DESCRIPTION OF THE ENVIRONMENT

3 DESCRIPTION OF THE ENVIRONMENT

3.1 LAND USE AND GEOLOGY

3.1.1 LAND USE

The primary focus of this EIA report centers on the establishment of new bauxite mines, a new loading station, and other related aspects of the industry in the South Manchester Plateau.

These establishments are recognised as requiring access to and the use of significant amounts of space, some of which may be in use for residential, commercial, farming or other uses. In this section we utilise combinations of historical data and information with observations, ground-truthing and knowledge of the area. The culmination of our efforts is summarized in below.

3.1.1.1 TOPOGRAPHY

The topography of Manchester is undulating with escarpments and highlands of which the most prominent are the Carpenters Mountains, Mile Gully Mountains, May Day and Don Figuerero Mountains.

3.1.1.2 AREA AND LAND COVER

The parish of Manchester occupies an area of 791.6 sq.km, which accommodates a scattering of villages and other urban settlements. Mixed cultivation is confined to the northern regions. Bauxite deposits have impacted on the levels of mixed cultivation. Large areas in the valleys are now used as pasture lands, some areas are in woodland and ruinate providing poor grazing for small herds of cattle and goats.

Citrus is cultivated in some areas as are mixed crops such as corn, coffee, Irish potatoes, pimento. Upland areas are cultivated in ackee, breadfruit, mango, cocoa, etc.

The Northern area comprises most of the parish's forests and forest reserves, within conservation areas.

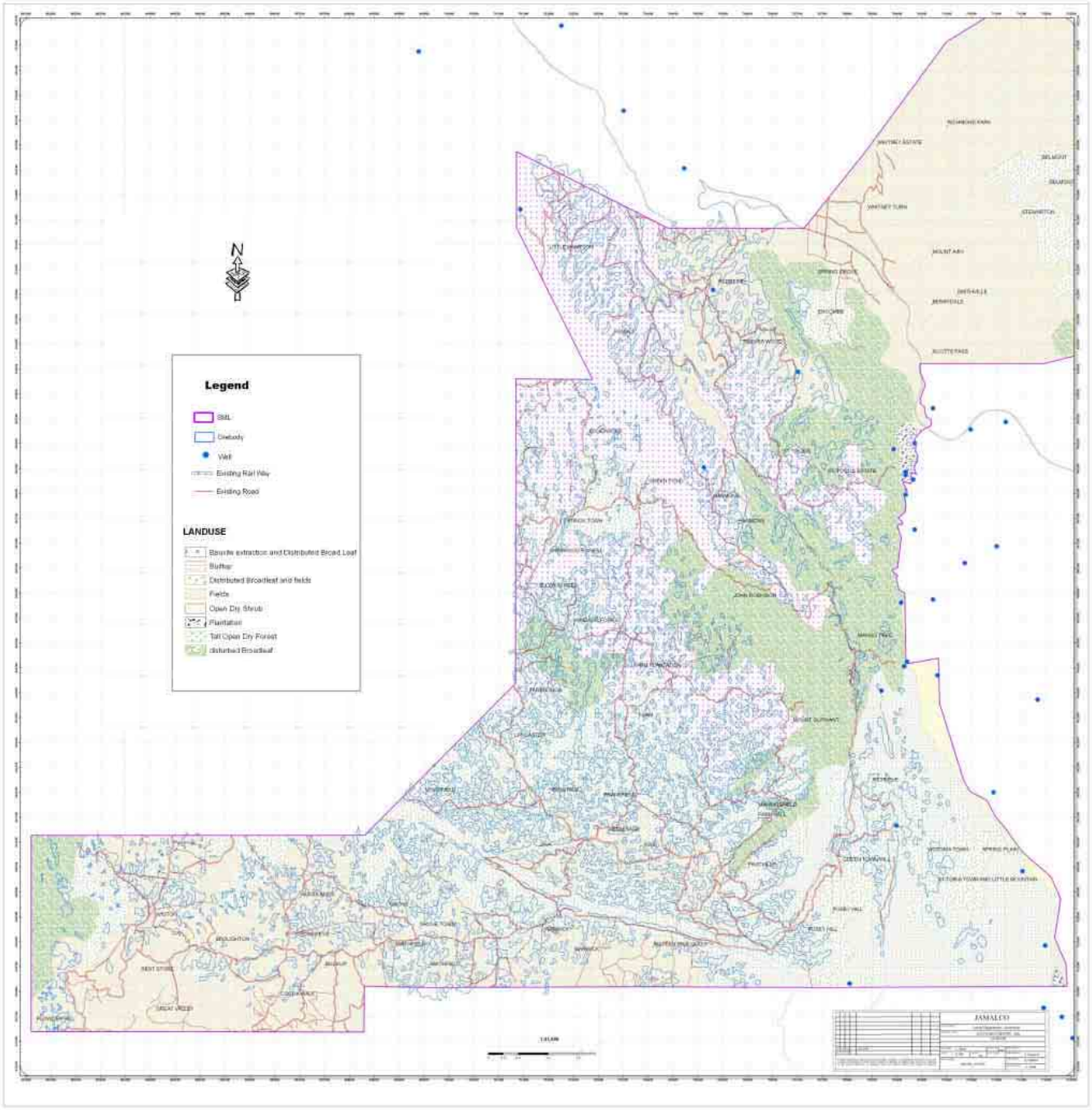

FIGURE 3-1 : LAND USE MAP FOR SML 130

3.1.1.3 LAND CAPABILITY

Agricultural land capability in Manchester varies between classes I, II, III and V. The following table identifies the suitability of each class. (Figure 1-1 below)

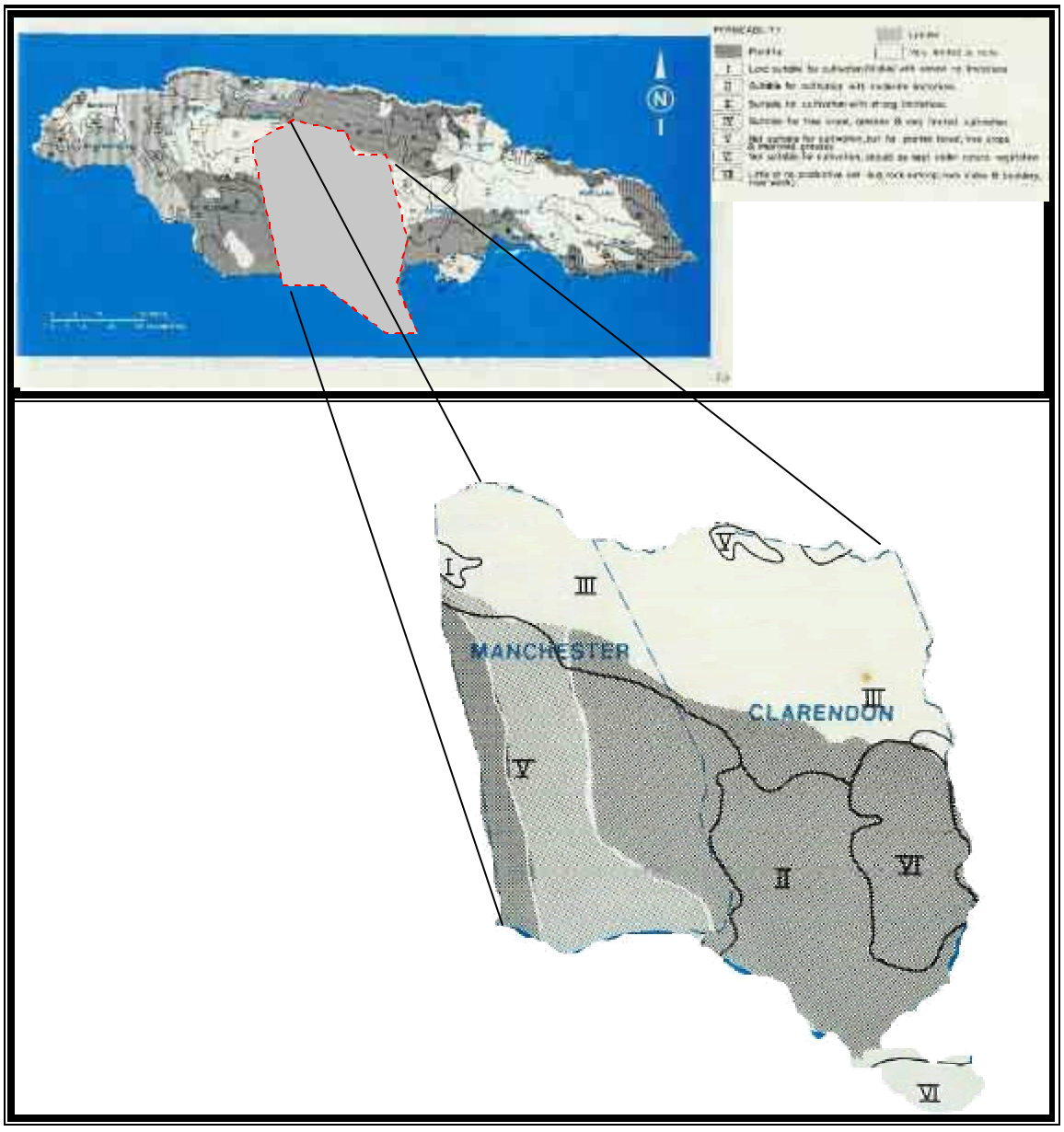

FIGURE 3-2: AGRICULTURAL LAND CAPABILITY

TABLE 3-1: AGRICULTURAL LAND CAPABILITY

LAND CLASS	CAPABILITY	PERMEABILITY
I	Suitable for cultivation (tillable) with almost no limitations.	Plentiful
II	Suitable for cultivation with moderate limitation	Plentiful
III	Suitable for cultivation with strong limitations	Very limited or none
V	Not suitable for cultivation, but for planted forest, tree crops and improved grasses	Limited
VI	Not suitable for cultivation – should be kept under natural vegetation.	Plentiful

3.1.1.4 DEVELOPMENT STRATEGY

The long term land management and development strategy is to allow for available resources to be used in a manner that ensures maximum economic benefits without contravening the general principles of conservation. In this regard there are definitions of growth centres for urbanization and conservation. Land uses include agriculture, national & marine parks, watershed areas, industrial forests, resort centres and bauxite deposits (See Figure 3-3).

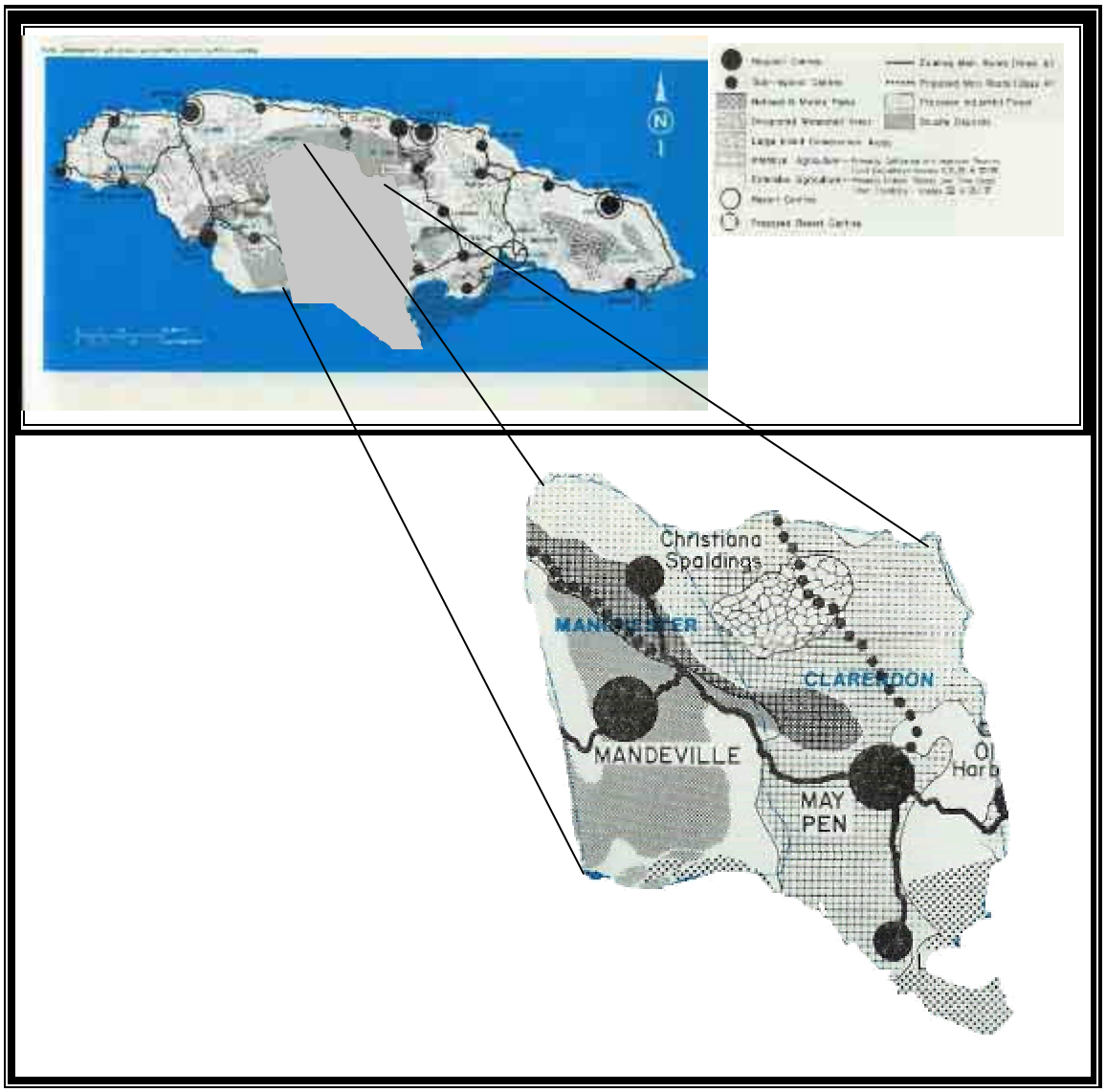

FIGURE 3-3: DEVELOPMENT STRATEGY

Physical, social and economic growth and development over the last 30 years, has been influenced by the bauxite/alumina industry through Alcoa, Alpart, and other foreign interests largely enhanced by Alcan of Canada (now Windalco). Mandeville, the parish capital, has become a strong financial and commercial location and also an important administrative centre which continues to experience growth.

Residential and commercial uses are developed in urban areas designated as villages, district centres, sub-regional centres and regional centres. The latter three are classified in the National Physical Plan 1978-1998.

In addition, there are scatterings of linear and star shaped villages along roadways and road intersections throughout Manchester, which have not been classified as growth points, though they continue to sprawl, leap frog and become conurbations.

3.1.1.5 INDUSTRIAL

Light industrial land use is confined to the hierarchy of rural/urban settlements and linear occupancy along district, sub-arterial and arterial roads. Heavy and special industrial plants include the bauxite processing plant at Kirkvine (Windalco).

Transportation and access routes, e.g. all classes of roads and railway lines link all urban centres and also penetrate agricultural areas, national parks and conservation areas.

