

WATERCOURSES AS LANDSCAPES IN THE U.S. VIRGIN ISLANDS: STATE OF KNOWLEDGE



Photograph courtesy of Julie Wright

Prepared by:
Lloyd Gardner, Stevie Henry, Toni Thomas



Water Resources Research Institute

University of the Virgin Islands



October 2008

This report is a product of the 2007 Water Resources Research Institute grant program, wherein it is identified as Project Number: 2007VI92B.

Disclaimer

The research on which this report is based was financed in part by the U. S. Department of the Interior, United States Geological Survey, through the Virgin Islands Water Resources Research Institute. The contents of this publication do not necessarily reflect the views and policies of the U. S. Department of the Interior, nor does mention of trade names or commercial products constitute their endorsement by the United States Government.

Acknowledgements

The authors of this report wish to convey their appreciation to all those persons and institutions that supported this effort, whether through provision of information and materials or general encouragement. We look forward to your continued support in promoting ghuts as important resources in the U.S. Virgin Islands.

For bibliographical purposes, this document may be cited as:

Gardner, Lloyd, Stevie Henry, & Toni Thomas. 2008. Watercourses as Landscapes in the U.S. Virgin Islands: State of Knowledge. Water Resources Research Institute, University of the Virgin Islands. U.S. Virgin Islands.

TABLE OF CONTENTS

Page No:

Acknowledgements	1
List of Tables	3
List of Figures	3
List of Acronyms	4
1. Introduction	5
1.1 Project Rationale	5
1.2 Methodology	6
2. Framework for Management of Watercourses in the U.S. Virgin Islands	8
2.1 Policy and Legal Framework	9
2.2 Institutional Arrangements for Ghut Management	17
3. Benefits of Watercourses in the U.S. Virgin Islands	21
3.1 Ghuts as Landscapes	21
3.2 Ghuts as Wildlife Habitats	22
3.3 Ghuts as Providers of Goods and Services	23
3.4 Ghuts and Historical Heritage	26
4. Current Status of Watercourses in the U.S. Virgin Islands	28
4.1 Environmental Quality	28
4.2 Influence of Land-use Practices on Ghuts	33
4.3 Initiatives Relevant to Ghuts	36
5. Major Issues Relevant to Ghuts in the U.S. Virgin Islands	42
6. Future Demand for Ghut Services	52
7. Recommendations for Design of a Ghut Management Program	54
7.1 Scope of the Proposed Management Program	54
7.2 Areas of Focus for the Proposed Management Program	54
Epilogue	56
References	57
Glossary of Terms	60
Appendix 1: Biographical Sketch of Project Team	61
Appendix 2: Contributors of Information and Materials	63
Appendix 3: Community Uses of Ghuts in the U.S. Virgin Islands	64
Appendix 4: 1994-2007 Comparative Analysis for Benner Bay/Jersey Watershed, St. Thomas	68

LIST OF TABLES

	<i>Page No:</i>
Table 1: Confirmed Sightings of Rare Wildlife Species in Ghuts (2003-2008)	29
Table 2: Wildlife Records – Anecdotal Information	30
Table 3: Ghuts of Interest	48

LIST OF FIGURES¹

	<i>Page No:</i>
Figure 1: Digital Terrain Model of St. Croix	10
Figure 2: Digital Terrain Model of St. John	11
Figure 3: Digital Terrain Model of St. Thomas	12
Figure 4: Ghuts of Interest on St. Croix	49
Figure 5: Ghuts of Interest on St. John	50
Figure 6: Ghuts of Interest on St. Thomas	51

¹ Figures 4-6, showing the Ghuts of Interest on the three islands, can also be viewed at <http://cdc.uvi.edu/ghutsproject.htm>.

LIST OF ACRONYMS

CDC	Conservation Data Center
CES	Cooperative Extension Service
DPNR	Department of Planning and Natural Resources
DPW	Department of Public Works
EAST	Environmental Association of St. Thomas
EDA	Economic Development Authority
GIS	Geographic Information Systems
HEC	Hydrologic Engineering Center
NPS	National Parks Service
NWS	National Weather Service
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USVI	United States Virgin Islands
UVI	University of the Virgin Islands
VICD	Virgin Islands Conservation District
VIDA	Virgin Islands Department of Agriculture
VI-EPSCoR	Virgin Islands Experimental Program to Stimulate Competitive Research
VINP	Virgin Islands National Park
VIRC&D	Virgin Islands Resource Conservation & Development Council
WRRRI	Water Resources Research Institute

WATERCOURSES AS LANDSCAPES IN THE U.S. VIRGIN ISLANDS: STATE OF KNOWLEDGE

1. INTRODUCTION

Streams were traditionally the major source of freshwater in the U.S. Virgin Islands. In addition, the streams, and the watercourses through which they flowed, provided food and recreational opportunities for humans, as well as habitats for flora and fauna.

Since the 1960s, development pressures have impacted negatively on these streams and watercourses, by changing the land-use patterns in the associated watersheds, and in some cases, altering the watercourses themselves. These changes affected the consistency and volume of stream flow, resulting in the need to develop other sources of potable water, notably wells and community catchments. The existence of these alternate sources of water reduced the level of attention paid to streams and the protection of watercourses. This lack of attention resulted in the situation where, in recent times, watercourses are used as dumping grounds for construction debris, household and commercial solid waste, and receptacles for overflow from municipal sewerages. The general community perception appears to be that watercourses (or ghuts as they are locally called) are useless places that are best filled or cleared to make space for buildings.

However, some of the traditional uses of streams and watercourses still continue, and for some groups, such as farmers on St. Thomas, runoff channeled by watercourses still form the major source of water for agriculture.

Though much is not known about the current ecological status of the streams, the habitat value of watercourses is considered to be high, due to the fact that these watercourses (ghuts) form some of the most diverse habitats in the U.S. Virgin Islands (USVI), and are therefore highly valuable from an ecological perspective (Devine et al, 2004, and Thomas and Devine, 2005).

Unfortunately, watercourses remain threatened landscapes, with direct and indirect adverse impacts resulting from construction activities, poor waste disposal practices, and poor land management practices.

1.1 Project Rationale

The University of the Virgin Islands-Cooperative Extension Service (UVI-CES), as part of its Natural Resources/Environmental Management and Water Quality Programs, promotes awareness of ghuts as important riparian habitats protected by USVI law. This program by CES focuses on the role of ghuts in the protection of wetlands and coastal water quality, as well as the contribution to the scenic beauty and recreational potential of the islands. Additionally, other departments within UVI conduct research and undergraduate teaching on streams and ghuts. Recent studies conducted as part of the United States Geological

Survey's State Water Resources Research Institute program, administered by the Water Resources Research Institute, noted the continuing use of ghuts for water supply and recreation. Both the studies and the ongoing programs of CES also identified a significant level of interest concerning ghuts on the part of some individuals and community groups.

Despite this continuing interest in ghuts and demand for water resources provided by ghuts, and despite the fact that watercourses are protected by law, there is no program that focuses directly on the protection or management of this particular resource. This lack of attention results in lack of enforcement of the relevant laws, even when community interests have expressed concerns regarding the impact of specific development activities on watercourses.

How does a community continue to degrade a resource that was used extensively in the past, which many of its members remember fondly, and that continues to provide goods and service to the community? This contradiction demanded an answer. One assumption was that the community is consistently bombarded with information concerning environmental protection programs, but those programs do not focus to any significant extent on the benefits to the community. It was therefore suggested that greater attention would be given to watercourses if they were treated as a resource base that potentially could provide significant benefits to the community, such as the provision of recreational spaces for residents and visitors.

This project, titled "Revitalization of Ghuts as Urban Recreational Spaces in the U.S. Virgin Islands", was designed to test the above assumption. The findings were to be used to develop a framework within which a watercourse (ghut) protection program can be established by the relevant natural resource management agencies and research institutions in the U.S. Virgin Islands.

The objectives of the project were:

- (a) Determination of the state of knowledge concerning ghuts in the USVI;
- (b) Review of the current programming relevant to ghuts/streams;
- (c) Preparation of a draft policy and plan for ghut management;
- (d) Seek endorsement of the ghut management program by the relevant public sector and research institutions, using a peer review process (in a workshop format) for plan review and finalization; and
- (e) Development of a demonstration activity involving one site each on St. Croix and St. Thomas.

This report is therefore one of three major outputs from the project, and focuses on the state of knowledge concerning watercourses in the U.S. Virgin Islands.

1.2 Methodology

The information for the state of knowledge review was compiled primarily from existing literature (including gray literature). Compilation of programmatic information from the

various institutions and stakeholders was used to complement the literature. Information on the use of ghuts by individuals and community groups was obtained through a consultation process, in which stakeholders were interviewed directly, were allowed to submit written information to the project team (Appendix 1), or through participation in two public meetings. The public meetings were used primarily for obtaining guidance and feedback on the proposed ghut management plan and demonstration activities (the other two project outputs).

The relevant regulatory institutions were contacted in writing to solicit information on relevant programs. The information was provided either in writing or through interviews with relevant officers of the institutions.

Maps contained in this report were compiled from the spatial database maintained by the Conservation Data Center of the University of the Virgin Islands.

The list of persons and institutions contributing information and materials is shown as Appendix 2.

2. FRAMEWORK FOR MANAGEMENT OF WATERCOURSES IN THE U.S. VIRGIN ISLANDS

In the U.S. Virgin Islands (USVI), a watercourse is commonly referred to as a “gut”, and the Virgin Islands Code uses both terms. The literature review undertaken for the preparation of this report did not reveal the origin of the name adopted in the USVI. Globally, the form of the word ghut that is used to refer to a watercourse is ghaut. The results of an internet search suggest that the English Language version of the term is derived from the word ghat, which is a word from India, and originally meant a pass between mountains. Though ghat was later translated by the Europeans to mean the mountains in a particular area of India, the term ghaut became widely used, and had several meanings attached, including:

- A pass through a mountain;
- A range of mountains;
- Stairs descending to a river;
- The ford of a river.

Within the countries of the Organization of Eastern Caribbean States, the form of the word that is found in law and everyday use is “ghaut”. Hence reference is found in Montserrat to watercourses with names such as Mosquito Ghaut and Tuitt’s Ghaut, while in St. Kitts-Nevis the names include Business Ghaut and Maddens Ghaut. In the adjacent territory of the British Virgin Islands, the form of the word is “ghut”, and they have watercourses with names such as Spring Ghut and Little Bay Ghut.

It is possible that in the USVI the word was derived as a shortened form of the word “gutter”, which could mean (i) a shallow trough below the eaves of a house, (ii) a shallow channel along the side of a road to carry off rainwater, or (iii) a track made by the flow of water. Oldendorp (1987) wrote that the streams that “...come up after a rainfall ..” are called “...guts or waterguts”.

Due to the fact that this report will be disseminated in digital form, and is therefore likely to be available on the internet, a globally-recognized form of the word will be used in this report when making a general reference to watercourses. In the case where a watercourse has been given a name, then reference to that specific watercourse will utilize the formal name, while a general reference will use the form “ghut”.

A watercourse is defined in Title 12, Chapter 3, Section 123(b) of the Virgin Islands Code (Annotated, 2006 Edition) as follows:

“For purposes of this Chapter, a natural watercourse means any stream with a reasonable well-defined channel, and includes streams which have a permanent flow, as well as those which result from the accumulation of water after rainfall and which regularly flow through channels formed by the force of the waters.”

2.1 Policy and Legal Framework

The policies for water resources management in the USVI are contained in the legal framework provided by the Virgin Islands Code. These laws reflect an appreciation by the government that water resources in the USVI are scarce, that the sources are threatened, and that, due to the drainage pattern created by the physiography of the islands (Figures 1-3), all development activities on land can result in immediate and deleterious impacts on coastal waters and marine resources.

Sections of the Virgin Islands Code that have a direct or indirect bearing on the management of watercourses are:

- Title 7, Chapter 3 – Soil Conservation;
- Title 12, Chapter 1 - Wildlife;
- Title 12, Chapter 3 – Vegetation Adjacent to Watercourses;
- Title 12, Chapter 5 – Water Resources Conservation;
- Title 12, Chapter 7 – Water Pollution Control;
- Title 12, Chapter 9A – Commercial Fishing; and
- Title 12, Chapter 13 – Environmental Protection.

(a) **Title 7 – Agriculture, Chapter 3 – Soil Conservation**

- Section 41: Declaration of policy.
“It is declared to be the policy of the legislature to provide for the conservation and development of the soil, water and other natural resources of the United States Virgin Islands, including, but not limited to the prevention and control of soil erosion, the prevention of flood-water and sediment damage, and the furthering of conservation, development, utilization, and disposal of water”.

Implication for Ghut Management:- This focus on the conservation of soil and water implies that agricultural and other development activities should be carried out in such a manner as to protect soil productivity and not impair the integrity of water bodies. Not only does this mean adopting methods to prevent erosion and improve flood control, it also means that waste discharges to watercourses should be prevented.

(b) **Title 12 – Conservation, Chapter 1 – Wildlife, Sub-chapter VI – Wildlife Restoration, Section 81: Wildlife restoration projects**

- Section 81(a) – States that the Virgin Islands Legislature accepts the provisions of *“an Act to provide that the United States shall Aid the States in Wildlife Restoration Projects, and for other Purposes”*. Act of Congress, September 2, 1937, chapter 899, 50 stat.917 (16 U.S.C. § 669 et seq.), and authorized the Commissioner (of the then Department of Conservation and Cultural Affairs) to secure any benefits available under the Act.

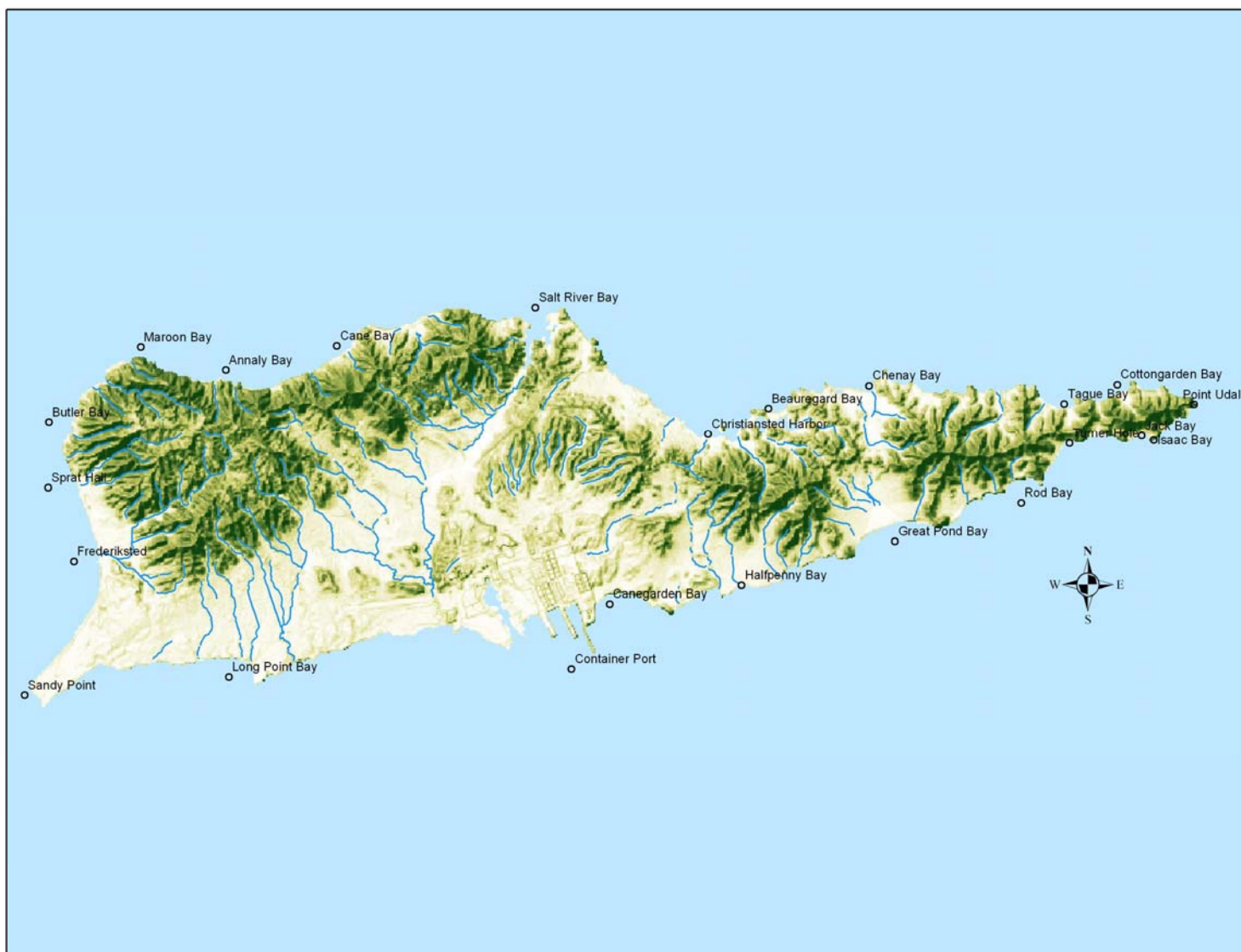


Figure 1: Digital Terrain Model of St. Croix



Figure 2: Digital Terrain Model of St. John

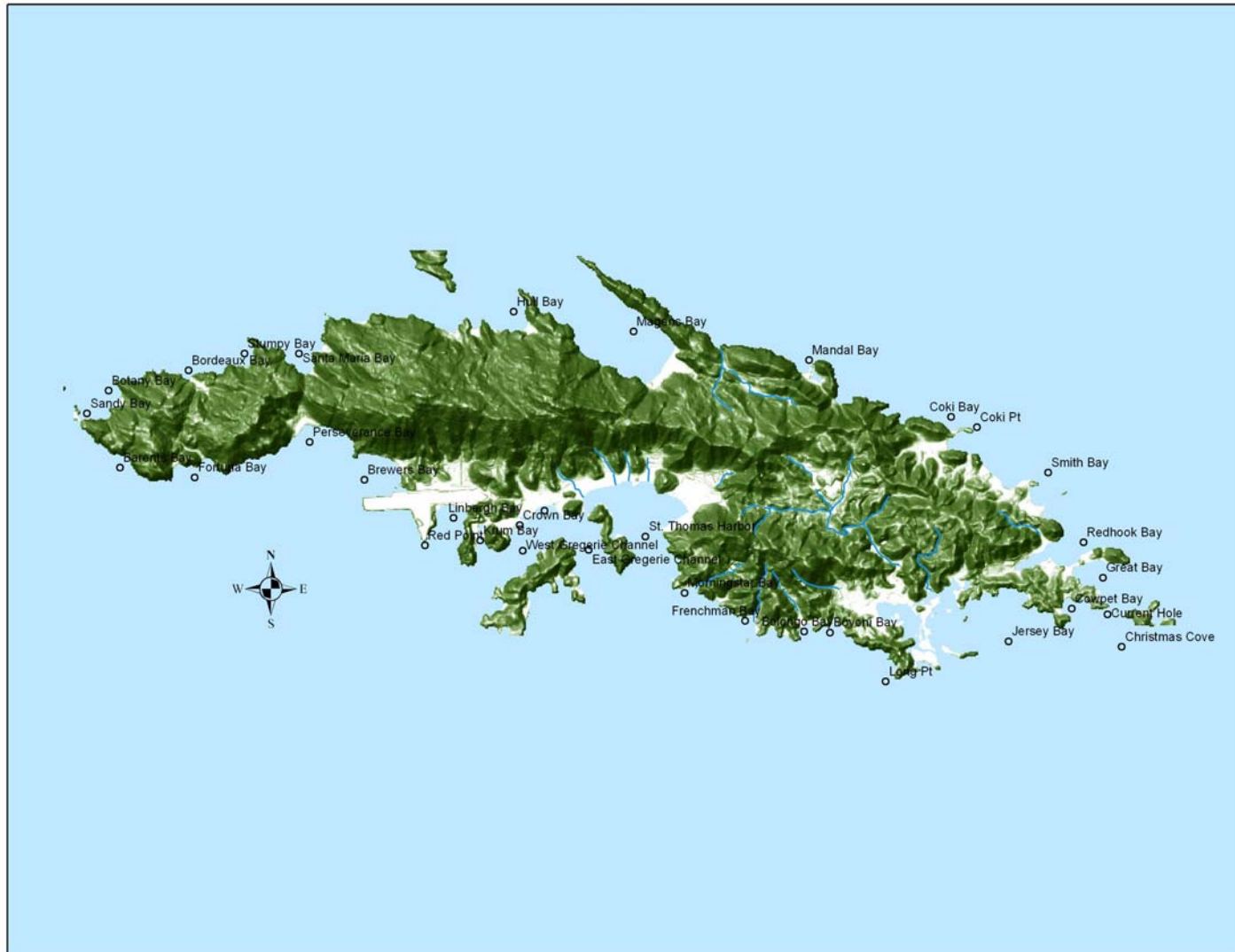


Figure 3: Digital Terrain Model of St. Thomas

- Section 81(b)(1) – Stipulates that wildlife projects may include “... *the selection, restoration, rehabilitation, and improvement of areas of land or water adaptable as feeding, resting, or breeding places for wildlife*”.

