

3.0 BASELINE ENVIRONMENTAL STATUS

Existing environmental set-up of the study area (area of influence around the project site) in general, and within the project site in particular, has been studied as described in subsequent sections.

3.1 TOPOGRAPHY & GEOLOGY

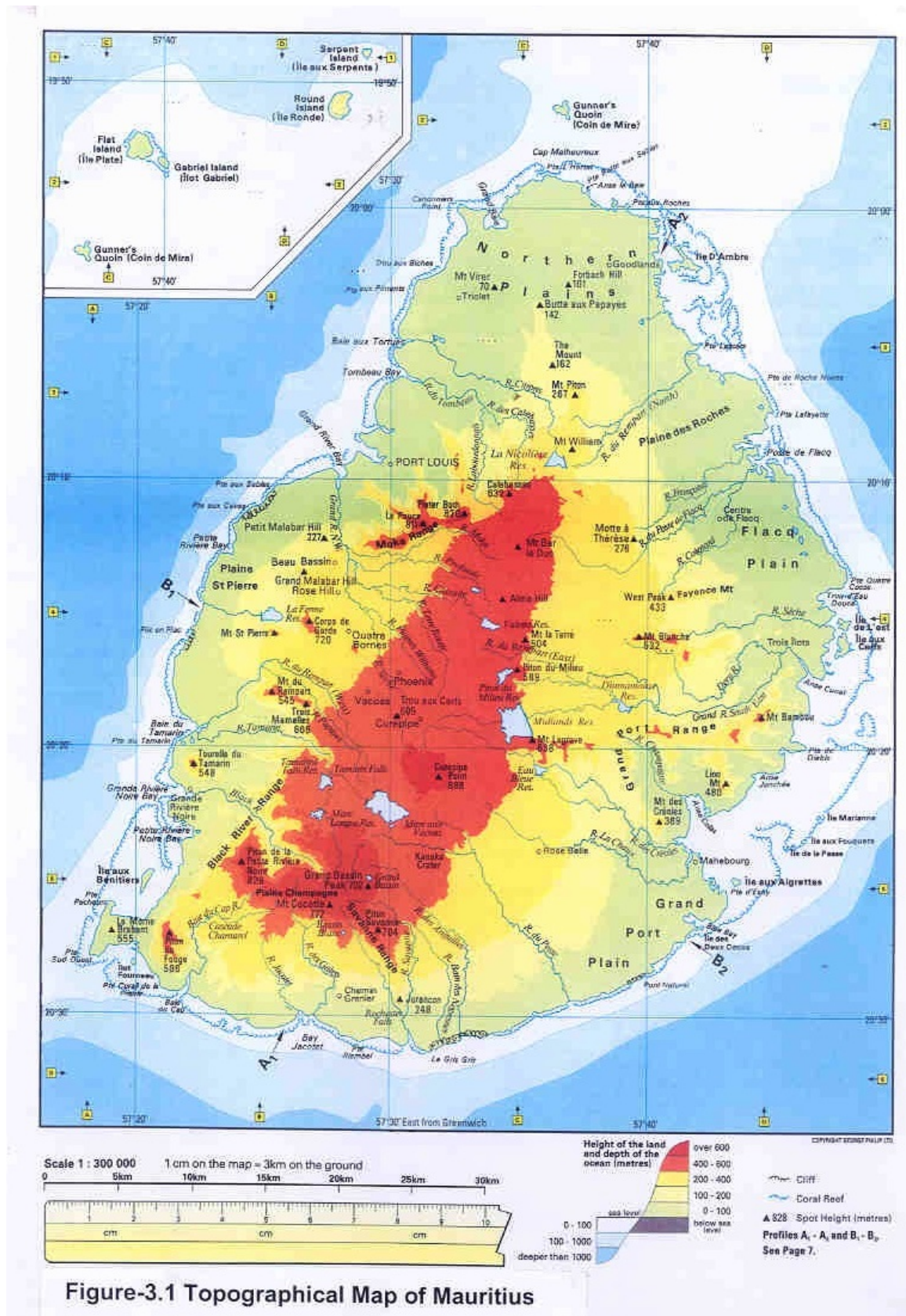
3.1.1 Topography

It is evident from the topographical map of Mauritius (Figure-3.1) that the Grand Baie site is located within a height varying between 18m and 23m AMSL. The general slope of the site is towards the South and South-East direction.

3.1.2 Geology

The island of Mauritius is entirely volcanic in origin, except for deposits of coral sands along the coast and deposits from alluvial erosion of the hard rocks. The hard rocks are volcanic deposits composed essentially of basaltic lava flows with some inclusions of pyroclastics.

Mauritius Island has been formed by a succession of volcanic episodes that began in the middle of the Miocene. The island emerged about 10 million years ago following a volcanic phase, mainly explosive and then intersected with periods of quiescence during which erosion modeled the relief. Except for some consolidated coral and shell debris in isolated remnant raised beaches, and the coral reefs and beach and sand dunes around most of the coast, Mauritius is entirely volcanic: an Older Volcanic Series and a Younger Volcanic series between which there was a long period of erosion (Table-3.1 & Figure-3.2). The Younger Series was subdivided into the Early and Late Lavas.