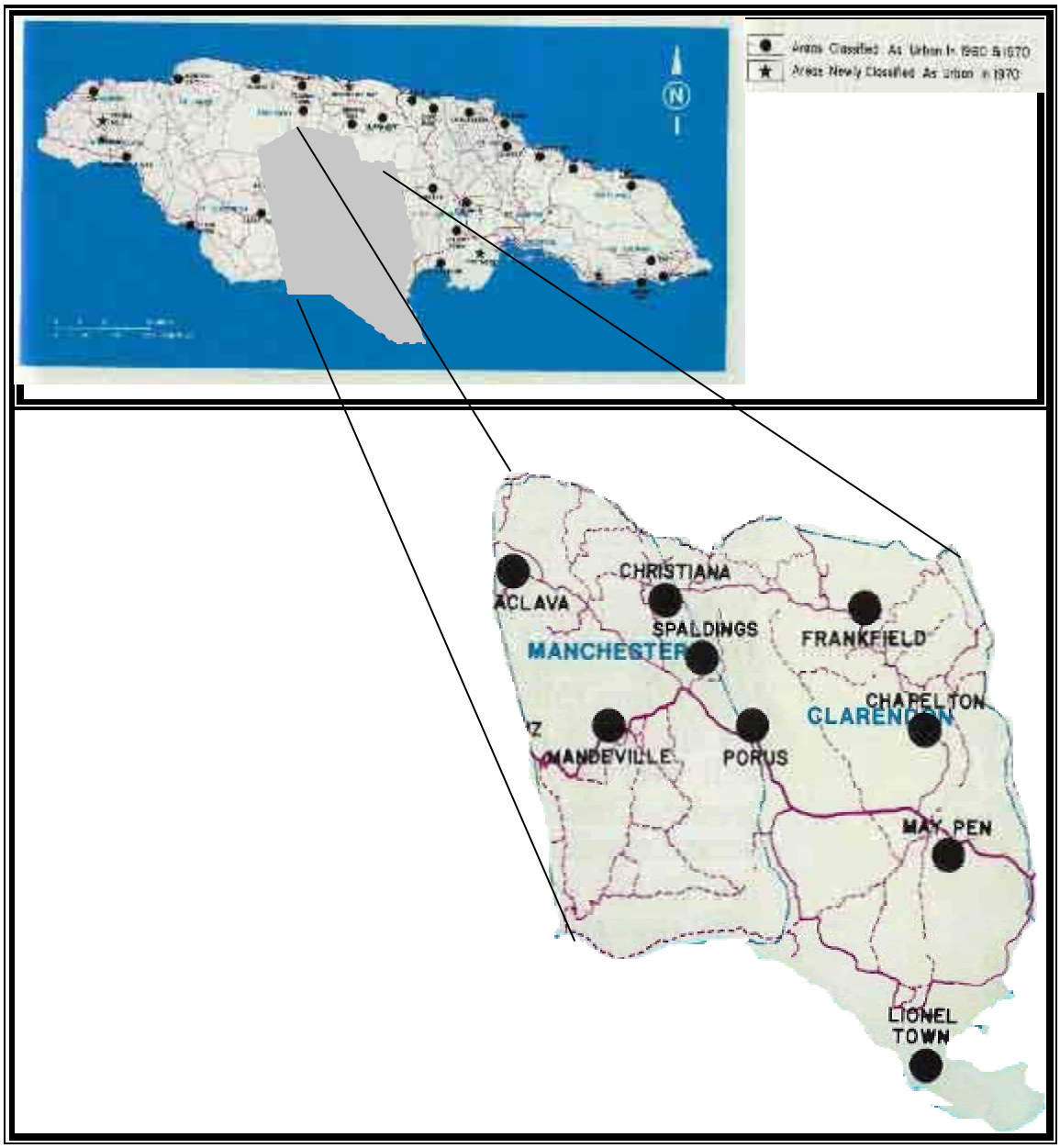

FIGURE 3-4: AREAS CLASSIFIED AS URBAN

3.1.2 URBAN SETTLEMENT DEVELOPMENT

TABLE 3-2: Urban Settlement Development

MANCHESTER – HEIRARCHY OF GROWTH CENTRES		
District Centres	**Sub-Regional Centres**	**Regional Centres**
Mount Oliphant	Cross Keys	Mandeville
Harmons		
Pusey Hill		
Red Berry		

3.1.2.1 PARISH COUNCIL/LAND USE ZONING

Manchester is covered by Development Orders and subsequently falls under the aegis of the Town and Country Planning Act. Thus any form of development requires an application to the relevant Local Planning Authority (Parish Council) for permission to carry out building, engineering and mining operations or change in the use of land or buildings.

There are no specific demarcated zones for land use, but there are general statements of intended uses, supporting requirements and standards.

3.1.3 AESTHETICS

There are several areas of outstanding natural beauty, visual and recreational amenity, and therapy. There are also areas which are aesthetically appealing and spiritually inspiring. The views from Spur Tree over the slopes toward the Alligator Pond and Canoe Valley coastal areas are magnificent. In additional there are remarkable 360° scenic views from the South Manchester Plateau, as in areas such as Pusey Hill.

A wide variety of microclimates exits throughout the parish, ranging from cool climatic conditions in Northern Manchester to warmer, drier conditions towards the southern coast of the Parish. The areas under study are adequately provided with transportation infrastructure – roads, haul roads, power transmission, and social infrastructure – hospitals (Mandeville), police stations, post offices, some government offices, schools, etc.

3.1.4 POTENTIAL USES

The Parish of Manchester is a designated watershed area. Some areas are designated as national parks and protected areas. Some are likely to be zoned for specific classification of industrial uses and buffer zones to avoid conflict and potential nuisances between industrial and residential users.

Most of the potential land uses in Manchester consists of future mining areas, existing mining areas and mined out lands for rehabilitation, forests and grassland.

The proposed project from JAMALCO includes the establishment of new mines, a new loading station and transportation corridors connecting the mines ultimately to the refinery in Halse Hall, Clarendon. The area to be mined is identified in the National Physical Plan 1978 – 1998 as Region D (Figure 3-5), the Manchester-Clarendon Region. Manchester has been extensively zoned and leased for bauxite mining operations.

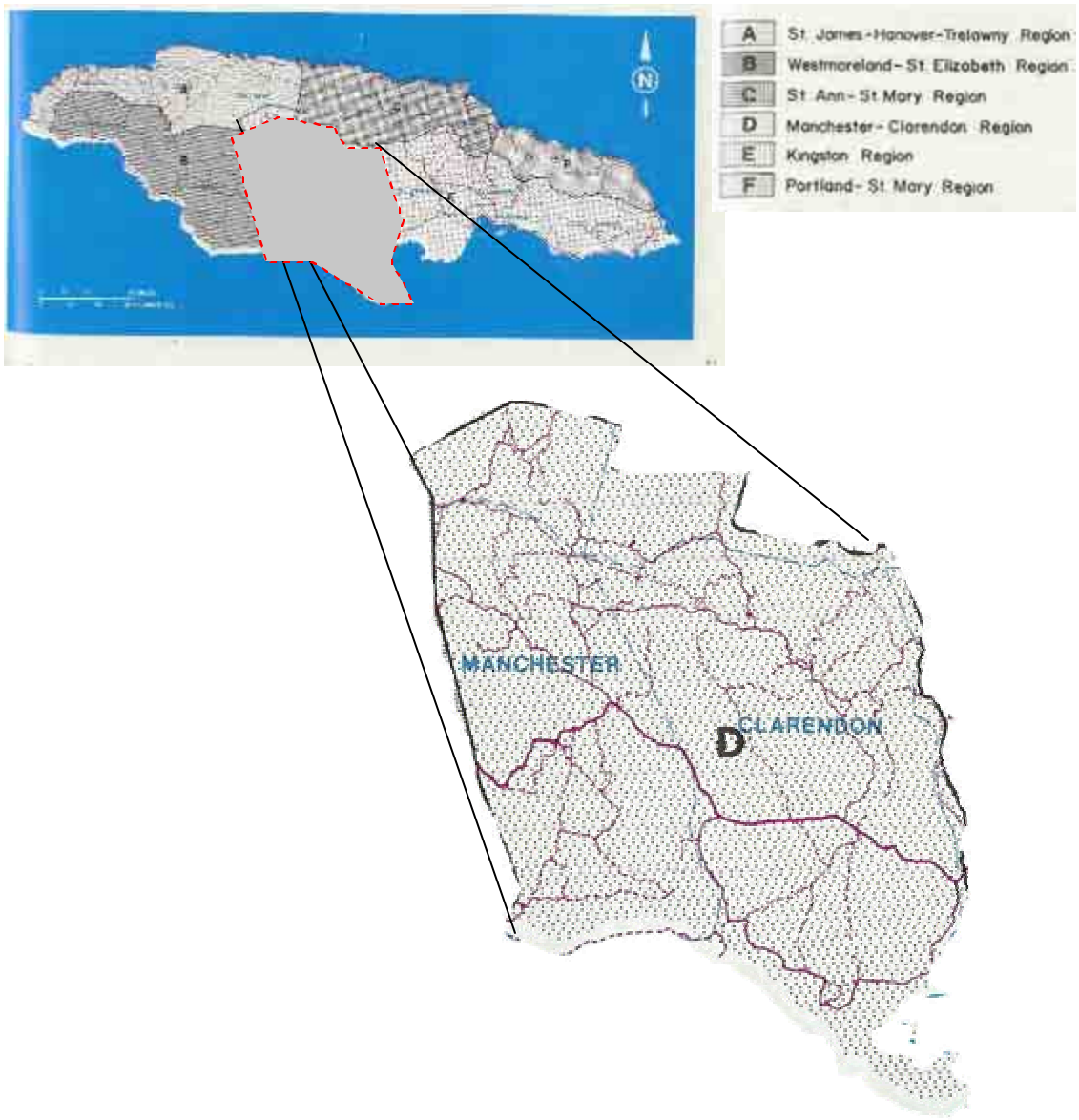

FIGURE 3-5: PLANNING REGION

3.2 GEOLOGY

3.2.1 GEOLOGICAL HISTORY

3.2.2 GEOMORPHOLOGY

There are 3 main geomorphologic features in the Manchester area of the Rio Minho basin, Manchester Highlands sub-basin.

- The rugged and well dissected Cretaceous volcaniclastics to the north (of Christiana)
- The highland areas of Tertiary limestones with different stages of karstic development
- The flat Pleistocene-Recent river alluvium along the South Manchester coastline between Round Hill in the east and Old Womans Point in the west

3.2.2.1 LANDFORMS ON THE CRETACEOUS VOLCANICLASTIC AREA.

The landforms are rugged and highly dissected. The dissection of most of the Cretaceous Central inlier is related to the Rio Minho River and its Tributaries. The Rio Minho flows to the east through Clarendon to the sea.

3.2.2.2 LANDFORMS OF THE LIMESTONE AREAS

The following landforms related to the karst areas can be recognized.

1) Karstlands of high relief with glades not well developed to the west of Mandeville

2) Karstlands of low relief with high cone density i.e. glades not well developed and dolines have little bauxite cover (west of Spur Tree)

3) Karstlands on steep slopes with collapsed features (concentric area from Spur Tree along the Coast and north to St. Jago west of the Milk River)

4) Karstlands with ridges and cones separated by bauxite filled glades (Manchester Plateau)

5) Flat sloping high level plain covered with thick bauxite soil (Roberts Run-Bousue area)

The areas showing the most mature karstic features are the northern and western sections of the Manchester Highlands.

3.2.3 STRUCTURE

3.2.3.1 GENERAL

The Manchester Highlands area is situated on the south central section of the Clarendon Block, which is delineated on the east and west by the NW-SE trending Wagwater and Cambridge – Santa Cruz faults, respectively. The E-W Duanvale fault system defines the northern boundary. The bedding planes of the Newport Limestone seem to indicate a general shallow (5^0 – 10^0) dip to the east. The Manchester Highlands is in fact, tilted slightly to the east.

3.2.3.2 FAULTS

Two main sets of faults cut the Manchester area. They trend:

- NNW- SSE and
- E-W

Mid-Miocene normal faulting initiated a subdivision of the area into elongated blocks trending NNW-SSE and late Pliocene-early Pleistocene tectonics produced renewed movement along old features. East of the Mile Gully synclinal axis step-faulting is consistently down to the west, while to the west of the axis, down-throw is to the east. The pattern again changes at the Spur Tree Fault, which down-throws to the west. This is believed to be related to the Spice Grove anticline. Thus an intimate relationship between faults and folds is found suggesting that they are genetically related. It appears that the Mile Gully syncline is the centre of collapse of a graben structure of which the Williamsfield Trough is but a part.

The complementary NE-SW faults are generally poorly developed, and only become important as crushed zones (which have implications for groundwater flow) in the southern and western Manchester Highlands.

There are two important sets of E-W trending fault zones which traverse the northern and southern boundaries of the area. The northern E-W crush zone, which passes through Spauldings, is believed to be the western extension of the Crawle River Fault, which Coates (1965) believes to have both lateral and vertical movement.

The Sixteen Mile Gully Fault extends from Round Hill in the east to Blenheim in the west. Several splay faults trending NNW-SSE join the Sixteen Mile Gully Fault.

A series of faults run parallel to the coast between Old Womans Point and Round Hill.

The two most important north-south trending faults are the Whitney and the Queen Town Hill Faults. Both faults are thought to be the east and west boundaries respectively of the Williamsfield "Trough" or "Graben". This is discussed in more detail below.

3.2.3.3 WILLIAMSFIELD "TROUGH" OR GRABEN

A Graben is a "down faulted block generally linear, bounded by gravity faults".

The Williamsfield Graben constitutes the major structural element of the Manchester Parish and the Rio Minho Hydrologic Basin. It is marked by a valley extending from Balaclava, St. Elizabeth through Mile Gully, Williamsfield, Porus and into Clarendon. The centre is marked by a line through Mile Gully, Williamsfield and St. Toolies to the scarp at St. Jago in Clarendon.

In the Balaclava area, the structure either shallows or dies out against the central inlier or the Crawle River Fault.

The Whitney Fault, which is considered to be the eastern boundary of the Williamsfield Graben, may be a gravity fault with its axial plane dipping to the west. The western boundary of the graben is considered to be the Queen Town Hill Fault which can be traced along the eastern border of the May Day Mountains, paralleling the Alligator Hole River in the south through Mango Tree, and Broad Leaf where it curves to the WNW through Royal Flat to the north of Mandeville.

3.2.4 ECONOMIC GEOLOGY

The economic potential of the Manchester area depends largely on the bauxite deposits located atop the Manchester Highlands (Plateau) and developed from the weathering of the Karst landscape. Large areas of the May Day and the Carpenters Mountains are known to have bauxite deposits and are under licence to either Alcoa (Jamalco) or Windalco.

Black sand deposits occur along the coastal strip between Farquhars Beach to the west and Old Womans Point to the east. These sands are magnetic and the deposits contain both ilmenite and magnetite. The deposits at Old Womans Point lie on a platform some 6 metres above sea level.

The limestones and dolomites that cover the majority of the area are relatively little used and if used is mainly for aggregate and road construction. A full economic appraisal of the limestones needs to be undertaken in light of the increased demand for industrial minerals both locally and overseas.

3.3 HYDROLOGY

3.3.1 GENERAL

Underground water has been used in the Rio Minho Hydrologic Basin since the early 1900. The Manchester Highlands as a part of this basin is partially supplied with groundwater for domestic purposes, not from wells drilled on the plateau, but from wells drilled to the east at Porus and to the west at Pepper, St. Elizabeth.

The Manchester Highlands occupy an area of 358 km^2. The area is composed entirely of limestone of the White Limestone Group. The primary Limestone Formation is the Miocene aged Newport member.

The Limestone plateau rises steeply from the sea to an elevation of over 300 metres. The thickness of the limestone, as pointed out in the Geology section, is expected to be at least 1500 metres.

The limestone being highly karstified has no surface drainage except in small glades and only in the extreme rainy season.

3.3.2 HYDROSTRATIGRAPHY

A hydrostratigraphic unit is a geologic formation (or series of formations) which demonstrates a distinct hydrologic character. Geologic formations are classified either as aquifers or aquicludes.

Rock formations with sufficient permeability to support perennial well and/or spring production are classified as aquifers. Rock formations with low permeability and which do not support perennial well and/or spring yield are classified as aquicludes. Surface water is the main potential of aquicludes because of their low permeability.

Within the Manchester Highlands, the limestone aquifer is the principal hydrostratigraphic unit. It occupies an area of 358 km^2 or 21% of the area of the Rio Minho Hydrologic Basin. The entire South Manchester area has the limestone formation as the main aquifer. Figure 3-6 below illustrates the hydrostratigraphy of the Manchester Highlands, and and Figure 3-7 illustrates the hydrostratigraphy for the proposed mining area (SML130).

