UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278

# Draft
# Environmental Impact Statement

# CRUZ BAY
# WASTEWATER FACILITIES PLAN

## St. John,
## U.S. Virgin Islands

MAY, 1987

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK. NEW YORK 10278

MAY 6 1987

To All Interested Government Agencies, Public Groups, and Citizens:

This is to inform you that the Draft Environmental Impact Statement for the Cruz Bay Wastewater Facilities Plan, St. John, U.S. Virgin Islands (U.S.V.I), is available for public review at the following locations:

Administrator's Office
Cruz Bay
St. John, U.S.V.I.

Enid M. Baa Library
#20 Dronningensgade
St. Thomas, U.S.V.I.

Ralph M. Paiewonsky Library
College of the Virgin Islands
St. Thomas, U.S.V.I.

U.S. Environmental Protection Agency
Region II
Environmental Impacts Branch
26 Federal Plaza, Room 702
New York, New York

Enighed Sprauve Library
Cruz Bay
St. John, U.S.V.I.

V.I. Department of Public Works
Sub-base
St. Thomas, U.S.V.I.

V.I. Department of Conservation and Cultural Affairs
#179 Estate Altona and Walgunst
St. Thomas, U.S.V.I.

U.S. Environmental Protection Agency
Caribbean Field Office
1413 Avenida Fernandez Juncos-Stop 20
Santurce, Puerto Rico

This environmental impact statement (EIS) was prepared by the U.S. Environmental Protection Agency (EPA), Region II, with the assistance of C.E. Maguire, Inc., an environmental planning and engineering consulting firm. The document has been prepared in accordance with the regulations implemented under the National Environmental Policy Act (NEPA).

The EIS is an issue-oriented, decision-making document which evaluates alternative wastewater treatment management plans for the Cruz Bay study area, addresses the impacts that each alternative may have on the surrounding environment, and develops an environmentally compatible, cost-effective, and implementable wastewater management plan. The major issues addressed in the EIS include: impacts to a national park, impacts to endangered and threatened species, impacts to cultural resources, secondary growth impacts, water supply impacts, and impacts to environmentally sensitive areas such as coral reefs and floodplains.

Public participation, especially at the local level, is an essential component of the decision-making process. Public meetings and Citizen Advisory Committee meetings were held during the preparation of this EIS to ensure input from local, territorial, and federal representatives. A public hearing has been scheduled for 7:30 PM July 14, 1987, at the Territorial Court Building, Boulon Center, Cruz Bay, to receive formal comments on the draft EIS. Your participation at this public hearing is encouraged.

In addition, written comments may be submitted directly to EPA. Written comments should be sent to this office, to the attention of: Chief, Environmental Impacts Branch, USEPA-Region II, 26 Federal Plaza, Room 702, New York, New York 10278. Comments must be received on or before July 29, 1987 to receive consideration in developing the final EIS.

If you need any additional information, please contact Mr. William Lawler, Environmental Impacts Branch, at (212) 264-5391.

Sincerely,

Christopher J. Daggett
Regional Administrator

Enclosure

Draft
Environmental Impact Statement
for the Cruz Bay Wastewater Facilities Plan
St. John, U.S. Virgin Islands

Prepared By:
U.S. Environmental Protection Agency
Region II

Abstract: In accordance with the National Environmental Policy Act (NEPA) and the regulations of the U.S. Environmental Protection Agency (EPA), a draft environmental impact statement (EIS) has been prepared for the Wastewater Facilities Plan for Cruz Bay, St. John, U.S. Virgin Islands. An evaluation of various alternative wastewater management plans is presented in the draft EIS, as well as evaluations of probable impacts to national park land, impacts to endangered and threatened species, impacts to cultural resources, secondary growth impacts, water supply impacts, and impacts to environmentally sensitive areas. Other important factors used in evaluating the alternative wastewater management plans were cost-effectiveness and implementability. Based on these evaluations, the alternatives proposed in the draft EIS (Alternatives E and F) include: additional sewering of the more densely populated portions of the study area (the core study area); replacement of the existing inadequate wastewater treatment facility discharging to Enighed Pond with a new oxidation ditch or rotating biological contactor wastewater treatment facility (to be located to the east of Enighed Pond) discharging to Turner Bay via an ocean outfall; and continued use of existing individual on-site wastewater disposal systems, with improvements where necessary, for the less densely developed portions of the study area (the extended study area). Because each of the alternatives presented in the draft EIS would require a substantial capital investment by the Government of the U.S. Virgin Islands, the final EIS will address possible scenarios for phasing the implementation of the selected project.

Public Hearing:

July 14, 1987 at 7:30 PM
Territorial Court Building
Cruz Bay
St. John, U.S. Virgin Islands

Contact for Information:

William Lawler
Environmental Impacts Branch
EPA - Region II
26 Federal Plaza, Room 702
New York, New York 10278
(212) 264-5391

Written comments must be received by EPA no later than July 29, 1987.

Approved by: Christopher J. Daggett [signature]
Christopher J. Daggett
Regional Administrator

May 6, 1987
Date

# EXECUTIVE SUMMARY

## EXECUTIVE SUMMARY

### A. OVERVIEW

The Cruz Bay study area needs an improved system of wastewater treatment and disposal.

The Cruz Bay study area on St. John, US Virgin Islands (shown in Figure ES-1) has significant need for improved treatment and disposal of wastewater. Most of the residences and businesses in the area are served by on-site wastewater systems. These systems generally do not function well in this area due to small lot sizes, steep slopes, and unsuitable soil conditions. Approximately 500 residences in the area are currently served by an extended aeration wastewater treatment plant, located on the berm between Enighed Pond and Turner Bay. This plant does not treat wastewater flows in an environmentally compatible manner and does not have sufficient capacity to treat projected wastewater flows from the study area. In addition, the plant has inadequate sludge handling facilities, malfunctioning bar screen units, malfunctioning pumps and other operational/maintenance deficiencies.

The Virgin Islands Department of Public Works conducted a study to address these needs in 1985.

In response to these problems, the Virgin Islands Department of Public Works (DPW) prepared a 1985 study entitled Comprehensive Plan for the Sewage Needs of Cruz Bay, St. John, Virgin Islands. The study recommended the implementation of centralized wastewater treatment facilities (including an oxidation ditch treatment plant and an ocean outfall) to serve the densely populated Cruz Bay watershed. Upon reviewing the Plan, the US Environmental Protection Agency (EPA) determined that an environmental impact statement (EIS) would be required to address potential impacts in more detail. A "notice of intent" to prepare this EIS was published in the Federal Register on November 15, 1985.