Implication for Ghut Management:- Ghuts that are identified as critical habitats for wildlife should be targeted for attention in wildlife projects, and such action could include the protection and rehabilitation of said ghuts.

(c) Title 12 – Conservation, Chapter 3 – Trees and Vegetation Adjacent to Watercourses. Sections 121-125 focuses on soil conservation

- Section 123 – Cutting or injuring certain trees:
 - (a) *No landowner or other person shall, except as provided in this Chapter, encourage, procure, cause or aid in the cutting or injury of any tree or vegetation within 30 feet of the center of any natural watercourse, or within 25 feet of the edge of such watercourse, whichever is greater.*
 - (b) *For purposes of this Chapter, a natural watercourse means any stream with a reasonable well-defined channel, and includes streams which have a permanent flow, as well as those which result from the accumulation of water after rainfall and which regularly flow through channels formed by the force of the waters.*
- Section 124 – Authorizes a landowner to cut or injure trees and vegetation on his own land, with the prior written permission of the Commissioner (of the Department of Planning and Natural Resources).

Implication for Ghut Management:- This Section is clearly intended to provide for the maintenance of buffer/filter strips along watercourses. The practice of clearing vegetation from the sides of ghuts and from within ghuts is obviously in contravention of this law. Disposal of construction debris and other practices that damage vegetation are also in violation of this law. The need to address flood control issues (related to tropical storms) and storm-water management on properties under development therefore require more attention as they relate to this law.

(d) Title 12 – Conservation, Chapter 5 – Water Resources Conservation

- Section 151: Definition of policy
“It is hereby declared to be the public policy of the Government of the United States Virgin Islands, in recognition of its sovereign duty to conserve and control its water resources for the benefit of the inhabitants of the United States Virgin Islands, that comprehensive planning and regulation be undertaken for the protection, conservation and development of the water resources of the United States Virgin Islands to the end that they shall not be wasted and shall be used to the fullest extent to meet the present and future needs for domestic, agricultural,

commercial, industrial, recreational and other public, beneficial purposes. It is further declared that an emergency condition exists with respect to the availability of surface and underground water in the United States Virgin Islands and that restrictions are necessary to prevent overpumping of water from wells, the depletion of surface and underground water, the intrusion of salt water and the resultant permanent destruction of underground water reservoirs as sources of potable water supply.

In view of the foregoing, all waters within the United States Virgin Islands are hereby declared to be public waters belonging to the people of the United States Virgin Islands, subject to appropriation for beneficial use in the manner set forth in this chapter and not otherwise”.

- Section 152(d) - ““water” shall be construed to include ponds, springs, wells, and streams and all other bodies of surface or underground water, natural or artificial, inland or coastal, fresh or salt, public or private”.
- Section 152(g) – This section provides for “Vested Rights”; that is, beneficial uses that were in place at the time of passage of the law.
- Section 153 – Persons wanting to take or withdraw water first need an Appropriation Permit from the Commissioner of the Department of Planning and Natural Resources, except such persons withdrawing less than 500 gallons per day for beneficial use.

Implication for Ghut Management:- This law is obviously intended to provide for comprehensive water resources management, which currently is not undertaken in the USVI. Implications specific to ghuts include:

- (i) All ghuts containing intermittent streams or permanent pools are publicly owned.
- (ii) All uses of streams/water from ghuts must be deemed to be beneficial, which implies that watercourses should not be used for waste disposal.
- (iii) Persons are allowed to appropriate water from watercourses, as long as the extraction is less than 500 gallons per day. Given the normal flow rates, extraction of 500 gallons per day of water will have significant negative impacts on flows, assuming that such an extraction rate can be maintained. However, this provision probably explains why impoundments were initially allowed in watercourses.

(e) Title 12 – Conservation, Chapter 7 – Water Pollution Control

- Section 181: Definition of policy
“Whereas the pollution of the waters of the United States Virgin Islands constitutes a menace to the public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life, and impairs beneficial uses of water, it is

hereby declared to be the public policy of the United States Virgin Islands to conserve the waters of the United States Virgin Islands and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life, and for domestic, recreational and other legitimate beneficial uses; to provide that no waste be discharged into any waters of the United States Virgin Islands without first receiving the necessary treatment or other corrective action to protect the legitimate beneficial uses of such waters; to provide for the prevention, abatement and control of new or existing water pollution; to authorize the United States Virgin Islands to implement the provisions of the Federal Water Pollution Control Act, and Acts amendatory thereof or supplementary thereto, and federal regulations and guidelines issued pursuant thereto so that permits may be issued by the United States Virgin Islands under the provisions of that Act”.

- Section 182(f) – Defines “Waters of the United States Virgin Islands” as “... *all waters within the jurisdiction of the United States Virgin Islands including all harbors, streams, lakes, impounding reservoirs, marshes, water-courses, waterways, wells, springs, irrigation systems, drainage systems and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, situated wholly or partly within or bordering upon the United States Virgin islands, including the territorial seas, contiguous zones, and oceans*”.

Implication for Ghut Management:- The definition of water to include streams and watercourses re-affirms the legal obligation of the regulatory agencies to protect watercourses from pollution.

(f) Title 12 – Conservation, Chapter 9A – Commercial Fishing

- Section 301: Purpose
“The Purpose of this chapter is to preserve, manage and protect the fishery resources, to regulate fishing and to secure its increase and development in all marine, estuarine and freshwaters within the jurisdiction of the United States Virgin Islands”.
- The law is administered by the Department of Planning and Natural Resources (replacing the Department of Conservation and Cultural Affairs).
- Section 320: Fishing in freshwaters, regulations
“Fishing is hereby prohibited in any public pond, lake, stream or other body of freshwater in the territory by any gear, devise or other means except that of angling; provided, that the Commissioner may grant permission, which shall be in writing, for the use of other fishing gear, devise or means of any person or organization for scientific purposes and for live exhibition by any licensed or publicly owned zoo or exhibitor of aquatic life”.

Implication for Ghut Management:- The law implies that freshwater fisheries resources should be protected and managed, and by extension, that includes their habitats, the ghuts.

(g) Title 12 – Conservation, Chapter 13 – Environmental Protection

- Section 531: Declaration of Policy
“The Legislature of the Virgin Islands hereby determines and finds that the lands and water comprising the watersheds of the United States Virgin Islands are great natural assets and resources; and that improper development of land results in changed watershed conditions such as; erosion and sediment deposition on lower-lying land and in the tidal waters, increased flooding, gut² and drainage filling and alteration, pollution, and other harmful environmental changes to such a degree that fish, marine life, and recreational and other private and public uses of land and waters are being adversely affected. In order to protect the natural resources of the United States Virgin Islands, promote the health, safety and general welfare of the citizens of the United States Virgin Islands, and to protect private and public property, the Legislature further finds and determines that it is necessary to establish by law an environmental protection program for land development to prevent soil erosion and for the conservation of beaches, shorelines and the coastal zone of the United States Virgin Islands”.
- Section 533 – Stipulates that an Earth Change Plan is to be approved by the Department of Planning and Natural Resources before any real property can be *“... cleared, graded, filled or otherwise disturbed for any purpose or use ...”*

Implication for Ghut Management:- This law clearly requires that processing of Earth Change Permits include provisions for prevention of ghut alteration and prevention of flooding downslope of the development activity. However, the current practice for storm-water management, as part of an Earth Change Permit, is to allow alteration and filling of ghuts. The law was meant to prevent the significant level of change in drainage patterns resulting from residential development that is currently taking place in some watersheds. Additionally, the disposal of construction debris in ghuts is also a harmful environmental change as implied in this law.

Rules and Regulations are promulgated to give effect to the policies and guidance provided in the Virgin Islands Code. Rules and Regulations of special interest to ghut management are:

- Water Quality Standards for the U.S. Virgin Islands, 2004; and
- Territorial Pollutant Discharge Elimination System Rules and Regulations, 2007.

² The emphasis is added simply to underscore the fact that the colloquial form of ghut also shows up in the law.

(i) Water Quality Standards for the U.S. Virgin Islands, 2004

This Regulation amended the water quality standards, as provided for by Title 12, Chapter 7, Subchapter 186 of the Virgin Islands Code. The Regulation accepts the definition of “waters” of the Virgin Islands as provided in Title 12, Chapter 7, Section 182(f). The Regulations reaffirms the generally acceptable quality of waters of the U.S. Virgin Islands by asserting that *“All waters of the U.S. Virgin Islands shall meet generally accepted aesthetic qualifications and shall be capable of supporting diversified aquatic life”*.

(ii) Territorial Pollutant Discharge Elimination System Rules and Regulations, 2007

This Regulation is a re-issuance of Title 12, Chapter 7, Subchapter 184 (Territorial Pollutant Discharge Elimination System) of the Virgin Islands Code. Though the Regulation focuses on water pollution prevention, sub-section 184-45 deals specifically with storm water discharge from a range of development activities.

2.2 Institutional Arrangements for Ghut Management

The institutions with regulatory responsibilities for ghut management in the U.S. Virgin Islands are the:

- Department of Planning and Natural Resources;
- Department of Agriculture; and
- Department of Public Works.

(a) Department of Planning and Natural Resources (<http://www.dpnr.gov.vi>)

The Department of Planning & Natural Resources (DPNR) was established in 1987, under Act 5265 of the Government Reorganization and Consolidation Act. One of the main elements of that Act was the reorganization of the Department of Conservation and Cultural Affairs to create the Department of Housing, Parks and Recreation and the Department of Planning and Natural Resources.

Information gathered from DPNR’s website states that the agency *“... serves as the agency responsible for the administration and enforcement of all laws pertaining to the preservation and conservation of fish and wildlife, trees and vegetation, coastal zones, cultural and historical resources, water resources, and air, water and oil pollution. DPNR is also responsible for oversight and compliance of land survey, land subdivision, development and building permits, code enforcement, earth change permits, zoning administration, boat registration, and mooring and anchoring of vessels within territorial waters. The Department formulates long-range comprehensive and functional development plans for the human, economic and physical resources of the territory. This Agency is mandated to promote,*

implement, support, maintain and coordinate library and information services and museums, and preserve items of historical significance in the archives of the Virgin Islands. The Department is further obligated to formulate functional development plans for the territory's human, economic and physical resources."

DPNR's website states that it is comprised of eleven (11) primary operating divisions, each with its own regulatory mandate. The divisions with responsibilities relevant to ghut management are:

- Division of Comprehensive and Coastal Zone Planning;
- Division of Building Permits;
- Division of Coastal Zone Management;
- Division of Environmental Enforcement;
- Division of Environmental Protection;
- Division of Fish and Wildlife; and
- Division of Archeology and Historic Preservation.

Division of Comprehensive and Coastal Zone Planning

The Division has broad responsibility for long-range comprehensive planning, as well as subdivision and zoning administration. The Division is also charged with providing information, technical assistance and support to various DPNR divisions, other USVI government agencies, the private sector, and the general public on matters such as Business Licensing, Subdivision and Coastal Zone Planning, and Land and Water Use Planning.

Division of Building Permits

The primary responsibility of the Division is to enforce and regulate building codes and regulations in the USVI. The major tasks associated with this responsibility include:

- Review of building designs, construction plans, contractor licenses and related documents.
- Evaluation of applications for building permits, issuance of permits, and permit administration.
- Inspection of building and construction sites.
- Monitoring of existing building codes and the proposal of new codes and regulations to address changing demographics, public safety, and environmental issues.

Division of Coastal Zone Management

The Division's main charter is to administer the Virgin Islands Coastal Zone Management Program, which was established by the Virgin Islands Coastal Zone Management Act (1974). The Coastal Zone Management Program focuses on management of coastal zone resources by regulating development and carrying out programs to protect, preserve and, where appropriate, enhance environment quality in the coastal zone. A major part of its development control responsibilities includes

provision of technical support to the Coastal Zone Commission, which reviews permit applications for development activities in Tier 1 of the coastal zone.

Division of Environmental Enforcement

The Division serves as the law enforcement arm of DPNR, and its “... *primary function is to enforce all laws applicable to the protection, preservation and conservation of the natural resources and overall environment of the USVI*”, specifically with reference to:

- *“Fish and wildlife;*
- *Antiquities and cultural resources;*
- *Boating safety; and*
- *Conditions stipulated in all permits related to development in the Territory, issued by the Department of Planning & Natural Resources”.*

Division of Environmental Protection

This Division is responsible for the protection and conservation of the natural resources (air, water, and land) of the USVI. The Division has also been delegated responsibility for environmental protection by the United States Environmental Protection Agency.

Division of Fish and Wildlife

This Division is responsible for “... *monitoring, assessing, and implementing public awareness and other activities that help to enhance and safeguard fish and wildlife resources in the USVI.*” The Division also plays an advisory role to other DPNR Divisions and other institutions concerning marine resources and wildlife in the Territory.

Division of Archeology and Historic Preservation

The Division is responsible for the protection of archaeological, historic, and cultural assets of the USVI. This includes “... *reviewing rehabilitation work that is eligible for federal and local tax incentives or federal grants, and for enforcing Acts 6234 and 2258 of the Antiquities and Cultural Act of the Virgin Islands, ...*”. The Division also functions as the Virgin Islands State Historic Preservation Office, whose duties include “... *administration of the National Register of Historic Places; surveying and inventorying of historic places and sites (on land and in coastal waters); reviewing and ensuring of compliance with federal and territorial preservation laws; historic preservation planning; securing of technical assistance, implementing of public education and identifying of cultural resources.*”

(b) V.I. Department of Agriculture

The V.I. Department of Agriculture (VIDA) is responsible for soil conservation practices on land under agriculture, and (based on the V.I. Code) maintaining buffer zones along ghuts. The Department exercises its authority in regards to ghuts mainly when earth change

activities are conducted on properties over which the VIDA has custodianship or on private lands (St. Croix) when land clearing / preparation work is requested.

The Department also supports the activities of the V.I. Resource Conservation District. *“The Virgin Islands Conservation District (VICD) was organized by the Virgin Islands Legislature to provide for the conservation and development of the soil, water and other natural resources of the Virgin Islands. The VICD is responsible for the broad soil and water conservation program set forth in Sections 41-49 of Title 7, Chapter 3 of the Virgin Islands Code”* (<http://www.pr.nrcs.usda.gov/partnerships/consdistricts.html>). The VICD is administered by a Board of Directors, comprised of eleven persons. The Directors *“... work with individuals, organizations and agencies interested in soil and water conservation, land use planning, watershed protection and flood prevention in the broadest sense to secure their assistance and support in planning and carrying out VICD's program”*. In that context, the VICD collaborates with the Natural Resources Conservation Service of the U.S. Department of Agriculture (USDA) in an advisory capacity, including review of the Virgin Islands Conservation Plan prepared by the USDA.

(c) Department of Public Works

The Department of Public Works (DPW) routinely deals with ghuts through three program areas:

- Road Development – The Department designs drains to accommodate rainfall events of 10-15 year return periods. The role of the Department in the development control process, relative to drainage issues, is restricted to projects where the development road intersects with the public road.
- Ghut Cleaning Program – The Department operates an ongoing program to clean ghuts, particularly during the hurricane season. This involves bushing the sides of the ghuts and removal of solid waste from the ghuts (particularly in the areas where the ghuts are channelized and there is the potential for flooding).
- Flood Mitigation – The Department undertakes flood mitigation works for roads, as well as general flood mitigation for properties in flood plains.

3. BENEFITS OF WATERCOURSES IN THE U.S. VIRGIN ISLANDS

Both printed and anecdotal information confirm the importance of streams in the past development of the U.S. Virgin Islands (USVI), and both indicate the significant changes in the availability of freshwater and the impact that changes in the ghuts had on the Virgin Islands community.

The literature suggests that the islands comprising the USVI were covered by forests when the Europeans arrived. Paiewonsky (2005) noted that the ghuts in Charlotte Amalie were beginning to dry up in the 1690s, and attributed the loss to farming methods in the hills above the town. He also noted that the significant loss of topsoil, due primarily to the farming methods, resulted in most farming activities moving to St. John in 1716, and then to St. Croix in 1733. Lawaetz (1991) noted that the cultivation of sugar cane on St. Croix resulted in more water running in the ghuts, with new springs starting from around 1750. He further suggested that the 1800s may have been the century when ghuts flowed all year long; that is, they were effectively perennial streams. Seaman (1980) claims that early 15th century reports noted that St. Croix possessed three (3) rivers and sixteen (16) brooks (ghuts). Forman (1974) stated that the report of the 3 rivers and 16 brooks was made by the French in 1651. He also noted that as late as 1914 there were a number of perennial streams on St. Croix. Seaman (1980) noted that perennial streams could be found as late as 1918, with the largest being the Estate Lower and Bethlehem Guts. Paiewonsky (2005) claims that the Fireburn Gut (Charlotte Amalie) “... *ran year round with fresh water*” (was a perennial stream) until 1950.

These and other writings chronicle the impact on drainage from development activity, with the result being that most ghuts had running water only after heavy rainfall events.

The seasonal nature of the streams has no doubt shaped the public perception of ghuts. Based on discussions with local environmentalists and staff in regulatory agencies, the statement can be made that watercourses are not currently perceived by the general public as providing much benefit beyond acting as channels for surface runoff, especially as it affects residential and commercial development.

This chapter explores the potential and actual benefits of watercourses/ghuts in the USVI and the ways in which ghuts are actually used by the community.

3.1 Ghuts as Landscapes

Thoughts of landscapes conjure images of pleasing vistas that are viewed and appreciated from a distance. Wikipedia (the online encyclopedia) offers a definition of the word that alludes to the various elements of this feature by stating that “A *landscape comprises the visible features of an area of land, including physical elements such as landforms, living elements of flora and fauna, abstract elements such as lighting and weather conditions, and human elements, for instance human activity or the built environment.*” The comparative

contributions of the component elements produce a landscape that is characteristic of those conditions.