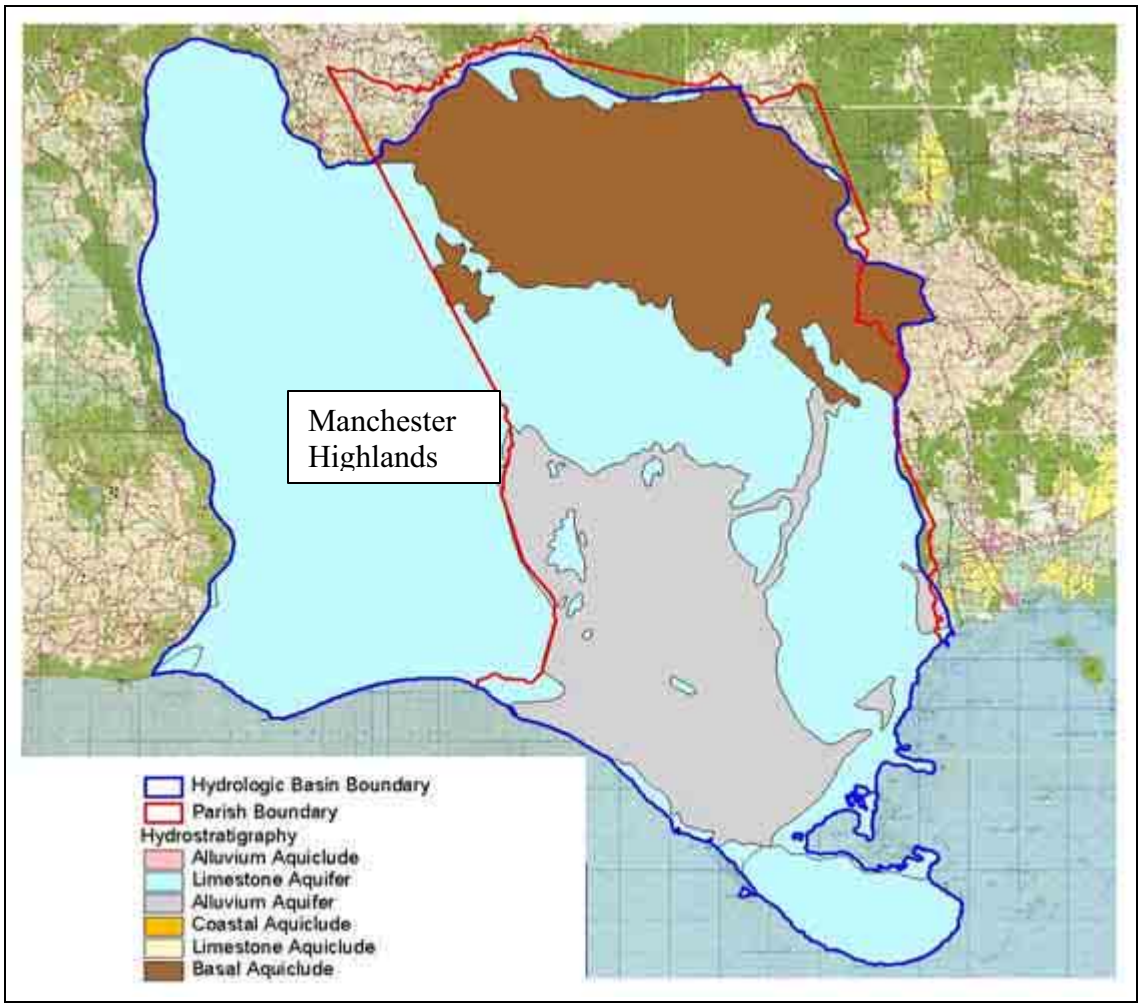

FIGURE 3-6: RIO MINHO HYDROLOGIC BASIN (INCLUDING MANCHESTER HIGHLANDS) HYDROSTRATIGRAPHY

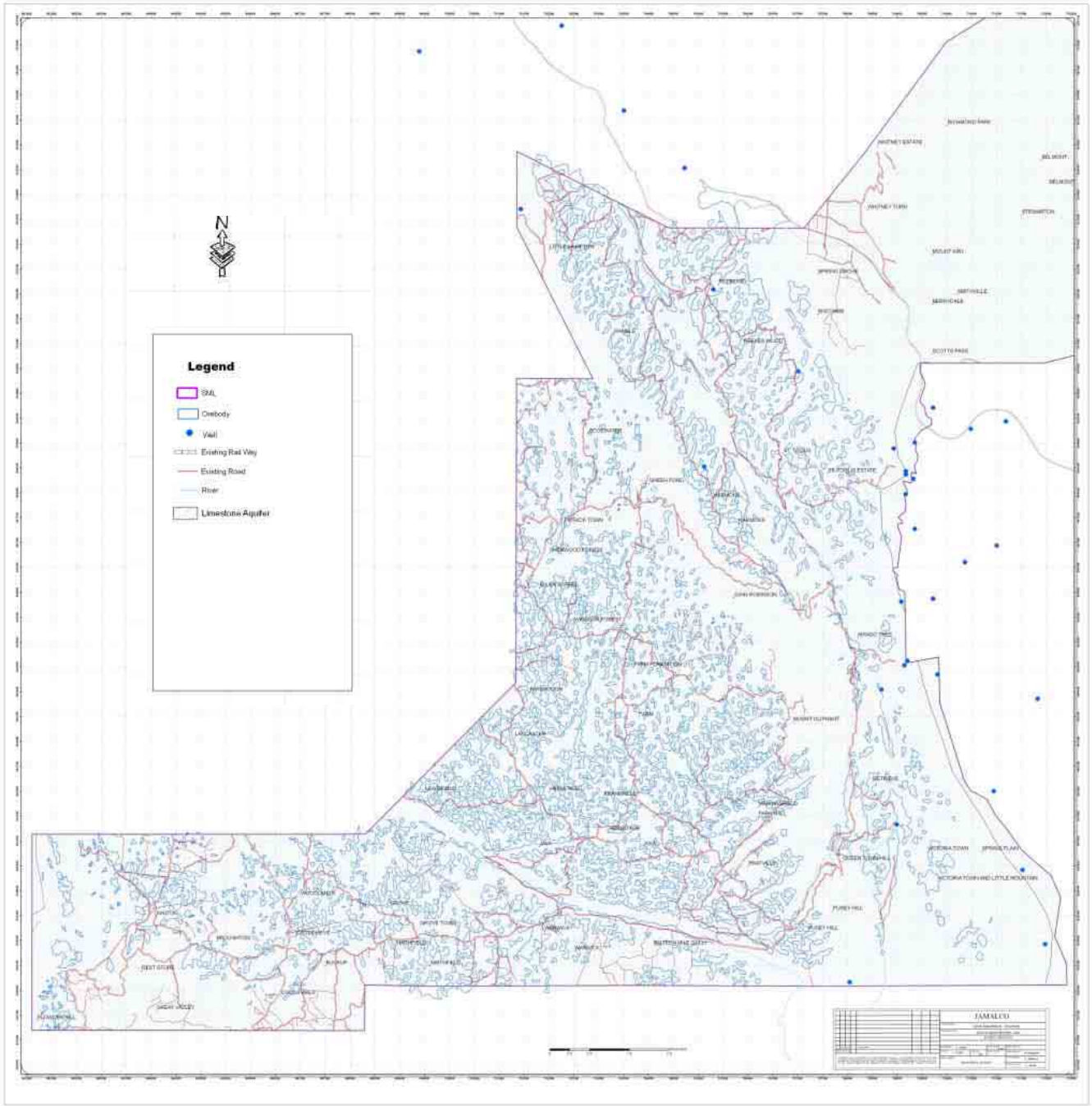

FIGURE 3-7: HYDROSTRATIGRAPHY OF SML 130

3.3.3 WATER RESOURCES POTENTIAL

The water resources potential of the Manchester Highlands falls into 3 types.

- Rainfall
- Surface Water Resources
- Ground Water Resources

3.3.3.1 RAINFALL RESOURCES

Average annual rainfall increases from 1000 mm at the coast to a maximum of 2045 mm at Mandeville in the north. Harvested rainfall was estimated at 0.45 Mm^3/yr (million cubic metres per year) and was used mostly on the Highlands where the unserved population was assumed to be 45,000 (NWC 1980). The rainfall supports groundwater recharge of 2.20 X 10^8 cubic metres per year and evapotranspiration of 3.4 X 10^8 cubic metres per year.

3.3.3.2 SURFACE WATER RESOURCES

There is no perennial or seasonal surface water sustained streams within the Manchester Highlands because of the high infiltration capacity of the limestone.

3.3.3.3 GROUND WATER RESOURCES

Groundwater occurs in a highly karstified limestone aquifer that outcrops over 98% of the Manchester Highlands. The aquifer is in direct hydraulic continuity with the sea in sections. The absence of a lithologic barrier at the coast together with the high transmissivity combines to produce a very low water table elevation with respect to sea level. Depth to water is in excess of 300 metres as proven by the well drilled at Victoria Town and boreholes drilled south of Battersea Mud Lake by Alcan to monitor water quality.

Aquifer discharge supports flow in four perennial streams along the coast, which sustains a 5.2 km^2 coastal swamp (part of Canoe Valley) being reserved as a National Park and a nature laboratory.

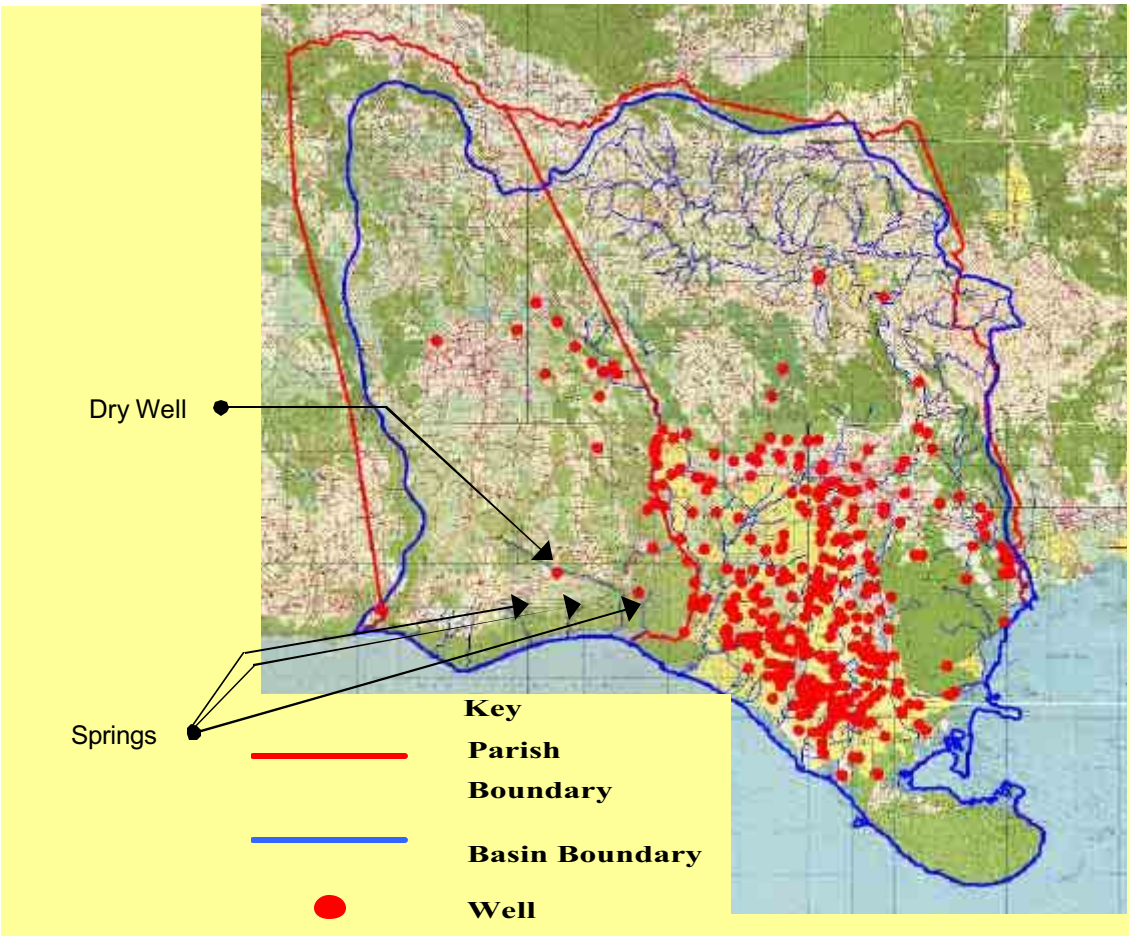

FIGURE 3-8: WELLS IN THE RIO MINHO HYDROLOGIC BASIN

3.3.3.4 WATER RESOURCES DEVELOPMENT

The majority of the population on the Manchester Highlands depends on rainwater harvesting to meet their domestic demands. Agriculture is 100% rainfed.

Only one production well has been successfully developed in the Manchester Highlands and this is the well at Victoria Town. This well has an average annual production of 0.10 Mm^3 and maximum monthly production of 0.02 Mm^3. In the dry season as aquifer recharge is reduced, the well yield falls significantly.

Water supply to the major urban centre, Mandeville, is from groundwater supplied by wells drilled at Porus, Manchester and at Pepper, St. Elizabeth.

The total annual production from the 3 wells at Pepper is 7 Mm^3 while from 2 wells at Porus the annual production is 3.45 Mm^3.

The wells at Porus tap the groundwater flowing in the Williamsfield Graben, a preferred flow path for groundwater. The Queen Town Hill Fault, which extends from Balaclava in St. Elizabeth, creates a high permeable zone and a preferred flow path for groundwater. Several springs that support flow at the St. Toolies and in the Milk River rise along this fault. The Milk River is 100% supported by groundwater drained from the limestone aquifer.

The reliable yield of the Milk River is zero as in the dry season when aquifer storage is low and the NWC and Windalco Wells at Porus are pumping, the river goes dry. However, since the extreme rainfall events associated with tropical storms, Isidore and Lilli in 2002, the Milk River flow has not fallen below 0.18 m^3/sec (15,552 m^3/d) and this was recorded between July 31 and August 5, 2004.

Two wells have been drilled in the extreme north of the Manchester Parish outside the Manchester Highlands. One well, drilled to a depth of 114.3m by Alcan, is located at the bottom of a large depression (to reduce drilling depth and cost) at Evergreen which floods periodically once aquifer storage is exceeded.

The second well is drilled north of the Alcan well at a higher elevation above the flood levels. This well is privately owned and was drilled to a depth of 91.5m. The licenced abstraction from the Evergreen Alcan well is 540 m^3/d while that of the Evergreen private well is 545 m^3/d.

The Water Resources Authority has identified well sites at Green Hill – Evergreen to meet the demands of Christiana. However, none has been drilled, as the costs are prohibitive.

The unutilized safe yield of groundwater under the Manchester Highlands has been identified as 81Mm^3/year. Development of this potential will be difficult and particularly costly given the need for 600 m deep wells and the high risks of failure associated with the compartmentalized nature of the highly permeable zones in the limestone.

3.3.3.4.1 MANCHESTER HIGHLANDS SPRINGS

The Manchester Highlands Springs are located along the coastal strip west of Round Hill in Clarendon. The springs represent natural discharge from the karstic limestone aquifer storage of the Manchester Highlands. Low permeability alluvium deposited on the down faulted southern block, on which the 5.2km^2 swamp is located, functions as a barrier to groundwater flow forcing water table discharges to rise above sea level along the 18 km long limestone/alluvium boundary. The discharges flow through the swamp to the sea principally as the Alligator Hole River, Swift River, Two Rivers, Gramble River and Gut River. Along the remaining 13 km of coastal aquifer boundary, the alluvium is absent and the limestone is in direct contact with the sea. Here aquifer discharge is at or below sea level, directly into the sea.