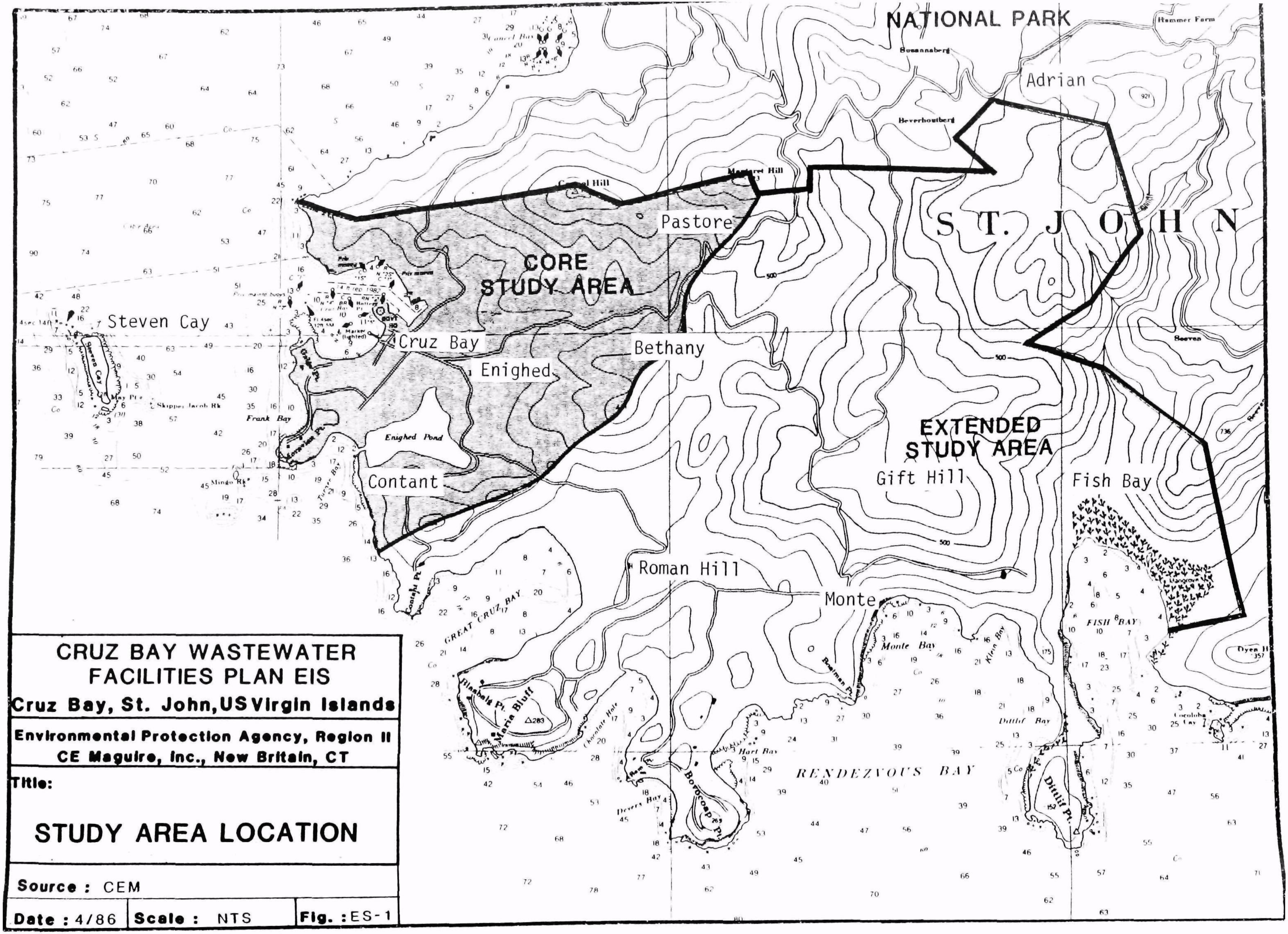
EPA is conducting this EIS to address potential project impacts in more detail.

A full scale public participation program was conducted for this project in order to encourage citizen involvement and awareness. The program included a public scoping meeting, formation of a Citizens Advisory Committee (CAC), CAC meetings, a door to door "needs survey", public meetings, a project newsletter, and responsiveness summaries.

EPA has conducted a full-scale public participation program for this project.

This Draft EIS presents a comprehensive description of:

- The alternatives considered for solving Cruz Bay's wastewater problems
- the existing and future conditions of the affected environment




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**

**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**

**CE Maguire, Inc., New Britain, CT**

**Title:**

## STUDY AREA LOCATION

**Source :** CEM

**Date :** 4/86 | **Scale :** NTS | **Fig. :** ES-1

This Draft EIS addresses the project alternatives, affected environment, and impacts.

the probable environmental impacts that could occur as a result of implementing the feasible alternatives

The appendices of this document include preliminary cost and design information for each of the feasible alternatives and documentation of the special studies conducted for this project.

B. PURPOSE AND NEED

The purpose of this project is to develop and evaluate a feasible wastewater management plan for the study area.

The purpose of this project is to develop and evaluate a feasible wastewater management plan for the Cruz Bay study area. The EIS process has been undertaken in order to address certain impacts and issues in more detail than the previous Comprehensive Plan for the Sewage Needs of Cruz Bay, St. John, US Virgin Islands and to permit the issuance of an EPA grant for construction of the selected project alternative.

Wastewater treatment and disposal needs are determined by assessing factors such as potential public health hazards, violations of water quality standards, and violations of the Territorial Pollution Discharge Elimination System (TPDES) permits. Structures using inadequate means of wastewater treatment and disposal are considered "in need" of improvements.

A needs survey was conducted in order to determine the specific wastewater needs of the study area.

A door to door survey was conducted for this project to determine the nature and extent of these wastewater treatment and disposal needs in the study area. This survey found that structures located on large lots outside of the densely populated Cruz Bay drainage basin are generally not "in need" because the large lots offer adequate space for on-site septic systems to function effectively. However, most of the structures located in the Cruz Bay drainage basin (called the "core study area") are "in need" because the existing on-site systems, latrines, and direct discharge methods used in this area fail to treat wastewater in an environmentally compatible manner. In addition, the structures which are served by the existing public treatment plant are considered to be "in need" because this plant does not function adequately.

On-site systems generally do not function adequately in the densely populated Cruz Bay drainage basin.

The discharge of poorly treated effluent from on-site systems serving individual structures in the core study area, as well as the public treatment plant present a potential threat to public health. In addition, effluent discharge from the treatment plant is in violation of the plant's TPDES permit.

**Structures in this drainage basin are generally in need of improved wastewater treatment.**

The needs survey indicated that nearly all of the structures in the core study area are "in need" of a centralized wastewater treatment system, while those outside of this area can continue to be served by on-site wastewater treatment systems. Detailed information on the needs of the study area are presented in Chapter II ("Alternatives") and Appendix A ("Needs Survey") of this Draft EIS.

## C. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

**Six wastewater management program alternatives have been considered.**

The following alternative wastewater management programs have been considered for addressing wastewater treatment and disposal needs in the study area:

- no action - including the continued use of existing methods of wastewater treatment and disposal
- rehabilitation - involving the improvement of the performance of the existing Cruz Bay wastewater treatment plant
- on-site program - involving the use of on-site systems for all structures not presently served by the existing treatment plant
- subregional program - involving either (1) the use of separate centralized treatment systems for the core study area and the outer study area, or (2) the use of a centralized treatment system for the core study area and on-site systems for the outer study area
- regional program - involving the use of a centralized treatment system for the study areas (core and extended)

In addition, a primary treatment program has been considered as a subalternative to the wastewater management programs evaluated. If allowed by the Clean Water Act, and if specific environmental criteria were able to be met, a primary level of wastewater treatment could potentially be used instead of secondary treatment for either the subregional or regional program. Construction and operation of new facilities to provide only primary treatment would be less expensive than those for providing secondary treatment. However, the Clean Water Act requires that all wastewater effluent discharged from publicly owned treatment facilities must be treated to at least secondary levels except for facilities which have applied for a "marine discharge waiver" of secondary treatment requirements, and which have been granted such a waiver by EPA in accordance with Section 301(h) of the

Act. There is insufficient information on which to determine whether such a waiver would be approvable, and in any case, the statutory deadline for applying for this marine discharge waiver expired on December 29, 1982. Therefore, primary treatment is not considered to be an implementable alternative.

**The recommended management program is a subregional plan combining advantages of both centralized and on-site treatment systems.**

Based on the findings of the Needs Analysis, the second subregional program was selected as the proposed wastewater management program. This program recommends the use of a centralized treatment system for the core study area and on-site systems for the extended study area.