The landscapes on St. John and St. Thomas are shaped to a large degree by the ghuts, as the



greater portion of each island is mountainous terrain. While the influence of the ghuts on the shaping of the landscapes is experienced to a lesser degree on St. Croix and Water Island, the large number of ghuts, and the influence of those ghuts on the placement and design of buildings, creates a panoply of landscapes that make the Virgin Islands an attractive location for visitors.

landscape. In the same manner that a scuba diver has to become immersed in the sea to fully appreciate coral reefs, a person wishing to fully appreciate the variety of vistas and experiences offered by ghuts have to be within the ghat. As such, recreational activities within ghats have always been a part of the Virgin Island experience, for both individuals and groups.

Landscapes can also be appreciated by immersing oneself within the

3.2 Ghats as Wildlife Habitats

Thomas and Devine (2005), in typifying the forests in the U.S. Virgin Islands, identified two distinct forest types associated with watercourses. These forest types are Gallery Moist Forest and Gallery Shrubland. Gallery Moist Forest is said to grow in ghats that drain the larger watersheds, particularly those that occur in the moister areas of the islands. Thomas and Devine (2005) identified good examples of Gallery Moist Forest as occurring in Caledonia Gut (St. Croix), Reef Bay Gut (St. John), and Bonne Resolution Gut (St. Thomas). Forests assist with the maintenance of ecological integrity of ghats through reduction of soil erosion, increasing infiltration of groundwater by slowing runoff, reduction of pollutants entering streams, and provision of habitat for wildlife. Ghats contain a number of rare and endangered species of plants (e.g. Egger's Cock's-spur (*Erythrina eggersii*)), yet inventories of these areas have not been undertaken.

Ghats also provide habitats for several species of fauna (Tables 1 and 2), several of which are rare and endangered. Uses of ghats by wildlife species include:

- (a) **Nesting** – A large number of bird species has been identified in ghats. Olasee Davis confirms the existence of wildlife records, from 1949-1968, which provide information on nesting, foraging, migration corridors, and watering holes. New assessments are needed to verify current nesting activity versus foraging and

migration uses. The ghuts that accommodate larger trees (e.g. the gallery moist forest) and permanent pools seem to offer greater (bird) species diversity (Gardner, 2008), and the availability of larger trees in ghuts provide more roost potential for bats (Jean-Pierre Bacle, personal communication).

- (b) **Foraging** – The permanent pools often contain aquatic fauna that are “fished” by other species, such as birds. Insects also congregate around pools, and thus become foraging grounds for birds and bats.
- (c) **Migration Corridors** – Ghuts form corridors that facilitate the movement of wildlife species (bats, birds, etc.), an increasingly important facility given the disturbance in the watersheds and the loss of lower-lying green areas to development pressures.
- (d) **Watering Holes** – Many species of wildlife (birds, iguanas, deer, bats, bees, goats, etc.) use the pools in ghuts as watering holes. This is particularly important in the dry season, when freshwater is scarce.

One of the more significant habitat functions provided by ghuts is based on the availability of permanent pools of water. Ghuts form the most extensive network of freshwater habitats in the USVI, and are extremely important for several aquatic species that spend part of their life cycle in freshwater and part in the marine environment.

3.3 Ghuts as Providers of Goods and Services

The role of streams and ghuts in supporting various forms of community development date from the colonization of the islands, and while the uses may have changed over time, ghuts continue to provide a range of goods and services to the communities in the USVI (Appendix 3). Goods and services provided over time include:

- Water for domestic purposes;
- Water for industrial purposes;
- Water for agricultural purposes;
- Food;
- Support to transportation services;
- Recreational opportunities;
- Living laboratory for environmental education; and
- Opportunity for research and teaching.

Provision of Water – Streams were the main source of water for domestic purposes in the USVI in the 18th and 19th centuries, and were still used to a limited degree as late as the early 1960s. Graham (1994) mentions that, prior to the 20th century, Savan Gut was an important resource to residents in the area, providing water for drinking, bathing, and washing clothes. Lawaetz (1991) wrote of the Government leasing Punch Spring in 1905 to supply water to Fredriksted, as well as the later construction of the Creque Dam for the same purpose. Dams were also constructed during the 19th and 20th centuries in Estate Canaan, Estate Adventure, Caledonia, and St. George ghuts to (i) control sediment, (ii) enable recharge of the aquifer,

and (iii) improve surface water in the streams (Olasee Davis, review comments on draft report). Historically, ghuts provided water for agricultural purposes on the three main islands, for irrigation of crops, watering livestock, and production of sugar. Paiewonsky (2005) wrote about the movement of agricultural activity from St. Thomas to St. John, and subsequently to St. Croix as a result of the decreased availability of water. Water was also used to turn waterwheels for generation of power and to support production purposes in the sugar and rum factories (Lawaetz, 1991). Gardner (2008) noted the construction of ponds at the end of ghuts by farmers in the Bordeaux area of St. Thomas for the purpose of storing surface runoff for watering crops.

Provision of Food – The literature contains references to the practice (historically) of collecting freshwater shrimps and fish from streams on St. Croix and St. Thomas (Seaman, 1980). Kesler (1980) also noted that some species of saltwater fish (tarpon, mullet, and haddock) were once found in Mint (Diamond) Gut, due to the large connection of the stream with the sea. Ghuts are no longer a significant source of fish for food, though Gardner (2008) noted that fish (likely Mountain Mullet) and crayfish are still caught in the Bonne Resolution Gut (St. Thomas).

Transportation – Ghuts may have played a limited role in providing a means of transportation in the early days of colonization of St. Croix. Kesler (1980) wrote that the Indians (Arawaks) sheltered their canoes in the quiet water inside the mouth of Mint (Diamond) Gut, and “*The small canoes were alternately paddled and carried to St. George*” (page 2). He also suggests that English farmers used Mint Gut as a means to transport sugar and tobacco from farms in the interior to the coast. Salt River provided the means for the early Amerindian settlers to travel to and from their settlement. There is no evidence that ghuts are still used for this purpose.

Recreational Opportunities – Recreational activities in ghuts previously included hunting, bathing, hiking, and catching fish and shrimp (Lawaetz 1991, Seaman 1980, Seaman 1993, Kesler 1980). Currently, the primary recreational activity is hiking, though there is anecdotal information indicating that fish is still caught in ghuts (Gardner, 2008)³. Hiking through ghuts is a frequent, and apparently growing, activity undertaken by individuals and groups. The St. Croix Hiking Association claims to use all ghuts on the island of St. Croix for hikes, though the major routes are Caledonia Valley, Butler Bay, Fountain, Canaan, Bethlehem, and Adventure Stream (Olasee Davis, personal communication). The St. Thomas Environmental Association mainly uses the



³ Olasee Davis reports that ghuts on St. Croix are still used for catching fish, bathing, washing cars, and hiking.

deJongh Gut (St. Thomas) for hiking, though it also uses the Neltjberg Gut (St. Thomas) and ghuts on St. John. A number of the trails promoted by the Virgin Islands National Park on St. John traverse ghuts. One of the trails on which the Park conducts guided tours is the Reef Bay Trail. Private tour companies also conduct hikes on the three main islands, and several of those hikes are within or traverse ghuts. Data on the frequency and number of persons participating in the group hikes and/or guided tours are generally not available. Data provided by the Virgin Islands National Park for the Reef Bay Trail indicate that 3,573 persons hiked that trail during Fiscal Year 2006/07. Information provided by Olasee Davis indicate that more than 6,000 persons per year participate in hikes that he conducts on St. Croix. Of that total, hikes to ghuts include more than 5,000 persons per year.

Education – Ghuts are increasingly being used as living laboratories to teach science in the elementary and junior high schools, particularly on St. Croix. Hikes are conducted through ghuts such as Mahogany Gut and Salt River for schools such as Ricardo Richards, Good Hope, and St. Croix Educational Complex (William Coles, personal communication). The V.I. Division of Fish and Wildlife on St. Croix also indicated that it is trying to establish other hikes for younger students and their families, so that they can be exposed to, and hopefully appreciate, the freshwater ecosystems on St. Croix. The Good Hope School is developing a lesson plan for teachers based on the Mahogany Gut walk (William Coles, personal communication).

Programs such as the Natures Environmental Role Model Program, established by the environmental club of Central High School (St. Croix), indicate an evolution towards more



structure for such programs (Jesus Espinosa, personal communication).

Research and Teaching – Faculty and students at the University of the Virgin Islands (UVI), as well as visiting researchers, periodically conduct research on water quality or wildlife in ghuts (Nemeth and Platenberg 2007 and Kelsey 2006). Such research is used in teaching at UVI, in supporting professionals in obtaining postgraduate degrees, and adds to the body of knowledge concerning the USVI environment. Use of ghuts by UVI for teaching has included fieldtrips for the ichthyology class (to survey freshwater fish), the Master of Science Degree students in marine and environmental science, and visiting college groups (Yale University and Kansas University - teaching biodiversity and conservation law).

3.4 Ghuts and Historical Heritage

The influence of water sources on the location, development, and (in past centuries) the continuity of settlements is widely known. Similarly, the location of streams and ghuts influenced the development of villages and towns in the U.S. Virgin Islands (USVI). This process started with the earliest settlers, when Amerindians used Turpentine Run (St. Thomas) to travel between the sea and their settlement in Estate Tutu (Righter, 2002). Similarly, the Arawaks utilised Mint (Diamond) Gut (St. Croix) to establish their settlement at Estate St. George (Kesler, 1980).

Graham (1994) notes that the three major drainage channels in Charlotte Amalie functioned not only to perform the task of drainage of storm water, but two of the ghuts divided the city into three distinctive sections, these being Kongens (King's) Quarter, Dronningens (Queen's) Quarter, and Kronprindsens (Crown Prince's) Quarter. These three ghuts are now identified as Savan Gut, Garden Street Gut, and Major Gut⁴. The Savan Gut separates Dronningens Quarter from Kronprindsens Quarter. This ghut starts higher up in the watershed in the area of Estate Elizabeth, passes through Estate Staabi (above which it is known as the deJongh Gut), and passes through Savan on its way to the sea (Woods, 1994). The Garden Street Gut separates Dronningens Quarter from Kongens Quarter. The ghuts also acted as shortcuts (passageways) when dry. Major open ghuts, such as Water Gut (Christiansted), were used more consistently as pedestrian thoroughfares.

The ghuts also influenced the economic and social life of the communities, through the provision of water for domestic, industrial, economic (such as laundry), and recreational activities (Section 3.3). Graham (1994) writes that "*Savan Gut, in fact, represents a kind of 'life line of settlement' to the multi-cultural diversity of the area*" (page 13).

Ghuts have left lasting influences on the social fabric of the Virgin Islands communities. Woods (1994) and Moolenaar (1994) noted that the Banaba Well in Savan not only provided water to the community, but was also the place from which political candidates and other "vocal" members of the community delivered speeches⁵. Areas in Charlotte Amalie and Christiansted are still referred to as Upstreet and Downstreet, and even the names of streets (e.g. Kommandant Gade Over Vaudet [over water]) suggest the past importance of ghuts in the development of Charlotte Amalie. One housing community on St. Croix, Watergut, is named after the actual ghut that flowed through the area. Water Gut was historically a major source of water for Christiansted, and the remains of the well can be seen (alongside the road leading from the police station to the seaport).

⁴ Nadine Marchena-Kean and Sean Krigger, personal communication.

⁵ Like the current behavior of gathering around the office water cooler, in older Caribbean communities, wells and washing holes also functioned as spaces for a significant level of social interaction. Outside of the references given above, there is little information on the social functions of water sources in the U.S. Virgin Islands. Many of the participants in this project agreed that this is one information gap that can best be filled by interviewing the older members of the community, and they recommended the development of an oral history project on water and ghuts.

Ghuts with known historical resources include:

- Savan Gut – Historic drainage channel designed and constructed during the Danish period.
- Water Gut – Historic feature (well).
- Bethlehem Gut – Remnants of the aqueduct and sugar works.
- Living Gut⁶ – Pre-Columbian Taino petroglyphs.
- Fairplain Gut – Amerindian site located at junction with tributary of Bethlehem Gut.
- Salt River – Major Amerindian site, and site of Columbus landing.
- Magen's Bay Gut – Amerindian site.
- Turpentine Run – Tutu Archeological Village (Amerindian site).



The accidental discovery of the Tutu Amerindian settlement, and the paucity of information on water sources as spaces for social discourse and development, suggest that there is much more to discover about the historical importance of ghuts in the development of the U.S. Virgin Islands.

⁶ The name is taken from Loftus, 2003. The gut crosses the Reef Bay Trail, and contains the Petroglyph Pool.

4. CURRENT STATUS OF WATERCOURSES IN THE U.S. VIRGIN ISLANDS

The picture painted by occasional articles in the daily newspapers in the U.S. Virgin Islands (USVI) and discussions with local environmentalists is one of continuing degradation of environmental resources, particularly ghuts and other types of wetlands. A 2004 inventory of wetlands and riparian areas in the USVI (Devine et al, 2004) focused on the development of an Index of Biological Integrity. One table in the report offers data on the percentage of wetland/riparian area relative to total watershed area, but offered no information on the status of the associated resources. Similarly, a 2004 State of the Environment Report for the USVI (Division of Environmental Protection, 2004) contains a section on wetlands, but no information on the status of wetlands nor any information whatsoever on ghuts.

Efforts during this project to determine the current status of ghuts in the USVI have relied on the few reports of studies that are focused on specific resources, and which were conducted in a small number of ghuts.

4.1 Environmental Quality

Flora and Fauna

A number of studies over the past five years show that a number of wildlife species still inhabit and/or use ghuts (Loftus 2003, Lindsay and Bacle 2004, Nemeth & Platenberg 2007, Gardner 2008, and Lindsay et al 2008). This includes a number of rare and endangered plants and animals (Table 1).

The literature indicates that most of the freshwater fauna found in the U.S. Virgin Islands (USVI) are native species. The introduced fish species identified in the USVI are the tilapia and guppy. Platenberg reports non-native fish in Dorothea, Brookman, Nadir, Perseverance, Santa Maria, and Magen's Bay ghuts (Personal communication-March 2008), though the species were not confirmed.

In addition to the information provided by the studies, a number of scientists and environmentalists reported (via personal communication during this project) the presence of a range of wildlife species (including a number of rare and endangered species) in ghuts on St. Croix, St. John, and St. Thomas (Table 2).

Freshwater fauna and other species inhabiting and/or using ghuts face a number of threats, including availability of habitats (pools and forest structure), solid waste disposal and effluent discharges to ghuts, removal of ghut vegetation and reduction of forest cover, sedimentation, highly variable water levels in pools, and physical alteration of ghuts.

Many of the aquatic faunal species are catadromous, and thus require unimpeded access from the ghuts to the sea and back. Many of the ghuts have been filled, realigned, or turned into storm drains to accommodate storm-water discharge in urban areas. Continued alterations of ghuts therefore reduce the chances of catadromous

species returning to the freshwater pools in the ghuts. This reduces not only the species diversity of the U.S. Virgin Islands, but also reduces the amenity value of the ghuts.

Table 1: Confirmed Sightings of Rare Wildlife Species in Ghuts (2003-2008)

Source	Ghut	Species Observed
Loftus, 2003	Fish Bay Gut, Battery Gut, and Living Gut	Mountain Mullet, Spiney Cheek Sleeper, Sirajo Goby, American Eel
Lindsay & Bacle, 2004	Fish Bay Gut and Battery Gut	Fish, shrimp, prawns, and snails; <i>Erythrina eggersii</i> (Egger's cock's-spur)
Nemeth & Platenberg, 2007	Neltjeberg Gut, Bonne Resolution (Dorothea) Gut, and Turpentine Run	• Shrimp - <i>Macrobrachium faustinum</i> - <i>Macrobrachium carcinus</i> - <i>Xiphocaris elongata</i> - <i>Atya lanipes</i> - <i>Atya innocous</i> • Fish - <i>Sicydium plumieri</i> - <i>Agonostomus monticola</i> (Mountain Mullet) - <i>Oreochromis</i> spp. (Tilapia) - <i>Poecilia reticulata</i> (Guppy)
Gardner, 2008	Bonne Resolution (Dorothea) Gut and Contant Gut	• Guppy (<i>Poecilia reticulata</i>) • Mountain Mullet (<i>Agonostomus monticola</i>) • Mozambique Tilapia (<i>Oreochromis mossambicus</i>)§ • Shrimp (<i>Atya</i> spp. and <i>Macrobrachium</i> spp.) • Goby (<i>Scydium</i> sp.) • Dragonfly larvae • Red-footed Tortoise (<i>Geochelone carbonaria</i>)‡ • Birds, iguanas, toads, bees
Lindsay et al, 2008	Living (Reef Bay) Gut	Red Fig-eating Bat (<i>Stenoderma rufum</i>)
§ - One specimen observed in Bonne Resolution Gut on one visit.		
‡ - One specimen observed in Contant Gut on one visit.		

Table 2: Wildlife Records – Anecdotal Information

Source	Ghut	Species Observed
1	Fish Bay Gut, Battery Gut, and Living Gut	Mountain Mullet, Spiney Cheek Sleeper, Sirajo Goby, American Eel
	Dorothea (Bonne Resolution) Gut, Santa Maria ghut, Neltjeberg Gut, and Reef Bay ghut (Living Gut)	Red Fig-eating Bat (<i>Stenoderma rufum</i>)
2	Caledonia Gut, Creque Gut and dam,	4 snail species, one species of guppy, one species of molly, one species of freshwater crab
	Caledonia Gut	3 shrimp species, Mountain Mullet, River Goby, Sirajo, Guppy, American Eel, and at least one snail
3	Dorothea Gut	Fish, shrimp, frogs, red-footed tortoise
	Nadir Gut	Fish, wetland birds
	Neltjeberg Gut	Fish, shrimp, frogs, crabs
	Caret Bay/Sorgenfri ghut	Fish
	Santa Maria Gut	Shrimp, tadpoles, Cuban Treefrog, crab
	Magen's Bay Gut	Shrimp
4 ⁷	Caledonia Gut	Bridled Quail-Dove, Caribbean Elaenia, Black-whiskered Vireo, American Redstart
	Creque Gut	Great Egret, Little Blue Heron, Green Heron, Black Crowned Night Heron, Yellow Crowned Night Heron, Common Moorhen, Black Necked Stilt, Lesser Yellowlegs, Scaly Naped Pigeon, White Crowned Pigeon, Bridled Quail Dove, Mangrove Cuckoo, Belted Kingfisher, Caribbean Elaenia, Northern Waterthrush, Red Tailed Hawk, Lesser Antillean Bullfinch
	Butler Bay Gut	Bridled Quail Doves, Scaly-naped Pigeon, American Redstart, Antillean Treefrog, St. Croix Anole, Common Dwarf Gecko
5	Bethlehem Gut, Castle Burke Gut, Concordia Gut	Shrimp, Mountain Mullet, River Goby, Sirajo, Guppy, American Eel
Sources: 1 Bacle, Jean-Pierre – Island Resources Foundation 2 O'Reilly, Rudy – U.S. Department of Agriculture 3 Platenberg, Renata – Division of Fish and Wildlife 4 Valiulis, Jennifer – Division of Fish and Wildlife 5 Olasee Davis – Cooperative Extension Service, UVI		

⁷ This information is taken in part from the database of the Division of Fish and Wildlife.

Water Quality

As the main drainage channels connecting the various land areas to the sea, ghuts collect and transport surface runoff from island ridge to the marine environment. As such, ghuts naturally transport any and all contaminants contained in the surface runoff. In the U.S. Virgin Islands, the water quality of ghut pools is impacted to a significant extent by human activities. An urban pollution survey of Charlotte Amalie and Christiansted in 1986 found that “... *low level, but chronic, pollution sources exist in nearly all of the urban drainage basins*” (Wernicke, 1986). The Unified Watershed Assessment Report (Department of Planning and Natural Resources, 1998) also noted the impact of surface runoff on water quality.