Flow measurements (spot measurements) made by the Water Resources Authority between 1973 to 1994 indicate a mean discharge of:

- 236,288 m^3/day for the Swift River
- 221,293 m^3/day for the Alligator Hole River
- 227,200 m^3/day for Two Rivers and
- 41,350 m^3/day for Gut River

Any additional groundwater development in the Manchester Highlands will reduce the outflow to the springs with an impact on the environment of the swamp that will become more saline.

3.3.3.5 WATER QUALITY

Water quality under the Manchester Highlands (Victoria Town well), at Porus within the Williamsfield Graben and at Evergreen indicates Calcium Bicarbonate type water. No contamination of water resources in the Manchester area has been noted except:

- Along the coastal zone where the seawater wedge has moved inland
- South of Battersea red mud lake at Windalco's Kirkvine Works where elevated sodium concentration has been detected.

The Manchester Highland Springs exhibit high chloride concentrations. The Alligator Hole River has a mean chloride concentration of 920 mg/l while the other rivers have

mean chloride concentrations varying between 1340 to 2420 mg/l. The difference in quality seems to be related to the elevation of the discharge and the rate of flow. The Alligator Hole River discharges at a higher elevation than the others and a direct relationship between salinity levels, elevation and the Ghyben-Herzberg principle can be determined. The Ghyben-Herzberg principle governs the occurrence of saline groundwater in coaster aquifers.

3.4 AIR QUALITY AND WEATHER

3.4.1 AIR QUALITY

3.4.1.1 AIR QUALITY MANAGEMENT PROGRAM

Jamalco has developed and maintained an Air Emissions Management Program to ensure compliance with the Natural Resources Conservation Authority (NRCA) ambient air quality standards, pending air quality regulations, Alcoa Air Emissions standards as well as to conform with ISO 14001 requirements and the company's EHS policy.

There was no major air quality/weather monitoring station in Southern Manchester from which the consultant was able to acquire recent data. Since the proposed developments for South Manchester are new, Jamalco will conduct extensive baseline air quality studies to be used for comparative analysis once mining and transportation operations begin in the area. Complete high technology telemetry based weather stations will be established at the Mt. Oliphant loading station in the South Manchester SML to measure and monitor weather conditions so that work in the area can be guided by factual information and allow for better protection of the communities from potential mining related negative impacts. Much like the weather stations at the refinery that Jamalco operates, newly established stations in South Manchester will provide supplemental data for the following parameters:

- Wind speed
- Wind direction
- Air temperature
- Barometric Pressure
- Ground temperature

- Precipitation and,
- Standard deviation of the Wind direction.

3.4.1.1.1 AIR EMISSIONS

The primary emissions anticipated in South Manchester from the mining operations will come from equipment and machinery operating in the mines and loading station. While not being deemed insignificant, it is not anticipated that any of these operations will generate significant amounts of air emissions that should be cause for alarm or concern to the citizens of the area. Periodic air emission monitoring will be conducted in the South Manchester area.

3.4.1.1.1.1 Particulates

Emissions of particulates are intermittently released as a result of mining activities, windblown dust associated with bulk material handling, transportation and stocking of raw material (bauxite).

Proven particulate control and dust suppression strategies have been employed at Jamalco facilities, which have significantly minimized particulate and fugitive dust emissions.

These include but are not limited to the use of hooded conveyors, sprinkler systems, and other irrigation methods.

The mining locations will implement a number of fugitive emission control measures (all proven methods adopted by Jamalco at its operating facilities) inclusive of the following:

- Controlling fugitive particulate emissions from storage piles through enclosures, covers or stabilization, minimizing the slope of the upwind face of piles where practicable. Confining as much pile activity as possible to the down wind side of piles.
- Limiting the size of loads to minimize loss of material to wind and spillage.
- Planting special wind breaks at critical points.
- Prompt removal of soil and other dust -forming debris from paved roads and scraping and compaction of unpaved roads to stabilize the road surface as often

as necessary to minimize re-entrainment of fugitive particulate matter from the road surface.

- Vegetating areas with grass.
- To the extent practicable restricting vehicular travel to established paved roads.
- Watering of unpaved roads and other unpaved open spaces as often as necessary to minimize re-entrainment of fugitive particulate matter from these surfaces. Drip irrigation is also practiced at the refinery.
- Maintaining good house keeping practices to minimize the accumulation of materials, which could become fugitive.

Only with the onset of mining operations and the implementation of dust minimising protocols and procedures will Jamalco be able to measure and report the impacts (if any) that the operations are having in terms of particulate air quality.

3.5 WEATHER

3.5.1 REGIONAL SETTING/SPHERE OF INFLUENCE

3.5.1.1 PROPOSED MINING AREA

The proposed mining area is located in Southern Manchester in a general area extending from Mount Oliphant in the East to Woodlands in the West, Green Pond in the North to Bossue in the south, as indicated on Figure 1-1.

Major settlements in the sphere of influence of the proposed mining area include:

- Mt. Oliphant
- Harmons
- Ellen Street
- Warwick
- Farenough
- Green Pond
- Farm Plantation
- John Robinson
- Cross Keys
- Cocoa Walk
- Pusey Hill
- Asia
- Hermitage
- St. Toolis
- Plowden Hill

This area comprises settlements of varying sizes and population, however, the bauxite deposits are distributed randomly throughout these communities and in many cases are void of human encroachment. The sphere of influence of the proposed mining activities is not anticipated to extend outside of the prescribed mining SML.

3.5.1.2 MINING AREA CLIMATE

Mean annual average rainfall is 2,032 mm (80 inches) per year. The historical pattern has light rains in May, a summer dry season marked by brief but torrential thunderstorms, a main rainy season from September to November and a marked dry season from November to April. However, both annual totals and daily rainfall patterns are highly variable. The stationary weather system over central Jamaica in June and July 2002 produced two-thirds of the parish's annual rainfall in 15 days.

Annual rainfall gradients decrease from north to south and west to east. The northern mountains have the highest volumes, often in the form of heavy fog. In the center, Mandeville averages over 80 inches while amounts are lower in sheltered parts, such as Grove Place to the south.

3.5.1.2.1 WINDSPEED AND DIRECTION[1]

The Wind rose plots shown from Figure 3-9 to Figure 3-13 represent or characterize the relevant meteorological data that is provided from the weather station at Knockpatriek Weather Station (AMV) and Halse Hall Weather Station (Jamalco) . They effectively show the predominant wind directions and speeds within a predefined period of time. On a typical Wind Rose plot there is a basic compass layout with the four major directions North, South, East and West. A series of shapes usually plotted from the central axis represent the direction of the wind with a series of concentric circles, which represent the percentage of the time the wind blows in that characteristic direction. The colour of shape depicts the wind speed in the particular direction.

3.5.1.2.1.1 Knockpatrick Weather Station (AMV)

The results showed for the entire year a predominant wind direction in a NWW direction at wind speeds of maximum 8.5 m/s (16 knots) 36% of the time. It also shows some Westerly flow around 15% of the time at wind speeds of around 5.40 m/s (11 knots).

[1] **Jamaica Bauxite Institute**, *Assessment of Dust Distribution in The Harmons, South Manchester Area During Pre-Mining Haul Road Construction*, Conrad Douglas and Associates Limited, April 2002

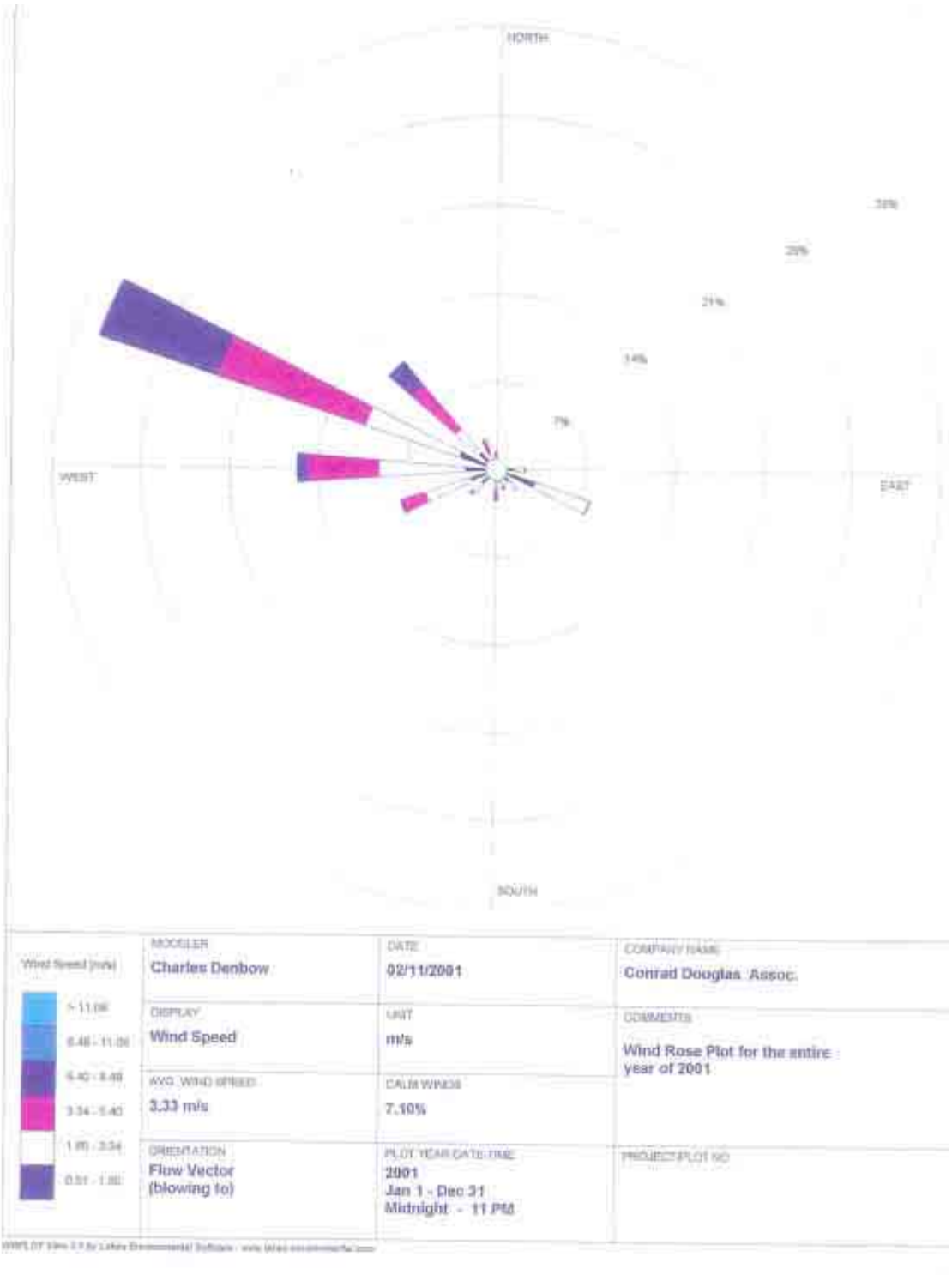

FIGURE 3-9: KNOCKPATRICK WEATHER STATION (AMV) – WIND ROSE PLOT FOR THE YEAR 2001

FIGURE 3-10: KNOCKPATRICK WEATHER STATION (AMV) – WIND ROSE PLOT FOR THE YEAR 2000

3.5.1.2.1.2 Halse Hall Weather Station (Jamalco)

The results for the entire year showed a range of wind directions spanning from the NE directions to the SW directions in an anticlockwise manner. However, it was seen that 9 to 12 % of the time the wind was blowing in a NE direction with speeds up 8.50 m/s. On the contrary, it was seen that 8 to 9% of the time there were small gusts in the SW to NW direction with maximum wind speeds of3.34 m/s (6 knots).