Alternatives were also considered for the following components of centralized treatment systems:

- wastewater treatment processes
- wastewater collection system technologies and routings
- wastewater effluent disposal technologies
- sludge disposal technologies
- wastewater treatment facility sites

**Six feasible overall wastewater treatment system alternatives were considered in detail.**

Comparative analysis of the component alternatives has produced six feasible overall treatment system alternatives. The six overall system alternatives are structured to function under the second subregional management program which recommends using a collection system for the core study area and various on-site technologies for the extended study area. In the core area, each of the six overall system alternatives includes a new 200,000 gallons per day (gpd) treatment facility at a new site, to replace the existing facility and site. A new wastewater collection system is proposed to extend from the existing sewer system. The proposed wastewater collection system includes the addition of approximately 6,873 m (22,680 ft) of sewers to the existing public wastewater collection system. In addition to the portions of Cruz Bay and Enighed served by the existing system, the proposed system would serve Pine Peace, Power Boyd's Plantation, portions of Contant and Pastore; and portions of Cruz Bay and Enighed that are not currently served.

**An additional 6,873 meters of sewers are recommended to supplement an existing collection system.**

The existing system is comprised of 2,600 m (8,600 ft) of sewers, including 1,282 m (4,232 ft) of 20 cm (8 in) diameter gravity sewer, 803 m (2,651 ft) of 25 cm (10 in) diameter gravity sewer, 409 m (1,349 ft) of 15 cm (6 in) diameter force main, and 110 m (364 ft) of 5-10 cm (2-4 in) diameter force main. The existing system also includes three pump stations (two ejector stations and one influent pump station).

In addition to this system, the following additions are proposed:

- 6,621 m (21,850 ft) of 20 cm (8 in) diameter gravity sewer
- 145 m (480 ft) of 10 cm (4 in) diameter force main
- 106 m (350 ft) of 5 cm (2 in) diameter pressure sewers
- one additional pump station to lift flows from the Power Boyd's Plantation area into the Cruz Bay drainage basin
- 50 grinder pumps for use in residences that are located below the sewer line.

**Two effluent disposal systems have been considered: an ocean outfall and land application.**

The proposed system would include using the existing pump stations. The capacity of the influent pump station would be expanded, but the ejector stations would not be altered. The proposed wastewater collection system is shown in Figure ES-2. Each alternative also recommends one of two effluent disposal systems, either ocean outfall or land application.

Land application of treated effluent at a near-by private resort is an innovative, low cost approach for wastewater disposal.

All of the alternatives would also include the disposal of sludge at the St. John municipal landfill until analysis of the sludge indicates whether or not land application is possible. A subalternative to these disposal systems is effluent disposal through land application at the Caneel Bay Resort. Land application of effluent could be substituted into any of the feasible overall system alternatives. This subalternative would not impact those environmental characteristics and features that would be negatively affected by the implementation of either the National Park Service land application alternative or the ocean outfall alternatives. In addition, the force main effluent pipe to Caneel Bay would cost considerably less than the ocean outfall system, approximately 1.5 to 1.8 million dollars, depending on the plant site selected. Although this effluent disposal subalternative has received much public support and initial positive reaction from the Caneel Bay Resort, it may be difficult to implement due to potential legal, political, and contractual complications. Therefore, it was not included with the following alternatives in this Draft EIS. However, should additional support, further commitments, and official approvals of this alternative be presented during the draft EIS comment period, it could be reconsidered as a viable alternative in the final EIS.

Given the aforementioned constraints, the feasible action alternatives are:

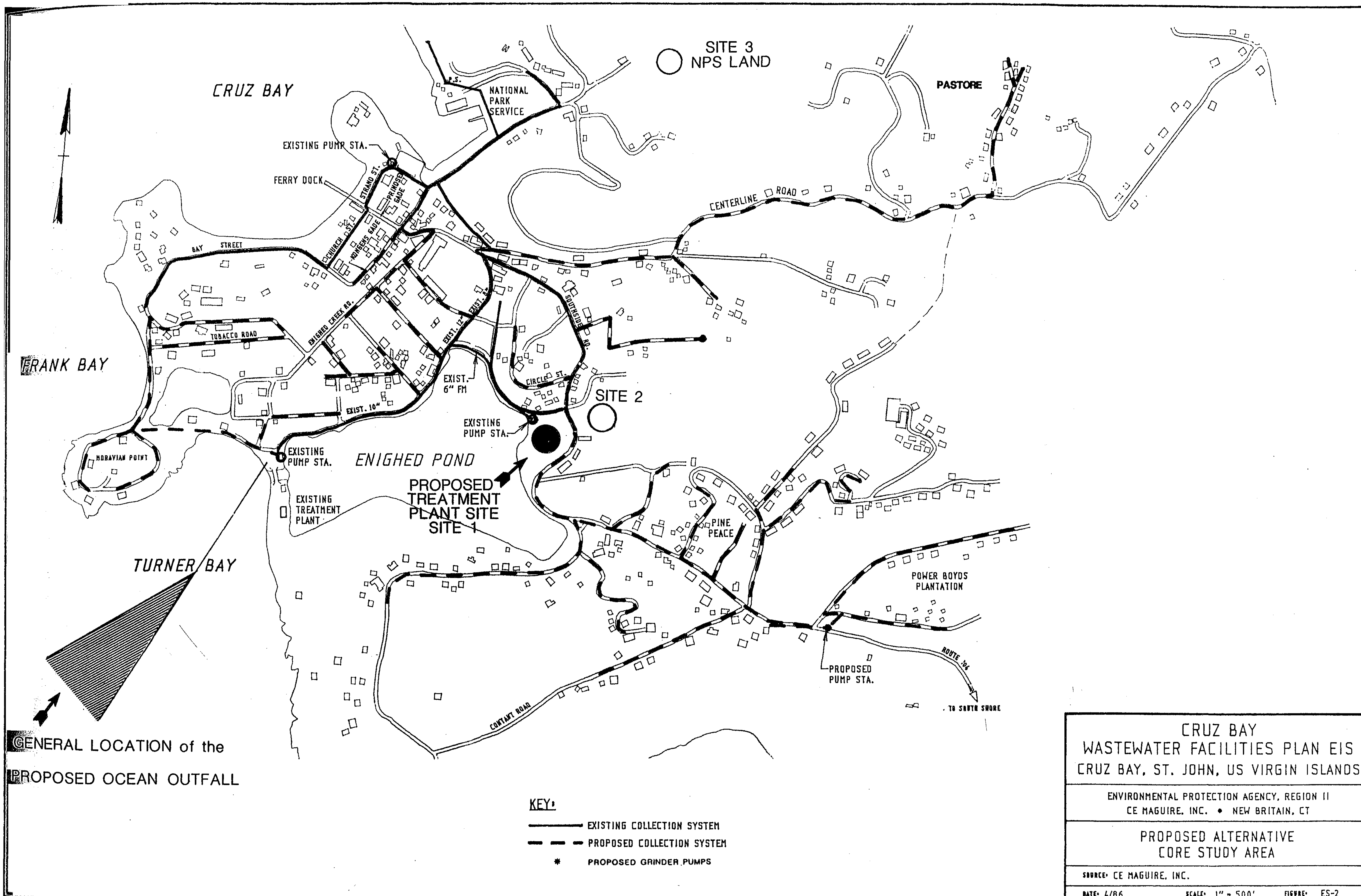
- Alternative A: Aerated lagoon treatment plant at site #3 with land application effluent disposal
- Alternative B: Aerated lagoon treatment plant at site #3 with ocean outfall effluent disposal
- Alternative C: Aerated lagoon treatment plant at site #2 with ocean outfall effluent disposal
- Alternative D: Recirculating sand filter treatment plant at site #2 with ocean outfall effluent disposal
- Alternative E: Rotating biological contactor treatment plant at site #1 with ocean outfall effluent disposal
- Alternative F: Oxidation ditch treatment plant at site #1 with ocean outfall effluent disposal

Alternative E, comprised of a Rotatating biological contacter and Alternative F, comprised of an oxidation ditch processing plant, both at Site #1 and with an outfall into Turner Bay, are the most feasible alternatives.