Despite this acknowledged influence of surface runoff on water quality, the water quality monitoring program of the Government of the U.S. Virgin Islands focuses only on coastal waters, primarily beaches. As a result, the information concerning the quality of water in ghuts is sparse. Available data is provided by a small number of reports detailing research on different ghut resources.

Loftus (2003), reported on water quality conditions in Living (Reef Bay) Gut and Fish Bay Gut, measured during the period 2001-2003. During his visits over the period, he found that “*Physical-chemical conditions in Living and Fish Bay guts were less variable compared with the coastal ponds. Water temperatures were cooler, and changed little by season, normally hovering around 25-26⁰C. Dissolved oxygen concentrations tended to be lower than in most coastal ponds, probably because of shading and organic material in the pools. Levels were higher in December (62%-supersaturation), and lower in the warm, low waters of March (10.5-58%). Values for pH ranged from 7.2-8.5 in December but rose above 10 in March*” (page 10).

Kelsey (2006) reported on the quality of water samples collected from storm water entering and leaving a pond within the Turpentine Run ghut (adjacent to the Weymouth Rhymer Highway) over a two-week period in November 2003. The water samples were tested for fecal coliform bacteria. The mean fecal coliform density for all samples was 28 colony-forming units per 100 milliliters of water (28cfu/100ml) at the pond inlet and 41cfu/100ml at the outlet. This is well within the USVI standards for recreational waters, but does not represent water quality conditions during significant rainfall events. On November 13, 2003, during a rainstorm, the coliform bacteria loading at the inlet and outlet were recorded as 3,286cfu/sec. and 4,919cfu/sec. respectively.

Nemeth and Platenberg (2007) determined that there were clear differences in water quality in the ghuts that drained developed watersheds versus those draining lesser developed watersheds. Water samples collected in the Turpentine Run, Dorothea (Bonne Resolution), and Neltjeberg Guts in October 2006 and February 2007 showed total nitrogen ranging from a low of 0.8mg/L in Turpentine Run to a high of

2.44mg/L⁸ in the Dorothea (Bonne Resolution) Gut. Total phosphorus ranged from 0.02mg/L in Neltjeberg Gut to a high of 0.41mg/L in Dorothea (Bonne Resolution) Gut. Other parameters measured included pH (7.19-7.85) and total dissolved solids (232-389 ppm).

The above data are merely snapshots of water quality condition in ghut pools, and do not present a clear enough picture of overall environmental quality. Coastal water quality provides additional information regarding the state of water quality in ghuts, in that:

- (a) The water quality of bays is used as the main criterion to categorize the environmental quality of watersheds; and
- (b) Closure of recreational beaches is often linked to storm-water discharge after rainfall events.

Unfortunately, using coastal water quality as a measure of environmental quality in watersheds does not provide much information on the environmental quality of permanent ghut pools or other ghut resources.

Riparian Forests

The report of the 2004 inventory of wetlands and riparian areas in the U.S. Virgin Islands (USVI) provides some indication of the proportion of watersheds that are classified as wetlands. The study focused on eighteen (18) of the fifty (50) watersheds in the USVI, and within this selected group, the percentage of wetland/riparian area to watershed area ranged from a low of 3.58% in the Madam Carty Watershed to a high of 26.49% in the Reef Bay Watershed (Devine et al, 2004). The report also made general comments regarding habitat types within the wetland/riparian areas, stating that *“Four of the six highly disturbed watersheds, as a result of size, contain significant habitat diversity, in many cases more than 10 habitat types. Reference watersheds are in most cases found to be on the low end of habitat diversity, usually less than seven and in some cases as low as 3. This is primarily due to size but also to geologic history”* (page 31). However, the report does not distinguish between wetlands generally (which include ponds and marshes) and riparian areas (which are only found along streams/in ghuts).

There are few detailed descriptions and inventories of ghut forests in the USVI. Thomas and Devine (2005) provide descriptions of the various distinct types and structures of gallery plant communities, which are based mainly on the different ghut locations, microclimates, and moisture availability. The Gallery Moist Forest is said to occur in the moister northern areas of the islands. This gallery forest type has been highly impacted by land clearing associated with development. Ghuts containing good examples of this forest type are Caledonia Gut, Solomon⁹ or Bonne Resolution Gut, and Reef Bay Gut (Thomas and Devine,

⁸ The high reading in the Bonne Resolution Gut is said to have been due to input of sewage effluent from a residence.

⁹ Solomon Gut appears to be a third name for the Bonne Resolution Gut.

2005). Gallery Dry Forest, Woodland, and Shrubland types can be found in ghuts in drier areas. The gallery vegetation that lines ghuts in drier areas may be larger and lusher than the surrounding vegetation because of more available moisture. However, in very dry areas, plants in ghuts may be undetectable from neighboring vegetation. In all areas, plant community structure and composition are naturally affected by available moisture, slope aspect, soil type/depth, and terrain.

While there is little information on the forest structure in the “ghuts of interest” (Section 5), the diversity of forest structure is said to increase the habitat value, as roosting/nesting and foraging opportunities increase with structural diversity.

4.2 Influence of Land-use Practices on Ghuts

The development activities of humans always produce impacts on the natural environment, directly or indirectly. In the U.S. Virgin Islands (USVI), the impacts of development activities on ghuts and associated resources include the following:

- Cutting of vegetation adjacent to, and within, ghuts;
- Increased volume and velocity of surface runoff;



- Increased sediment in surface runoff;
- Changing the alignment of natural drainage channels;
- Filling drainage channels;
- Impoundment of ghuts;
- Dumping of solid waste (construction debris, garbage, household appliances and furniture, used tyres);

- Disposal of liquid pollutants (primarily sewage effluent from residents and treatment plants¹⁰); and
- Channelization of ghuts for storm-water management purposes.



The above practices result by the following factors:

- (a) **Ignorance/Indifference** – Land management practices that remove vegetation too close to the edges of ghuts, clear-cut areas, disturb topsoil without adequate erosion control measures, and other similar practices create a range of impacts. These include loss of habitat, increased rates and volumes of surface run-off, and increased sediment loading in surface runoff. Sometimes the person engaged in the practice is simply not aware of the implications of the activities. All too often, the person or business entity does not care, and attempts by neighbours, environmentalists, and even regulatory agencies to effect an improvement in the practice may yield little positive response. This latter attitude is independent of the size of the development, and is displayed by individuals with small residential properties and corporations undertaking multi-million dollar developments on land parcels of hundreds of acres in size. The disposal of waste into ghuts is another example where indifference contributes to a significant degree to negative practices.
- (b) **Impact of Scale** – The small size of the islands means that land is a limiting factor in the development process. As such, the use of land is maximized, especially development activities on small lots. Given the topography of the islands, ghuts traverse most lots, and in an effort to fully utilize the land, ghuts are often re-aligned or filled.

¹⁰ The deliberate disposal of sewage effluent to ghuts is not widespread. Disposal from municipal treatment plants take place from the Bordeaux and Brassview treatments on St. Thomas. However, there are infrequent inputs when there are breaks in the transmission lines.



- (c) **Greed** – The desire to maximize profits sometimes lead to development practices that result in significant damage to both the natural and built environments. This is particularly associated with flood damage to private property and public infrastructure. Anecdotal information received during this project indicates that there have been cases where lawsuits resulted from such damage. There is no information to determine the extent of the problem, or the cost to settle such legal battles.
- (d) **Lack of Appropriate Options** – Public sector projects in housing and infrastructure have resulted in past incidences of change in drainage patterns, creating damage to infrastructure and private property. Cases such as the Mon Bijou housing project show that inappropriate land use can have significant and costly impacts on ghuts, and conversely on the development of communities.
- (e) **Need for Storm-water Management** – The topography of the islands require that the use and development of land take into consideration the management of surface runoff. The channelization of ghuts to form storm drains (in both public and private projects) reduces the ability of catadromous (freshwater faunal species) to return to the ghat pools. This focus on storm-water management also results in the practice where drainage channels are routinely realigned and ghuts are cleared of vegetation. This matter of the impact of storm-water management on ghuts is an issue that requires more attention.



A comparison of land uses in four watersheds on St. Thomas showed an increase in the density of residential units from 1989 to 1999 (Gardner, 2008). Given the continued construction of residential and commercial projects, it is assumed that not only has the increase in residential density continued, but land use changes have also taken place. Data produced by the Virgin Islands Bureau of Economic Research show that the value of construction permits issued during the period 2000-2007 totaled approximately \$2.3 billion (<http://www.usviber.org/publications.html>). Some of those projects are located in close proximity to ghuts, and many involved re-zoning of land use classes.

Concern about the impact of development on drainage patterns led the project team to commission a comparative analysis of drainage in a watershed for two different time periods. The analysis was conducted by the Conservation Data Center (University of the Virgin Islands), using the Benner Bay/Jersey Watershed as the test area (Appendix 4).

The researchers caution that the results of the analysis should not be extrapolated to other watersheds, but concluded that *“The results of this limited study reveal that during the period major development occurred in areas impacting the Turpentine Run Ghut there was an increase in the average stream flow rate for that ghut”*.

4.3 Initiatives Relevant to Ghuts

Though there are only three Departments of the Government of the U.S. Virgin Islands with regulatory responsibility for ghut management, there are several public and civil society institutions with current or planned initiatives of relevance to ghuts, including:

- Department of Planning and Natural Resources;
- Department of Agriculture;
- Department of Public Works;
- U.S. Department of Agriculture;
- Economic Development Authority;
- University of the Virgin Islands;
- Virgin Islands Resource Conservation and Development Council, Inc;
- Environmental Association of St. Thomas;
- Coral Bay Community Council, Inc.; and
- Virgin Islands National Park.

(a) Department of Planning and Natural Resources (DPNR)

The Water Pollution Control Program managed by the Division of Environmental Protection is the main program within DPNR that is of relevance to ghuts. The elements of the Water Pollution Control Program are:

- Ambient Monitoring Program;
- Territorial Pollutant Discharge Elimination System;

- Virgin Islands Beach Monitoring Program; and
- Storm Water Discharge Pollution Prevention.

The four programs listed above focus on coastal water quality, and there is no monitoring of freshwater systems. The 319 Grant Program (Section 319 of the Clean Water Act) funds community projects dealing with non-point source pollution. Two (2) projects in 2003 and 2005 focused on ghuts. There were:

- Bethlehem Old Works Emergency Spillway protection Project.
- Estate Bethlehem Watershed Water Quality Demonstration Project – The project focused on a 19-acre farm that was flooded regularly by storm water runoff from adjacent urban development. The project involved the construction of a storm water retention pond on the main tributary to Adventure Gut, construction of stream-bed crossing for livestock, and construction of fencing to prevent livestock from entering the ghut.

A Wetlands Program was created by the Division of Environmental Protection in 2002, and the first activity was an inventory of wetlands and riparian areas (2002-2004). A second phase of the project is supposed to commence in 2008, and this second phase is supposed to include the development of an assessment and monitoring program. The Conservation Data Center (UVI) and the Island Resources Foundation implemented the first phase of the project, and both institutions will collaborate with the Division in Phase 2.

The management of the Earth Change Permitting System by the Division of Environmental Protection has increased the focus on storm-water management associated with construction projects. The Division is currently in discussion with the Federal Emergency Management Agency to undertake a project concerning the determination of the capacity of ghuts to manage run-off during storm events¹¹.

The Division of Archeology and Historic Preservation (within DPNR) has identified a number of ghuts with historic resources, and plans to use these resources for educational purposes. The main ghuts that have been identified for use in supporting walking tours are Savan Gut (Linear Park Project) and the portion of Major Gut from Kongens Gade to Norre Gade¹² (both in Charlotte Amalie, St. Thomas). In addition to the intention to restore historic sites located adjacent to ghuts, the Division has also supported researchers in conducting an inventory of historic bridges in the USVI (Rosenkvist, 2007).

(b) Department of Agriculture

The Virgin Islands Department of Agriculture (VIDA) administers a Forest Stewardship Program, through which land use plans are prepared for property owners with more than three (3) acres. These plans focus on the protection or restoration of ghuts and riparian

¹¹ This information was shared by the Division of Environmental Protection during the second public meeting for the project, held on March 27, 2008.

¹² Information received during interviews with staff members of the Division.

vegetation. The VIDA is in the process of determining the feasibility of rehabilitating the impoundments constructed for watering livestock.

(c) Department of Public Works

The Department of Public Works (DPW) operates a ghut cleaning program. This focuses mainly on removing vegetation and debris from ghuts prior to the start of the hurricane season. Removal of solid waste from ghuts is restricted to the lower, paved portions of ghuts in the urban areas.

The Department also implements flood mitigation works. The next major flood mitigation project is to channel the runoff from the ghut draining into Bolongo Bay (Darryl Smalls, personal communication). The intent is to change the ghut profile to channel the runoff into the salt pond.

(d) U.S. Department of Agriculture

The programs of the U.S. Department of Agriculture (USDA) that are relevant to ghuts are operated through the Natural Resources Conservation Service. The farm support program of the Service includes the preparation of Conservation Plans for farms. A Farm Conservation Plan would include a focus on ghuts if there is one present on the farm.

A more specific focus on ghuts is provided through the Resource Conservation & Development Program. The program provides administrative and technical assistance to the Virgin Islands Resource Conservation and Development Council. The Estate Adventure Trail project is one ghut-related project supported by the Program. Other ghut projects proposed under the program include:

- Ghut restoration at Estate Southgate – the drainage pattern changed, and the runoff is undercutting the road.
- Ghut restoration at Catherine's Rest – runoff from the ghut is eroding the driveway of a neighbouring property.

(e) Economic Development Authority

The program of the Economic Development Authority (EDA) that is relevant to ghuts is the Enterprise Zone Initiative. The EDA intends to work with the V.I. State Historic Preservation Office to implement the Savan Gut Linear Park project.

(f) University of the Virgin Islands

The University of the Virgin Islands (UVI) has three units that manage programs concerned with ghuts; Water Resources Research Institute (WRRI), Cooperative Extension Service (CES), and Conservation Data Center (CDC).

WRRI supports research and training in water resources matters in the USVI and the rest of the Caribbean. Funds provided to WRRI by the U.S. Geological Survey support research in water-related matters, including ghuts. This project is an example of ghut-specific research funded by the WRRI, and the results include reports produced by Nemeth and Platenberg (2007) and Gardner (2008). The wider mission of WRRI, which can support a range of activities relevant to ghuts, include:

- To conduct research on water resources and related areas;
- To assist in the training of students and water resources professionals;
- To provide information exchange in the area of water resources, not only locally and regionally, but also on a national and international level.

CES provides extension services in several areas of community development, primarily family & consumer science, agriculture, and natural resources management. As part of its natural resources and water quality programs, CES advocates for the management of ghuts. CES has conducted training sessions, workshops, demonstration projects, field trips, and produced supporting educational displays, posters, environmental protection handbooks, factsheets and other promotional materials related to ghuts in the USVI. CES will also participate in the second phase of the USVI Wetlands Inventory Project.

The CDC supports research in all areas of development in the USVI, including water resources. The CDC participated in the first phase of the USVI Wetland Inventory Project, and will take the lead role in the second phase. The CDC also supports the various research projects undertaken as part of the WRRI grant program.

As partners, CDC and CES were awarded funding from the VI Department of Agriculture Urban and Community Forestry program to produce a wetlands and watersheds handbook for resource managers that will focus on the islands' drainage systems (2008-9). CDC and CES recently (2006-2008) collaborated on a research project funded by the Virgin Islands Experimental Program to Stimulate Competitive Research (VI-EPSCoR). This pilot study investigated the impacts of land-based activities on off-shore coastal resources. With specific relevance to ghuts, the project formulated quantitative methods for evaluating the integrity of ghuts through the use of GIS technology.

(g) Virgin Islands Resource Conservation and Development Council, Inc

The Virgin Islands Resource Conservation and Development (VIRC&D) Council, Inc. is a non-profit, 501(c)(3) organization that was incorporated in June 1990. The VIRC&D Council is a membership-based institution, with membership by public and civil society

institutions and individuals (<http://usvircd.org/vircd.who.html>). Administrative and technical support to the Council is provided by the Natural Resources Conservation Service of the U.S. Department of Agriculture.

The VIRC&D Council implements projects throughout the USVI, including projects dealing with ghuts. An example is the Estate Adventure Nature Trail on St. Croix, a 3/4 mile hiking trail located at Estate Adventure, opposite the main offices of the V.I. Department of Agriculture. The trail runs along a portion of the ghut that runs from the Big Fountain and River Watersheds to the sea.

(h) Environmental Association of St. Thomas

The Environmental Association of St. Thomas (EAST) is a non-profit, environmental, membership-based organization that functions primarily as an advocacy institution. EAST hikes in ghuts on St. John and St. Thomas, and in response to the interest generated during this project, has expressed an interest in participating in a ghut management initiative in the deJongh Gut.

(i) Coral Bay Community Council, Inc.

The Coral Bay Community Council is a non-profit organization whose mission is “... *to provide an effective means for residents of Coral Bay to participate in planning the future of Coral Bay development, by providing education and information on planning processes, and a forum for government, citizens, and developers to discuss plans. The agenda focuses on: land and water use planning, infrastructure, development and environmental issues*” (www.coralbaycommunitycouncil.org). The Council recently received a \$300,000.00 grant from the U.S. Environmental Protection Agency to support implementation of the Coral Bay Watershed Management Plan during Fiscal Years 2009 and 2010. The project will employ a storm-water engineering expert to address issues such as pollution in ghuts, excess storm-water flows, filling and altering of ghuts, and similar issues (Sharon Coldren, personal communication).

(j) Virgin Islands National Park

The Virgin Islands National park (VINP) covers more than 7,000 acres of land and 5,600 acres of submerged lands. In addition to the tours conducted along ghuts, the resource management program addresses issues of concern to ghut resources, such as pollution. The VINP collaborates with local and national institutions on research projects within the park.

Inter-Agency Arrangements

Though there are several institutions with programs relevant to ghuts, and though some collaborate on specific initiatives, there is no mechanism, formal or informal, for institutions to cooperate on ghut initiatives. This is one of the issues that have to be addressed if ghuts and associated resources are to be protected.

5. MAJOR ISSUES RELEVANT TO GHUTS IN THE U.S. VIRGIN ISLANDS

The foregoing sections of this report have discussed the policy, legislative, and management frameworks relevant to ghuts in the U.S. Virgin Islands (USVI). The current status of ghuts and associated resources, and the factors acting on them, have also been discussed. This Section identifies the major issues relevant to ghuts, and recommends a number of actions to address concerns or improve management options. The major issues include:

(a) Inadequate Policy Framework

The current policy framework offers some level of protection to ghuts through its policy and legislative provisions to prevent pollution and maintain the integrity of wildlife habitats. However, that policy guidance has not been translated into a cohesive policy framework specific to ghuts. The various agencies with regulatory responsibilities have developed more detailed policy positions on issues of general relevance to ghuts, but have not developed any intervention specific to ghuts. For example, the water pollution control program of the Division of Environmental Protection focuses on coastal water quality. The watershed program of the same Division is constructed within the context of non-point source pollution reduction. Nowhere in the watershed program is there any emphasis on water resources management, wildlife management, or forest resources management. Similarly, the wildlife conservation strategy for the USVI, developed by the Division of Fish and Wildlife, has no focus on ghuts, neither as a type of wetland nor as a unique habitat containing rare wildlife species.