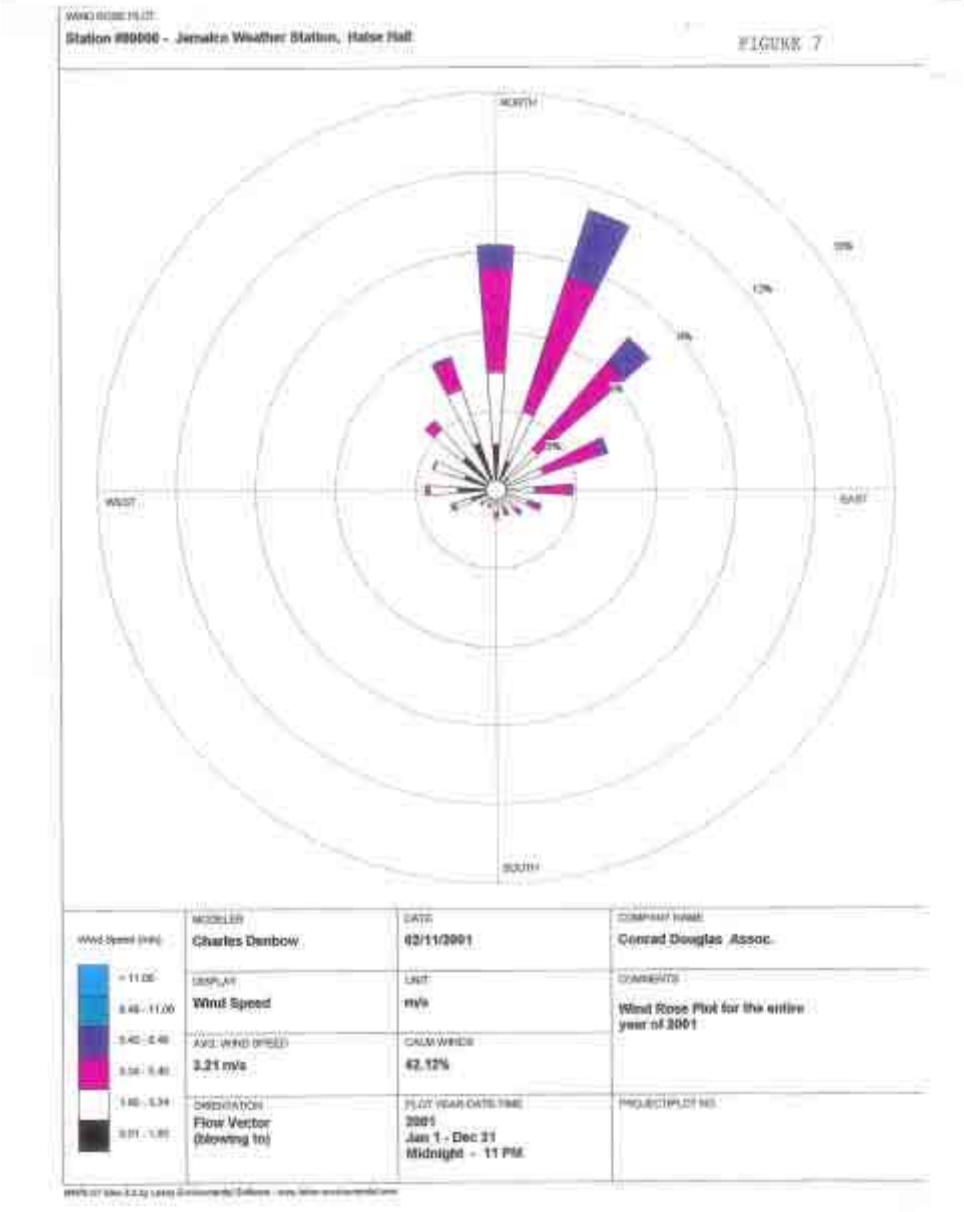

FIGURE 3-11: JAMALCO WEATHER STATION, HALSE HALL – WIND ROSE PLOT FOR YEAR 2001

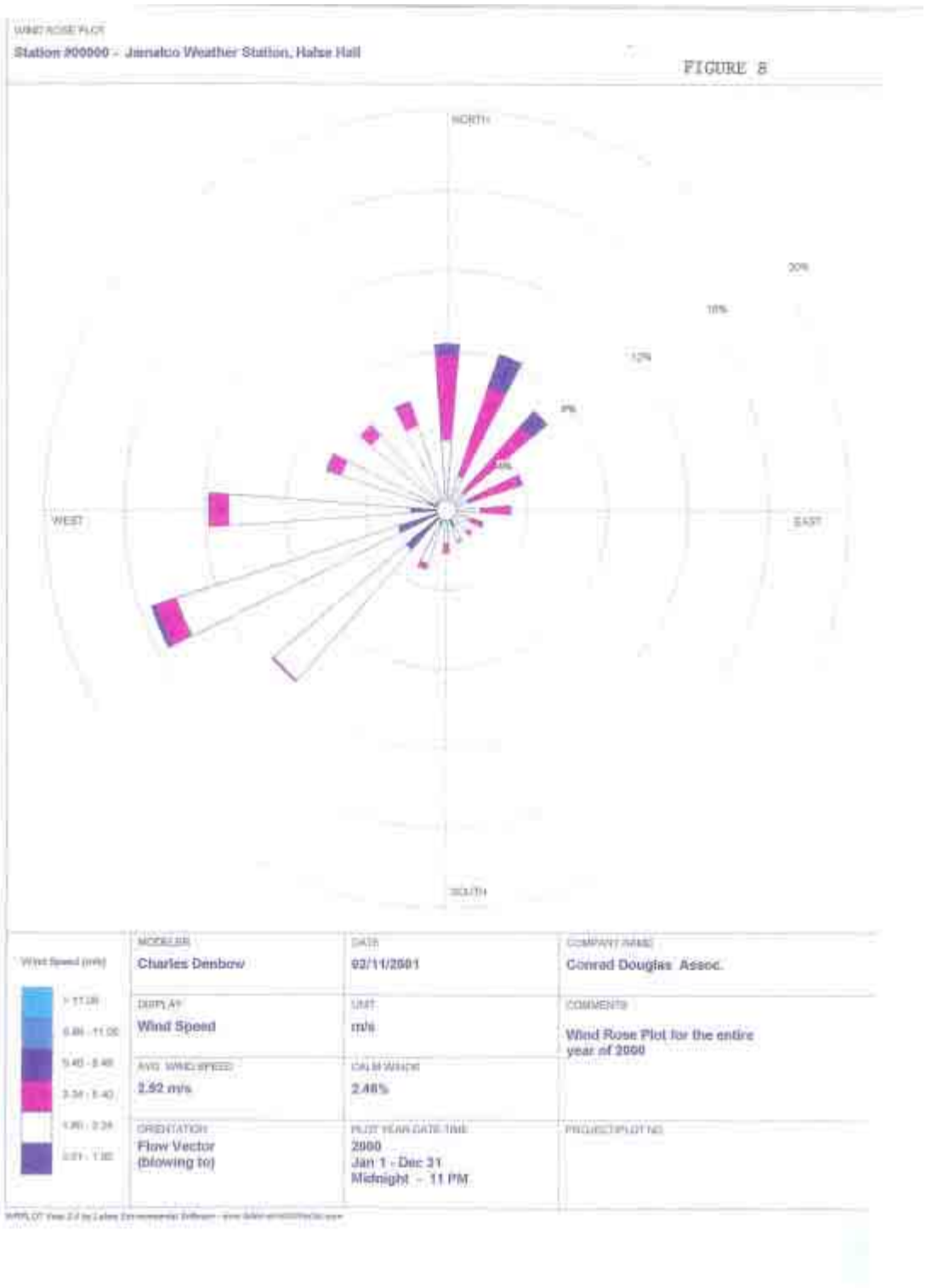

FIGURE 3-12: JAMALCO WEATHER STATION, HALSE HALL – WIND ROSE PLOT FOR YEAR 2001

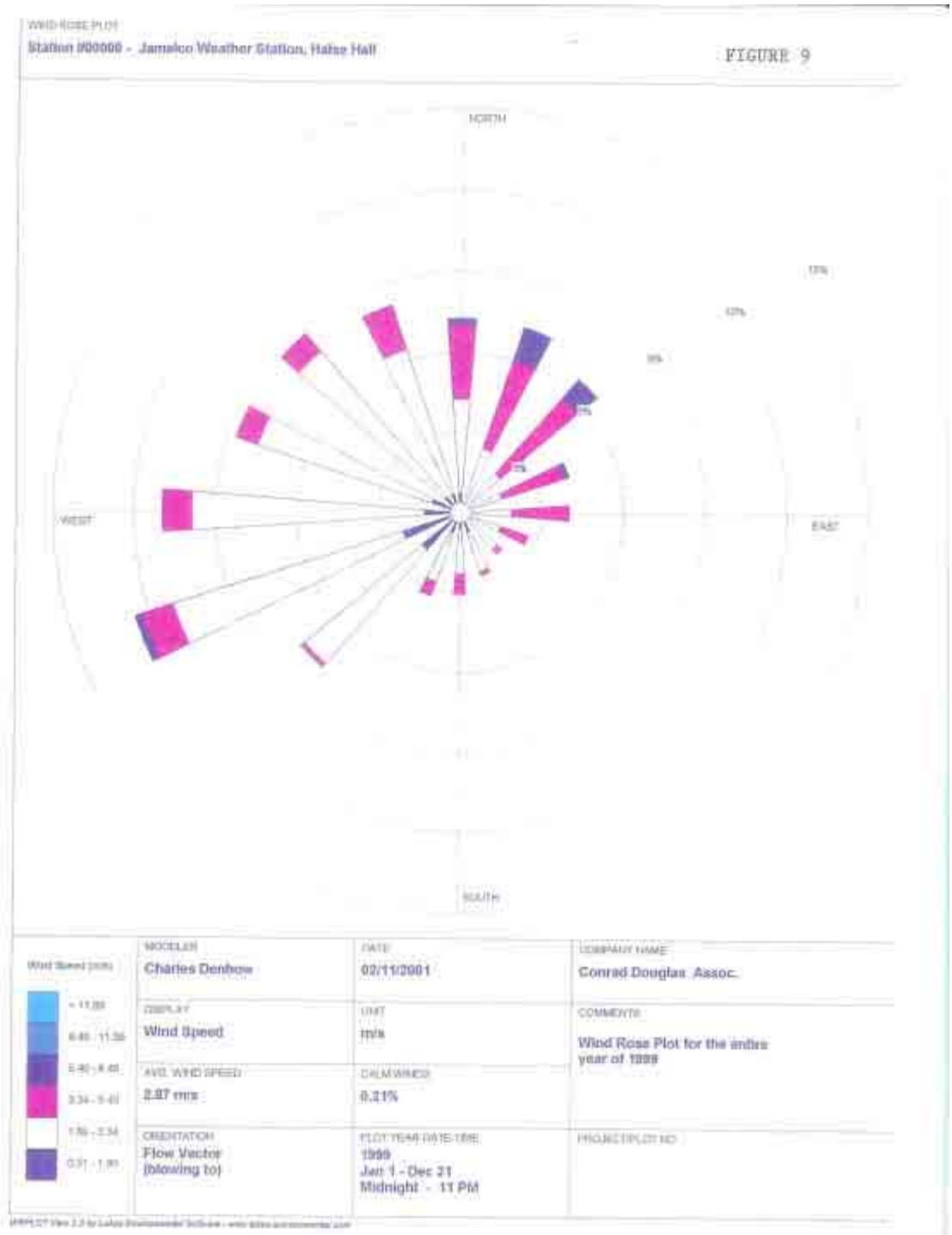

FIGURE 3-13: JAMALCO WEATHER STATION, HALSE HALL – WIND ROSE PLOT FOR YEAR 1999

3.6 WILDLIFE AND VEGETATION

3.6.1 INTRODUCTION

Bauxitic soils in Jamaica are relatively infertile and do not support mature vegetation that could typically be found on other soil types under the influence of the prevailing climatic conditions. Tree species are found on the limestone outcrops, with mainly grasses and small shrubs in areas overlying the bauxite in the depressions. Bauxite mining operations normally are confined to the depressions interspersed between limestone hillocks and this is reflected in the profile of mined areas.

The proposed mode of transport of bauxite ore from the new mining site to the plant is by trucks on dedicated haul roads to the new RopeCon conveyor system from the proposed Mount Oliphant Loadout Station to the St. Jago Rail head, a distance of approximately 3.2km. Rail transport is the mode of transport currently used to move mined ore (from existing mines along the Manchester plateau) from the railhead at St Jago to the refinery at Halse Hall, Clarendon.

3.6.2 METHODOLOGY

The ecological assessment was conducted primarily through qualitative methods supported by literature research. The literature review was based on a series of relatively current studies which employed the use of quantitative methods for several areas in the sphere of influence of the project sites. Methods employed included the following:

- Aerial photography and land use classification mapping to identify plant species distribution and classification.
- Ground- truthing to confirm land use classification and vegetation type and distribution
- Plant collection and plant identification through the aid of a recognized taxonomist and herbarium

- Literature research of information related to the geographical influence of the proposed project to generate species inventories .

- Animal identification through field guides, photography, vocalization, tracks, fecal deposits, burrows among others.

3.6.3 ECOLOGICAL CONTEXT

The gradation of vegetation types is influenced by several factors, namely:

- elevation,
- temperature,
- degree of rainfall, and
- soil types

The South Manchester Plateau experiences warmer, drier temperatures and less frequent rainfall than the North Manchester Highlands and thus have species which exhibits strong xerophytic characteristics.

3.6.3.1 NATIONAL BIOLOGICAL DIVERSITY – INTERNATIONAL AND NATIONAL LEVELS

Jamaica is rated fifth highest in endemic plants of any island, worldwide. Based on information through the National Strategy and Action Plan on Biological Diversity in Jamaica (2003), of the 3,304 known vascular species to occur in the country at least 28% are endemic.

TABLE 3-3-Flora diversity[2]

Terrestrial flora	# of indigenous species	# of endemic species	% endemicity
Bromeliads	60	22	36.7
Orchids	230	60	26
Ferns	579	67	11.5
Cacti	20	10	50
Palms	10	7	70
Grasses	~200	1	0.5

Faunal species similarly have high levels of endemicity with land birds showing 45% and amphibians and reptiles showing a 100% and 76%, respectively

[2]Source: National Strategy and Action Plan on Biological Diversity in Jamaica - 2003

TABLE 3-4- Fauna diversity[2]

Terrestrial fauna	# of indigenous species	# of endemic species	% endemicity
Land snails	514	505	98.2
Grapsid crabs	9	9	100
Jumping spiders	26	20	76.9
Fireflies	48	45	93.8
Butterflies	133	20	15
Ants	59	6	10.3
Amphibians	22	22	100
Reptiles	43	33	76.7
Shore & Seabirds	39	1	2.6
Land birds	67	30	44.8
Bats	21	2	9.5
Other mammals	2	2	100

In order to protect this diversity, the Government, through the Forestry Department, has entered into a Memorandum of Understanding with Jamalco, guided by a 'no-net-loss' policy where the two organizations will work to compensate for the loss of forest cover due to mining operations. This will see the establishment of new forests on selected reclaimed bauxite mined out areas as well as the protection and preservation of existing forests. The full text of the MOU is presented in Appendix III: Reforestation plan in Jamaica –Memorandum of understanding between Ministry of Agriculture- Forestry Department and Alcoa.

3.6.4 FINDINGS

3.6.4.1 DESCRIPTION OF VEGETATION TYPES

The vegetation found in the areas of Mount Oliphant, Retrive, Queen Town, Pusey Hill, Asia, John Robinson, Green Pond etc was composed primarily of dry limestone vegetation interspersed with secondary scrub and pastureland. The vegetation in the mining area is typical of that to be expected in drier areas and could be indicative of more freely draining soils. Of the sixteen families found, two are common endemics, Bull Thatch and Climbing Cactus. Eighteen species were identified. Anthropogenic intrusion is evidenced by the presence of species such as banana (*Musa sp*), Bastard Cherry (*Erhritia tinnifolia*) and Coolie Plum (*Ziziphus mauritiana*).

At least three distinct vegetation types were identified in the project area covering the study area;

- Dry Limestone Forest (various degrees of disturbance)
- Agricultural and pastureland
- Secondary scrub (Thorn scrub)

3.6.4.1.1 DRY LIMESTONE FOREST

In dry limestone forested areas trees were thin boled (basal diameter ranged from 6 to 72 cm) and branched high off the ground, perhaps a result of competition for light. The canopy was shallow but continuous. The understorey was quite open with low light penetration and primarily had saplings of the larger species mainly on the steep limestone slopes. Few openings were observed in the canopy probably due to the effects of Hurricanes Ivan (2004), Dennis (2005) and Emily (2005) or cutting for coal burning. Epiphytes and climbers were well represented. The practice of charcoal burning and the provision of yam sticks have removed many large trees from vast areas. The best forests exist along gullies of steep limestone slopes.

Leaf litter was poor along the slopes and decomposition rates appeared slow. The substrate was fragmented limestone rock. Termite mounds were also noted. Termites act as an important nutrient recycler by digesting cellulose of dead or fallen trees.

The dominant species included *Thrinax parviflora* (Bull thatch, thatch palm) and *Polypodium sp*. (fern) which grew in obvious clusters. *Simaruba bursei* (Red Birch) was the dominant emergent tree, prominent for its burnt red, flaky bark. Its prevalence is probably due to fire resistance and unsuitability for lumber or charcoal. Specimens of *Agave soblifera* (Maypole) with their bright yellow inflorescence were also readily identifiable.

Climbing, scrambling and epipihytic plants were represented by climbing cacti and the common orchid, *Broughtonia sanguinea.* No rare or endemic species were identified.

PLATE 3-1: VEGETATION RECORDED IN DRY LIMESTONE FOREST

PLATE 3-2: EPIPHYTES AND FERNS OF THE DRY LIMESTONE FOREST

3.6.4.1.2 AGRICULTURAL AND PASTURELAND

These areas are predominantly open but contain a considerable number of trees and hedges planted to provide crops, shade, ornamentation and demarcation. One small farm had at least seven species of fruit trees on a plot size of approximately 0.1ha (0.25 acre).

In some areas, huge tracts of unmaintained pastureland were observed. These areas were mostly overgrown with herbs and weeds. Species such as Spanish needle, Shame-o-lady (*Mimosa pudica*), fern (*Polypodium sp.),* and devils' whip (*Achyranthes indica*) were common. Bare ground was indicated only by foot paths or recently cleared fields for cultivation.

Farm plots in the area primarily featured yam *(Diosocea sp),* but other crops included corn (*Zea Mays*), sweet potato (*Ipomoea batatas*) and cassava (*Manihot esculenta*), sorrel and banana (*Musa sp.*). In areas visited these farming areas in combination with buildings and recreational areas, largely replaced the natural vegetation of the valley floor.

PLATE 3-3: PASTURELAND AND FARM PLOT

3.6.4.1.3 SECONDARY SCRUB (THORN SCRUB)

Secondary scrub forest mainly comprises sparsely used and abandoned pastures. These areas are overgrown to form a secondary thorn scrub dominated by Logwood (*Haematoxylon sp.*).

The vegetation here is generally exposed to dry and hot conditions. Wild poponax plants (*Acacia sp.*), of average height 2 m (6.5ft), were highly branched with deep canopies, accounting for an estimated 60% of the plants height. However, the plants did not form a continuous canopy. A herb or sub-canopy was not represented in the savannah area.