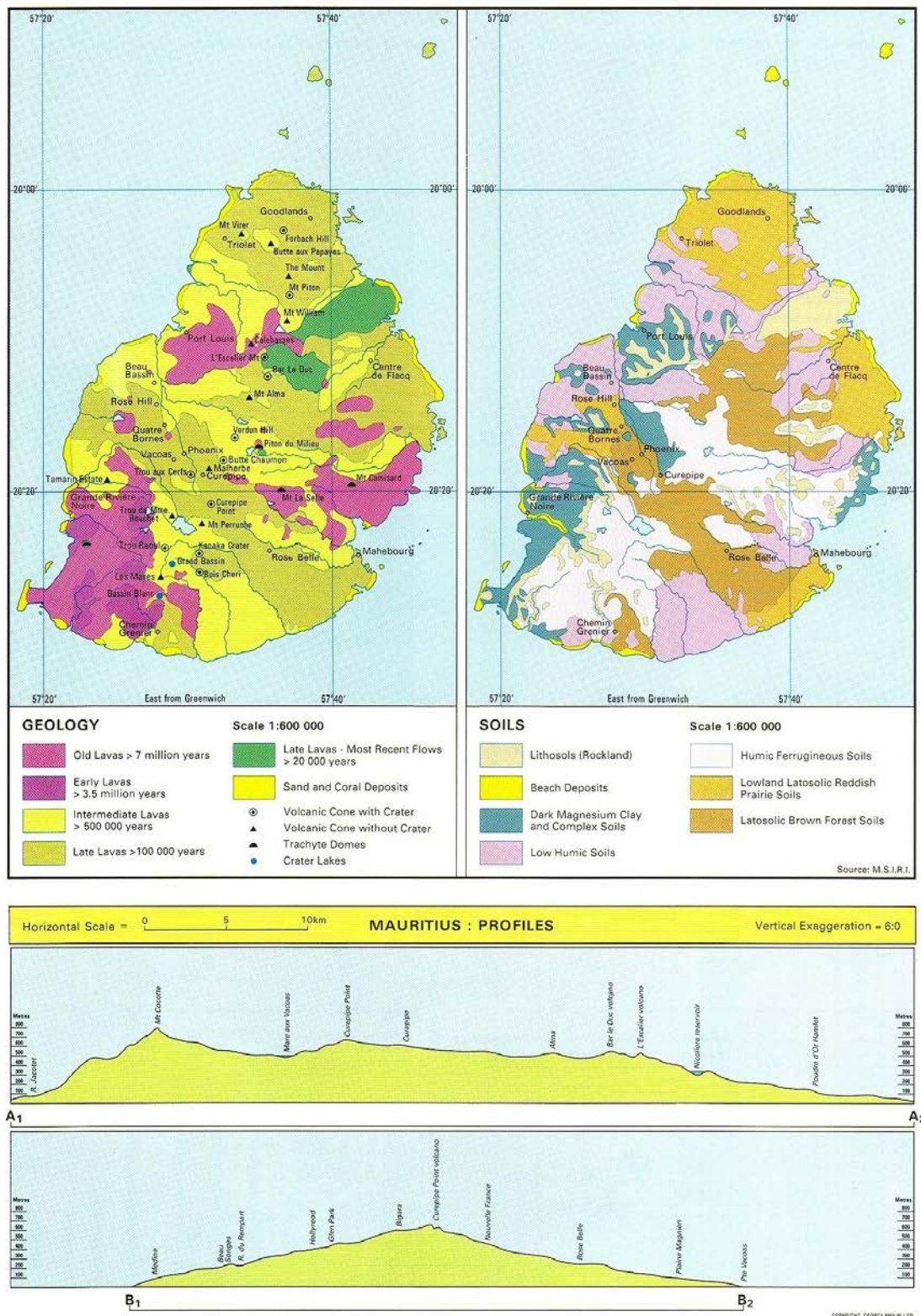


Figure 3.2: Geological and Soil Map of Mauritius

Table-3.1 Geological Formations of Mauritius

Older Volcanic Series	Old Lavas		
Younger Volcanic Series	Early Lavas		
	Intermediate Lavas		
	Late Lavas	Earlier Flows	
		Main Flows	Grand Baie Site
		Recent Flows	
Non-volcanic Formations	Raised reefs, beaches and old dunes		

The Intermediate and Late Lavas cover the 70% of the island but in comparison with the earlier volcanism their volume is relative small. They comprise a whole series of flows from about 1 to 8 m thick, of generally highly vesicular olivine basalt, often with coarse grained doleritic textures and usually light grayish in colour. Scoriaceous zones are common at the top and base of flows and these appear to be more abundant in the Late Lavas.

Basalts: It is an irregular piling of basaltic flows whose cumulated thickness can exceed one hundred metres. Healthy flows alternate with flows transformed by weathering, which is a sign that emissions of lavas, far from being continuous, have occurred intermittently. When the flow is important and when the slope is sufficient, lava tunnels exist generally at the exit of ancient topographic breaches for example visible at the surface where the roof has collapsed. At outcrops, these are massive basalts, vesicular and micro fissured that we find as slabs well cleaned by agents of erosion. The base of these flows indicates signs of progression. They are scoriaceous and their thickness can vary from one metre to ten metres.

3.2 SOIL

Weathering processes have altered the layers of basalt and pyroclastics. The pattern of weathering has been varying on account of the vesicular and fractured nature of the basalt. The pyroclastics weather faster than basalt. The resulting soils are also varied in nature.