This issue of the inadequacy of the policy framework also results in lack of clarity regarding institutional jurisdiction, and thus responsibility for programming. The public becomes aware of this problem when infractions occur but necessary enforcement actions are not taken. Inadequate enforcement encourages wrongdoing, and allows small infractions to escalate into major impacts when not corrected, which leads to further degradation of ghut resources.

Participants in the second public meeting (March 27, 2008), in which the findings of this report and the draft ghut management strategy were discussed, were asked to recommend an appropriate policy framework for management of ghuts. The general agreement was that ghut management should be placed within the general context of watershed management, even though the current watershed management policy and programming was not broad enough to encompass all the issues relevant to ghuts (e.g. research, resource harvesting, recreation, wildlife management).

The ghut management strategy for the USVI must address the issue of the formulation of an appropriate policy framework for ghut management.

(b) Existence of Significant Threats

Ghuts and associated resources are subjected to a number of impacts from the various forms of development, in both the construction and operational phases of these development activities. The threats include:

- (i) **Changed Drainage Patterns** – The construction of residences, commercial buildings, and public buildings (e.g. churches) result in changes in the drainage patterns, starting from high up in the watersheds. Such constantly-changing drainage patterns create problems for storm-water management by public agencies, result in flooding of private property and roadways, and damage to infrastructure. At a more significant level, it puts into question the validity of the drainage maps currently used to assess storm-water management designs in the development control process.
- (ii) **Sedimentation of Waterways** – The 1998 Unified Watersheds Assessment Report (Department of Planning and Natural Resources, 1998) states that sediment is the primary non-



point source pollutant causing impairment of the waters of the USVI.

- (iii) **Disposal of Construction Waste** – Debris and other wastes (e.g. concrete) from construction sites are occasionally dumped into ghuts. In the case of soil, that results in major sedimentation problems in the ghuts and nearshore marine environment.
- (iv) **Solid Waste Disposal** – Solid

waste deposited into ghuts include household garbage and furniture, tyres, and accidental spillage from the solid waste collection skips. This results in a reduction in amenity value of areas, blocked drains, and health concerns.

- (v) **Agricultural Waste** – Runoff from agricultural lands include sediments and organic waste. The pollutants not only pollute the ghuts, but are also transported to the coastal areas.
- (vi) **Sewage Disposal** – Sewage is deposited directly into ghuts from two municipal sewage treatment plants on St. Thomas, from broken sewer lines, and from commercial and residential properties.



- (vii) **Bacterial and Nutrient Contamination** – In addition to the agricultural waste and direct sewage inputs, bacterial and nutrient contamination of ghuts result from the large number of septic systems used in residential sewage treatment. The 1998 Unified Watersheds Assessment Report (Department of Planning and Natural Resources, 1998) identifies bacterial contamination as one of the two primary non-point source pollutants causing impairment of the waters of the USVI.
- (viii) **Removal of Ghut Vegetation** – Removal of vegetation from the banks and within ghuts increases the threat of erosion, decreases stream slope stability, and can result in collapse of roads. One of the results of threats to ghuts is the loss of rare and endangered species. Rare plant species are often found in ghuts, and some of those locations have been subjected to development pressures. Neither the frequency of occurrence of such rare species nor the extent of damage from development activities is known, so the significance of the problem has not been determined. However, any loss of rare species is deemed a significant loss from a biodiversity perspective.

In addition to the threats emanating from individual activities, the clustering of commercial activities and the constant re-zoning of land use create development zones for which there is no associated infrastructure to provide the required social services, especially those required for waste management. For example, the clustering of two construction companies, a laundromat, and other commercial operations in the area of Susannaberg and Adrian (St. John) has created a defacto industrial zone at the top of the Fish Bay Watershed. In the absence of adequate infrastructure and environmental management interventions to deal with the associated landuse and waste, there is concern that the operations will result in significant adverse impact on Battery Gut and Fish Bay Gut.

These threats are not new. Threats to water sources by development activity were identified during the 1960s, and protection of groundwater recharge areas and ghuts were recommended at that time (Office of the Lieutenant Governor, 1970).

(c) Ghuts and Stormwater Management

The Project Plan for the 1973 Resource Conservation and Development Project (Virgin Islands Department of Agriculture, 1973) noted that land development and construction were creating significant changes in hydrology, manifesting in larger quantities and faster discharge rates for storm water. In addition to the increased flood potential caused by these changes, the filling in of ghuts and the encroachment on ghuts by buildings increases the hazard from flooding. Ghuts with high levels of infringement from development activity (identified by the report) included Bethlehem Gut, Salt River, and Water Gut (St. Croix) and Lindberg Gut and Turpentine Run (St. Thomas). The report noted that more than 275 earthen dams had been constructed across ghuts in the USVI for the purpose of impounding surface runoff from storms.

The problem has only gotten worse since 1973. A computer simulation carried out by the Conservation Data Center during this project showed that several homes were well within the 30ft. buffer zone (set in law) along the Bonne Resolution Gut. It is common in the U.S. Virgin Islands to observe well-defined ghuts running through small developments (such as the Mongoose Junction shopping mall on St. John). In fact, some buildings are actually



paced within ghuts. Major drainage problems, such as occurred at Mon Bijou (St. Croix) and currently occurring at Bolongo Bay (St. Thomas), result in significant property damage, law suits, and very high costs of mitigation.

There are elements of the drainage problem that are less obvious, but no less problematic. As construction of residential units (whether single family or multi-family) increases, the practice is to change the drainage on both small and large lots. In fact, storm-water permits are not required for residential developments under one (1) acre (Consultations, January 15, 2008). This changing drainage pattern creates problems for homes, commercial developments, and infrastructure lower in the watershed. On a large enough scale, this practice (and resulting problems) brings into question the utility of the Water Resources Map, which was prepared in 1978, and which is still used to evaluate storm-water management plans included in applications for Earth Change Permits.

The Territorial Pollutant Discharge Elimination System Rules and Regulations (2007) contain a sub-section (184-45) that deals specifically with storm water discharge from a range of development activities. However, this does not adequately address the issue of large discharge volumes and rates, impact on gut resources, and impact on infrastructure and developments lower in the watershed. It certainly does not address the issue of the constantly-changing drainage patterns in the upper portions of the watersheds.

(d) Gaps in Knowledge

There are significant information gaps concerning ghuts in the USVI, and such gaps encompass ecological elements for which no data exist, the current status of all ghuts and associated resources, and even what information is based on perception rather than facts. Information gaps identified during this project include:

- (i) **Ghuts and Associated Wildlife** – As shown by Section 4.1, there is very little information on ghuts and associated wildlife species, particularly rare and endangered floral and faunal species. This paucity of data has resulted in the USVI Wildlife Conservation Strategy (Division of Fish and Wildlife, 2005)

not including ghuts as a specific habitat requiring management intervention. It was suggested that this inadequate focus on ghuts as wildlife habitats is influenced by a general lack of understanding of freshwater habitats (William Coles, consultation, January 17, 2008). Platenberg (2006) proposed the inclusion of ghuts as a specific wetland type requiring management intervention, but that recommendation has not yet been translated into public policy or institutional programs.

- (ii) **Recreational Use Patterns** – It is known that recreational use of ghuts is promoted by individuals, institutions, community groups, and tour groups. However, there is very little information on seasonality, frequency, type of activity, size of groups, age of users, and other such data needed to establish patterns of use. Even groups that routinely use ghuts for recreational purposes, such as the St. Croix Hiking Association and the Environmental Association of St. Thomas, do not maintain records of use. The only data available is provided by the Virgin Islands National Park, which maintains records of the number of persons participating in trail hikes¹³. Data for Fiscal Year 2006/2007 shows 3,573 persons participating in the Reef Bay Trail hike.
- (iii) **Location and Status of Historical and Cultural Resources** – There are records that state the location of some historical resources within ghuts (Section 3.4). The current status of those resources is less clear. An examination of the condition of historic structures at 43 national parks in the U.S. system by the Center for State of the Parks found examples of deteriorating historic structures (National Parks Conservation Association, 2008). One would expect that historical resources not under the active management of any institution will suffer the same fate.
- (iv) **Ghut Water Quality** – Current data on ghut water quality is sparse, and cannot be used to support decision making for management interventions or development of future uses. A ghut water quality monitoring program should be established by the relevant agency, and programs dealing with watershed management, pollution control, or recreation should be linked to the revised water quality standards for Class A Waters (wildlife) and recreational waters.
- (v) **Programs and Initiatives** – There is currently no mechanism for information sharing on programs and initiatives relevant to ghuts. Even during the consultation process for this project, persons would mention initiatives but not share information on those initiatives. This includes projects of U.S. Government agencies dealing with flood assessment and freshwater species assessment.

¹³ The Virgin Islands National Park does not have access to data on hikes taken by private groups or individuals.

(e) Information Management

It is clear that ghuts played an important role in the development of the U.S. Virgin Islands, and continue to provide a range of goods and services. It is equally clear that there are threats to ghuts and associated resources. Reduction of threats and optimization of the beneficial contributions from ghuts require that the institutions (public, private, and civil society) that are responsible for the development processes are able to make informed decisions concerning ghuts. Yet it obvious from the above discussion that there are gaps in both the knowledge base and the development planning and environmental management programs.

In order to improve protection of ghuts and associated resources, it is here recommended that the regulatory agencies compile a list of the “Ghuts of Interest”. Ghuts so identified would become priority areas for research, and more rigorous and focused management interventions.

The following criteria are recommended as a starting point in the selection of ghuts to be added to the list of Ghuts of Interest:

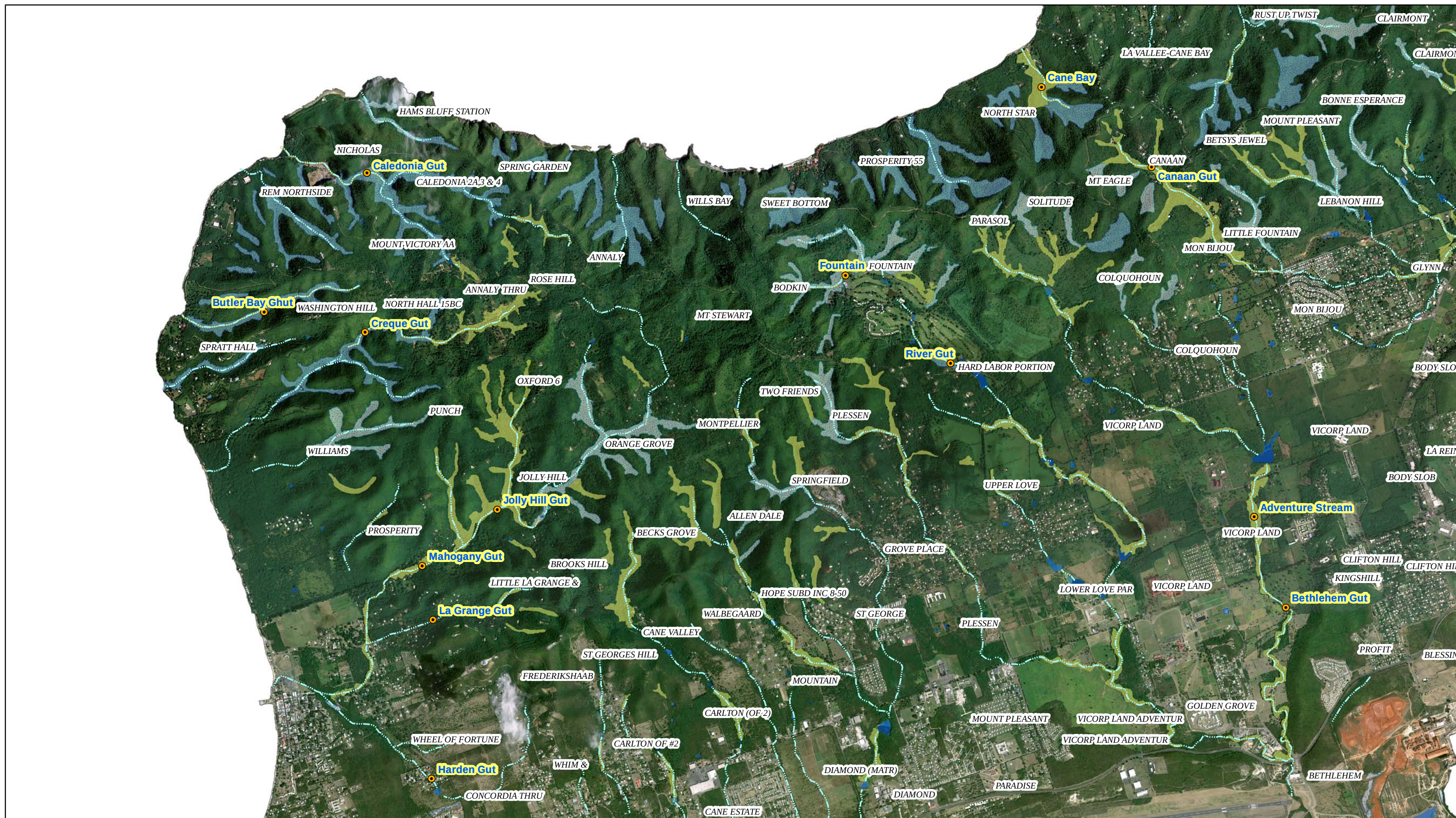
- Ghuts with permanent pools;
- Ghuts currently used for recreational purposes;
- Ghuts supporting other community uses;
- Ghuts containing critical habitats;
- Ghuts supporting endangered species of plants or animals;
- Ghuts containing significant historic, archeological, or cultural resources;
- Ghuts that are the primary drainage channels for stormwater; and
- Ghuts facing significant threats (e.g. waste disposal).

Using the above criteria and the information on ghuts reviewed during this project, a potential list of Ghuts of Interest has been compiled. This includes 13 ghuts on St. Croix, 5 on St. John, and 10 on St. Thomas (Table 3 and Figures 4-6)¹⁴.

¹⁴ Figures 4-6, showing the Ghuts of Interest on the three islands, are very large digital files, and are therefore not included in the digital version of this report. They can be viewed at <http://cdc.uvi.edu/ghutsproject.htm>.

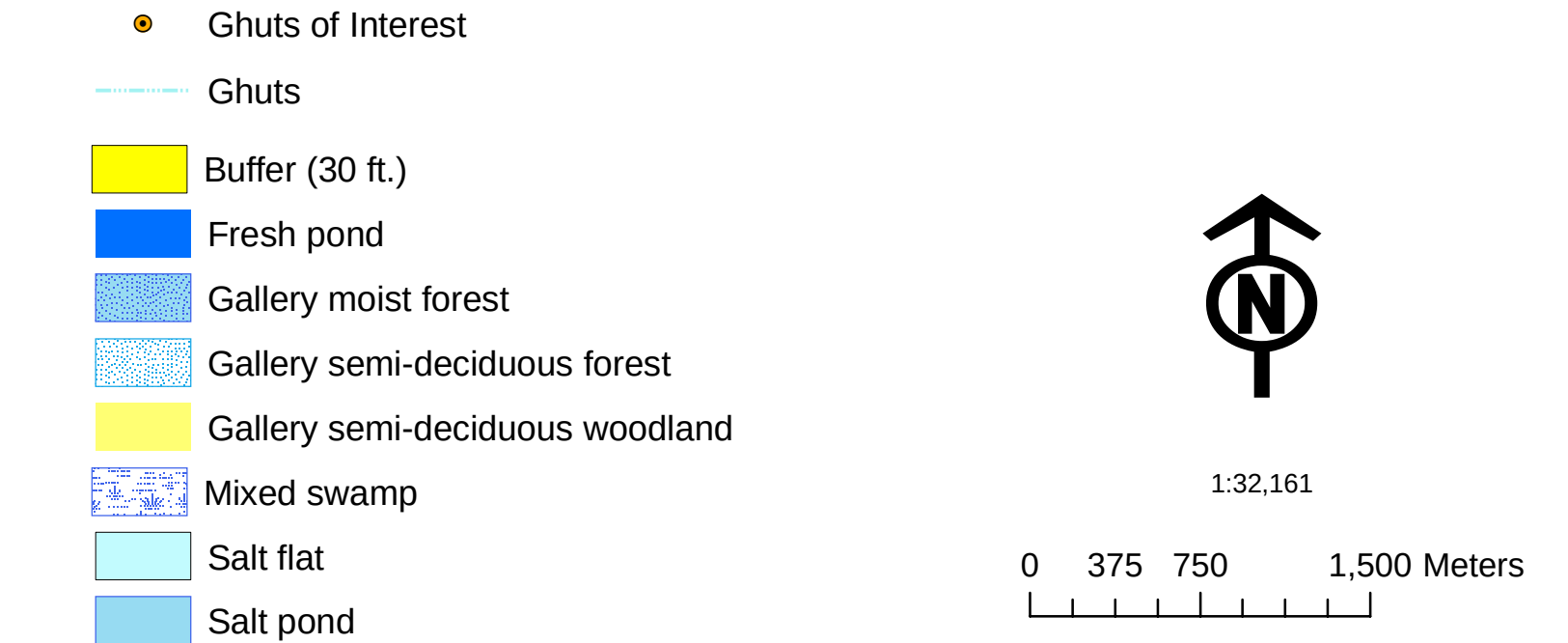
Table 3: Ghuts of Interest

St. Croix	St. John	St. Thomas
Adventure Stream	Battery Gut	Bonne Resolution (Dorothea) Gut
Bethlehem Gut	Fish Bay Gut	Caret Bay/Sorgenfri ghut
Butler Bay ghut	Guinea Gut	Contant Gut
Caledonia Gut	Johnny Horn ghut	deJongh Gut
Canaan ghut	Living (Reef Bay) Gut	Magens bay Gut
Cane Bay ghut		Nadir Gut
Creque Gut		Neltjeberg Gut
Fountain ghut		Santa Maria Gut
Harden Gut		Savan Gut
Jolly Hill Gut		Turpentine Run
La Grange Gut		
Mahogany Gut		
River Gut		
<u>Sources:</u> Table 1, Table 2, Appendix 3.		