Other conspicuous tree species included Poinciana and Guango. Historically introduced pasture grasses are found in the area. These include include Guinea grass *(Panicum maximum)* and species from the genus *Andropogon.*

TABLE 3-5: VEGETATION OF SOUTH MANCHESTER MINING AREAS

FAMILY NAMES	SCIENTIFIC NAMES	STATUS/ RANK
DIVISION: PTERIDOPHYTA [FERNS]		
Polypodiaceae	*Adiantum fragile*	
	A. pyramidale	
	A. tenerum (Maiden Hair)	
	Blechnum villosum	*very rare*
	B. occidentale	
	Cheilanthes micrphylla	
	Cyclopeltis semicordata	*rare*
	Lastreopsis effusa	*rare*
	Nephrolepsis biserrata	
	N. exaltata (Boston fern)	
	N. multiflora	
	Polypodium dispersum	
	P. heterophyllum	
	P. pectinatum	
	P. phyllitids (Cow tongue)	
	P. plumila	
	P. polypodioides (Resurrection fern)	
	Pteridium aquilinum var caudatum	
	Pteris longfolia	
	Tectaria heracleifolia	
	Thelypteris kunthii	
	T. patens	
	T. reptans	
	T. tetragona	*rare*
Schizaeaceae	*Anemia adiantifolia*	
CLASS: GYMNOSPERMAE [TREES & SHRUBS]		
Pinaceae	*Pinus caribaea var. hondurensis (Honduras pine)*	
SUB CLASS: MONOCOTYELDONAE		
Agavaceae	*Agave sobolifera (May pole)*	Frequent
	Agave sp. (sterile) (century palm)	
	Furcraea hexapetala	
	Yucca aloifoli (yacca)a	
Amaryllidaceae	*Hippeastrum puniceum (wild amaryllis)*	
	Zephyranthes carinata (pink zephyrllies)	
	Z. citrina (yelloe zephyrllies)	
Araceae	*Anthurium cordifolium (anthurium)*	
	A. grandifolium(anthurium)	
	Philodendron lacerum (Philodendron)	

	Syngonium auritum (five finger)	
	S. podophyllum (nine finger)	
	Xanthosoma sagittifolium (coco)	
Arecaceae (Palmae)	*Acrocomia spinosa (macca fat)*	endemic
	Chrysalidocarpus lutescens (Madagascar palm)	
	Cocos nucifera (coconut)	
	Elaeis guineensis (oil palm)	*rare*
	Roystonea altissims (upland royal palm)	endemic
	Sabal maritimum (jamaicacensis) (bull thatch)	
	Thrinax parviflora (thatch palm)	endemic
Asparagaceae	*Asparagus setaceus (asparagus fern)*	
Bromeliaceae	*Anananus comusus (pineapple)*	
	Catopsis berteroniana (wild pine)	
	Guzmania monostachia (wild pine)	
	Hohenbergia spinulosa (giantwild pine)	endemic
	H. urbaniana (giant wild pine)	endemic
	Tillandsia balbisiana (wild pine)	
	T. fasciculata (wild pine)	
	T. pruinosa (wild pine)	
	T. recurvata (wild pine)	
	T. setacea (wild pine)	
	T. utriculata (wild pine)	
Commelinaceae	*Callisia fragrans (Mexican callisia)*	
	Tradescantia spathacea(boat lilly, moses in the bull rushes)	
Cyperaceae	*Scleria lithosperma*	
Dioscoreaceae	*Dioscorea alata (white yam)*	
	D. cayennensis (yellow yam)	
Dracaenaceae	*Sansevieria hyacintoides (brown string hemp)*	
	S. trifasciata (brown string hemp)	
Iridaceae	*Trimezia martinicensis*	
	T. steyermarkii	
Musaceae	*Musa hybrid cultivars (bananas & plantains)*	
Orchidaceae	*Bletia purpurea*	
	Broughtonia sanguinea	endemic
	Oeceoclades maculate (African spotted orchid)	
	Oncidium luridum	
	Ponthieva racemosa	
Poaceae (Grasses)	*Bambusa vulgaris (bamboo)*	frequent
	Bracharia reptana (para grass)	

	Chloris barbata (purple top)	
	Cymbopogon citratus (lemon grass)	
	Cynodon nlemfuensis (Bahama grass)	
	Digitaria decumbens (pangola grass)	frequent
	Digitaria sp. (crab grass)	
	Eleusine indica (fowl foot grass, yard grass)	
	Eragrotis pilosa	
	Ichnanthus pallens (rice grass)	
	Lasiacis divaricata (bamboo grass)	frequent
	Olyra latifolia	
	Oplismenus hirtellus	
	Panicum kaxum	
	P. maximum (guinea grass)	
	Paspalum fimbriatum	
	Paspalum sp. (razor grass)	
	Pennisetum purpureum (elephant grass)	frequent
	Rottboellia exaltata (corn grass)	
	Saccharum officinarum (sugar cane)	abundant
	Setaria geniculata (monkey grass)	
	Sporoboñus indicus	
	Themeda arguens (piano grass)	
	Tricholaena rosea	
	Tripsacum laxum	
	Zea mays (corn)	
Smilacaceae	*Smilax balbisiana (wild chaney root)*	
SUB CLASS: DICOTYELDONAE		
Acanthacaea	*Ruellia macrophylla*	
	Thunbergia alata (black eyed suzan)	
	T. fragrans	
Amaranthaceae	*Achyranthes aspera (devil's horse whip)*	frequent
	Iresine diffusa	
Anacardiaceae	*Anacardium occidentale (cashew)*	frequent
	Comocladia pinnatifolia (maiden plum)	
	Mangifera indica (mango)	
	Metopium brownie (poison wood)	
Apocynaceae	*Angadenia lindeniana*	
	Beaumontia grandiflora	
	Forsteronia floribunda	
	Mandivilla torosa	
	Plumeria marchii (wild frangipani)	Endemic
	Tabernaemontana laurifolia	
	T. wullschaegelii	endemic
	Thevetia peruviana (lucky nut)	
	Urechites lutea (*Pentalinon luteum in recent publ.)*	

Araliaceae	*Dendropanax arboreas*	
Asclepiadaceae	*Asclepias curassavica*	
	A. nivea	frequent
	Metastelma leptocladon	
	Euphorbia poinsettia (orange milkweed)	
	Euphorbia hirta (white milkweed)	
	Metastelma sp. (sterile)	
Bignoniaceae	*Crescentia cujete (calabash)*	
	Spathelia campanulata	
	Tecoma stans	
Bixaceae	*Bixa orellana*	
Bombacaeae	*Ceiba pentandra (silk cotton tree)*	
Boraginaceae	*Cordia brownei*	
	C. globosa var humilis	
	C. jamaicencis	endemic
	Ehretia tinifolia	
	Heliotropium angiospermum	
	Tournefortia hirsutissima	
Burseraceae	*Burseria simaruba (red birch, tourist tree)*	frequent
Cactaceae	*Hylocereus triangularis*	endemic
	Rhypsalis baccifera	
	Selenecereus grandiflorus (night blooming ceris)	
Canellaceae	*Canella winterana (wild cinnamon)*	
Caprifoliaceae	*Viburnum alpinum*	endemic
Caricaceae	*Carica papaya (papaya)*	
Casuarinaceae	*Casuarina equisetifolia(Australian pine)*	
Celastraceae	*Schaefferia frutescens*	
Combretaceae	*Terminalia catappa (West Indian almond)*	
	T. latifolia (Broadleaf)	endemic
Compositae (Asteraceae)	*Bidens alba var radiate (Spanish needle)*	frequent
	B. reptans	
	Calea jamaicensis	endemic
	Conyza Canadensis	
	Emilia sonchifolia (paint brush)	
	Eupatorium odoratum	
	E. villosum	
	Mikania micrantha (quaco bush)	
	Partenium hysterophorus	
	Pentacalia discolor (white back)	endemic
	Pluchea carolinensis	
	Pseudelephantopus spicatus	
	Tridax procumbens	
	Vernonia acuminata	endemic

	V. divaricata	
	Wedelia gracilis (Marigold)	
Convolvulaceae	*Cuscuta Americana (love winder, love bush)*	
	Dichondra repens	
	Ipomea indica var. acuminate (wild slip)	
	I. tiliacea (wild slip)	
	Merrimia umbellate	
	Turbina corymbosa (Christmas pops)	
Crassulaceae	*Bryophyllum pinnatum (leaf of life)*	
Cucurbitaceae	*Cayaponia racemosa*	
	Cucurbita pepo (pumpkin)	
	Momordica charantia (cerasse)	frequent
Erythroxylaceae	*Erythroxylum confusum*	
Euphorbiaceae	*Acidoton Urens (scratch bush, cowitch*	endemic
	Alchornia latifolia	
	Aleurites moluccana (Jamaican walnut)	
	Chamaesyce hyssopifolia (milkweed)	
	Codiaeum variegatum (garden croton)	
	Croton humilis	
	C. linearis (wild rosemary)	
	C. nitens	
	Euphorbia oerstediana	
	E. tirucalli (pencil tree)	
	Gymnanthes lucida (crab back)	
	Jatropha multifidda	
	Manihot esculenta (cassava)	
	Pedilanthus tithymaloides (monkey fiddle)	
	Poinsettia pulcherrima (poinsettia)	
	Ricinus communis (castor oil)	
Flacourtiaceae	*Casearia guianensis (wild coffee)*	
	C. hirsuta	
	Zuelania guidonia	
Gentianaceae	*Lisianthius longiflorus*	endemic
	Gesnaria acaulis	endemic
	Rytidophyllum tomentosum (search me heart)	endemic
Guttiferae (Clusiaceae)	*Calophyllum calaba*	
	Clusia flava	
	C. rosea (tar pot, card gum)	
Labiatae (Lamiaceae)	*Epimeredi indicus*	
	Hyptis pectinata	
	H. suaveolens (wild mint)	
	Leonotis nepetifola	

	Salvia serotina	
	Satureja viminea (black mint)	
Lauraceae	*Licaria triandria (sweetwood)*	
	Nectandra coriacea (sweetwood)	
	Persea Americans (avocado pear)	
Leguminosae subfamily - Caesalpinioideae	*Bauhinia divaricata (bull hoof)*	
	Caesalpinia decapetala (wait-a-bit)	
	Chamaecrista lineata	
	Delonix regia (Poinciana)	
	Haematoxylum campechianum (logwood)	abundant
	Hymenaea courbaril (W.I. locust, stinking toe)	
	Senna ligustrina	abundant
	S. occidentalis (wild coffee)	abundant
	S. simea (cassia)	
	Tamarindus indica (tamarind)	
Leguminosae subfamily - Faboideae (Papilionaceae)	*Abrus precatorius (John Crow bead)*	
	Cajanus cajan (gungo pea)	
	Canavalia altipendula	endemic
	Centrosema virginiannum	endemic
	Cracca caribaea	
	Crotalaria retusa	
	Desmodium axillare (stick tight)	
	D. incanum (stick tight)	
	Erythrina corallodendrum (quick stick)	
	Flemingia strobilifera (wild hops)	
	Galactia striata	
	Gliricidia sepium (quick stick)	
	Macroptilium lathroides	
	Piscidia piscipula (dog wood)	
	Rhynchosia minima	
	Stylosanthes hamata	
Leguminosae subfamily - Mimosoideae (Mimosaceae)	*Acacia farnesiana*	
	A. macracantha	
	A. tortuosa	
	Adenanthera pavonina (John Crow bead)	
	Calliandra portoricensis	
	Desmanthus virgatus	
	Leucaena leucocephala	
	Mimosa pudica (shame-o-lady)	

	Pithecellobium alexandri	endemic
	P. unguis-cati	
	Samanea saman (saman, guango)	
Loranthaceae	*Oryctanthus occidentalis (mistle toe, scorn the ground)*	endemic
Malpighiaceae	*Byrsonima coriacea*	
	Malpighia glabra	
	Stigmaphyllon puberum	
Malvaceae	*Bastardia viscosa (stinking weed)*	
	Hibiscus elatus (blue mahoe)	
	H. rosa-sinensis (hibiscus, shoe black)	
	H. sabdariffa (sorrel)	
	Malvastrum americanum	
	M. corchorifolium	
	Malvavviscus arboreus var. penduliflorus	
	Pavonia rosea	
	Sida acuta (broomweed)	
	S. glutinosa (broomweed)	
	S. spinosa (broomweed)	
	S. urens (broomweed)	
	Urena lobata	
	Wissadula amplissima	
	W. fadyenii	
Melastomataceae	*Blakea trinervia (cup and saucer)*	endemic
	Miconia laevigata (mackerel bush)	
	Tetrazygia pallens (ashes bush)	endemic
Meliacea	*Cedrela odorata (cedar)*	
	Guarea swartzii	endemic
	Swietenia mahagoni (mahogany)	
	Trichilia hirta	
Menispermaceae	*Cissampelos pareira*	
Moraceae	*Artocarpus altilis (breadfruit)*	frequent
	Brosimum alicastrum (breadnut)	
	Cecropia peltata (trumpet tree)	
	Ficus aurea (wild fig)	
	F. citrifolia (wild fig)	
	Ficus sp. (wild fig)	
Myrsinaceae	*Ardisia sp. (sterile)*	
	Mysine acrantha	
	Wallensis sp.(sterile)	endemic
Myrtaceae	*Eugenia axilllaris*	
	E. biflora	
	Eugenia sp. (sterile)	
	Pimenta dioica	
	Psidium cattleianum	

	P. guajava	
	Syzygium jambos	
Nyctaginaceae	*Pisonia aculeata*	
Papaveraceae	*Argemone mexicana*	
	Bocconia frutescens	
Passilfloraceae	*Passiflora oblongata*	endemic
	P. rubra	
	P. sexflora	
	P. suberisa	
Phytolaccaceae	*Rivina humilis (broomweed)*	
	Trichostigma octandrum	
Piperaceae (Black pepper family)	*Peperomia amplexicaulis (silver bush)*	
	P. obtusifolia	
	Piper amalago (jointer)	
	P. hispidum	
	P. murrayanum	
Plumbaginaceae	*Plumbago scandens (white plumbago)*	
Polygalaceae	*Polygala jamaicensis*	
	Securidaca brownei	endemic
Polygonaceae	*Coccoloba longifolia (wild grape)*	
	C. swartzii (wild grape)	
	C. uvifera (sea grape)	
Ranunculaceae	*Clematis dioica (wild clematis)*	
Rhamnaceae	*Colubrina arborescens*	
	C. elliptica	
	Krugiodendron ferreum (iron wood)	
	Ziziphus mauritiana (coolie plum)	
Rubiaceae	*Chiococca alba*	
	C. parvifolia	
	Coffea arabica (coffee)	
	Guettarda argentea	
	Hamaelia sp. (sterile)	
	Morinda citrifolia (hog plum)	
	Portlandia albiflora (portlandia)	endemic
	P. grandiflora (portlandia)	endemic
	Psychotria glabrata	endemic
	P. nervosa	
	P. pubescens	
	Spermacoce assurgens (Borreria laevis of Adams) (Mongoose weed)	
	S. verticillata	
Rutaceae	*Citrus aurantifolia (swingle lime)*	
	C. limon (lemon)	
	C. paradisi (grapefruit)	

	C. reticulata (tangerine)	
	C. sinensis (sweet orange)	
	Spathelia sorbifolia (mountain pride)	endemic
	Zanthoxylum martinicense (yellow prickly)	
	Zanthoxylum sp. (sterile)	
Sapindaceae	*Allophylus cominia*	
	Blighia sapida (ackee)	frequent
	Mellicoccus bijugatus (guinep)	
	Paullinia barbadensis	endemic
	Serjania mexicana	
Sapotaceae	*Chrysophyllum cainito (star apple)*	
	C. oliviforme (wild star apple)	
	Manilkara zapota (naseberry)	
	Pouteria multiflora	
	Sideroxylon portoricense (Bumelia nigra of Adams) (black or red bullet)	
	S. salicifolium	
Simaroubaceae	*Picramnia antidesma (bitter wood)*	
	Picrasma excelsa (bitter wood)	
Solanaceae	*Capsicum baccatum (bird pepper)*	
	Cestrum diurnum	
	Lycopersicon esculentum (tomato)	
	Solanum eruanthum	
	S. torvum (susumber)	frequent
Sterculiaceae	*Guazuma ulmifolia*	
	Waltheria indica	
Thymelaeaceae	*Daphnopsis americana ss. cumingii*	
Tiliaceae	*Triumfetta semitriloba*	
Turneraceae	*Turnera ulmifolia (ramgoat dash-a-long)*	
Ulmaceae	*Celtis trinervia*	
Urticaceae	*Pilea microphylla (artillery plant)*	
	P. nummulariifolia	
	Pilea sp.	
Verbenaceae	*Duranta erecta*	
	Holmskioñdia sanguinea (Japanese hat)	
	Lantana camara (sage)	frequent
	L. involucrata (sage)	frequent
	L. reticulata (sage)	frequent
	L. trifolia (sage)	frequent
	Petitia domingensi (fiddle wood)s	
	Stachytarpheta cayennensis (vervine)	
	S. jamaicensis (vervine)	
Viscaceae	*Phoradendron quadrangulare (scorn the ground)*	
	P. trinervium (scorn the ground)	

Vitaceae	*Cissus verticillata (wall saddle)*	
	Leea cocinea (leea)	
	Vitis tilliifolia (wild grape)	

3.6.4.2 ROPECON CONVEYOR ROUTE LOADOUT STATION TO PLANT

Transport of ore from the Loadout Station to the plant will be via a raised conveyor across the Mount Oliphant community and the forested ridges between Mount Oliphant and the St. Jago railhead (from thorn scrub/pastureland to dry limestone forest type vegetation).