As per the soil map of Mauritius (Figure-3.2) the soils of the project site are as under (Table-3.2):

Table-3.2 Soil Types of the Project Site

Project Site	Soil Group	Families	Special Phase
Grand Baie	Lowland Latosolic Reddish Prairie Soils	Mont Choisy	Rocky

Source: Soil Map of Mauritius (Provisional Classification) (Scale 1:100,000) published by Directorate of Overseas Surveys 1957

Lowland Latosolic Reddish Prairie Soils:

Although these series have been developed on Late Lavas, moderate weathering has occurred on account of a mean annual rainfall of 1,000mm to 2500mm. The Mont Choisy family is characterized by the shallow soils on slightly weathered Late Lavas with abundant rock outcrops transitional to Lithosols. The A horizon is dark colored, high in organic matter and grades into a lighter reddish to reddish brown coloured B horizon. These soils are somewhat acidic with pH ranging between 6.0 to 6.9. The range of acidity has been observed to be about the same in the lower horizons. The texture varies from silty clay to silty clay loam and the soils have been determined to be mostly clays.

3.3 LAND USE

Major part of the island of Mauritius is devoted to sugarcane. Next in rank for covering the land surface are the forests consisting of some plantations and the rest nature reserves.

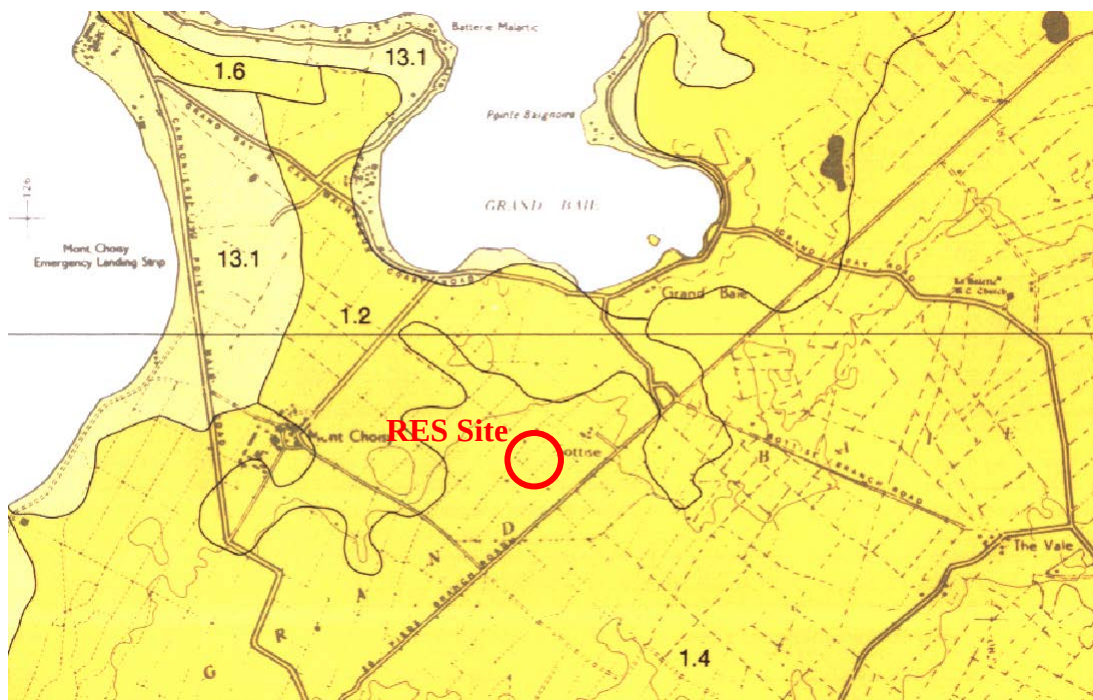


Figure 3.3: FAO/MSIRI map

As per the Land Resources and Agricultural Maps (1:50000) of Mauritius, 1973 published by Food and Agricultural Organization (FAO) of the United Nations and Mauritius Sugar Industry Research Institute (MSIRI), the land features of the project site (refer to Figure 3.3) are summarized in Table-3.3:

Table-3.3 Land Features of the Project Site

Project Site	Item	Description
Grand Baie	Land complex	Late Lava Coastal Plains and Inland Slopes
	Land unit	1.4
	Landforms	Almost flat to gently undulating; hummocks with aereas or rough rocky terrain
	Soil type	Latosolic Reddish Prairie (LRP) soils; shallow to very shallow, gravelly, reddish brown silty clay loams; frequent bedrock exposures and rock piles
	Agricultural suitability	S2 - sugar cane, mixed cropping S3 - food crops
	% of total land	8.3% of total land mass in Mauritius

Source: Land Resources and Agricultural Maps (1:50000) of Mauritius, 1973 published by Food and Agricultural Organization (FAO) of the United Nations and Mauritius Sugar Industry Research Institute (MSIRI).

S1: Highly Suitable

S2: Moderately Suitable

S3: Marginally Suitable

S4: Suitable

Grand Baie (Land Unit 1.4): The FAO and the MSIRI identify the site area as forming part of the Younger Volcanic series. FAO and MSIRI map classifies the different regions into Land Units. The site comprises Land Unit 1.4. The site consists of almost flat to gently undulating land. Hummocks are of low relief and low frequency form resulting from the moderate degree of weathering on either Late Lavas of intermediate age or more readily weathered scoriaceous basalts extruded in these flows. The soils on some part are very shallow to shallow Latasolic Reddish Prairie soils. At the other extreme they become quite stony or boulder.

Existing Land Use at Project Site:

The project site is presently under sugarcane cultivation to its full extent. It does not accommodate any flora and fauna that are of any ecological interest. The site does not fall in environmentally and ecologically sensitive areas such as river reserve, wetlands, or springs.

3.4 DRAINAGE

There are no drainage paths due to the fact that the site is located on a relatively flat terrain and the highly permeable nature of the geological formations of the area. In order to cater for the drainage of the development, a storm water drainage network will be provided to discharge into a series of soakaways, French drains and a retention pond. Only the overflow will be diverted into an existing drainage system in the area. The site drainage design philosophy is discussed in detail in section 2.6.2 of this report.

