

CHAPTER 2 BACKGROUND

2.1 PHYSICAL CHARACTERISTICS

2.1.1 PHYSIOGRAPHY

The British Virgin Islands (BVI) consists of over forty islands, islets and rocks which belong to the Virgin Islands archipelago, of which the largest islands are the United States Virgin Islands of St. Thomas and St. Croix, **Figure 1.1**. The islands are about 60 miles east of Puerto Rico and 140 miles north-west of St. Kitts, located near latitude 18.3° N, and longitude 64.5° W. They rest on the Greater Antilles submarine ridge at its eastern extremity and are separated from the Lesser Antilles by the deeper water of the Anegada Passage.

The islands which make up the British Virgin Islands can be placed into four groups . To the south extending for about 20 miles are a series of islands including Peter Island, Norman Island, Ginger Island, Cooper Island terminating in the island, of Virgin Gorda. The second group is parallel to the first group and extends for about 15 miles and consists of Tortola, Beef Island, Great Thatch, Great Camanoe and Guana Island.

The shallow, three to four mile wide Sir Francis Drake Channel separates the two groups. To the north-west of the Tortola group lies the third group consisting of Jost Van Dyke, Little Jost Van Dyke, and the Tobago Cays, which are separated from the second group by a shallow channel. Anegada forms a fourth unit about 30 miles north of Virgin Gorda to the north-east of Tortola. The total area of the British Virgin Islands is about 59 square miles. This study focuses on the four larger inhabited islands of the BVI - Tortola, Virgin Gorda, Anegada, and Jost Van Dyke, Tortola is the largest and most developed island and the center of government. It is an elongated island oriented roughly east-west, about twelve miles long and three miles wide with a total area of about 24 square miles.

Figure 1.1

The highest point is Sage Mountain with an altitude of 1,780 feet. The capital Road Town, has developed around Road Harbor which is a large south-facing bay on the south coast of Tortola. For the purposes of this study, Beef Island a small island off the eastern tip of Tortola is regarded as part of Tortola. They are connected by a bridge which spans the narrow Beef Island Channel .

Virgin Gorda is the second most developed island with a total area of about 9 square miles. It consists of a central rectangular landmass with two peninsulas, one to northeast and the other to the southeast. The length from end to end is about 10 miles and the greatest width about 2 miles. The main settlement on Virgin Gorda is Spanish Town which occupies the low plateau of the southern peninsula. The highest point is 1359 feet at Gorda Peak.

Jost Van Dyke is the next most developed island. It is irregularly shaped with a maximum length of 4.2 miles and width of about 0.75 miles and a total area of about 4 square miles. The main settlement on Jost Van Dyke is Great Harbor around the south facing bay of the same name. The highest point on Jost Van Dyke is Majohny Peak at 1054 feet. Anegada is a very flat relatively large elongated island oriented roughly east-west with a total area of about 13 square miles. It is 10 miles long and 2 miles wide with a maximum elevation of only 26 feet. The only, developed area is a small town known as The Settlement found on the south coast.

With the exception of Anegada the islands are hilly with most of the landmass consisting of steep slopes which rise precipitously from the sea. Tortola is composed of a series of hills forming a central spinal ridge along the length of the island. Most of the ridge is above 1000 feet in elevation. Hillslopes are uniform and steep, often in excess of 40° and cut extensively with drainage lines. Well developed steep drainage channels called ghuts run from the ridges to the coastline producing a series of small coastal valleys separated by spurs which extend to the coastline. Narrow relatively flat coastal strips composed of alluvium form the flood plains of the larger ghuts which are adjacent to the larger bays.

The topography of Jost Van Dyke is very similar to that of Tortola on a smaller scale. Virgin Gorda has a central peak 1,370 feet high which is part of a ridge oriented north south. A lateral ridge projects from the eastern side of the central landmass forming a long narrow peninsula. A relatively flat plateau known as >The Valley= is connected to the southern end of the central landmass. The coastline of the islands with the exception of Anegada, are generally rugged with steep rocky headlands indented with bays.

Wide sandy beaches have developed in the larger bays especially those associated with the largest watersheds. Anegada is very a flat limestone island with one quarter of its surface area occupied by salt ponds. The western part of the island and the northern coastline is mantled by carbonate sands, with a well developed dunes complex. The rest of the islands' surface consists of exposed limestone bedrock with abundant sink holes and solution pits typical of karst limestone land forms.

2.1.2 CLIMATE

The islands lie within the northeasterly trade wind belt and possess a moderate, subtropical climate with average daily temperatures of 87°F varying from highs of 92°F and winter lows of 67°F. Daytime summer temperatures are tempered by a steady sea breeze and usually there is a fall of about 10°F at night.