Legend

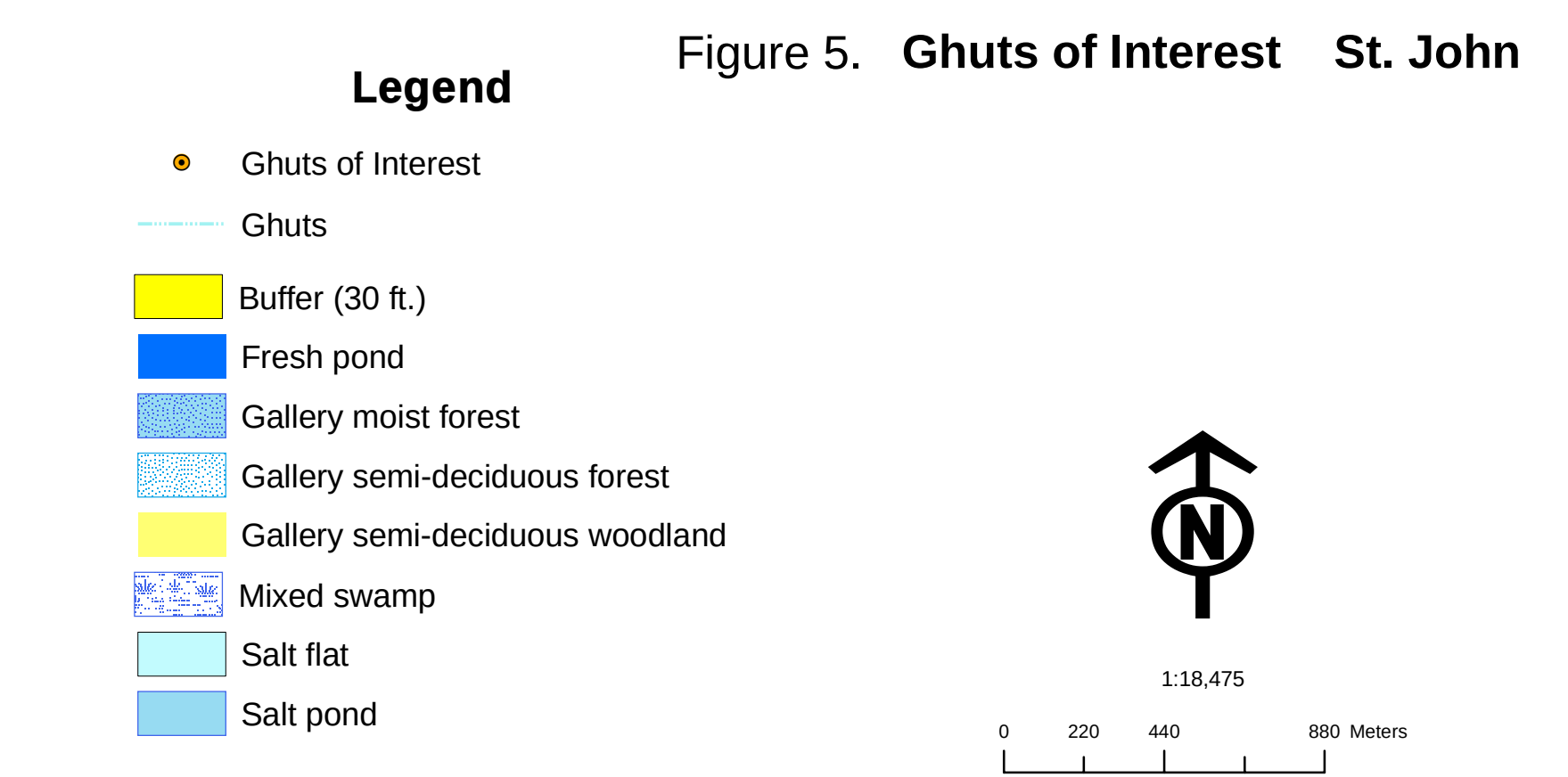
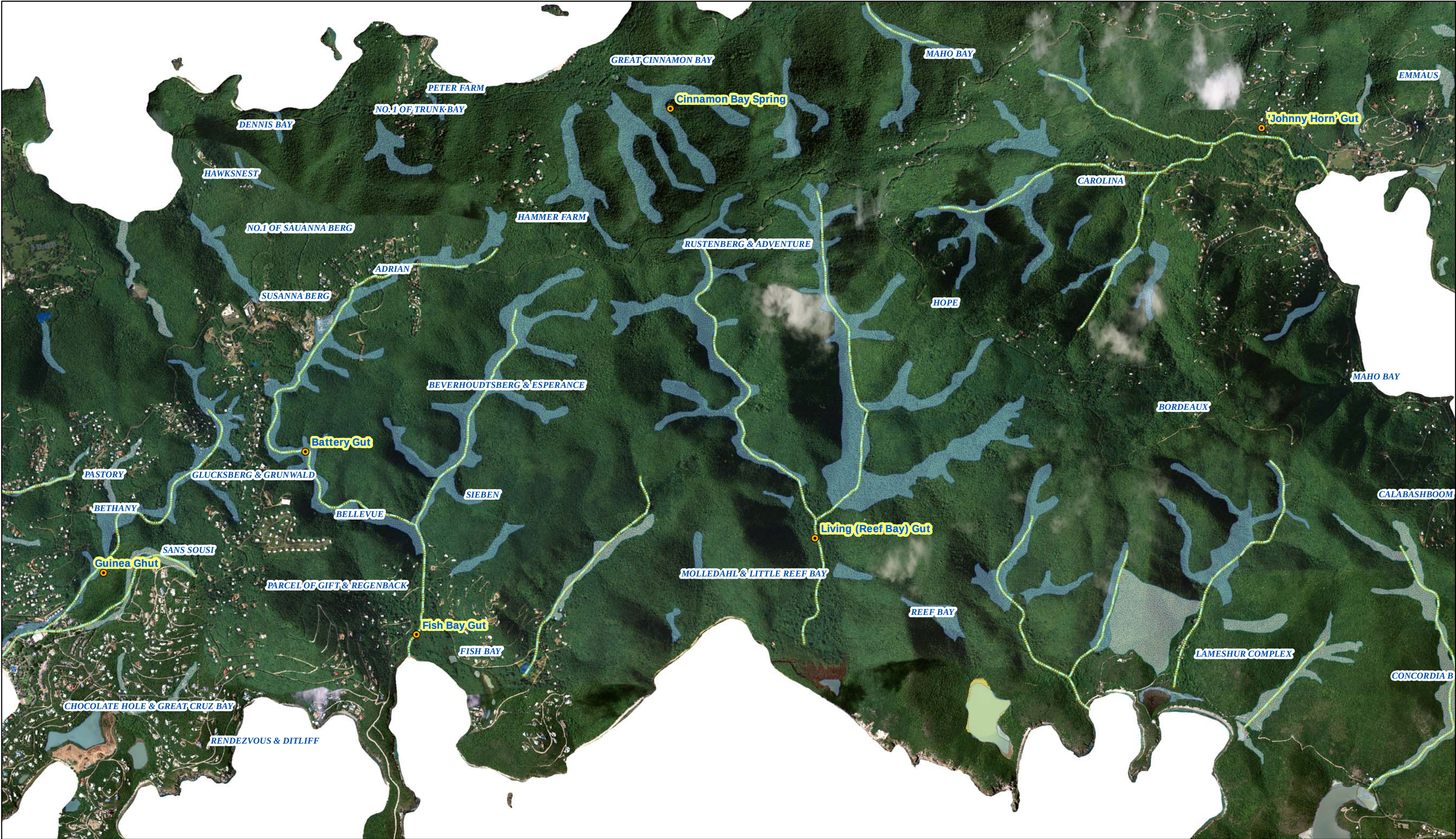
Figure 4. **Ghuts of Interest St. Croix**



	Pools	Recreational Purpose	Community Uses	Critical habitats	Significant flora/ fauna	Cultural Resources	Threats
Adventure Stream	☐	☒	☒	☐	☐	☐	☐
Bethlehem Gut	☒	☒	☒	☒	☒	☒	☐
Butler Bay Ghut	☐	☒	☒	☐	☐	☐	☐
Caledonia Gut	☒	☒	☒	☐	☒	☒	☐
Canaan Ghut	☐	☒	☒	☐	☐	☐	☐
Cane Bay	☒	☐	☐	☒	☒	☐	☐
Creque Gut	☒	☒	☒	☒	☒	☒	☐
Fountain	☐	☒	☒	☐	☐	☐	☐
Harden Gut	☐	☐	☐	☐	☒	☒	☐
Jolly Hill Gut	☐	☐	☒	☐	☐	☐	☐
La Grange Gut	☒	☐	☐	☒	☒	☐	☐
Mahogany Gut	☒	☐	☒	☒	☒	☐	☐
River Gut	☒	☐	☒	☐	☐	☐	☐

Source:
University of the Virgin Islands. Rapid Ecological Assessment, 2000.

U.S. Army Corp. Puerto Rico and the US Virgin Islands
DIGITAL ORTHOPHOTO PROJECT, 2007.

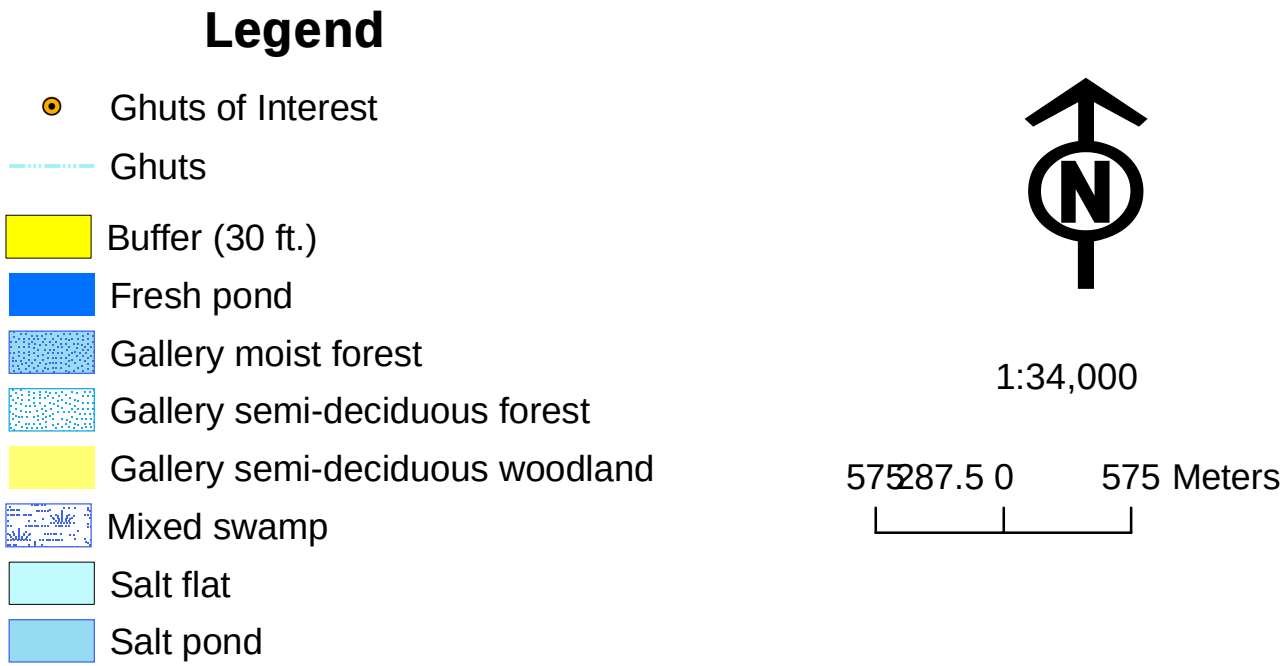


	Pools	Recreational Purpose	Community Uses	Critical habitats	Significant flora/ fauna	Cultural Resources	Threats
Battery Gut	☒	☒	☐	☒	☒	☐	☒
Fish Bay Gut	☒	☒	☐	☐	☐	☐	☒
Guinea Gut	☒	☒	☐	☒	☒	☐	☒
Johnny Horn ghut	☐	☒	☐	☐	☐	☐	☐
Living Reef Bay Gut	☒	☒	☐	☐	☒	☒	☐

Source:
University of the Virgin Islands. Rapid Ecological Assessment, 2000.

U.S. Army Corp. Puerto Rico and the US Virgin Islands
DIGITAL ORTHOPHOTO PROJECT, 2007.

Figure 6. Ghuts of Interest St. Thomas



6. FUTURE DEMAND FOR GHUT SERVICES

The discussion below on future demand for goods and services provided by ghuts in the U.S. Virgin Islands is based primarily on the inputs from the participants in the two public meetings, and as such, it is not a definitive statement of future demand. Goods and services provided by ghuts for which there is future demand include the following:

(a) Water

Water in ghuts will be required by wildlife to support both life-cycle requirements and general habitat requirements.

Ghuts are also tapped by farmers for water for irrigation of crops and for watering livestock. The projects by the University of the Virgin Islands to support farmers in St. Thomas, and the recent initiative by the Department of Agriculture concerning impoundments, suggest renewed focus on the potential of ghuts to provide water for agricultural purposes.

The rapid movement of surface runoff from the hills to the coastal areas has been noted elsewhere in this report. This decreases the recharge of the aquifers. The 2004 State of the Environment Report for the USVI (Division of Environmental Protection, 2004) states that groundwater “... *accounts for 30% of the public/private water supply and has provided up to 100% of the public’s potable water supply after major disasters such as Hurricane Hugo ...*” (page 38). However, the 1998 Unified Watershed Assessment Report (Department of Planning and Natural Resources, 1998) noted the continued depletion of the groundwater sources, citing the Smith Bay area as an area that had showed a significant drop in groundwater level since 1990. Given the fact that a number of large development projects have been approved across the USVI (notably in Smith Bay), continued depletion of groundwater sources can be anticipated.

Recharge of groundwater is one potential benefit of ghuts. As mentioned in Section 5, the Project Plan for the 1973 Resource Conservation and Development Project (Virgin Islands Department of Agriculture, 1973) noted that more than 275 earthen dams had been constructed across ghuts in the USVI for the purpose of impounding surface runoff from storms. Smith (1989) noted that, in addition to control of runoff during heavy rainfall, the earthen dams constructed by the Federal Government also formed a source of water for livestock and wildlife, and allowed for recharge of groundwater. Smith proposed the construction of impoundments specifically for groundwater recharge. However, care has to be exercised in the construction of impoundments in ghuts, as such impoundments can have deleterious effects on migrating aquatic fauna.

(b) Recreational Opportunities

Though the data on recreational use of ghuts is very sparse, it is clear that there is a significant level of use by individuals and groups. The establishment of new trails, such as the Estate Adventure Trail, may increase community recreational use of trails and ghuts. The

initiative to have St. Croix designated as a heritage district may also increase the use of ghuts for recreational activities.

(c) Educational Opportunities

The use of ghuts to support formal and non-formal education offerings appears to have increased in the past five years (Section 3.3). This demand could increase in the future due to (i) increased activities in environmental clubs in high schools on St. Thomas¹⁵, (ii) increased linkages between UVI and external universities to support research activities in the USVI, and (iii) the establishment by UVI of a Master of Science Degree in Environmental Sciences.

(d) Biodiversity Protection

The continued degradation of watersheds from human activities is expected to be exacerbated by the impacts of climate change resulting from global warming. Ghuts and associated forests will take on increased importance as wildlife habitats. There is growing concern about the vulnerability of species on small islands, and thus protection of ghuts and associated resources becomes more important from the wider perspective of biodiversity protection.

(e) Disaster Mitigation

It is generally accepted that the characteristics of some ecosystems mitigate natural hazards, such as flooding. Storm water management in the USVI has particular implications for ghuts, hence the initiative by the Division of Environmental Protection and the Federal Emergency Management Agency to assess the capacity of ghuts to manage run-off during storm events. This takes on increased importance when viewed within the context of increased development density in the watersheds and projected changes in the weather pattern as a result of global warming.

The value of ghuts to the USVI community is one topic discussed with residents and resource management staff during this project. There seems to be general agreement that, in addition to the current benefits, the contribution of ghuts to the development of the USVI can be increased, primarily in the areas of tourism (eco-tourism and heritage tourism), groundwater recharge, water for agriculture, and community gardens (agriculture and greening of the main towns).

¹⁵ Charlotte Amalie High School has a very active environmental club, and the environmental club at the Adelita Cancryn High School has developed an Environmental Ranger program.

7. RECOMMENDATIONS FOR DESIGN OF A GHUT MANAGEMENT PROGRAM

The preceding sections of this report clearly demonstrate that ghuts are valuable resources, providing a range of goods and services that support the development processes in the U.S. Virgin Islands (USVI), both historically and at the present time. It appears that there is general interest in, and future demand for, ghuts and associated resources. It is also clear that though there are laws and programs that are of relevance to the protection of ghuts, there is no policy or program that specifically targets ghuts and associated resources.

It is suggested that this deficiency can only be corrected through the development of a ghut management program.

7.1 Scope of the Proposed Management Program

Several factors determine the scope of the proposed ghut management program, including; (i) the existence of laws and programs of relevance to ghuts; (ii) the absence of any specific focus on ghuts; (iii) and the low probability of obtaining new resources for a completely new program.

Based on the above-stated factors, no new/separate program is proposed. Instead, ghut management initiatives should be integrated into existing programs. The ghut management program would set the overall policy and management framework for the specific initiatives to be designed and undertaken by the agencies with the relevant legal mandates and/or relevant regulatory responsibilities.

Though there are several agencies with programs relevant to ghuts, there is no established mechanism for information sharing and program linkages. As such, a ghut management program would require the development of new institutional arrangements. This would necessarily include civil society institutions, with potential roles ranging from program design to project management.

7.2 Areas of Focus for the Proposed Management Program

The ghut management program must focus on the conservation of ghuts and associated resources, facilitating sustainable use of those resources where appropriate. In pursuing this overall goal, the program should:

- (a) Address the Priority Issues – especially the development of an appropriate policy framework and the reduction of threats (Section 5).
- (b) Establish an appropriate institutional framework.
- (c) Identify and estimate the future demand for ghut resources, and develop a program for supporting community use while protecting the ecological integrity of those resources.

- (d) Increase public awareness of the benefits of ghuts and associated resources, as well as improve public support for ghut management.
- (e) Establish appropriate mechanisms to support information sharing and reporting to the various partners, stakeholders, and the USVI community.

The ghut management program proposed above is elaborated in the second output (report) from this project, and is titled: A Strategy for Management of Ghuts in the U.S. Virgin Islands.

Epilogue

“Today I nostalgically wonder how so much change could have taken place in so short a time; how the norms of a people and the soul of an island could have vanished so tracelessly and completely within the memory of one man. I also wonder about the great wheeling and fluting hordes of golden and black-bellied plover, for they too have vanished.” (Seaman, 1980, Ay-Ay, P. 113).

Will the current generation have similar thoughts tomorrow?

References

Department of Planning and Natural Resources and United States Department of Agriculture. 1998. *Unified Watershed Assessment Report: United States Virgin Islands*.

Devine, Barry, Stevie Henry, Dayle Barry, Pedro Nieves, and Christy Loomis. 2004. *The Virgin Islands Wetlands and Riparian Areas Inventory: A Pilot Study to Characterize Watersheds and Wetland Ecosystems - Phase I Final Report*. Conservation Data Center, University of the Virgin Islands. August 2004.

Division of Environmental Protection. 2004. *State of the Environment: United States Virgin Islands*. Department of Planning and Natural Resources.

Division of Fish and Wildlife. 2005. *A Comprehensive Wildlife Conservation Strategy for the U.S. Virgin Islands*. Department of Planning and Natural Resources, Government of the U.S. Virgin Islands.

Forman, Richard T. 1974. *An Introduction to the Ecosystems and Plants on St. Croix, U.S. Virgin Islands*. West Indies Laboratory, Fairleigh Dickenson University.

Gardner, Lloyd. 2008. *Changes in Riverine Hydrology on St. Thomas, U.S. Virgin Islands: A Pilot Study*. Water Resources Research Institute, University of the Virgin Islands.

Graham, Roy Eugene. 1994. *HABS/HAER Documentation: Historic Features, Savan Gut, St. Thomas, USVI*. AIA Associates and US Army Corps of Engineers.

Jordan, Donald G. 1975. *A Survey of the Water Resources of St. Croix, Virgin Islands*. United States Department of the Interior (Geological Survey).

Kelsey, Rense Heath. 2006. *Fecal Pollution Modeling, Source Identification, and Management in the Southeastern Coastal Zone*. University of South Carolina.

Kesler, Ben R. 1980. *Priceless Heritage: History and Lore of Estate St. George, Home of the St. George Village Botanical Garden of St. Croix, U.S. Virgin Islands*. Benjamin R. Kesler. St. Croix, U.S. Virgin Islands.

Lawaetz, Erik J. 1991. *St. Croix 500 Years: Pre-Columbus to 1990*. Paul Kristensen.