3.5 WATER RESOURCES

Mauritius can be considered as a well-watered island. Even the sub-humid coastal regions can be regarded as having adequate water. The island has a radial surface drainage pattern of major drainage areas with perennial streams and minor drainage areas lying between the major ones. The riverless zones of the Late Lavas are important groundwater storage basins. Surface storage of water is mostly confined to natural basins in the central table-land. About 52% of all the water distributed for consumption is sourced from underground water beds; the remaining consists of surface water collected in reservoirs.

On account of the shallow nature of the lithomerge with relatively high clay and silt fractions lying over hard impervious basalt, this island is generally not bestowed with any rich ground water resources. Seepage rate is also small. As a result, at the bottom of basins with low gradient soggy marshy soil tends to develop. Immediately after rains, soil in any given part of the island feels soggy. However, an exception to this rule is found in the terrain traversed by Segments 7 to 10, where the fractured nature of the surface geology, seepage rate is high, contributing to availability of rather rich ground water resource above the underlying impervious massive lava layers.

Groundwater is compartmentalized in aquifers by structures of ancient volcanic formations. There are five principal aquifers in Mauritius but they are exploited differently. As per the aquifer map of Mauritius (Figure 3.4), the Grand Baie site falls in the Aquifer-V which is the Aquifer of Northern Plains.

The aquifer of the Northern Plains is bounded by the rivers Citron and du Rempart in the south and by the coast line. Most of the area is underlain by fresh, scoriaceous and vesicular lavas. The isohypse map of the recent basalt roof shows that the geological formation is of intermediate basalt. The superficial part of the aquifer is of moderately to highly weathered pyroclastics and show some characteristics of semi-confined aquifers. There area is practically devoid of surface drainage due to the high permeability of the soil. The depth of water table is within 5m of ground level near the coast and can reach between 10m – 50m (dry season) over most of the Northern Plains.

With the increase in water demand and groundwater abstraction, flow of groundwater has reversed leading to seawater intrusion in the aquifers. This is further accentuated with the rise in sea level due to Climate Change. As this phenomenon is increasing, the groundwater potential declines. The aquifers are contaminated with salt which will take years to remove. The site is located within the seawater intrusion area. However, with the different drainage systems in place as described in section 2.6.2 and the relatively high permeability due to the non-weathered nature of the geological formation, the development promotes aquifer recharge with soakaways, French drains and infiltration ponds hence retarding salt water intrusion to progress further inland.

3.6 CLIMATE AND METEOROLOGY

The climate is equable maritime sub-tropical humid. Rain comes in all months although the weather never remains the same for more than a few days at a stretch. It is frequently affected by disturbances of both temperate and tropical types. The direction of wind is generally from the East, although the cyclones hit the island from the West. The topography of the island is such that the mid-summer temperature at the Central Plateau and the mid-winter temperature at the coast are similar.

In general, climate can be considered as comprising two seasons: a winter from May to October during which the island experiences a cool and comparatively dry season under the predominant influence of steady southeasterly trade winds, and the summer from November to April, which is a warm and wet season often affected by tropical cyclones. July is the coldest month with mean temperatures of 21.9°C and 20.7°C at sea level in the leeward and windward exposures respectively, and 16.4°C in the central tableland at an elevation of about 600 m. February is the warmest month with corresponding mean temperatures of 27.8°C, 26.1°C and 22.3°C. The difference in mean temperature between the two months of July and February is only 5.5°C.

During the hot season that is between December and March, when the South East Trade Wind is mild but the cyclonic activity is high, torrential rains of high intensity occur.