Rainfall occurs usually as showers of short duration resulting from the lifting and cooling of humid air as it passes over the islands. Average annual rainfall is 50 inches varying from about 35 inches along the coast and on to about 80 inches on Mt. Sage per year. The heaviest showers occur during the periods September-December when over 50% of annual rainfall occurs. The driest period is between January and April.

A detailed rainfall analysis is presented in Chapter 4. Extreme rainfall events are associated with cold fronts which occur during the winter months and with tropical waves, depressions, storms and hurricanes during the summer months from June to November. A

detailed analysis on hurricanes is presented in Chapter 3. The dominant wind direction is NE with the other main directions being NE and SE with an average speed of 20 Km/h.

2.1.3 GEOLOGY

The British Virgin Islands, Puerto Rico, and the US Virgin Islands are part of a relatively small crustal block on the northeastern corner of the Caribbean plate. The block is bounded by the Puerto Rico Trench in the north, the Anegada Trough in the southeast, the Martes Trough to the south, and Mona Canyon to the west. The Anegada Trough is a major crustal feature, known as an intraplate rupture and extends from the Caribbean Plate boundary in the northeast in a southwesterly direction.

The British Virgin Islands, Puerto Rico, and the US Virgin Islands are the exposed high points of a relatively flat submarine shelf resting on this crustal block known as the Puerto Rico-Virgin Island Platform which lies submerged at a depth of about 100 feet below current sea level. During the Pliocene age this platform formed a single subaerial landmass or super-island.

The geology of Puerto Rico and the Virgin Islands is similar consisting of a series of volcanic and igneous rocks typical of island arc plate boundary settings, with associated sedimentary sequences and igneous intrusives. The rocks have been regionally metamorphosed, deformed and hydrothermally altered as a result of several phases of intense tectonic activity.

Of the islands being examined all except Anegada are underlain by a series of well stratified, steeply dipping, marine-lain volcanics and associated sedimentary rocks of Cretaceous age. The rocks exposed in Tortola consists largely of well stratified metamorphosed volcanics interlayered with sedimentary rocks with smaller outcrops of pyroclastic volcanics in the north, stratified metamorphosed marine sediments in the west and plutonic igneous rocks in the east.

Jost Van Dyke is underlain entirely by pyroclastic volcanics, while Virgin Gorda and Beef Island are composed almost entirely of plutonic intrusives. Anegada is composed entirely of reef limestone deposited in Pliocene time. The volcanics consist of a series of tuffs, breccias, lava flows and shallow intrusives, which are andesitic in composition. They have all undergone regional metamorphism. These rocks are hard, medium grained, highly fractured rocks which form beds ranging from a few centimeters to a meter thick. The beds are oriented with a pervasive east-west strike and dip steeply to the south at angles greater than 45°.

The pyroclastic volcanic rocks range from fine grained tuffs to coarse grained agglomerates with boulders of breccia which are less stratified but also have an east-west strike. The metamorphosed marine sediments consist of well stratified fine to medium grained terrigenous sediments and limestones with a pervasive east-west strike. Plutonic igneous rocks consist of intrusive diorites which are coarse grained, hard, massive rocks, which are extensively jointed. In Virgin Gorda significant metaliferous deposits are associated with these rocks. Metaliferous ore which has been extracted in the past include copper, chalcopryite, malachite, native copper, haematite, pyrites and molybdenite.

The surficial deposits consist of alluvium, beach deposits, littoral deposits boulders, and artificial fill. Alluvial deposits are confined to the lower reaches of the valleys where they form relatively flat alluvial lowlands adjacent to the sea. The alluvium exposed along the stream courses is a poorly sorted mixture of sediments, ranging from clay to boulders with occasional lenses of sand and gravel from 1-5 feet thick. In St. Thomas where the depositional environment is similar, beds of sand and gravel up to 3 feet thick have been found lying on or near underlying bedrock surface are the remnants of former stream channels now buried by more recent alluvium.

The alluvium has been estimated between 60-100 feet deep. In some areas there are littoral deposits intermixed with fine decomposed coral silts and sands. Beach deposits consists of

unconsolidated, loose, medium grained carbonate sands. The most extensive beach deposits are found on western side of Anegada where a well developed beach ridge complex has developed with stabilized sand dunes. Soils throughout the islands are shallow, friable, immature, residual soils generally less than 18 inches thick. These soils are medium to coarse grained, well graded, sandy silts generally with a dark yellow brown color. There are extensive areas of reclaimed land in Road Town and along sections of the south coast of Tortola which have been developed over the last 25 years.

Large boulders form significant surficial deposits especially in southern Virgin Gorda where large boulders up to 10 meters in diameter form an expansive boulder field. Smaller boulders are also found on Beef Island and along some ridge tops in Tortola. These boulders are the products of long term subaerial and marine spheroidal weathering of plutonic igneous rocks.