Lindsay, Kevel and Jean-Pierre Bacle. 2004. *Confirming the Presence of Rare and Endangered Plant Species: Fish Bay – Battery Gut Watershed, St. John, US Virgin Islands*. June 2004. Internal Trip Report, Island Resources Foundation.

Lindsay, Kevel, Jean-Pierre Bacle, and Gary G. Kwiecinski. 2008. *A Survey of Bats of St. John, U.S. Virgin Islands*. Final Report, April 2008. Island Resources Foundation.

Loftus, William F. 2003. *Inventory of Fishes in Inland Fresh and Brackish-water Habitats of Virgin Islands National Park*. Final Project Report. USGS-Florida Integrated Science Center-Center for Water and Restoration Studies.

Moolenaar, Ruth M. 2005. *Legacies of Upstreet: The Transformation of a Virgin Islands Neighborhood*. We From Upstreet, Inc. St. Thomas, U.S. Virgin Islands.

Moolenaar, Ruth M. 1994.'Savanne', in *Savaneros*. Chaneel Callwoods-Daniels (Ed.). Division of Archeology and Historic Preservation. January 1994.

National Parks Conservation Association. 2008. *The State of Our National Parks: A Resource Index*.

Nemeth, Donna and Renata Platenberg. 2007. *Diversity of Freshwater Fish and Crustaceans of St. Thomas Watersheds and its Relationship to Water Quality as Affected by Residential and Commercial Development*. Water Resources Research Institute, University of the Virgin Islands.

Oldendorp, C.G.A. 1987. *A Caribbean Mission*. Edited by Johann Jakob Bossard. English Edition and Translation by Arnold R. Highfield and Vladimar Barca. Karoma Publishers, Inc.

Office of the Lieutenant Governor. 1970. *The U.S. Virgin Islands and the Sea*. Government of the Virgin Islands of the United States.

Paiewonsky, Michael. 2005. 'At the 'Head of Pave Street': Historical Notes on Kongens Quarter and the Early History of St. Thomas', in Moolenaar, Ruth M. 2005. *Legacies of Upstreet: The Transformation of a Virgin Islands Neighborhood*. We From Upstreet, Inc. St. Thomas, U.S. Virgin Islands.

Platenberg, Renata. 2006. *Wetland Conservation Plan for St. Thomas and St. John, U.S. Virgin Islands*. Draft, July 2006. Division of Fish and Wildlife, Department of Planning and Natural Resources.

Righter, Elizabeth (Ed.) 2002. *The Tutu Archeological Village Site: A Multidisciplinary Case Study in Human Adaptation*. Routledge.

Robinson, M. Tully et al. 1973. *Water Records of the U.S. Virgin Islands, 1962-69*. U.S. Geological Survey.

Rosenkvist, Arne. 2007. *Registration of Bridges on the Former Danish West Indian Islands: A Report on Old Roads and Bridges of the Virgin Islands*. Denmark.

Seaman, George A.: 1980. *Ay-Ay: An Island Almanac*. George A. Seaman. Saba, Netherlands Antilles.

Seaman, George A.: 1993. *Every Shadow is a Man: A Journey Back into Birds and Time*. George A. Seaman. St. Croix, U.S. Virgin Islands.

Smith, Alan D. 1989. 'Surface Water Resources in the Virgin Islands', in *Proceedings of the Virgin Islands Water Resources Conference*. Hari J. Krishna (Ed.). July 24-26, 1989. Water Resources Research Center, Caribbean Research Institute, University of the Virgin Islands.

Thomas, Toni and Barry Devine. 2005. *Island Peak to Coral Reef: A Field Guide to the Plant and Marine Communities of the Virgin Islands*. University of the Virgin Islands.

U.S. Geological Survey. 1950. *Geology and Ground-Water Resources of St. Croix, Virgin Islands*. Geological Survey Water Supply Paper 106. U.S. Government Printing office.

Virgin Islands Department of Agriculture. 1973. *U.S. Virgin Islands Resource Conservation and Development Project: Project Plan*. Government of the U.S. Virgin Islands and U.S. Department of Agriculture.

Wernicke, Werner. 1986. *Urban Pollution Survey: Christiansted and Charlotte Amalie, U.S. Virgin Islands*. Donald L. Hamlin Consulting Engineers, Inc., Government of the Virgin Islands.

Woods, Edith deJongh. 1994. 'Historic Savan', in *Savaneros*. Chaneel Callwoods-Daniels (Ed.). Division of Archeology and Historic Preservation. January 1994.

U.S. Virgin Islands Division of Fish and Wildlife photographs of field trips to ghuts: <http://www.vifishandwildlife.com/Education/Images/FieldTripPhotos.htm>

Glossary of Terms

Bush	A common term used in the USVI (and the Caribbean) to mean (a) shrub or clump of shrubs, (b) mixture of tall grass and saplings, or (c) any combination of grasses, shrubs, and young trees that is not maintained in a manicured fashion.
Catadromous	Adjective used to describe fish that swim down rivers to the sea to spawn. The juveniles then return to freshwater to complete the life cycle.
Ghut	Common term for watercourse. The USVI variation of the word ghut is usually “gut”.
Riparian	Adjective used in reference to rivers and streams. Example, riparian rights (right of owner of property that is adjacent to a stream to use water from that stream).
Watercourse	<i>“..., a natural watercourse means any stream with a reasonable well-defined channel, and includes streams which have a permanent flow, as well as those which result from the accumulation of water after rainfall and which regularly flow through channels formed by the force of the waters.”</i> <u>Source:</u> Title 12, Chapter 3, Section 123(b) of the Virgin Islands Code (Annotated, 2006 Edition).

Appendix 1: Biographical Sketch of Project Team

Lloyd Gardner (M.Sc.) is an environmental planner who has been involved in environmental management in Jamaica and the Caribbean for more than 26 years. Mr. Gardner's experience spans both the public and private sectors, starting with the Government of Jamaica in 1982. As a Director in the Natural Resources Conservation Authority (1988-1991), he was responsible for policy development and program planning in coastal zone management, national parks, and development control. Additionally, Mr. Gardner served on the Board of Directors and Advisory Committees of several planning agencies. Since joining the private sector as an environmental planning consultant in 1992, Mr. Gardner has provided consulting services to a wide range of regional and international private, intergovernmental, civil society, bilateral, and multilateral organizations. Mr. Gardner maintains active involvement in Jamaican, Caribbean, and international non-governmental organizations.

In addition to his career as a consultant with Environmental Support Services, LLC (<http://www.ess-caribbean.com>), Mr. Gardner collaborates on research projects with public institutions such as the University of the Virgin Islands.

Toni Thomas (B.A.) has been a Natural Resources Agent in the University of the Virgin Islands Cooperative Extension Service (UVI-CES) for 20 years. Through UVI-CES, Ms. Thomas serves as an environmental consultant to the general public, government personnel, teachers, students, construction-site managers, and resource managers such as the Magens Bay Authority, (which manages Magens Bay and Linquist Beaches). In 1983, she helped establish and maintain the diagnostic herbaria of Virgin Islands vegetation at UVI-CES based on the New York Botanical Garden and Smithsonian Institute collections. Ms. Thomas has written and illustrated several articles, posters and publications featuring Virgin Islands plants and natural habitats including "Guts, Virgin Islands Natural Treasures" and "Building Eco-Friendly Walkways and Trails in the Virgin Islands" (posters). She co-authored the book *Island Peak to Coral Reef: A Field Guide to the Plant and Marine Communities of the Virgin Islands* (2006) with Dr. Barry Devine, and co-researched the book *Remarkable Big Trees in the U.S. Virgin Islands* (2007) with Dr. Robert Nicholls. Ms. Thomas has conducted several vegetation surveys and environmental assessments on St Thomas, St. John, off-shore cays and the British Virgin Islands. She is currently part of a scientific team conducting a rapid ecological assessment and watershed and wetland studies of the U.S. Virgin Islands.

Stevie Henry (MCRP) has been the Data Manager of UVI's Eastern Caribbean Center/Conservation Data Center since 1997. He holds a Bachelor of Arts Degree in Social Science from UVI (1989) and a Master's Degree in Community and Regional Planning from the University of New Mexico (1992).

Mr. Henry has focused on the development of a Geographic Information System (GIS) for the U.S. Virgin Islands. He has been the project coordinator for several significant territorial mapping projects, including the 2000 mapping of the U.S. Virgin Islands Vegetation and

Marine Communities, the Virgin Islands 1989 and 1999 Land Use Inventory, and the 2002 Virgin Islands Zoning and Comprehensive Land and Water Use Plan.

He has been an authorized Environmental Systems Research Institute (ESRI) ArcView instructor since 1999.

In 2006, Mr. Henry was a charter member of the Virgin Islands Geospatial Information Council. The goal of this council is to coordinate all geospatial information in the Territory for the efficient and effective delivery of services to the residents and visitors of the Virgin Islands. Mr. Henry currently serves as the Council's chair-elect.

Appendix 2: Contributors of Information and Materials

Institution	Person	Contact Information
University of the Virgin Islands	Donna Nemeth	dnemeth@uvi.edu
	Roy Watlington	rwatlin@uvi.edu
	Olasee Davis	odavis@uvi.edu
DPNR-Division of Coastal Zone Management	Janice Hodge	janice.hodge@dpnr.gov.vi
	Carl Howard	carl.howard@dpnr.gov.vi
DPNR-Division of Environmental Protection	Diane Capehart	capehart.diane@vidpnr-dep.org
	Anita Nibbs	nibbs.anita@vidpnr-dep.org
	Syed Syedali	syedali.syed@vidpnr-dep.org
V.I. Energy Office	Bevan Smith	bsmith@vienergy.org
NPS-Virgin Islands National Park	Rafe Boulon	rafe_boulon@nps.gov
	Paul Thomas	paul_thomas@nps.gov
V.I. Water and Power Authority	Werner Wernicke	
Coral Bay Community Council	Sharon Coldren	coralbaycommunitycouncil@hotmail.com
U.S. Department of Agriculture	Rudy O'Reilly	rudyo_reilly@pr.usda.gov
	Julie Wright	julie_wright@pr.usda.gov
Central High School - St. Croix	Jesus Espinosa	jssspns@yahoo.com
VI Waste Management Authority	May Adams Cornwall	
	Mirko Restovic	mrestovic@viwma.org
DPNR-Division of Fish & Wildlife	William Coles	wcoles@vitelcom.net
	Jennifer Valiulis	jennifer.valiulis@gmail.com
	Renata Platenberg	vi.wildlife@gmail.com
Department of Public Works	Darryl Smalls	
DPNR-VI State Historic Preservation Office	Lorna Thomas	lorna_thomas@vishpo.com
	Sean Krigger	sean_krigger@vishpo.com
	David Brewer	david_brewer@vishpo.com
Island Resources Foundation	Jean-Pierre Bacle	DCBacle@aol.com
Economic Development Authority	Nadine Marchena-Kean	nmarchena@usvieda.org
Virgin Islands Cultural Heritage Institute	Myron Jackson	myron.jackson@dpnr.gov.vi
DPNR = Department of Planning and Natural Resources NPS = National Parks Service VI = (U.S.) Virgin Islands		
Special thanks to Julie Wright, Dale Morton, William Coles, and Jesus Espinosa for the photographs.		

Appendix 3: Community Uses of Ghuts in the U.S. Virgin Islands

Ghut	Past Uses	Current Uses
St. Croix		
Bethlehem Gut	- The Estate Bethlehem plantation (1736) developed around the water supply provided by the ghut. - Supported USGS gauging stations (at Colquhoun and Upper Bethlehem) for stream-flow measurements, 1962-1969.	Hiking by St. Croix Hiking Association.
Harden Gut	- Provided water for laundering clothes. - Recreation (swimming, bird watching)	N/D
Jolly Hill Gut	- Supplied water (via aqueduct) to operate the water wheel used in the sugar mill in Little LaGrange and to supply water to the cane fields. - Supported USGS gauging station (at Jolly Hill) for stream-flow measurements, 1962-1969.	USGS gauging station for stream-flow measurements.
Little La Grange	Water for irrigating cane fields.	- N/D - Still supports fish species (Fat Sleeper and 2 species of guppies).
Lower Love Gut	Fish for food (mudfish/goby)	N/D
Upper Love Gut	- Fish for food (eels) - Recreation (bird shooting)	N/D
Castle Burke Gut	Fish for food (mulletts, gut “lobsters”)	N/D
Concordia	- Fish for food (mudfish/goby) - Recreation	N/D
Caledonia Gut	Recreation. Seaman found the goby – <i>Sicydium plumieri</i> – in this ghut.	Hiking by St. Croix Hiking Association.
Fair Plane Gut (Lower portion of Bethlehem Gut, where it enters the estuary.)	Recreation (fishing, bird shooting, swimming)	N/D
Salt River	Water for drinking and agriculture	Recreation and education
River Gut (Other name for Upper Love Gut?)	- Dammed at Estate Upper Love for provision of fresh water. - Supported USGS gauging stations (at River, Holy Cross Church, Golden	N/D

Ghut	Past Uses	Current Uses
	Grove, & Alexander Hamilton Airport) for stream-flow measurements, 1962-1969.	
St. George's Gut	Recreation (bird watching/bird shooting)	N/D
La Grande	N/D	N/D
Mint Gut (also known as Diamond Gut)	- Used by Arawaks to travel to St. George. - Used by English farmers to move sugar and tobacco from St. George to coast, for shipment off-island	N/D
Creque Gut	- Water for domestic and agricultural uses - Supported USGS gauging station (above Mount Washington Reservoir) for stream-flow measurements, 1962-1969.	2 species of shrimp (<i>Macrobrachium</i> sp. and Fairy Shrimp) found in dam. - Recreation (photographs)
Mahogany Gut	N/D	- Used by Good Hope School for environmental education - Currently supports fish species (Mountain Mullet, American Eel, <i>Macrobrachium</i> sp.)
Butler Bay	N/D	Hiking by St. Croix Hiking Association
Fountain	N/D	Hiking by St. Croix Hiking Association
Canaan	N/D	Hiking by St. Croix Hiking Association
Adventure Stream	N/D	- Hiking by St. Croix Hiking Association - Environmental Education by VI Resource Conservation and Development Council
Cane Bay	N/D	Supports fish species (Mountain Mullet and 3 species of shrimp)
Envy Spring	Supported USGS gauging station (at Alexander Hamilton Airport) for stream-flow measurements, 1962-1969.	N/D

Ghut	Past Uses	Current Uses
St. John		
Battery Gut	▪ Hiking	▪ Research
Fish Bay Gut	▪ Hiking	▪ Hiking ▪ Research ▪ Supports aquatic faunal species
Johnny Horn Trail ghut	▪ Recreation	▪ Recreation
Living Gut	▪ Recreation	▪ Recreation (VINP conducts tours of trail and ghut)
Guinea Gut	▪ Supported USGS gauging station (at Bethany) for stream-flow measurements, 1962-1969.	▪ Current location for USGS gauging station.
Cinnamon Bay Spring	▪ Supported USGS gauging station for stream-flow measurements, 1962-1969.	▪ N/D
St. Thomas		
Savan Gut (Also known historically as Brower's Gut and Jigget Gut. Savan Gut is the lower portion of the deJongh Gut.)	▪ Saturday and Sunday mornings, the Savanneroes would catch and roast "jumbo shrimps" from the upper reaches of the ghut. ▪ The female Savanneroes laundered clothes for marines/sailors in the ghut, especially after heavy showers of rain. ▪ The laundry scenes were captured on film and canvas by local and visiting artists.	▪ Thoroughfare ▪ Farming by community youths
deJongh Gut	▪ Water for community uses ▪ Food (see also above) ▪ Recreation (bathing in pools and hiking)	▪ Recreation (hiking)
Bonne Resolution Gut	▪ USGS gauging station located at Bonne Resolution ▪ Water for agriculture ▪ Recreation	▪ USGS gauging station ▪ Recreation (hiking and catching shrimp and fish)
Turpentine Run	▪ USGS gauging stations located at Mt. Zion and Mariendal ▪ Recreation ▪ Historical route for Tianos to move from the coast to the village in Tutu	▪ USGS gauging station ▪ Recreation ▪ Research
Lovenlund Gut	▪ Supported USGS gauging station (at	▪ N/D

Ghut	Past Uses	Current Uses
	Lovenlund), 1962-1969.	
Contant Gut	▪ Water for domestic use	▪ N/D
Neltjeberg Gut	▪ N/D	▪ Recreation (hiking)
Magen's Bay Gut	▪ N/D	▪ Recreation (hiking)
Sources:	Lawaetz (1991), Seaman (1980), Seaman (1993), Kesler (1980), Robinson et al (1973), Jordan (1975)	Olasee Davis, Rudy O'Reilly, William Coles.
USGS = U.S. Geological Survey N/D = no data available VINP = Virgin Islands National Park		

Appendix 4:
1994-2007 Comparative Analysis for
Benner Bay/Jersey Watershed
St. Thomas, Virgin Islands

1994-2007 Comparative Analysis for Benner Bay/Jersey Watershed St. Thomas, Virgin Islands

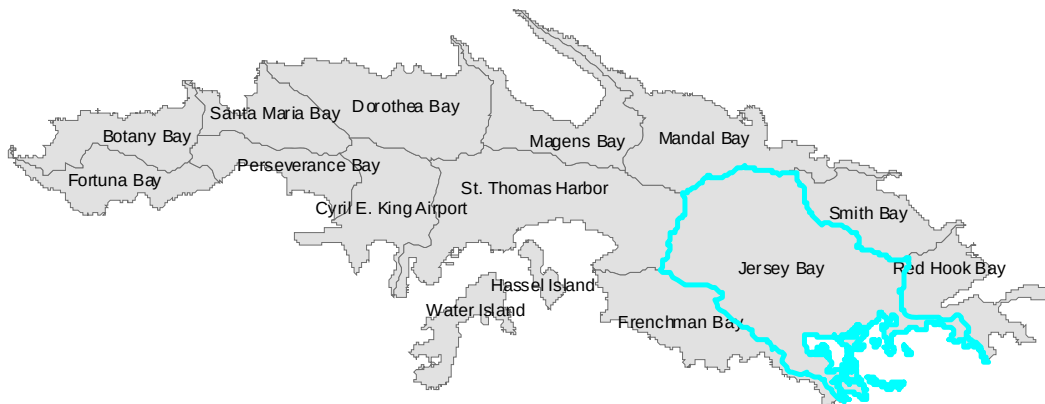
Stevie Henry and Pedro Nieves, UVI-ECC/Conservation Data Center

INTRODUCTION

The tracking of activities within a watershed is required for effective management of this area. This tracking includes a quantitative assessment of development changes and its impact on the drainage network for that watershed. The Benner Bay/Jersey Watershed was chosen as the target area for this analysis because of the number of large developments occurring after 1994 with impact on the Turpentine Run Ghut.

The Benner Bay/Jersey Watershed has a drainage area of approximately 3,578.362 acres. It is the largest subwatershed on the island of St. Thomas. The Turpentine Run Ghut is located in the Benner Bay/Jersey Watershed and is approximately 2.13 miles.

Figure 1: Jersey Watershed, St. Thomas, VI



Studies have shown that increased impervious areas increases the quantity of surface runoff. This report presents a comparative analysis of the drainage pattern in the Benner Bay/Jersey Watershed between the periods 1994 and 2007.