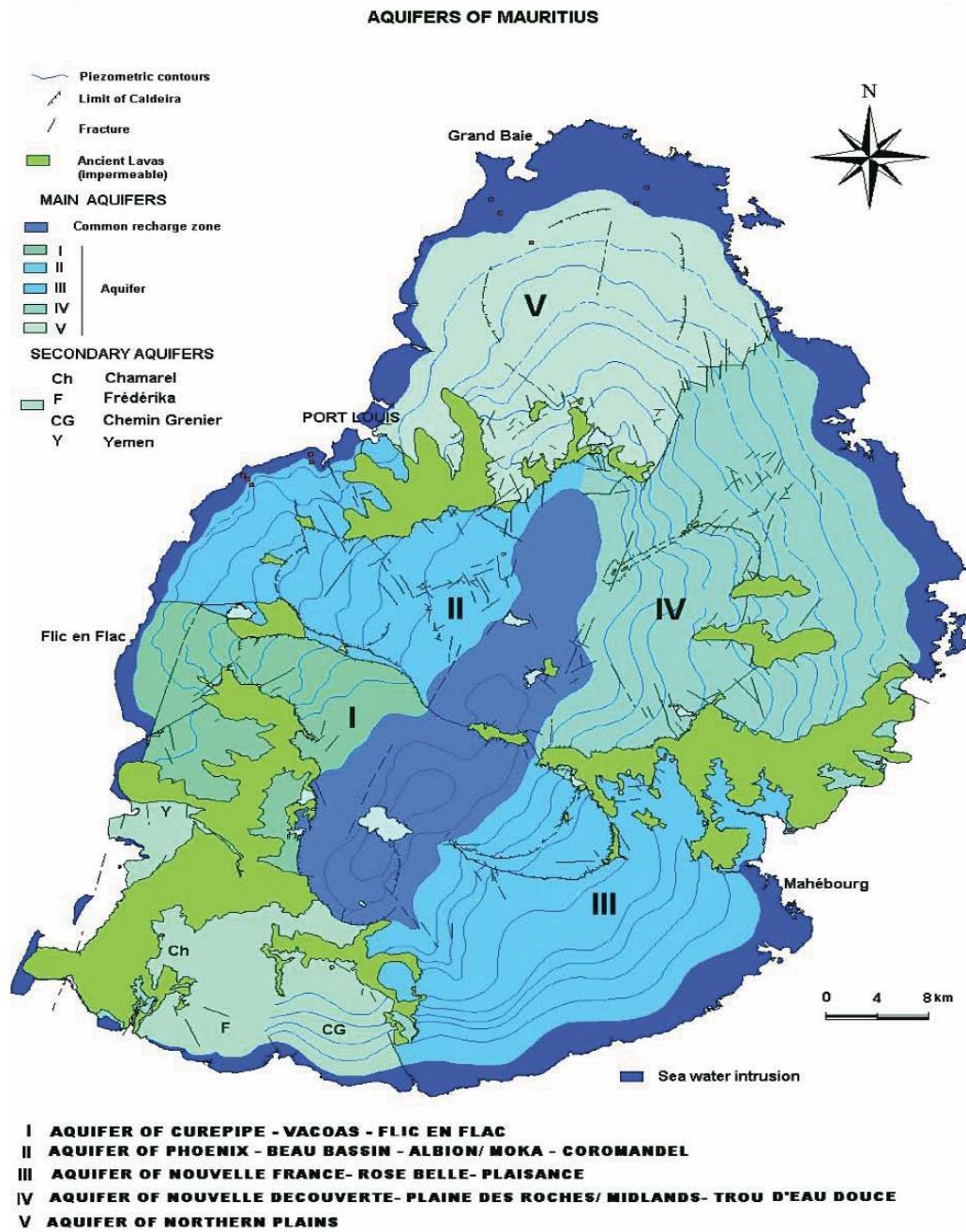


Figure 3.4: Aquifer map of Mauritius

On the other hand, during the cool months of June to September, the south East Trade Wind will be strong, rainfall will be very frequent but not with high precipitation (less than 100 mm per month). October and November may be drier still.

The months of most frequent cyclones are from December to March. The incidence of tropical cyclones is of considerable importance to agriculture and economy. There are, on average, 2 to 3 intense cyclones (with an indicated wind speed > 65 knots (~120 kph)) in the southwest Indian Ocean in a year. During the passage of the very destructive cyclone Carol in 1960, a wind gust of 159 mph (~ 256 kph) was recorded.

Mauritius Trade Winds, land and sea breezes

Trade winds are southeasterly surface winds that generally blow from the subtropical high pressure zone. The south-east trade winds have a direct effect on the climate of Mauritius. There is a light breeze from south-eastern direction the whole year through.

Local wind is affected by the sea and land breeze effects and will show change of direction with time of day. On calm nights, places on the eastern slope may experience a land-breeze blowing towards the sea, and therefore with a pronounced westward component.

Cyclonic Winds

The south-western Indian Ocean is a region known for its cyclonic activity. Cyclones are very low-pressure regions, which have very high wind speeds that increase in magnitude in the direction of the centre of the cyclone. Tropical cyclones usually occur during the months of December to May. February is the most active month in terms of cyclonic formation; this is based on the data collected by the National Meteorological Services at Vacoas. Table 3.4 indicates the monthly occurrences of observed cyclones.

Table 3.4 Monthly Percentage Occurrences of observed Cyclones

MONTH	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Total
%	18.1	20.8	30.6	18.1	9.7	2.8	100

From the observation of cyclonic wind speeds during the same period, the National Meteorological Service has also established that the average for the wind velocities is 140 km/h (75 knots).

Mauritius is subject to occasional tropical cyclones characterized by low pressure, high wind systems which typically occur in the months of December through March. Over the period, 39% of cyclones have been classified as 'weak' (gust speeds <48 km/hr), 42% as 'moderate' (gust speeds between 48-80 km/hr) and 19% as 'strong' with gust speeds >80 km/hr).

Table 3.5 gives the maximum gust speed of major cyclones of 100 km/h or more, which has affected Mauritius during last 10 years.

The Inter-Tropical Zone of convergence gets located much further to the north of the equator in the months of May to September than during November to April, when it is located close to Mauritius. Seasonal shifts of this zone produce tropical cyclones, visiting Mauritius in the summer months.

Table 3.5: Major Cyclones in and around Mauritius

Cyclone	Month - year	Highest Gust Speed (km/hr)
<i>Not Named</i>	Apr-1892	240
<i>Not Named</i>	Mar-1931	180
<i>Not Named</i>	Jan-1945	157
<i>Alix</i>	Jan-1960	200
<i>Carol</i>	Feb-1960	256
<i>Jenny</i>	Feb-1962	235
<i>Danielle</i>	Mar-1964	219
<i>Gervaise</i>	Feb-1975	280
<i>Claudette</i>	Dec-1979	221
<i>Laure</i>	Mar-1980	201
<i>Bakoly</i>	Dec-1983	198
<i>Firinga</i>	Jan-1989	190
<i>Hollanda</i>	Feb-1994	216
<i>Dina</i>	Jan-2002	228

The strongest gusts recorded instrumentally at Mauritius have been of 280 km/h, (Gervaise at Mon Desert, February 1975) and records of gusts of 250 km/h have been

made in earlier cyclones, (e.g. Carol, 1960). Figure 3.5 shows the past major cyclone tracks on Mauritius.