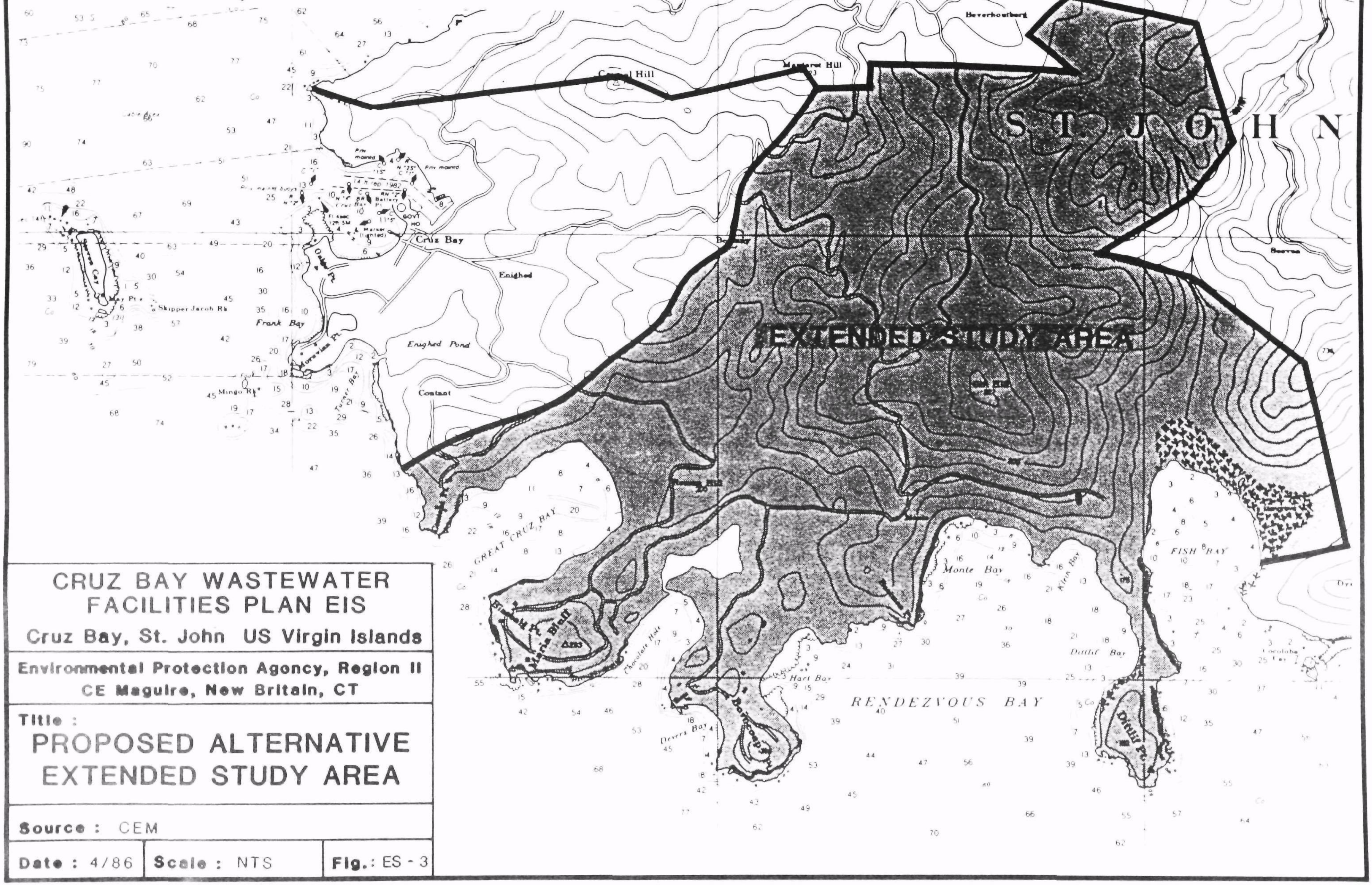
A comparative evaluation was conducted between each overall wastewater treatment system based upon the following criteria; cost, environmental impacts, implementability, and land lost to future development. In addition to these criteria, comments from various government agencies, the Citizen's Advisory Committee, and the general public were also taken into consideration. This evaluation resulted in the preliminary selection of Alternatives E and F as the most feasible alternatives. These alternatives are illustrated in Figures ES-2 and ES-3. Alternative E, a rotating biological contactor treatment plant and Alternative F, a oxidation ditch treatment plant, would both utilize an ocean outfall effluent disposal system in Turner Bay and would be located at Site #1 (across the street from the WAPA power plant). These alternatives also include the proposed wastewater collection system described in the previous section and illustrated in Figure ES-2.

Other alternatives would have greater adverse environmental impacts than the selected alternatives.

Although alternatives E and F are the most costly in dollars of the six alternatives, they will have the least environmental impact, will cause the least amount of land to be lost to future development, and are the most implementable options for Cruz Bay.


CRUZ BAY
SITE 3
NPS LAND
NATIONAL PARK SERVICE
PASTORE
EXISTING PUMP STA.
FERRY DOCK
STRAND ST.
PRINCESSE GADE
CHURCH ST.
KONGENS GADE
BAY STREET
CENTERLINE ROAD
TOBACCO ROAD
ENIGHED CREEK RD.
EXIST. 12"
EXIST.
SOUTHSIDE RD.
FRANK BAY
CIRCLE ST.
EXIST. 6" FM
SITE 2
EXIST. 10"
EXISTING PUMP STA.
MORAVIAN POINT
EXISTING PUMP STA.
ENIGHED POND
PROPOSED TREATMENT PLANT SITE
SITE 1
EXISTING TREATMENT PLANT
PINE PEACE
TURNER BAY
POWER BOYDS PLANTATION
PROPOSED PUMP STA.
ROUTE 104
TO SOUTH SHORE
CONTANT ROAD
GENERAL LOCATION of the PROPOSED OCEAN OUTFALL
KEY:
EXISTING COLLECTION SYSTEM
PROPOSED COLLECTION SYSTEM
PROPOSED GRINDER PUMPS
CRUZ BAY
WASTEWATER FACILITIES PLAN EIS
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS
ENVIRONMENTAL PROTECTION AGENCY, REGION II
CE MAGUIRE, INC. • NEW BRITAIN, CT
PROPOSED ALTERNATIVE
CORE STUDY AREA
SOURCE: CE MAGUIRE, INC.
DATE: 4/86
SCALE: 1" = 500'
FIGURE: ES-2

The use of on-site wastewater treatment systems, including trench systems, seepage pits, evapotranspiration beds, and mound systems, is proposed for the extended study area.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**

**Cruz Bay, St. John US Virgin Islands**

**Environmental Protection Agency, Region II**

**CE Maguire, New Britain, CT**

**Title :**

**PROPOSED ALTERNATIVE EXTENDED STUDY AREA**

**Source :** CEM

**Date :** 4/86 **Scale :** NTS **Fig.:** ES - 3

Although Alternatives A-D are less costly than Alternatives E and F, they would incur greater environmental impacts. In addition, Alternative A or B would present a major implementation issue due to the complications involved with proposing any type of project in a National Park area. Additionally, Alternatives C or D may pose some implementability issues as well as eliminating 10 acres of land that has future potential as an area for affordable residential development.