The data and tools used in this project serves as a demonstration of the opportunities available to convert spatial data to new knowledge. The data inventory for this project includes:

- [St. Thomas Watershed](#)
- [2000 Rapid Ecological Assessment](#)
- [1994 Elevation](#)
- [2007 Elevation](#)
- [2007 Aerial](#)

APPROACH

The analysis for the Benner Bay/Jersey Watershed involves three phases:

1. Change in vegetation communities 1994 and 2007

2. Change in drainage network 1994 and 2007
3. Analysis of historical rainfall and stream flow rate data

PROCESS and RESULTS

Change in vegetation communities

Clip Features: The ESRI ArcView® GIS clip feature tool was used to create the Benner Bay/Jersey Watershed Rapid Ecological Assessment layer. The Benner Bay/Jersey Watershed was selected from St. Thomas Watershed layer and defined as the clipping area (represents the cookie cutter). The Rapid Ecological Assessment – Vegetation Communities layer under the St. Thomas Watershed was defined as the input layer. The output layer was comprised of only the features within the clipping area. Along with the shape of the features the new output layer table contained the entire input layer attributes (characteristics of feature e.g. Area, Perimeter or Vegetation Structure).

Figure 2: **Clipped vegetation communities for the Benner Bay/Jersey Watershed**



The Benner Bay/Jersey Watershed Rapid Ecological Assessment (REA) layer delineated the developed and vegetated areas based on 1994 ground conditions. The delineated vegetated areas are classified into 8 vegetation structures (see *Island Peak to Coral Reef* (2005) for a detail description of the vegetation structures). Areas developed after 1994 were updated to calculate the loss of vegetated areas between 1994 and 2007. Figure 3 shows where three of the major developments occurred in the Benner Bay/Jersey Watershed between 1998 and 2003:

- Cost-U-Less 1998
- Price Smart 2001
- Home Depot 2003

A table summarizing the amount of acres per vegetation structure was generated for 2000 and 2007. Table 1 shows there was a 4 percent increase in the developed category. In contrast, there was a 3 percent and 7 percent decline in the herbaceous and shrubland category respectively.

Figure 3: Portion of Benner Bay/Jersey Watershed

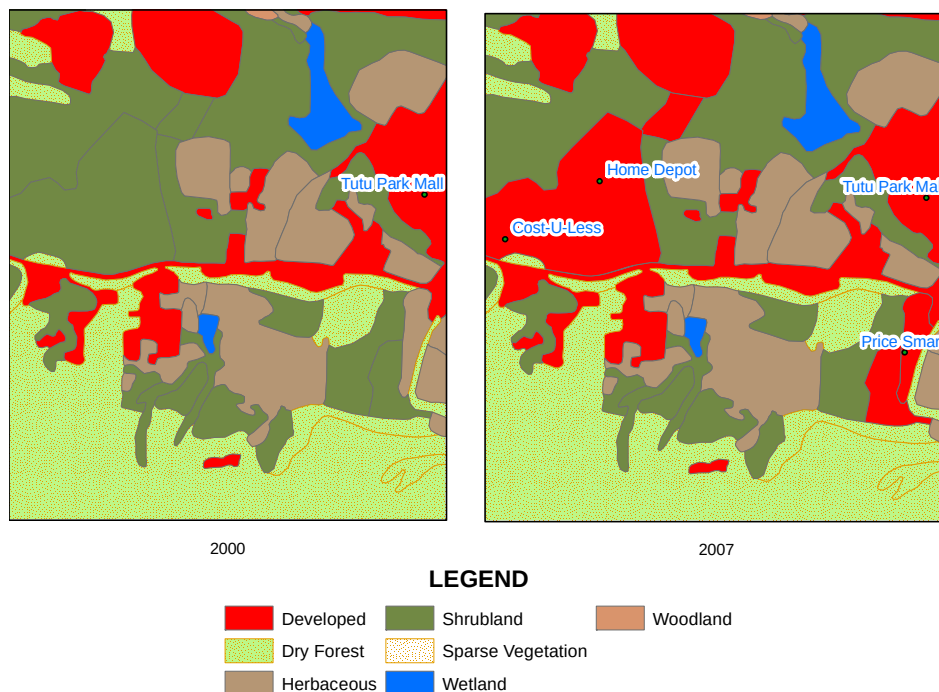


Table 1: Change in Jersey Watershed Vegetation Structure 1994 to 2007

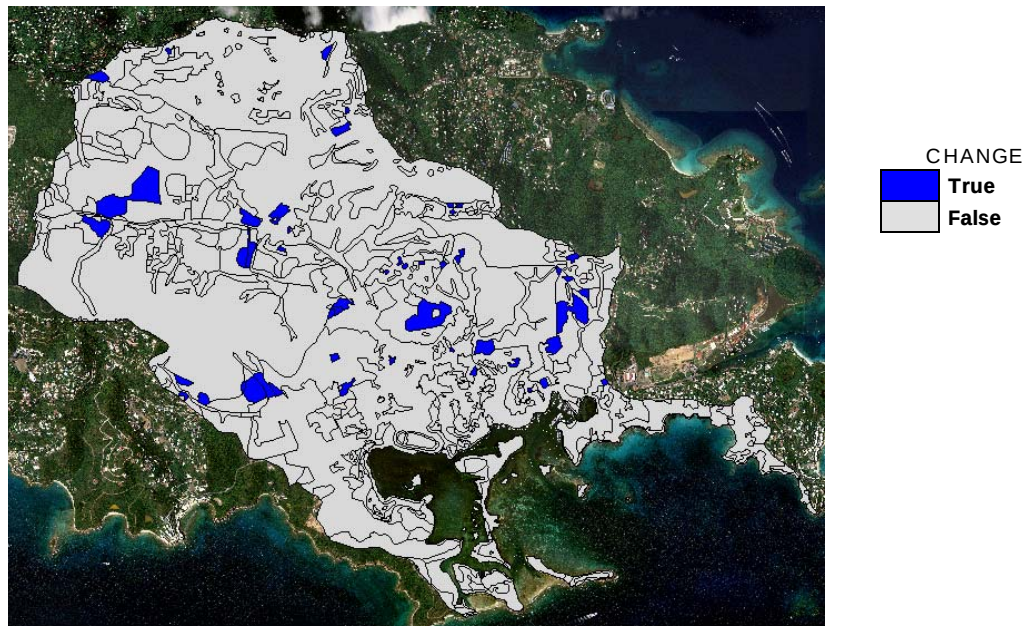
STRUCTURE	2000 ACRES	2007 ACRES	% Change
Developed	1297.7560	1356.0400	4%
Dry Forest	1235.0300	1235.0300	0%
Herbaceous	158.3460	153.5100	-3%
Shrubland	716.5320	663.0840	-7%
Sparse Vegetation	9.7400	9.7400	0%
Wetland	152.5820	152.5820	0%
Woodland	8.3760	8.3760	0%
	3578.3620	3578.3620	

Change in drainage network

The stream analysis methodology used was developed by the U.S. Army Corps of Engineer's Hydrologic Engineering Center (HEC), and is used to more precisely map drainage characteristics of an area. The Hec-GeoHMS Version 1.1 was used as an extension of ArcView GIS 3.2 (see www.hec.usace.army.mil for more info on hec analysis). HEC analysis assumes that all the rainfall is run-off and none is absorbed or evaporated.

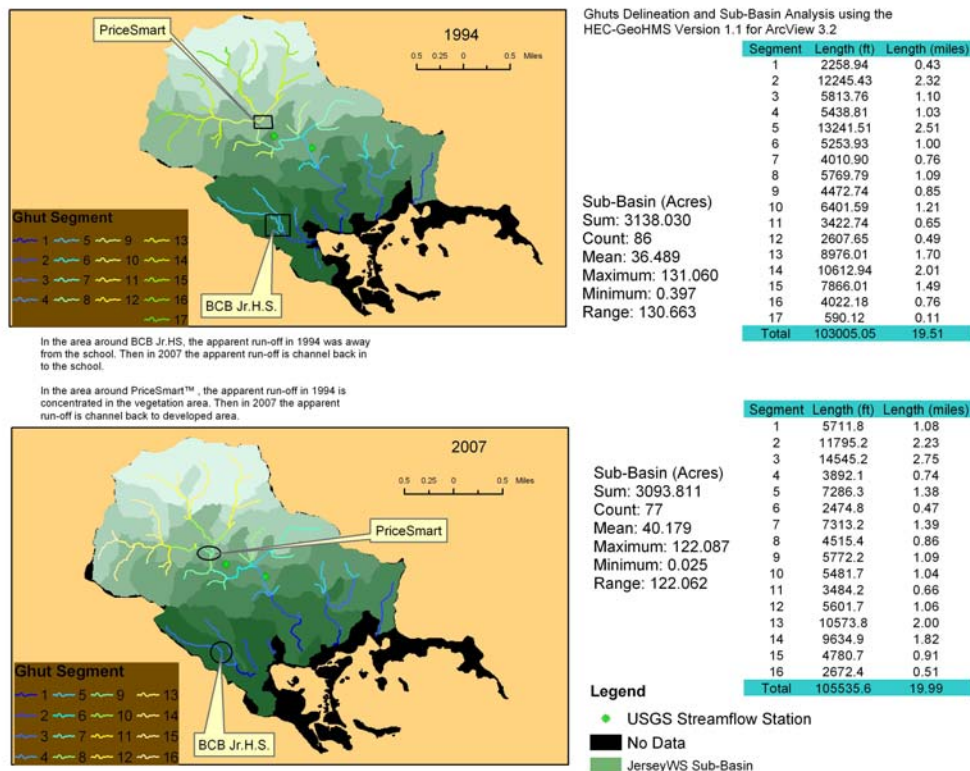
The source for the 1994 Digital Terrain Model is the U.S. Army Corp. of Engineers 1994 U.S. Virgin Islands Project. The source for the 2007 Digital Terrain Model is the U.S. Army Corp. of Engineers 2007 U.S. Virgin Islands Project. The clip feature source was the U.S. Virgin Islands Department of Planning and Natural Resources 1999 Watershed Boundary.

Figure 4 : Areas where development occurred after 1994 in the Benner Bay/Jersey Watershed



HEC analysis shown in Figure 5 shows a significant change in the drainage network pattern occurring only in two areas (Bertha C. Boschulte [BCB] Middle School and PriceSmart™). In 1994, the area around the BCB Middle School the apparent run-off was away from the school; however in 2007, the apparent run-off is channeled back toward the school. In the area around PriceSmart™, the apparent run-off in 1994 is concentrated in a vegetated area. Conversely in 2007, the apparent run-off is channeled in a developed area.

Figure 5: 1994 and 2007 HEC Analysis for the Benner Bay/Jersey Watershed



Historical Rainfall and Stream Flow Rate Data

To analyze the change in surface water flow after 1994 in the Benner Bay/Jersey Watershed stream flow data collected by the U.S. Geological Service (USGS) Turpentine Run gauge station was downloaded. The dataset analyzed covered the period January 1994 through November 2006. In addition, rainfall data covering the same period was downloaded from the National Weather Service (NWS). Despite the Fort Mylner NWS station being located in the subject watershed, the rainfall data used for the analysis came from the St. Thomas Airport NWS station. Rain data collection at the Fort Mylner station was discontinued 1995.

The top 100 rainfall (unit = inches) events occurring during the period of analysis were selected along with stream flow rate (unit = cubic feet per second) for that same event.

The distribution of events by year is shown in Table 2. The mean and median for each year was calculated.

Figure 6: Turpentine Run Ghut and Turpentine Run Mt. Zion USGS Station



Table 2 100 Rainfall and Turpentine Run Stream Flow Events 1994-2006

YEAR		Rainfall (in)	Stream Flow (cf/s)	YEAR		Rainfall (in)	Stream Flow (cf/s)
1994	Mean	1.25	0.80	2002	Mean	1.67	3.14
	N	4	4		N	8	8
	Std. Deviation	0.47	0.87		Std. Deviation	0.87	3.13
	Grouped Median	1.17	0.54		Grouped Median	1.57	2.60
1995	Mean	1.37	2.58	2003	Mean	2.09	60.40
	N	8	8		N	14	14
	Std. Deviation	0.33	1.94		Std. Deviation	1.25	106.78
	Grouped Median	1.50	2.45		Grouped Median	1.59	5.30
1999	Mean	1.55	20.25	2004	Mean	2.20	77.71
	N	9	9		N	9	9
	Std. Deviation	0.65	37.94		Std. Deviation	2.16	168.06
	Grouped Median	1.54	7.00		Grouped Median	1.19	8.60
2000	Mean	1.57	3.55	2005	Mean	1.50	7.13
	N	3	3		N	19	19
	Std. Deviation	0.32	3.18		Std. Deviation	0.98	8.57
	Grouped Median	1.60	3.40		Grouped Median	1.16	3.70
2001	Mean	1.21	2.09	2006	Mean	1.12	1.88
	N	11	11		N	15	15
	Std. Deviation	0.30	2.90		Std. Deviation	0.24	1.92
	Grouped Median	1.14	0.75		Grouped Median	0.98	1.20

In Figure 7 it shows there was an increase in average rainfall between 1994 and 2000. For the same period there was also an increased in the average Turpentine Run stream flow discharge (see Figure 8). Nevertheless, when the average rainfall declined 2001 below the 1994 average rainfall the 2001 average stream flow (0.75 cf/s) was higher than the 1994 average stream flow (0.54 cf/s). Despite the 2006 average rainfall (1.0 in) being lower the 2001 average rainfall (1.1

in) the 2006 average stream flow (1.2 cf/s) was higher than the 1994 and 2001 average stream flows.

Figure 7: 1994-2006 Median Rainfall (inches)

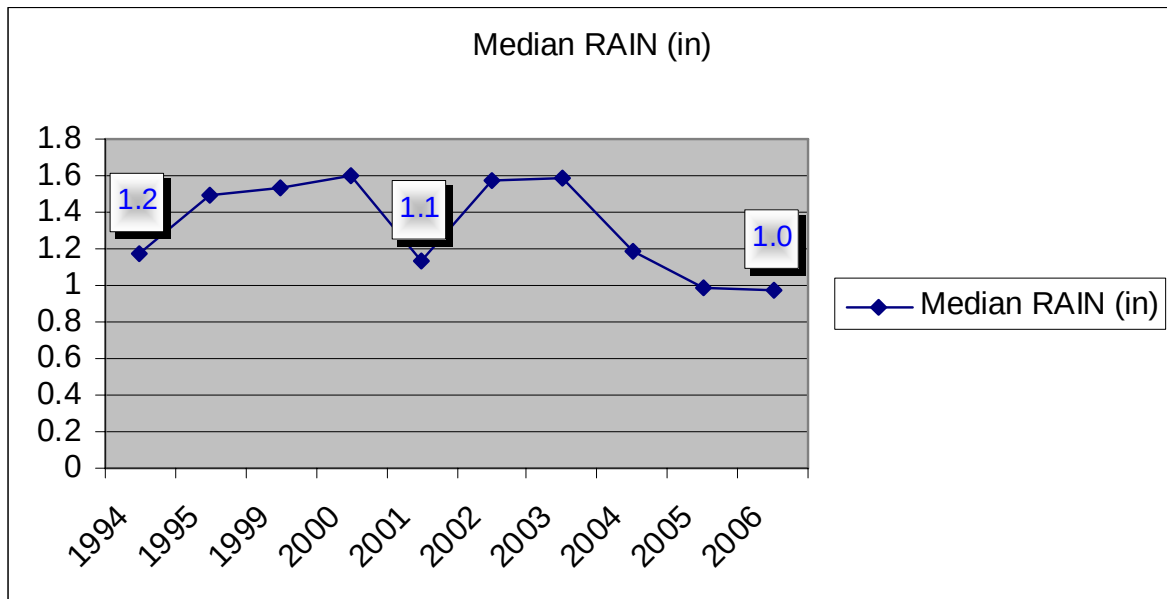
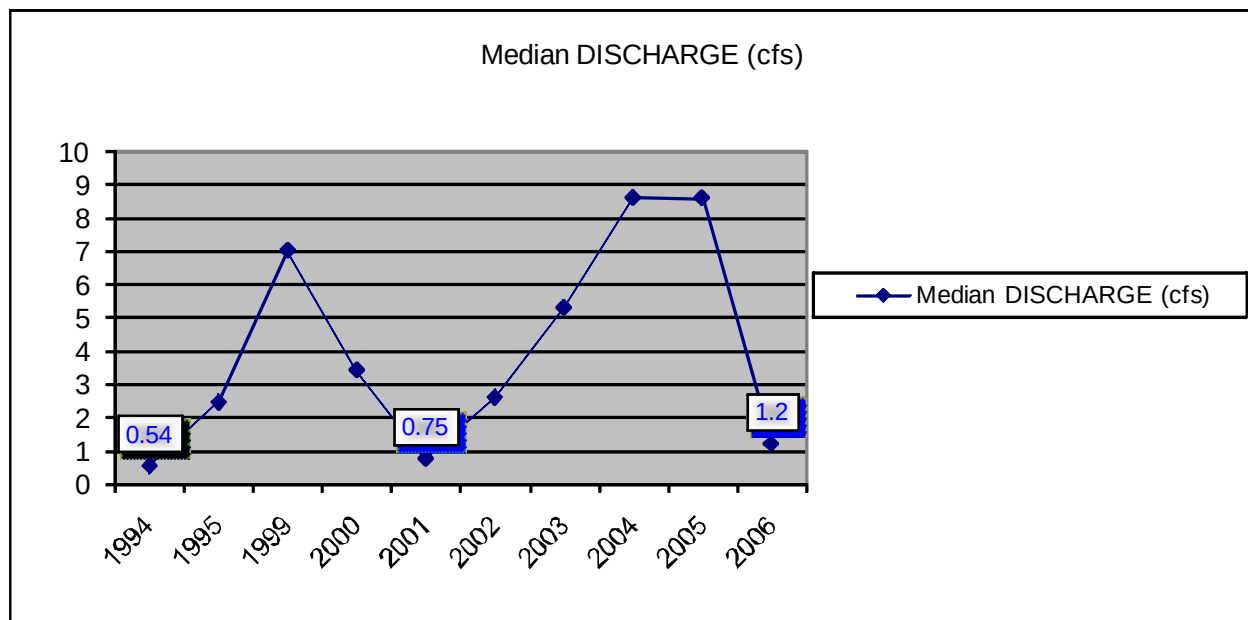


Figure 8: Turpentine Run Station Median Flow Rate Discharge



CONCLUSION

The use of Geographic Information System (GIS) tools provided an efficient way to historically analyze the Benner Bay/Jersey Watershed. The update of the vegetation map for the study watershed only required the delineation of those areas that had changed after the original map.

The HEC analysis reduced the time that would have been needed to perform complicated calculations to create the drainage network system for 1994 and 2007.

The results of this limited study reveal that during the period major development occurred in areas impacting the Turpentine Run Ghut there was an increase in the average stream flow rate for that ghut. The results of this study should not be generalized. During the period being analyzed channels were improved or expanded. A more extensive study is needed to analyze the stream flow rate during the unimproved channel period versus the improved channel period.

This study supports the need for establishing and maintaining environmental monitoring stations for the purpose of planning and to measure post development impact. Flooding is a watershed management issue familiar to individuals who are technical or nontechnical. The history of housing development in the Virgin Islands is replete with cases where anecdotal information and technical studies warning of flooding were ignored for the benefit of increasing the stock of affordable housing units. Interviews with residents of St. Croix: Mon Bijou, Williams Delight, or St. Georges and St. Thomas: Bovoni, Nadir or Lindberg would reveal words of regrets - "if I had only known".

GIS provides the opportunity for building public awareness and an efficient approach to comprehensive planning. The map outputs for this project provide a visual of the drainage and development patterns in the watershed. This visualization is useful in explaining to a non-technical audience the areas that may be prone to flooding and the impact changes in the landscape may have on its surrounding area. This is possible through the integration of data collected, maintained and shared by public and private organizations.