Coal kilns (new and used) were observed in the limestone forest at various points along the proposed conveyor route to the railhead, indicating that local forest species were being harvested for charcoal production.

Summary

Elevation and human influence impacted on the species composition in most areas. The steep sided slopes maintained the best example of original forest cover. Few endemics were recorded including Thatch Palm but were all common in distribution.

Historically introduced pasture grasses are found in the area. These include include Guinea grass *(Panicum maximum)* and species from the genus *Andropogon.*

3.6.4.3 FAUNAL STUDIES

3.6.4.3.1 GENERAL FAUNAL DESCRIPTION

The primary focus of the faunal studies was on the avifauna in the area and for the other species noted such as insects, reptiles and amphibians. Analysis of avifauna species was conducted in relation to habitat types as outlined above in the vegetation analysis.

Based on the BEG's Agriculture Limited Report (2000) done on behalf of Jamalco, at least 48 bird species were observed with 13 of these being endemics and 12 winter migrants. This list comprises the important and regular elements of the aviauna (see Table 3-6 below).

Many bird species are dependent on the forest and as such are affected when sections are opened up. Species such as Jamaican Vireo, Caribbean Tody, Greater Antillean Bullfinch, and the Stolid Flycatcher are dependent on the forests. The BEG's report however, found two-thirds of the breeding species and all but one winter species did not show marked decline as a result of increased human impact on habitats. Some species showed increased numbers in residential and agricultural areas, such as; cattle Egret, Yellow-faced Grassquit, Turkey Vulture and Greater Antillean Grackle.

The secondary scrub was found to be the principal habitat for several species including; Mourning dove, Antillean Palm Swift and the Grasshopper Sparrow to name a few.

Literature sources confirmed that major nesting periods are between January and May.

TABLE 3-6: AVIFAUNA OF SOUTH MANCHESTER

FAMILY	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK
Accipitridae	*Buteo jamaicensis*	Red-tailed Hawk	endemic
Apodidae	*Tachornis phoeicobia*	Antillean Palm Swift	
Ardeidae	*Bubulcus ibis*	Cattle Egret	
Caprimulgidae	*Chordeiles gundlachii*	Antillean Nighthawk	Summer migrant
Cathartidae	*Cathartes aura*	Turkey Buzzard	
Coerebinae	*Coereba flaveola*	Bananaquit	endemic
Cucilidae	*Crotophaga anis*	Smooth-billed Ani	
Coccyzidae	*Coccyzus minor*	Mangrove Cuckoo	
Columbidae	*Columba leucocephala*	White-crowned Pigeon	
Columbidae	*Columbina passerina*	Common Ground Dove	
Columbidae	*Geotrygon versicolor*	Crested Quail Dove	endemic
Columbidae	*Zenaida asiatica*	White-winged Dove	endemic
Columbidae	*Leptotila jamaicensis*	Caribbean Dove	
Columbidae	*Zenaida aurita*	Zenaida Dove	endemic
Columbidae	*Zenaida macroura*	Mourning Dove	
Emberizinae	*Ammodramus savannarum*	Grasshopper Sparrow	
Emberizinae	*Loxipasser anoxanthus*	Yellow-shouldered Grassquit	endemic
Emberizinae	*Tiaris bicolor*	Black-faced Grassquit	
Emberizinae	*Tiaris olivacea*	Yellow-faced Grassquit	
Falconidae	*Falco sparverius*	American Kestrel	
Fringillidae	*Loxigilla violacea*	Antillean Bullfinch	
Fringillidae	*Sicalis flaveola*	Saffron Finch	introduced
Hirundinidae	*Hirundo fulva*	Cave Swallow	
Icteridae	*Quiscalus niger*	Greater Antillean Grackle	
Icteridae	*Icterus leucopteryx*	Jamaican oriole	
Icteridae	*Molothrus bonariensis*	Shiny Cowbird	
Mimidae	*Mimus polyglottos*	Northern Mockingbird	
Picidae	*Melanerpes radiolatus***	Jamaican Woodpecker	endemic

FAMILY	SCIENTIFIC NAMES	COMMON NAMES	STATUS/RANK
Psittacidae	*Aratinga nana***	Olive-throated Parakeet	endemic
Psittacidae	*Forpus passerinus*	Green-rumped Parrotlet -	introduced
Strigidae	*Pseudoscops grammicus*	Jamaican Owl	
Thraupinae	*Euphonia jamaica***	Jamaican Euphonia	endemic
Thraupinae	*Euneornis campestris*	Orangequit	endemic
Thraupinae	*Spindalis nigricephala*	Jamaican Stripe-headed Tanager	endemic
Todidae	*Todus todus***	Jamaican Tody	endemic
Trochilidae	*Anthracothorax mango*	Jamaican Mango	endemic
Trochilidae	*Mellisuga minima*	Vervain	
Trochilidae	*Trochilus polytmus polytmus***	Red-billed Streamertail	endemic
Turdidae	*Turdus jamaicensis***	White-chinned Thrush	endemic
Tyrannidae	*Myiarchus barbirostris***	Sad Flycatcher	endemic
Tyrannidae	*Myiarchus validus***	Rufous-tailed Flycatcher	endemic
Tyrannidae	*Myiarchus stolidus*	Stolid Flycatcher	
Tyrannidae	*Myiopagis cotta*	Jamaican Elarnia	endemic
Tyrannidae	*Tyrannus caudifasciatus*	Loggerhead Kingbird	
Tyrannidae	*Tyrannus dominicensis*	Gray Kingbird	Summer migrant
Tytonidae	*Tyto alba*	Common Barn Owl	
Vireonidae	*Vireo altiloquus*	Black-whiskered Vireo	Summer migrant
Vireonidae	*Vireo modestus*	Jamaican Vireo	endemic
WINTER MIGRANTS			
Coccyzidae	*Coccyzus americanus*	Yello-billed Cuckoo	
Parulidae	*Dendroica caerulescens*	Black-throated Blue Warbler	
Parulidae	*Dendroica coronata*	Yellow-rumped Warbler	
Parulidae	*Dendroica discolor*	Prairie Warbler	
Parulidae	*Dendroica dominica*	Palm Warbler	
Parulidae	*Dendroica magnolia*	Magnolia Warbler	
Parulidae	*Dendroica tigrina*	Cape May Warbler	
Parulidae	*Geothlypis trichas*	Common Yellowthroat	
Parulidae	*Mniotilta varia*	Black and White Warbler	
Parulidae	*Parula americana*	Northern Parula	
Parulidae	*Seiurus aurocapillus*	Ovenbird	
Parulidae	*Setophaga ruticilla*	American Redstart	

Families - 25
Endemics - 19

3.6.4.4 OTHER FAUNA

Insects were fairly well represented, with butterflies and bees being the most obvious of the group. Lepidoptera (butterflies etc.) were represented with at least 5 different species noted. More importantly is the ecological functions of these insects where they act as pollinators. Other insect's species included ants, beetles, stinkbugs, wasps and honeybees.

3.6.4.4.1 AMPHIBIANS AND REPTILES

Reptiles and amphibian were not noted during surveys however literature reviews indicated the likely occurrence of certain species in the study area. Please refer to Table 3-7 below, which provides a list of potential amphibians and reptiles in study area.

There are at least four species of *Arrhyton sp.* of which three are endemic. The snakes feed on other reptiles and amphibians such as *Anolis spp, Eleutherodactylus* adults and eggs as well as *Sphaerodactylus spp*. Of the *Sphaerodactylus spp* one, not endemic, has a range extending to the study area.

In addition, at least six *Anolis spp* are suspected to occupy the area. Of these six species at least five are endemics with one species thought to be extinct.

Of the amphibians at least 15 species are thought to have the potential to occur in the study area and of these fifteen, twelve are endemic. Furthermore, nine of those species are *Eleutherodactylus spp.*

TABLE 3-7: TERRESTRIAL INVERTEBRATE [AMPHIBIANS & REPTILES] KNOWN TO INHABIT SOUTH MANCHESTER[3]

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
COLUBRIDAE	*Arrhyton funereum*	Jamaican Black Groundsnake	E
	Arrhyton callillaemum	Jamaican Red Groundsnake	E
TYPHLOPIDAE	*Typhlops jamaicensis*	Jamaican Thunder Snake, Jamaican Blindsnake	E
GEKKONIDAE	*Sphaerodactylus argus*	Jamaican Stippled Sphaero	-
ANGUIDAE	*Celetes duquesneyi*	Blue-Tailed Galliwasp	E
	Celetes d crusculus		E
	Celetes barbouri	Limestone Forest Galliwasp	-
IGUANIDAE	*Anolis valencienni*	Jamaican Twig Anole	E
	Anolis sagrei	Cuban Brown Anole	-
	Anolis opalinus	Opal-Bellied Anole	E (Possibly extinct)
	Anolis garmani	Jamaican Giant Anole	E
	Anolis grahami	Jamaican Turquoise Anole	E
	Anolis lineatopus	Jamaican Gray Anole	E
TEIIDAE	*Ameiva dorsalis*	Jamaican Ameiva	-
EMYDIDAE	*Trachemys terrapen*	Jamaican Slider	-
HYLIDAE	*Osteopilus brunneus*	Jamaican Laughing Frog	E
	Hyla wilderi	Green Bromeliad Frog	E

[3] Additional information from Caribherp: West Indian Amphibians and Reptiles, http://evo.bio.psu.edu/caribherp/lists/JAM-LIST.HTM, Accessed September 8, 2005

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
	Hyla marianae	Yellow Bromeliad Frog	E
LEPTODACTYLIDAE	*Eleutherodactylus planirostris planirostris*	Cuban Flathead Eleuth	-
	E. pantoni pantone	Jamaican Yellow-Bellied Eleuth	-
	E.junori	Rock Pocket Eleuth	E
	E.jamaicensis	Jamaican Bromeliad Eleuth	E
	E.grabhami	Jamaican Pallid Eleuth	E
	E gossei gossei	Jamaican Forest Eleuth	E
	E. gossei oligaulax		E
	E. cundalli	Jamaican Rock Eleuth	E
	E. cavernicola	Portland Ridge Eleuth	E
	E. calyptahyla crucialis		E

Families -9
Species - 28 E - Endemics - 21

3.6.4.4.2 BUTTERFLIES

As with amphibians and reptiles, this group was not surveyed and literature searches did not yield concrete data on species distribution. Information from the BEG's report 2000, which focused on faunal studies in Southern Manchester, indicated the likely occurrence of certain species. The report identified seven families accounting for 41 species. Of which nine are endemic species or subspecies.

3.6.4.4.3 OTHER INVERTEBRATES

The BEG's report (2000) also identified species such as moths and, microlepidoptera. Please refer to the species list below:

TABLE 3-8: INVERTEBRATES OF SOUTH MANCHESTER

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
ORDER: LEPIDOPTERA [Moths & Butterflies]			
Arctiidae	*Ammalo helops*		
	Calidota strigosa		
	Eunomia rubripunctata		Endemic
	Cosmosoma achemon		
	Cosmosoma auge		
	Cosmosoma fenestrata		
	Horama grotei		Endemic
	Empyreuma anassa		Endemic
	Phoenicoprocta jamaicensis		Endemic
	Composia credula		Rare

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
	Correbidia sp.		Rare
Hyponomeutidae	*Atteva auria*		
Pyralidae	*Diaphina hyalinata*		
	Epipagis huronalis		
	Anania florella		
Sphingidae	*Enyo biosduvali*		
	Erinnyis alope		
Geometridae	*Nepheloleuca foridata*		
ORDER: ODONATA [Dragonflies and Damselflies]			
Aeshnidae	*Coryphaeschana adnexa*	Needle case	
Libellulidae	*Erythemis simplicollis*		
	Erythemis plebeja	Needle case	
	Tramea abdomiinalis	Needle case	
	Tramea insulris	Needle case	
	Tramea binotata	Needle case	
	Erythrodiplax aunrata	Needle case	
	Erythrodiplax bernice	Needle case	
	Dthemis rufinervis	Needle case	
	Macrothemis celeno	Needle case	
	Lepthemis vesiculosa	Needle case	
	Anax junius	Needle case	
	Micrathytyria didyma	Needle case	
	Pantala flavescens	Needle case	
Zygoptera (Damsel flies)	*Unidentified sp.*	Needle case	
ORDER: MANTODEA [Praying Mantis]			
	Stagmomatis domingensis	Praying mantis	
ORDER: ISOPTERA [Termites]			
	Nasutitermes nigricepes	Termite; Duck ants; white ants	
	Procyptotermes cornicepes	Termite; Duck ants; white ants	
ORDER: ORTHOPTERA [Grasshopers & Crickets]			
Gryllidae	*Halpithus sp*	Cricket	
Acrididae	*Orphullela punctata*	Small Grasshopper	
	Neoconocephalus affinis	Grasshopper	
	Stilpnochlora laurifolium	Grasshopper	
Noctuidae	*Ascalapha odorata*	Black Witch, Duppy Bat	
	Melipotis sp.		
	Sylectra ericata		
	Leucania juncicola		
	Thysania xenobia		
	Cinccia sp.		
ORDER: DERMAPTERA [Earwigs]			
	Euborellia annulipes	Earwig	
	Cabidora rip aria	Earwig	
ORDER: HOMOPTERA [Plant bugs]			

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
Membracidae	*Tyolzygnus fasciatus*		
Cidadidellidae	*Poeciloscata laticepes*		
ORDER: HEMIPTERA [True bugs]			
Gerridae	*Gerris sp.*		
Pentatomidae (Stink bugs)	*Loxa viridis*	Stink Bug	
	Nezara viridula	Stink Bug	
	Proxy victor	Stink Bug	
	Euschistatus bifibulous	Stink Bug	
	Alcaeorrhyndicus grandis	Stink Bug	
	Proscys victor	Stink Bug	
Cydinidae	*Tominotus communis*		
Rediviidae		Stick insect	
Pyrrhocoridae (Stainers)	*Dysdercus jamaicensis*	Police man bug; Love bug	
	Oncopertus sanderchatus		
	Oncopertus pictus		
ORDER: NEUROPTERA [Lace wings & ant lions]			
Chrysopidae	*Chrysopa bicornea*	Ant lion; Nanny Goat	
Myrmelontidae	*Hesperoleon sp.*	Green lace wing	
ORDER: DIPTERA [Flies]			
Tipulidae	*Limonira sp.*	Daddy long leg; crane fly	
Syrphidae (Flower flies)	*Ornidia obesa*		
	Copestylum inatoma		
	Copestylum tamaulipanaum		
	Pseudodorus clavatus		
	Toxomerus pulchallus		
Bombylidae	*Paecillathrax lucifer*	Bee fly	
Stratyomyidae (Soldier flies)	*Hermatia illuscells*	Soldier fly	
Assilidae	*Leptogaster jamaicensis*	Robber fly; bee fly	
	Cerotainia jamaicensis	Robber fly; bee fly	
	Ommatis alexanderi	Robber fly; bee fly	
Tephritidae	*Anastrepha sp*	Fruit fly	
Stphylinidae	*Carpelimus petomus*		
	Carpelimus sp.		
Tenebrionidae	*Tarpela metabilis*		
ORDER: COLEOPTERA [Beetles]			
Cincindellide	*Cicindela carthagena jamaicana*		
Coccinellidae	*Chalieorus cacti*	Lady bird beetle	
	Cycloneda sauguinea	Lady bird beetle	
Scolytidae	*Xyleborus sp.*	Shotgun borers	
Chrysomelidae	*Coptocyia jamakana*		
	Metriona flavolineata		
	Diabrotica bivittata		
	Disonycha laevigate		
	Homophoeta albicellis		