The selection of the most feasible alternatives is preliminary.

EPA will identify the selected plan after evaluating all public comments on this draft EIS.

It should be noted that the proposal of Alternatives E and F as the most feasible alternatives is preliminary, and does not represent the ultimate selection of a wastewater treatment plan for Cruz Bay. After receiving and evaluating all public comments on this draft EIS, EPA will prepare a final EIS which will identify the selected project alternative. Because each of the alternatives presented in the draft EIS would require a substantial capital investment by the Government of the Virgin Islands, the final EIS will address possible scenarios for phasing the implementation of the selected project, consistent with the goals and requirements of the Clean Water Act. Although EPA may decide to award grant assistance for implementing major portions of the selected project, issuance of this EIS does not constitute a commitment on the part of EPA to fund the project in whole or in part.

## D. AFFECTED ENVIRONMENT

**Existing and future conditions of the affected environment were analyzed.**

Analysis of the affected environment in the study area included consideration of existing conditions (including land resources, water resources, ecosystems, and economic/legal conditions, constraints to growth, and future conditions including population and water use projections).

Existing sensitive conditions in the affected environment relative to this project include:

- shallow, easily eroded soils
- surface water and marine water quality
- significant habitats
- endangered species
- national park lands
- cultural resources.

A Constraints Analysis was conducted to identify and evaluate conditions which serve to limit (or constrain) future development in the study area. The primary constraints are steep slopes, developed areas, public ("P") zones, National Park Service land, Coastal Zone Management land, existing water supply, and other conveniences. Other constraints include flood prone areas, soil limitations, significant habitats, aquifer recharge areas, cultural resources, the existing public sewer system, the existing power supply, the existing infrastructure, and available services.

**Population and per capita water use are expected to increase dramatically in the next 25 years.**

The analysis of future conditions focused on population projections and water use. The study area's population is projected to increase from approximately 1,900 (current) to approximately 3,000 in design year 2010. Per capita water use is also expected to increase (from 25 gallons per capita per day (gpcd) to 50 gpcd) due to the planned implementation of a new public water supply.

## E. ENVIRONMENTAL IMPACTS OF THE FEASIBLE ALTERNATIVES

Implementation of any of the feasible action alternatives for this project would involve various short-term, long-term primary, and secondary consequences or "impacts". A comparative assessment of these impacts influences the selection of a proposed alternative and the development of recommended measures to lessen or "mitigate" impacts.

**This project may cause short-term impacts to soil, water quality, and the economy....**

Principal short-term (construction-related) impacts associated with the feasible alternatives are likely to include potential disturbance to topsoil, surface water quality, marine water quality, coastal and marine ecosystems, and cultural resources. Project construction is also likely to cause a positive short term impact to the study area's economy.

**....and long term impacts on water quality, land use, and the economy.**

Principal long-term primary impacts which may result from this project are associated with flood hazards, soil erosion, surface and marine water quality, coastal and marine ecosystems, odors, land use, and a wastewater facility user fee.

No significant secondary impacts are expected to result from the feasible alternatives because the implementation of improved wastewater facilities is not likely to induce development in the study area. However, the patterns in which future development takes place may be influenced by the layout and service area of these facilities.

**Overall, impacts on the environment will be positive.**

Specific mitigation measures have been recommended in order to lessen the extent of adverse impacts that are expected to result from project implementation. If these measures are properly practiced, adverse project impacts would most likely be minimal. Overall, the environmental impacts of this project would be positive, particularly with respect to water quality, the health of coastal and marine ecosystems, and public health.

# CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

## LIST OF FIGURES

LIST OF FIGURES (Cont'd.)

LIST OF TABLES

# I. PURPOSE AND NEED

# I. PURPOSE AND NEED

## A. INTRODUCTION

EPA may fund 55 - 100% of eligible costs for constructing municipal wastewater facilities in Cruz Bay.

The Clean Water Act of 1972 and its Amendments authorize the U.S. Environmental Protection Agency (EPA), under the Construction Grants Program, to award grant assistance ranging from 55% to 75% of the eligible costs of constructing municipal wastewater treatment facilities. In addition, under the provisions of the Omnibus Territories Act of 1977, the requirements for local matching funds for Territories and Possessions of the United States can be waived, allowing EPA to fund up to 100% of eligible project costs. EPA has determined that the award of grants for construction of wastewater treatment facilities in the Cruz Bay study area represents a major federal action significantly affecting the quality of the human environment and that preparation of an environmental impact statement (EIS) is required. The EIS process, mandated by the National Environmental Policy Act, is designed to evaluate a full range of wastewater management alternatives, including the no-action alternative, and compare the costs and potential environmental effects of each.

An Environmental Impact Statement (EIS) is required for this project.

EPA and its consultant, CE Maguire, Inc., believe that the proposed alternative represents the most environmentally sound, cost-effective, and implementable solution to the water pollution problems in the study area.

## B. BACKGROUND

There are serious deficiencies to the existing public wastewater facilities in Cruz Bay.

Since 1981, the centralized public wastewater treatment and collection system facilities in the Cruz Bay area have consisted of an extended-aeration package treatment plant and approximately 1.6 miles of gravity collector sewers and force mains. A 1983 study noted serious deficiencies in the operation, maintenance, and safety of the Cruz Bay facilities. In an effort to correct these problems, the Government of the Virgin Islands developed a draft facilities plan for the Cruz Bay study area (entitled Comprehensive Plan for the Sewage Needs of Cruz Bay, St. John, VI) and submitted it to EPA in 1985. The plan proposed a treatment system including an oxidation ditch wastewater treatment plant, to be located at the existing plant site, with an ocean outfall discharging treated effluent in the vicinity of Turner Bay, as well as additions to the existing collection system to consist primarily of gravity collector sewers and grinder pumps. After review of the draft facility plan, EPA decided to prepare this EIS to more thoroughly evaluate all feasible alternatives in terms of environmental and economic impacts to the Cruz Bay area. The result of this process

The EIS process establishes a wastewater management plan for Cruz Bay.

has been the proposal of an environmentally sound, cost-effective and implementable wastewater management plan to serve the Cruz Bay study area for the foreseeable future.

## C. NEED FOR THE PROPOSED PROJECT

According to the 1980 U.S. Census, the total population of St. John was 2,480, with approximately 1,930 persons residing in the Cruz Bay study area. An initial task in the preparation of this draft EIS was an analysis of the wastewater treatment needs of the study area. This included surveying the current wastewater treatment methods utilized by the 535 structures presently located in the densely populated Cruz Bay drainage basin, referred to as the core study area, as well as a representative sample of structures presently located outside of the drainage basin, referred to as the extended study area.

A door to door survey was conducted to identify wastewater treatment needs in the study area.

The majority of the wastewater generated in the Cruz Bay study area is treated by septic tanks, or by other types of on-site disposal systems. Generally, the on-site systems serving structures in the extended study area function properly, due to large lot sizes which allow wastewater to be treated effectively. However, the on-site systems serving structures within the core study area do not function properly due to steep slopes, small lot sizes, and unsuitable soil conditions, which hinder the ability of these systems to treat wastewater effectively, and thereby, create a potential health hazard.

On-site wastewater treatment systems do not function properly in the densely developed "core" study area.