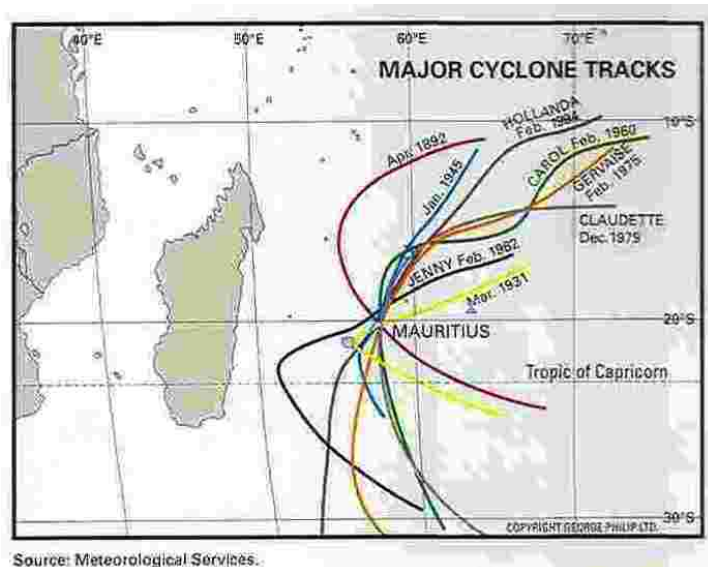


Figure 3.5: Major cyclone tracks on Mauritius

Relative Humidity

Mean monthly relative humidity varies from 86% in March to 80% in October in Vacoas (Central Plateau). Corresponding figures for Plaisance (Coastal) are 85% and 78% and Pamplemousses are 84% and 77%. So, we can deduce that the relative humidity at Grand Baie is within the same range.

Rainfall Intensity

Mean annual rainfall ranges from a minimum of 800 mm on the west coast to over 3,600 mm in the central tableland, giving an increase of more than 2,800 mm over a distance of about 20 km. During winter from May to October, rainfall expressed in as a percentage of annual rainfall, varies between 30% and 35% in locations exposed to trade winds, and between 10% and 30% in the western leeward areas.

The mean annual average rainfall over Mauritius as a whole is about 2,100mm. Two-thirds of this total falls in the summer months of November to April. The driest month is October with only 74mm or 3.5% of the total. November is taken as the first wet month, as it receives an average 4.7% of the total, but it is noted that rainfall in November is

more variable than on other months, depending to some extent on whether early warm season depressions affect the island or not in any particular year.

Figure 3.6 gives the 30-year average annual rainfall (the 1951-1980 normal rainfall) over Mauritius in the form of isohyets.

The South-East of Mauritius receives the oceanic air with its moisture content and benefits from the forced uplift resulting from its passage over sloping lands and hills. The annual areal normal for the Grand Baie Site is around 1350mm (Table 3.6), of which about 70% is received in the period November to April. The winter months thus receives a fair amount of rain and can be considered only relatively dry. The driest month is September with only 46mm or 3.4% of the yearly total.

Table 3.6: Monthly and annual normals in millimeters, 1971-2000

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pamplemousses	206	240	159	158	99	68	73	75	46	48	50	128	1350
% of Year	15.3	17.8	11.8	11.7	7.3	5.0	5.4	5.6	3.4	3.6	3.7	9.4	100

Source: Mauritius Meteorological Services

High intensity rainstorms are common and rainfalls of the order of 375 mm in 24 hours have been recorded, particularly influenced by low pressure troughs, weak depressions and tropical cyclones.

The above noted features of rainfall demand longitudinal and cross drains along the roads. The capacities of the drains are normally designed by local run-off characteristics in relation to intensity of rainfall for 10-year return period.

Past meteorological data of the project area have been collected from the Meteorological Services. The climatologic features are summarized in Table-3.7.

