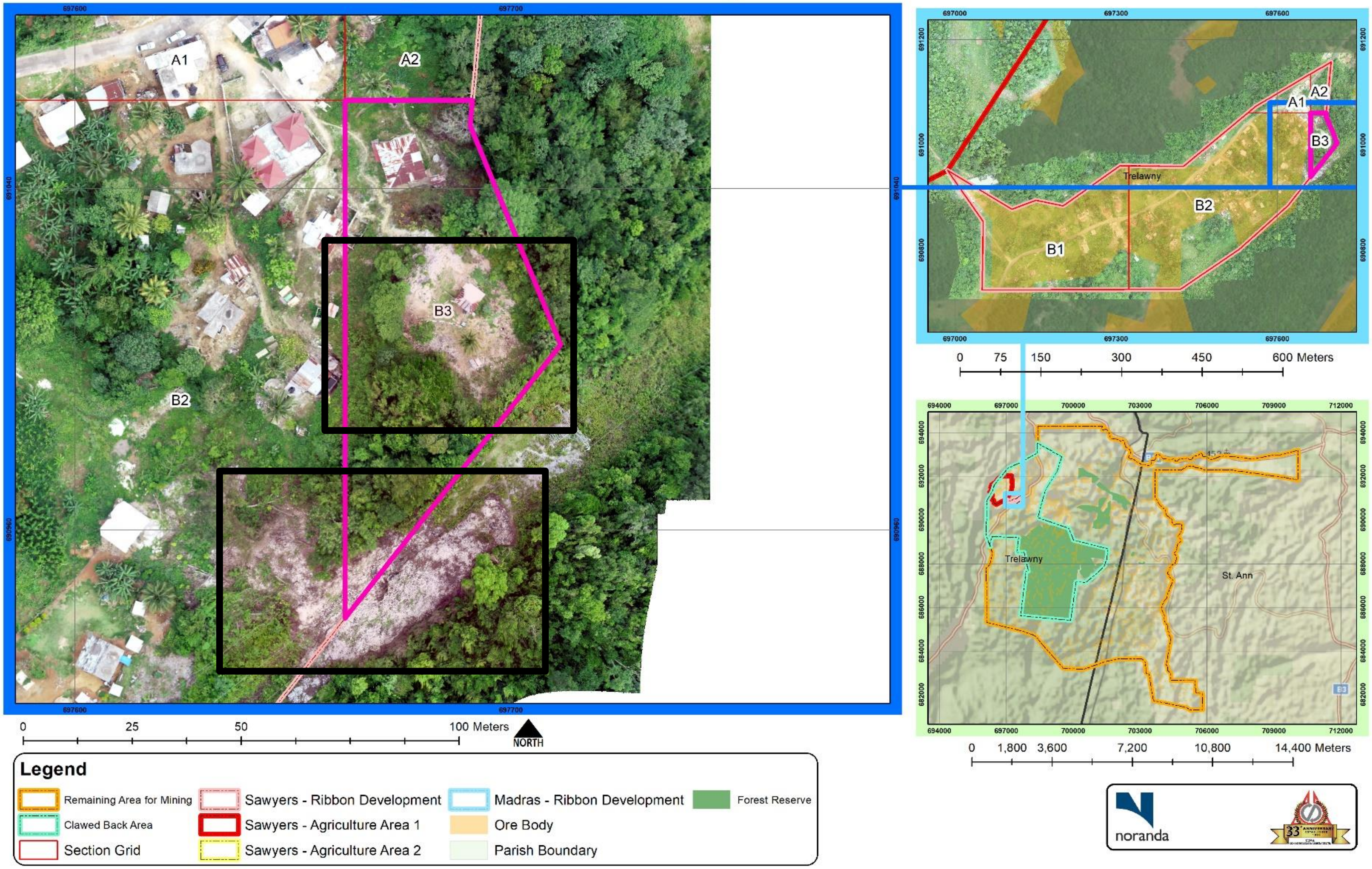
Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities.

Sawyers: Ribbon Development - Section B2



Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities. Hillsides partially cleared to facilitate development of physical infrastructure and residential developments.

Sawyers: Ribbon Development - Section B3



Ribbon development with settlements, high floral biodiversity in the adjacent remnant hillocks and agricultural activities. Hillsides partially cleared to facilitate development of physical infrastructure and residential developments (Shown in black boxes –vegetation stripped exposing limestone base rock).

Appendix XXIV: Attendance Register – South Trelawny Environmental Agency Stakeholder Consultation Meeting

MEETING WITH STEA @ ALBERTTOWN HIGH SCHOOL
PROPOSED MINING IN SML 173
ATTENDANCE REGISTER – JUNE 19, 2019

NAME	CONTACT
Marcia Campbell	401-7687
Jacqueline Binns	891-9664
Emanuel Campbell	427-9266
Kenneth Grant President Trelawny Ass. of Lay Magistrates	280-8195
Mark McHardy	460-0925
Mervin Bryan	369-3089
Kayon Smith	421-9238
Thonelle Walters	871-6794
Daniel Brown	569-3529
Tamar Case	482-9699
Ainsworth Smith	586-2044
Georgia Grant	347-520-0306
Hugh Dixon	876 393-6584
Melesia Brown	391-8600
MARK RICHARDS	
CONRAD DOUGLAS	