In addition, an existing centralized wastewater treatment plant and collection system serves 92 structures in the core study area. Based on on-site performance inspections and sampling surveys, the treatment plant does not function properly, allowing inadequately treated wastewater to be discharged to Enighed Pond and Turner Bay. This situation appears to be the result of inadequate or deteriorating plant equipment, inadequate capability for sludge treatment and removal, and the lack of funds to provide for a sufficient operation and maintenance program.

An additional concern is the anticipated increase in water use in the Cruz Bay study area. Currently, water in the Cruz Bay area is supplied from individual cisterns and a public water supply, which obtains water pumped from mid-island wells and barged from the desalination plant on St. Thomas. Planning is underway for improving the water supply situation on St. John. If the current water supply is improved, water use is expected to increase and to exacerbate the existing wastewater treatment and disposal problems.

Based on the findings of the draft EIS, the residents of the Cruz Bay core study area are in need of an improved centralized wastewater treatment system, and those outside of this area should continue to utilize on-site wastewater treatment and disposal facilities with improvements dictated by a case-by-case analysis. These improvements are necessary to improve wastewater disposal and water quality in the Cruz Bay study area, and thereby, eliminate a potential public health hazard.

# II. ALTERNATIVES

## II. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

This chapter will evaluate alternative wastewater management programs.

The preparation of an environmental impact statement for a wastewater facilities plan is based upon the development and evaluation of alternative methods of meeting a study area's wastewater treatment needs. The purpose of this chapter is to present this evaluation by screening alternative wastewater management programs and various alternatives for each component of an overall wastewater treatment system. This will permit the development of the most environmentally sound, cost-effective, and implementable system for the Cruz Bay study area.

Wastewater management programs are comprehensive approaches to addressing the study area's wastewater needs. A wastewater treatment system is the complete network of wastewater facilities required to meet these needs. The primary components of a wastewater treatment system are:

The wastewater management programs are comprehensive approaches including five major components.

- wastewater treatment processes
- wastewater collection system technologies and routings
- wastewater effluent disposal technologies
- sludge disposal technologies
- wastewater treatment facility sites

Component alternatives are combined to develop feasible overall wastewater treatment system alternatives.

Several alternatives have been developed for each of these components. Each alternative has been evaluated for its feasibility based on criteria such as topography, availability of space, construction cost, operation and maintenance (O&M) cost, degree of technological complexity, reliability, implementability and public acceptance. The environmental impacts of each alternative are also a primary evaluation criteria. Only the primary advantages and disadvantages of each alternative will be discussed in this chapter. A more detailed discussion of impacts is presented in Chapter IV, Environmental Impacts of Feasible Alternatives. This evaluation allows the selection of the most environmentally sound, cost-effective, and implementable alternative technology for each component. These component alternatives are then combined to develop overall wastewater treatment system alternatives. This chapter will first address the wastewater management program alternatives, then the feasible wastewater treatment technologies available, and finally, the alternatives for an overall wastewater treatment system.

## A. ALTERNATIVE WASTEWATER MANAGEMENT PROGRAMS

Six wastewater management programs have been considered for this project. They are:

There are six possible programs.

- no action
- rehabilitation of existing facilities
- individual (on-site) wastewater management program
- subregional wastewater management program
- regional wastewater management programs

In addition, a subalternative, the primary treatment program, has been considered for the subregional and regional programs. This subalternative would involve the use of only a primary level of wastewater treatment, rather than a secondary level. Each program alternative will be discussed in the following subsections.

### 1. No Action

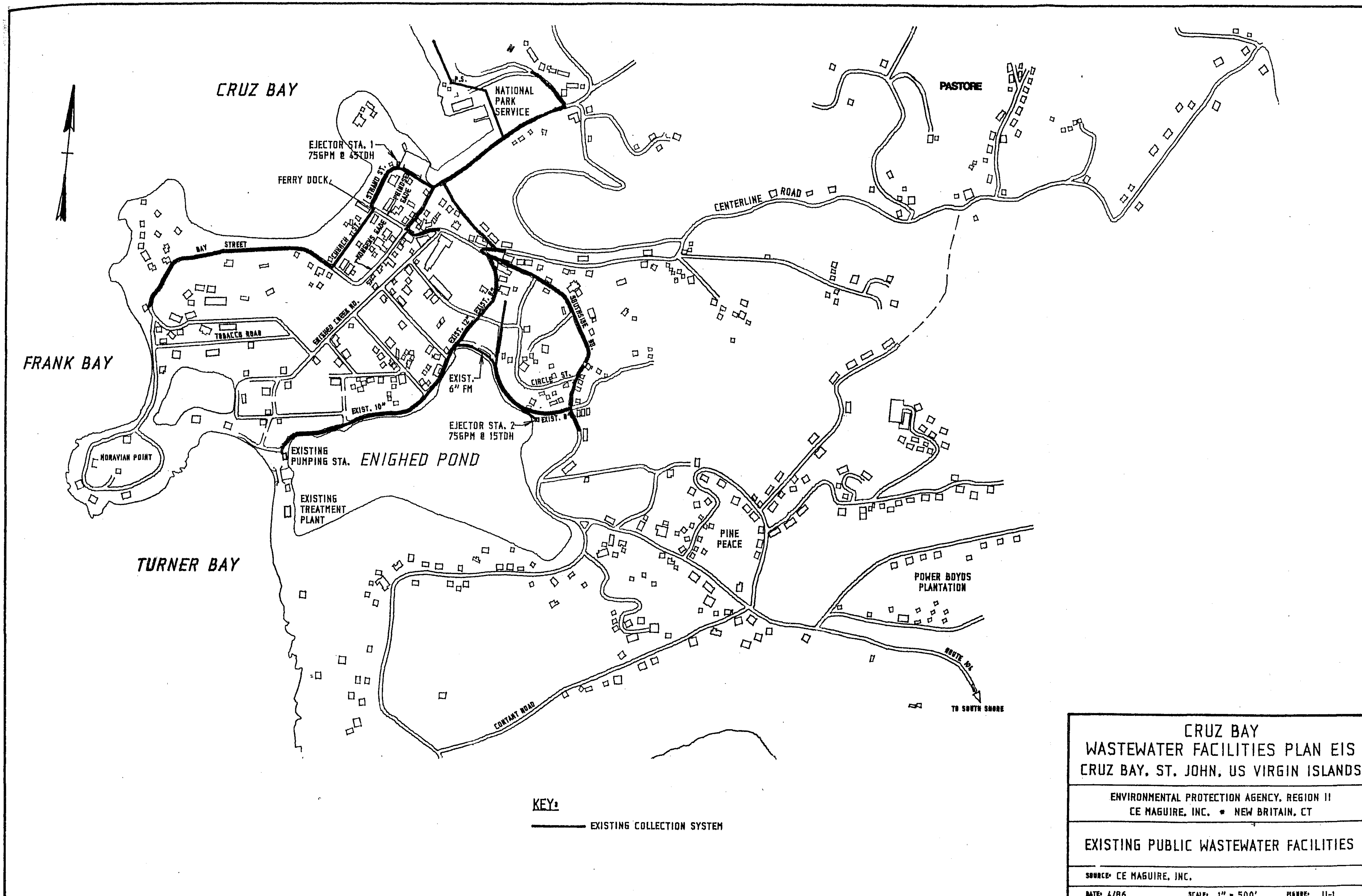
No improvements to existing services would be instituted under the no action alternative.

The no action alternative would involve making no changes or expansions to the study area's existing wastewater treatment system. Most structures would continue to use on-site systems or direct discharge, as would all future structures.

The existing public wastewater facilities do not treat wastewater in an environmentally sound manner.