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
	Cerotoma ruficornis		
Cerambycidae	*Eburia postica*		
	Oreodera sp.		
	Chlorida festiva		
	Elaphidon spinicorne		
	Neoptychodes trilineta		
	Neoclytus longipes		
	Neoclytus sp.		
Scarabeeidae (Scarab beetle)	*Paragymentis lanius*		
	Ligyrus fossor		
	Macraspis tetradactyla		
	Strategus sp.	News bug	
	Oniticellus cubiensis	Dung beetle	
	Phanaeus vindex		
Dyticidae	*Unidentified sp.*		
ORDER: HYMENOPTERA [Ants, Wasps & Bees]			
Scolidae	*Compsomeris dorsata*		
	Campsomeris attrata		
Ichneumonidae	*Icheumonus sp.*	Night wasp	
Apidae	*Euglossa jamaicensis*		
	Centris sp.		
	Apis mellifera	Honey bee	
	Exomolapsis sp.		
Megachilidae	*Megachile concina*	Leaf cutter bee	
	Megachile poyei	Leaf cutter bee	
Sphecidae	*Sceliphron asimile*	Mud wasp	
	Zeta abdominalae	Mud wasp	
	Pachydynerus nasidens	Mud wasp	
Vespidae	*Polistes crinitus*	Red wasp	
	Polistes hunteri	Red wasp	
	Polistes major	Big red wasp	
Chalcidae	*Spilochalsis sp.*		
Formicidae	*Paratrechina longicornis*		
	Crematogaster sp.	Black ant	
	Pheidole sp.	Biting ant	
	Camponutus sp.	Carpenter ant; Big red ant	
	Trachymymex jamaicensis	Gardening ant	Endemic
ORDER: COLLEMBOLA [Springtails]			
	Unidentified sp.	Springtail	
SPIDERS			
	Peucetia sp.	Anancy Spiders	
	Argiope aurunita	Anancy Spiders	
	Micrathena sp.	Anancy Spiders	
	Phalaugium sp.	Anancy Spiders	
MILLIPEDES			
	Julida sp.	Forty leg	
ORDER: IXODES [Ticks]			
	Boophilous microplus	Cattle tick	

FAMILY NAMES	SCIENTIFIC NAMES	COMMON NAMES	STATUS/ RANK
ORDER: ISOPODA			
	Unidentified sp.	Woodlouse	
ORDER: OLIGOCHAETA [Earth Worms]			
	Pheretima sp.	Earthworm	
	Proto scolex sp.	Earthworm	
SNAILS			
	Thelidomus aspreera		
	Sagda jayana		
	Sagda anodon		
	Sagda torrefactor		
	Plectocycoltus jamaicensis		
	Lucidella granulosa		
	Lucidella anroela		
	Lucidella sp.		
	Urocoptis aspera		
	Urocoptis brevis		
	Urocoptis sp.		
	Orthalicus undatus		
	Eutrochatella sp.		
	Pleurodonte autalucena		
	Tudora jayana		
	Tudora tectilabris		
	Tudora banksiana		
	Tudora sp.		
	Dentelaria sp.		

Families -50
Endemics - 5

3.6.4.5 ECOLOGICAL RELATIONSHIPS

- **Soil fertility and Trees.** It is well established that the presence of trees contribute significantly to soil amelioration. Trees provide a number of functions; physically, they prevent soil erosion by protecting the soil from direct rainfall through interception with their canopies, and they improve soil stability through their root systems. Chemically, they improve soil quality by additions of organic matter (leaf litter, decomposing branches and root exudates) and through leaching from stem and leaves.

  The species *Samanea saman* (Guango) may play a greater role in this regard. The plant is a nitrogen fixing tree, and large specimens are frequent in several areas.

- **Plant dispersal and Pollination.** Several of the plant species have specialized relationships with birds to ensure pollination and seed dispersal. One such case occurs with bromeliads being pollinated by *Trochilus polytmus polytmus* (Red-billed streamertail) and the *Cecropia peltata* (Trumpet tree) whose seeds are dispersed by birds.

- **Habitats** Several plant species provide valuable habitats for animal species. In general provide feeding and nesting grounds for bird species. In addition to creating microhabitats, such as bromeliads and other epiphytes. These plants in turn support the breeding species as tree frogs and crabs.

3.6.4.6 BIODIVERSITY LEVELS

In summary, a general survey and literature searches of the South Manchester mining, transportation and loadin station areas and vicinity has revealed that while several endemic species have been identified, no rare or endangered species were observed. A comparison of potential species (likely to occur) diversity in the various study areas indicated good representation when matched against national levels.

Jamalco has commissioned extensive independent biodiversity studies of the South Manchester mining area out of concern for the preservation and conservation of Jamaica's biodiversity species

FIGURE 3-14: Comparison of Biodiversity Levels

	Observed species	Endemics	Potential species from literature	Endemics	National levels	Endemics
Plants	60	2	47	Not indicated by study	3,304	167
Birds	39	10	144	19	106	31
Bats	0	N/a	9	1	21	2
Butterflies	5	unknown	41	9	133	20
Amphibians	0	N/s	14	12	22	22
Reptiles	0	N/a	16	11	43	33
Snails	2	unknown	19	Not indicated	514	505

Note- numbers include bird migratory species

Listing from Quaco rock and Bird Cave rock omitted

3.6.5 CONCLUSIONS & RECOMMENDATIONS

3.6.5.1 CONCLUSIONS

The proposed project although wide in its geographical scope will only impact (in a reversible manner) on the ecology of the specific mining areas, the footprint of the RopeCon System and the area in Mount Oliphant selected for the loading station. This will involve the clearing of vegetation and its associated disruption to fauna.

However, Jamalco has made significant preparations for this unavoidable aspect of the development project through its ground breaking Memorandum of Understanding with the Forestry Department to implement a "Land Care Management Plan" for areas slated for mining. In respect of other elements of the project the impacts willl be minimal:

- The railway network and transportation corridor is already in existence and its operation will pose no new threat to vegetative cover and the environment in general. No new rail lines will be added in South Manchester.
- Species noted in the study area are relatively common.

3.6.5.2 RECOMMENDATIONS

The area of concern will be the proposed mining areas, where vegetation will have to be removed to facilitate mining. In such cases the following steps should be taken:

- Land clearance should be kept to a minimum to reduce unnecessary habitat loss
- Care should be exercised to minimize anthropologic influences on nearby areas of significant biological value.
- Where possible, important plant species should be removed for preservation. The involvement of such groups as the Jamaica Orchid Society to do sweeps of the areas before clearance should be considered. The same should apply to smaller animals such as tree frogs or snakes. This is a good opportunity for the involvement of local NGO's to aid with this effort.

- Jamalco should consider organizing a response team through NGO and community contacts to deal with any important species that may be displaced during mining.

- Indigenous species should be preserved for use in the rehabilitation programme to promote re-establishment of similar vegetation types, in keeping with Jamalco's policies and the MOU with the Forestry Department.

In the case of the SML proposed for mining in Southern Manchester, it is recommended that Jamalco continue to study the area to capture the seasonal variations in vegetation, fauna and habitat types and their ecological relationship right up to the commencement of mining.

3.7 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

3.7.1 SUMMARY

No feature, object or structure that could be considered a significant archaeological or historical resource was identified in the assessment of the SML. Searches of the Jamaica National Heritage Trust database did not provide any indications specific to the SML. This is not to say that heritage resources do not exist in the area, but that none were identified.

Jamalco will exercise due caution and care in its mining operations. If Jamalco should identify anything that appears to be of historic or cultural significance, the JNHT will be contacted and a Heritage Retrieval Plan implemented.

3.8 NOISE LEVELS AND VIBRATION

3.8.1 MINING

During mining operations, it is anticipated that the potential for noise impact will come primarily from the utilization of heavy equipment and blasting (where necessary). Because of the location of Jamaica's bauxite deposits atop limestone deposits, it is usually easy to access the ore by simply removing the overburden, in cases where

blasting is required, experience and the use of best practices allow for the required outcome to be achieved with the least impact on surrounding communities.

Noise will be generated by heavy equipment and machinery, however, the identification of bauxite deposits in the proposed mining area in South Manchester makes it difficult to predict the closeness of residents to mining activities. What is known is that Jamalco has a noise management policy that has governed its mining operations in Jamaica for many years which will continue to be implemented. Additionally, from time-to-time Jamalco utilizes the service of third-party monitors to collect noise data.

Monitoring of nearby residences and communities will be undertaken as necessary to collect both baseline noise level data and measurements to ensure that noise standards are not exceeded. All complaints related to noise will be addressed as Jamalco is committed to complying with the regulations.

3.8.2 AUDIOMETRIC SURVEY

The audiometric survey was conducted using calibrated handheld digital audiometers. Noise levels were measured at various locations selected because of their proximity to planned activities and residential areas within the communities.

3.8.3 VIBRATION ANALYSIS

Data from vibration analysis studies of the proposed mining areas, surrounding communities inclusive of the proposed loading station were not available at the time of completion of this EIA report.

To derive truly conclusive scientific data on vibration potential and mitigation if necessary, a detailed program of investigation should be developed and implemented throughout these areas on an objective basis using scientifically approved criteria and techniques.

Sufficient vibration data should be generated which would be subjected to statistical analysis over all operating conditions. This should also take into account other factors in the environmental baseline which may contribute to the introduction of errors and inaccuracies in these observations.

The introduction of the RopeCon conveyor system is new to Jamaica. However, it represents a marked improvement in terms of performance and quiet operation over any other similar system in place on the island at this time. The conveyor runs on Teflon rollers that are efficient and acoustically quiet. While the system is not anticipated to be noisy, the communities of Southern Manchester through which the conveyor will pass will need to sensitised to the technology and any potential impacts that may be associated with it. The conveyor system will be hooded (covered) to system, hence dust, falling debris would be considerably ameliorated. Roadways under the convetor system will be covered where the crossing occurs to further minimise any unforeseen potential problem. The consultant recommends that Jamalco implements periodic vibration measurements or review of structural assessments in its monitoring programme.

3.9 NATURAL HAZARD VULNERABILITY

3.9.1 NATURAL HAZARD VULNERABILITY - MANCHESTER

3.9.1.1 FLOODING

Although flooding has occurred in the limestone regions of Manchester Parish in times of unusually heavy and/or prolonged rainfall (e.g. at Porus, Harmons and Content in 2002), there are no historical records of flooding in the proposed mining area. Due to the predominant gentle slopes of the area and the physical impacts of the mining activities, mined out areas will be utilised (in some cases) as stabilisation areas for rainwater to control surface drainage and run-off that may impact on communities. Stormwater control and management are features of mining plans implemented by Jamalco.

3.9.1.2 LANDSLIDES

There appear to be no historical records of landslides in the district. However, the near vertical slopes on some limestone hills bounded by faults or with mature karst topography makes such slopes susceptible to rock falls. Also, on steep slopes where cultivation has resulted in soil erosion there is the potential for the accumulation of screes, which could become unstable. Mining activities conducted within the guidelines of the mining and rehabilitation plans will not increase the likelihood of landslides in the area.

3.9.1.3 SEISMIC ACTIVITY

3.9.1.3.1 LOCAL

Local earthquakes occur but are unlikely to affect mining operations.

Figure 4-11 below shows the maximum expected Maximum Mercalli Intensity (MMI) across various regions of the island; the figure also allows for a 10% probability in the possible exceedance of these expected values within 50 years of each occurrance. Jamalco's mining operation in the South Manchester area is anticipated and expected to feel tremors from earthquakes between 7-8 MMI. The expected effects from such tremors range from small slides and caving in and/or along sand or gravel banks, to the cracking of wet ground and steep slopes.[4]

[4] http://www.uwiseismic.com/Earthquakes/eq_monitoring.html#Anchor-MEASURIN-48543

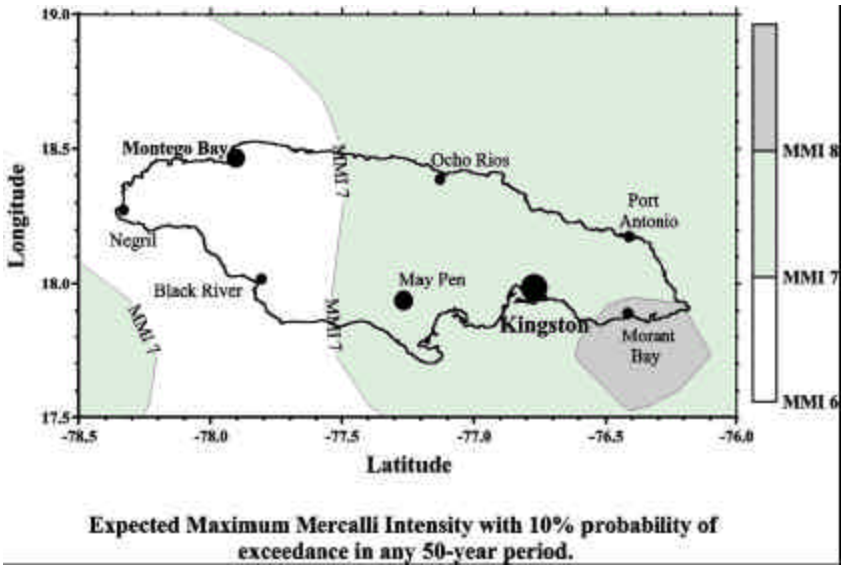

FIGURE 3-15: MAXIMUM MERCALLI INTENSITY IN JAMAICA[5]

The proposed mining area consists of Karst areas showing various landform characteristics. The Karstlands showing greatest bauxite depsits are the Karstlands with ridges and cones, which are separated by bauxite filled glades (Manchester Plateau), and the Karstlands with flat sloping high level plain covered with thick bauxite soil (Roberts Run-Bousue area). In both Karstland landforms, the bauxite deposits are located in areas where the terrain is essentially flat and not steeply sloped. Therefore, these areas are unlikely to experience the cavings or landslides associated with the expected earthquake intensities.

The proposed transportation corridor from the mining area in South Manchester to the bauxite refinery in Clarendon is three phase, employing the use of haulage trucks, the new RopeCon system and the use of railway. The haulage trucks will travel by dedicated haul roads from the mining area to the Mt. Oliphant loading station where the mined ore will be screened and transported by RopeCon to the St. Jago railhead from where it travels by rail to the refinery. These proposed methods of transportation will use infrastructure that will be designed to withstand expected earthquake intensities, such damage is commonly associated with earthquakes of the order of 10-12 MMI. Any potential spillages of the transported bauxite ore, from the truck or cart through vibration, should be readily alleviated through the implementation of Jamalco's proven standard methods of haulage and rail transportation.

[5] http://www.oas.org/CDMP/document/seismap/

3.9.1.4 CONCLUSIONS

There appears to be no impediments from a geological standpoint, to mining bauxite in the proposed area of Southern Manchester Parish.

The mining operations are not likely to encounter problems or unique situations that will require any major adjustment in methodology or management protocol different from those experienced in current mining areas.