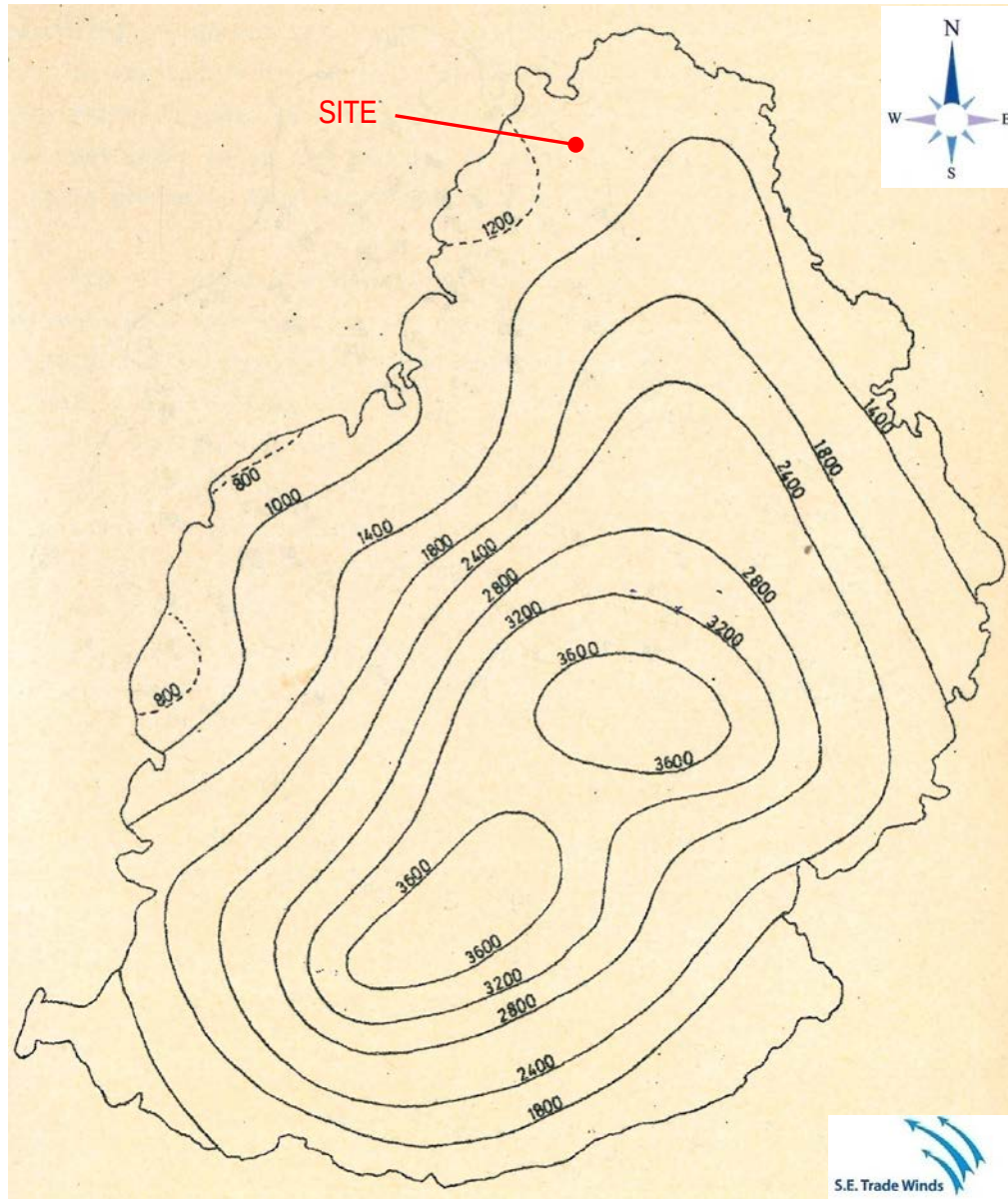


Figure 3.6: Mauritius Rainfall Normals 1951-1980 (Padya, 1984)

Table-3.7 Climatologic Features of the Project Site

Project Site	Range of Mean Monthly Temperature (°C)	Range of Monthly Total Rainfall (mm)	Total Annual Rainfall (mm)
Pamplemousses	Max of 25.7 (July) – 31.1 (Jan) Min of 16.1 (July) – 22.2 (Feb)	46 (Sep) – 240 (Feb)	1350

Source: Mauritius Meteorological Services

Figure 3.7 below shows the mean summer and winter temperature variation in Mauritius.