2.1.4 SURFACE DRAINAGE

Surface drainage on the islands is controlled to a large extent by the topographic and geologic features of the watersheds. Most runoff takes place through steep gullies called ghuts, except Anegada where surface runoff occurs as very shallow sheet flow. The ghuts are temporary streams with significant runoff occurring as storm discharge following rains of 1 inch or more. A detailed drainage analysis is presented in Chapter 4.

2.1.5 GROUND WATER

The alluvium and the bedrock aquifers found on the islands occur as small individual, hydraulically interconnected water-bearing units with boundaries coinciding with the watershed divides. Each valley is essentially a self-sustaining hydrologic unit. Alluvial deposits in the valleys are recharged by any rainfall which results in storm runoff generally occurring in varying amounts about 6 times in a year of average rainfall in Tortola.

Water in the volcanic and associated sedimentary rocks is confined to open fractures and joints. Recharge to the bedrock occurs once or twice a year from rainfall that exceed 2 to 3 inches in 24 hours.

2.2 SOCIO-ECONOMIC SETTING

2.2.1 DEMOGRAPHICS

The population of the BVI is 16,115 (1991 census). Of the total 13,200 live in Tortola, 4000 in Virgin Gorda, 162 in Anegada, and 140 in Jost Van Dyke and 144 in the other islands. There has been a doubling of the population between 1984 and 1994 due to a large influx of migrants who currently reside and work in the BVI. Expatriates account for over 45% of the present population, most of whom are from the other Caribbean countries.

2.2.2 ECONOMY

The British Virgin Islands has a small open but stable economy in which the currency is the US dollar. Most goods are imported through ports of entry including sea ports and airports, while there are no significant visible exports. The major shipping port is Port Purcell in Road Town, Tortola which handles containers and break bulk cargo. The Beef Island airport handles most air freight including the services of three major courier companies. The major commercial sectors include international financial services, tourism, agriculture, construction, general commerce and trade, The government employs over 2000 persons.

The international finance services industry which largely involves off-shore company registration is currently the largest earner of foreign exchange. It is a major employer of professionals and medium skilled persons. The industry provides important linkages with

accounting, legal and banking services. This industry which has grown rapidly since 1985 presently offers an important service to a predominantly international clientele.

Tourism is the second largest earner of foreign exchange generating yearly receipts of over US\$ 250 million and is the largest single employer in the private sector. There are over 40 small hotels, most of which are in Tortola as well about 10 guest houses and over 650 charter boats. The charter boat aspect of tourism in the BVI is very significant. It contributes a major portion of accommodation, trade, in terms of provisioning as well as important service linkages in areas such as boat repair and servicing. The BVI receives over 200,000 stop-over visitors and over 80,000 cruise ship passengers per annum.

2.3 HAZARDS AFFECTING THE BRITISH VIRGIN ISLANDS

The British Virgin Islands is exposed to natural and man-made hazards which have the potential to cause significant loss of life and property, as well as serious damage to the environment, and the economy. The natural hazards to which the BVI is exposed consist primarily of the effects of tropical systems and related weather systems that includes land borne flooding, wind damage, and coastal flooding and the ground shaking effects of earthquakes. Landslides also pose a minor threat.

Man-made hazards largely consist of the potential accidental exposure of the environment to hazardous chemicals, large explosions, and accidents related to mass transportation of people. In this respect oil spills represents the greatest man-made or technological hazard to the BVI.

The damage potential and the high probability of occurrence of these natural hazards makes them far more significant than man-made hazards. This report therefore focuses on natural hazards which were studied in detail, while the man-made hazards are only briefly described.

Hurricanes and earthquakes are the natural hazards that pose greatest threat to the BVI. It is the opinion of the author that hazard mitigation activities in the BVI, be concentrated on reducing the potential impact of these two hazards.

In the following chapters tropical cyclone systems that produce hurricanes, and their effects are described, followed by a description of the nature of earthquake hazards in the BVI. Since weather systems other than tropical cyclone systems have the potential to cause major flooding, this hazard is treated in a separate chapter. In all cases the possible distribution and magnitude of the hazardous phenomenon is assessed to determine the degree of exposure or susceptibility of locations in the BVI.

To arrive at a determination of the risk posed by a particular phenomenon, requires that the elements at risk be established. For this project therefore, an inventory of the elements at risk in the BVI was carried out to identify the entities which can be affected by particular hazards. This largely consisted of the mapping of most buildings and other significant structures such as roads, utility distribution networks, and jetties.

The vulnerability or intrinsic predisposition to damage from hurricane force winds of the main structural types in the BVI was evaluated. Some general statements are made regarding, the vulnerability to storm surge, inland flooding, and ground shaking due to earthquakes. Based on the degree of vulnerability established, estimates of potential damage were calculated.

Finally some approaches to loss reduction are recommended in the form of mitigation strategies. These include both structural and nonstructural measures which address mitigation for existing and future development, and highlight the importance of incorporating mitigation issues into the planning process.