The layout of the existing public wastewater facilities is shown in Figure II-1. These facilities include an extended aeration treatment plant with a wastewater flow capacity of 76 cubic meters per day ($m^3pd$) (20,000 gallons per day (gpd)), and a collection system with over 1.6 kilometers (1 mile) of gravity sewers and force mains and three pump stations. Approximately 520 residents in the central Cruz Bay area are served by these facilities, creating average flows of 49 $m^3pd$ (13,000 gpd). The system does not treat wastewater in an environmentally sound manner. Appendix C.3 presents more detailed information on the existing public wastewater facilities.

Approximately 1,500 residents of the study area not currently served by the existing public wastewater facilities continue to use on-site systems or direct discharge to a waterbody for disposal of wastewater. Direct discharge to


CRUZ BAY
P.S.
NATIONAL PARK SERVICE
PASTORE
EJECTOR STA. 1
75GPM @ 45TDH
FERRY DOCK
STRAND ST.
PRINCE GADE
CHURCH ST.
KONGENS GADE
BAY STREET
CENTERLINE ROAD
FRANK BAY
TOBACCO ROAD
SOUTHSIDE RD.
CIRCLE ST.
EXIST. 12"
EXIST. 6" FM
EXIST. 10"
EXIST. 8"
EJECTOR STA. 2
75GPM @ 15TDH
EXISTING PUMPING STA.
ENIGHED POND
MORAVIAN POINT
EXISTING TREATMENT PLANT
TURNER BAY
PINE PEACE
POWER BOYDS PLANTATION
CONTANT ROAD
ROUTE 104
TO SOUTH SHORE
KEY:
EXISTING COLLECTION SYSTEM
CRUZ BAY
WASTEWATER FACILITIES PLAN EIS
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS
ENVIRONMENTAL PROTECTION AGENCY, REGION II
CE MAGUIRE, INC. • NEW BRITAIN, CT
EXISTING PUBLIC WASTEWATER FACILITIES
SOURCE: CE MAGUIRE, INC.
DATE: 4/86
SCALE: 1" = 500'
FIGURE: II-1

Most on-site treatment systems do not treat wastewater effectively.

the sea or land is clearly not an environmentally acceptable means of wastewater disposal. On-site systems can be an acceptable means of wastewater disposal in some parts of the study area, but are not in others. The discussion presented in Appendix C.4 describes acceptable on-site disposal systems in detail.

Some onsite systems in the study area fail to function properly, posing threats to public health and environmental quality.

For example, on-site systems appear to function effectively in outlying areas, as shown in Figure ES-1, (such as Gift Hill, Fish Bay and Monte) where lot sizes are relatively large, slopes are relatively gradual, and the soils are relatively deep and permeable. However, they generally do not function well in the densely developed and relatively steep portions of the study area, as shown in Figure ES-1, (such as Enighed, Cruz Bay, Contant, and Power Boyd's Plantation). Some on-site systems in the study area fail to function properly, some are odorous, and many overflow during periods of rainfall. These failures and overflows pose threats to public health and environmental quality.

The no action alternative would involve no capital costs, but would cause a continued threat to the environment.

The only advantage of the no action alternative is that it would involve no capital cost, because no new facilities would be constructed. The primary disadvantage is that no action would involve continued and increased environmental degradation and public health hazards caused by wastewater treatment and/or disposal problems. Therefore, the no-action alternative is clearly an unacceptable course of action.

2. Rehabilitation of Existing Facilities

The rehabilitation alternative would involve improving the performance of Cruz Bay's existing wastewater treatment plant. This plant currently does not provide an adequate level of treatment for the estimated 49 $m^3$pd (13,000 gpd) of wastewater flow it receives. The plant's primary deficiencies include:

The rehabilitation alternative would involve the improvement and expansion of existing public wastewater facilities.

- malfunctioning pumps
- inadequate aeration of basins
- the absence of automatic chlorination (disinfection) equipment
- malfunctioning bar screen units

- inadequate sludge handling facilities
- improper discharge of wastewater effluent
- poor facility maintenance
- inability to handle shock loadings caused by septic system pump-outs being introduced intermittently.

The rehabilitation of the treatment plant would require the correction of these and other deficiencies (such as the lack of an outfall system). This would allow the plant to treat and dispose of the existing wastewater flows to the plant in an environmentally sound manner.

Rehabilitation of existing facilities is not a feasible alternative.

However, given its 76$m^3$ pd (20,000 gpd) capacity and the estimated 380 $m^3$ pd (100,000 gpd) existing flow from the core study area, this treatment plant could not adequately meet the study area's wastewater treatment needs. In addition, expansion of the existing plant would be extremely difficult due to the physical structure of the plant, as well as the constraints of the plant's site. Disadvantages of this site are its location in the 100 year flood zone, possible impacts from major storms and their resultant wave action, and a potential conflict with the V.I. Port Authority plan to develop a commercial port in Fnighed Pond which would necessitate the removal of any access to the site (McComb Engineering, 1985). Consequently, rehabilitation and improvement of existing facilities would not be a feasible wastewater management program alternative for the study core area.

3. Individual (On-site) Management Program

The individual management program would involve the expansion of existing on-site systems.

The individual management program would involve the repair, rehabilitation and expansion of existing individual ("on-site") systems. In addition, future homes and businesses in the study area would be required to construct and use their own on-site systems.

Most of the residents in the study area use on-site systems (particularly septic tanks) to treat wastewater. As discussed under the no action alternative, on-site systems function effectively in some portions of the study area, but very poorly in other portions. Wastewater discharged from homes or businesses using an on-site system is treated on the property of the discharging source rather than piped to a centralized facility for treatment.

Three types of on-site systems considered feasible for use in the study area are:

**Three types of on-site systems are feasible for use in the study area.**

- conventional septic systems
- septic tank/mound systems
- septic tank/evapotranspiration beds

Appendix C.4 includes a detailed description of these on-site technologies in terms of how they function and under what conditions they function most effectively.

**Each of these on-site systems include use of septic tanks for primary treatment.**

Each of these technologies includes a septic tank as a means of primary treatment. The purpose of the septic tank is to collect and trap solids. These solids would then be periodically removed (typically once every 3-5 years) and disposed of at a septage lagoon or suitable wastewater treatment facility. Septic tanks used in these systems should have at least a 1900 liters (500 gallons) capacity to be effective.

**The individual management program would involve low capital costs but would not be feasible in many areas.**

The primary advantage of the individual management program is that capital cost would be relatively low (relative to other programs) as no large-scale, centralized wastewater facilities would be required. The primary disadvantage is that use of on-site systems in many parts of the study area is not feasible due to the density of development and topography. Therefore, reliance upon the use of on-site systems alone would cause increased environmental degradation and health threats due to insufficient treatment and disposal of wastewater effluent.

4. <u>Subregional Wastewater Management Program</u>

**The subregional management program addresses the study area's wastewater needs in terms of development clusters.**

The subregional management program addresses the study area's wastewater needs in terms of areas of dense development (or "subregions") rather than on an individual or regional basis. Typically, this would involve constructing wastewater systems for the densely developed areas and maintaining on-site treatment for outlying homes which are not located in any densely developed area. Subregional programs are most suitable for areas with distinct clusters of development and sufficient amounts of land to site a wastewater treatment facility near each cluster.

Two subregional management program schemes have been considered for the study area:

- using one community system for the core study area and another for the extended study area

- using a community system for the core study area and on-site systems for the extended study area

The first of these subregional schemes would require the use of two treatment plants with accompanying collection and effluent disposal systems. One treatment plant would serve all structures in the core study area, shown in Figure ES-1. The existing treatment plant near Turner Bay could possibly be used for this purpose, if rehabilitated and expanded. A new treatment plant would be required to serve the extended study area, including the areas of Fish Bay, Gift Hill, Monte, and Roman Hill, as shown in Figure ES-1.