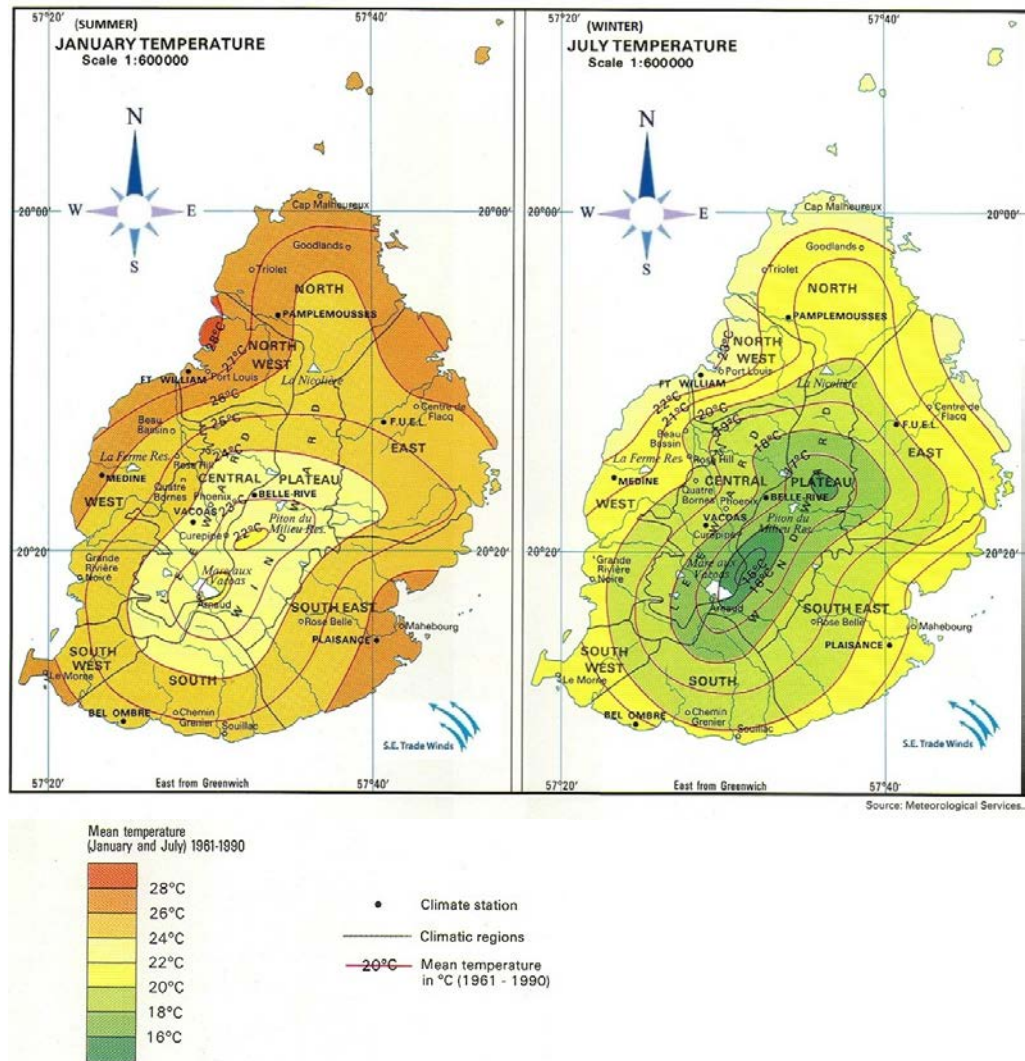


Figure 3.7: Seasonal Temperature Variation in Mauritius

3.7 FLORA and FAUNA

3.7.1 Flora

The flora of the Island of Mauritius has been impacted upon over many centuries through man induced processes. The pristine forest was cleared and brought under cultivation between 1772 and 1810. So there is almost no indigenous vegetation left on the site. The river reserves below the 150 m contour were de-reserved by law in 1965, re-reserved by law in 1971.

This has resulted in a complete modification of the flora along the river reserves. However, the River Reserves are now protected under the Forest and Reserves Act No. 41 of 1983.

In the first instance, the natural vegetative covers on nearly all land with relatively gentle slopes have been largely removed to make room for plantations of sugarcane. Then, many exotic species of vegetation were introduced into this island, which have turned invaders to suppress many of the indigenous species of vegetation. In most forest plantations, preference has been given to the exotic species. About one third of the area of this island has a cover of uncultivated vegetation, of which a major part is under shrubs.

The project site is presently cultivated for sugarcane to its full extent. It does not accommodate any endemic/endangered species, any rare flora or fauna that are protected by law.

3.7.2 Fauna

No endangered animal species was noticed during field survey nor was any reported by the local people. All the mammals found on the common exotic ones. A few of them are the Black Rat and the Ship Rat, the Mongoose and hare.

3.8 SOCIAL ENVIRONMENT

Social environment can be conveniently described in terms of population, features of urbanization, occupational pattern, ethnic features, objects of religion, etc.

3.8.1 Population

From the population statistics it is evident that the population in the island of Mauritius is growing steadily. Between 2000 and 2010 the annual average population growth rate was 0.87%. This growth is taking place across all the districts of the island. A glimpse on this feature of the society in Mauritius in general and of the project area in particular can be obtained from Table-3.8.

Table 3.8 Growth of Population

Regions	2000		2010		Annual Growth Rate (%) 2000-2010
	Population	Density per sq. km	Population	Density per sq. km	
Island of Mauritius	1,143,069	613	1,243,084	667	0.87
District of Plaines of Wilhems	358,182	1762	384,434	1891	0.73
District of Grand Port	106,665	410	115,377	559	0.82
District of Savanne	66,356	271	70,430	288	0.61

Source: Annual Digest of Statistics 2001 & 2010, Central Statistics Office

3.8.2 Patterns of Urbanization

The above mentioned growth of population is reflected in an asymmetric order in terms of urban and rural components of the society. The rate has been faster for the rural population. This is reflected in Table 3.9.

It is worth mentioning that the largest settlement of the Republic of Mauritius is the capital City of Port Louis. It is also important to note that practically the entire urban population of this island is found within the two neighbouring districts of Port Louis and Plaines Wilhems. This feature of regional concentration of urban population is arising from the fact that the five settlements of Port Louis, Beau Bassin-Rose Hill, Quatre Bornes, Vacoas-Phoenix and Curepipe are the only designated urban places. Between these urban centers, the growth rate has not been the same. For being away from Port Louis, the rate of growth has been higher. This suggests that area spread of urban functions is a continuing process in this island.

Table 3.9 Growth of Urban and Rural Population in the Island of Mauritius

Categories	Population		Annual Growth Rate (%) between 2000-2010
	2000	2010	
<i>Rural Population</i>	640,024	711,125	1.11
<i>Urban Population</i>	503,045	534,163	0.62
• Port Louis	144,303	148,416	0.29
• Beau Bassin/Rose Hill	103,872	110,866	0.67
• Quatre Bornes	75,884	81,899	0.79
• Vacoas/Phoenix	100,066	108,347	0.83
• Curepipe	78,920	84,635	0.72

Source: Annual Digest of Statistics 2001 & 2010, Central Statistics Office

3.8.3 Occupational Pattern

The society is experiencing the impacts of economic transformation. This is reflected in the shifts in the pattern of employment. From the limited data that is available in this regard, Table-3.10 has been constructed. Although the data is somewhat dated, one can easily see that the processes of economic transformation have been operating over a long time.

This table clearly shows that the shift has been in favour of service industry. This is another sign of transformation towards increasing urbanization. The features of the more recent period have been discussed under economic environment in a subsequent section of this chapter.

3.8.4 Ethnic Features

There are no ethnic features currently on the site that would require preservation or would be disturbed by the construction works.

Table 3.10 Shift in Sectoral Employment between 2009 & 2011

Sector	% Shift in 2011 over 2009
Agriculture, forestry & fishing	(-) 0.5
Mining & Quarrying	(+) 0.0
Manufacturing Industry	(-) 3.5
Electricity, gas & water	(+) 0.2
Construction	(+) 2.6
Wholesale & retail trade	(+) 4.3
Hotels & Restaurants	(+) 2.2
Transport, Storage & Communications	(+) 0.2
Financial Intermediation	(+) 0.9
Real Estate, renting and business activities	(+) 3.4
Public administration and defense; compulsory social security	(-) 0.5
Education	(+) 1.0
Health and social work	(+) 2.8
Other services	(+) 0.8
TOTAL	(+) 13.9

Ministry of Economic Planning & Development (2011)