The second of the subregional schemes would require the use of a single treatment plant to serve the core study area, as in the first scheme. However, structures in the extended study area would be served by individual on-site systems rather than by a centralized treatment plant.

The core study area is densely developed whereas the outer study area is sparsely developed.

The core study area, namely Cruz Bay, Enighed, Pastory and a portion of Contant and Bethany, is characterized by dense development and may be considered one large cluster of development. The extended study area is characterized by very sparse, scattered development except in small clusters such as Fish Bay, Gift Hill, Bovocoap Point, and Roman Hill. The needs survey conducted for this project (Appendix A) indicated that on-site systems generally function well in the extended study area due to the larger lot sizes, and some residents in this area expressed opposition to the possibility of

On-site systems generally function well in the outer study area.

The second subregional scheme is more appropriate than the first scheme.

constructing public sewers. In addition, it would not be cost-effective or environmentally sound to use a community system in the extended study area due to the expense of constructing the extensive sewer lines that would be required to serve the widely scattered residences. Also, construction of a wastewater collection system in the rural areas of St. John would be likely to have the secondary impact of inducing scattered development in environmentally sensitive areas. For these reasons, the second subregional scheme (using a community system for the core study area and continued reliance upon on-site systems for the extended study area) is more appropriate than the first scheme.

A primary advantage of the subregional wastewater management program is that it provides the environmental benefits of using centralized treatment where on-site treatment may not be appropriate. In addition, it avoids the potentially high cost of connecting discrete clusters of development to one centralized collection system and the cost of constructing a centralized treatment plant with capacity for the entire study area. Another advantage of this scheme is that it would allow different methods of wastewater treatment to be used for areas with different needs. Specifically, it would allow centralized treatment in the densely developed core study area and on-site treatment in the sparsely developed extended study area.

A primary disadvantage of both subregional schemes is that each would involve a greater capital cost than the no action or individual programs. This is especially true for the first subregional scheme, which would require construction of two wastewater treatment plants and an extensive collection system.

5. Regional Wastewater Management Program

A regional management program serves the needs of the entire study area with a single centralized wastewater treatment system.

A regional management program addresses a study area's wastewater needs by serving the needs of the entire study area with a single, centralized, "regional" wastewater treatment system. This system would include one centralized treatment plant and one collection system which would extend throughout the core study area and the extended study area.

The primary advantage of this type of program is that wastewater treatment at a single centralized plant would take advantage of economies of scale, and discharge of effluent would be limited to a single, controllable discharge point. The primary disadvantages are that this program would involve a relatively high capital cost (much higher than all other programs) and require the extension of sewers into areas where these sewers are likely to be neither necessary, cost-effective, environmentally sound, nor publicly acceptable.

6. Primary Treatment Program

A subalternative program involving primary wastewater treatment has been considered.

This subalternative would involve the use of centralized wastewater facilities, but would use only a primary level of treatment under either the subregional or regional program. Both the subregional and regional wastewater management programs assume a secondary level of treatment (additional treatment measures beyond those involved in primary treatment), as presented in the preceding discussions.

A primary level of treatment could be substituted for the secondary level, if allowed by the Clean Water Act.

Primary treatment generally consists of grit removal, primary (initial) settling, and disinfection of wastewater prior to disposal. Secondary treatment includes primary treatment measures as well as additional treatment measures (e.g., aeration, biological digestion, settling) prior to wastewater effluent disposal. Secondary treatment removes additional impurities that are not removable from wastewater by only primary treatment.

This subalternative would involve a lower capital cost than other alternatives considered.

If allowed by the Clean Water Act, and if specific environmental criteria were able to be met, a primary level of wastewater treatment could potentially be used instead of secondary treatment for either the subregional or regional program. Construction and operation of new facilities to provide only primary treatment would be less expensive than those for providing secondary treatment. However, the Clean Water Act requires that all wastewater effluent discharged from publicly owned treatment facilities must be treated to at least secondary levels except for facilities which have applied for a "marine discharge waiver" of secondary treatment requirements, and which have been granted such a waiver by EPA in accordance with Section 301(h) of the Act. There is insufficient information on which to determine whether such a waiver would be approvable, and in any case, the statutory deadline for applying for this "marine discharge or 301(h) waiver" expired on December 29, 1982. This deadline can only be changed by an amendment to the Clean Water Act.

Ocean disposal of effluent after primary treatment would require key performance factors.

The principal advantage of the primary treatment alternative is that it would involve lower capital costs (see Table C.5-9 of Appendix C) than either the subregional or regional alternatives (using secondary treatment). This alternative may be environmentally acceptable if the characteristics of the discharge, as well as oceanographic conditions in the area of the outfall area are such that the effluent could be discharged without creating adverse environmental impacts. A determination concerning the feasibility of granting such a marine discharge waiver, if the Clean Water Act currently allowed an application to be submitted, is outside the scope of this impact statement. However, to aid public understanding, the key performance factors which would need to be demonstrated by an applicant for such a waiver are addressed in the following paragraphs.

> To assess the effects to an aquatic environment of a discharge of less than secondary treated effluent, biological, water quality and physical assessments would need to be conducted. It must be demonstrated that the discharge will not have an impact on the protection and propagation of marine life immediately beyond the zone of initial dilution (ZID). Distinctive habitats of limited distribution, (e.g., coral reefs and seagrass beds) must not be adversely impacted.

Killing of corals can result in negative impacts on fauna as well.

> Coral reefs, coral outcroppings, and epifauna (i.e., soft-coral, sponge) communities are complex, highly productive communities of plankton, algae, corals and other invertebrates, as well as reef habitat dependent finfish. Although corals occupy only a portion of the reef, or coral outcropping community, a selective killing of corals can result in the migration or death of much of the other fauna (Chester, 1969). Therefore, should stress associated with the discharge of

sewage exceed the tolerance of the coral portion of the community, the entire community can be adversely affected (Johannes, 1975). Besides being sensitive to stress, coral reefs, and to a lesser extent individual coral organisms and patch reefs, have a very slow recovery rate. Up to a decade is needed for a reef to recover from even a small, localized disturbance. Because of the slow growth rate of Caribbean coral reefs (117 to 833 years to accrete 1m), full recovery from severe damage to a well developed reef may require centuries. Depression of algal grazers (e.g., certain fish, sea urchins) can inhibit reef recovery by allowing benthic algae to monopolize the hard substrates, thereby effectively displacing other organisms which may colonize these habitats, or occupy dependent niches. More extreme habitat modifications may totally preclude complete recovery. Furthermore, because of the extremely slow recovery rates, a rare event (e.g., unusual hydrographic conditions, plant failure) can have long lasting effects on corals, especially older, well developed reefs.

Even small localized disturbances can have lasting effects.

It must be demonstrated that the discharge will comply with all applicable water quality standards. These include, but are not limited to BOD, DO, suspended solids, turbidity, pH, fecal coliform and the mixing zone standards. Effluent and ambient concentrations of DO, suspended solids, fecal coliform, other applicable substances, and pH levels must be known to assess the potential for violations of the water quality standards. A great degree of initial dilution serves to prevent elevated concentrations of pollutants from severely impacting receiving waters and, therefore, is conducive to the attainment of water quality which assures protection of marine organisms. Since the outfall/-diffuser location and design (i.e., port spacing, port diameter and configuration, velocity and angle of discharge, depth of discharge) significantly affects the degree of initial dilution which an outfall can achieve, these variables must be known before an evaluation of the facility's compliance with water quality standards can be made.

The wastewater discharge must comply with all applicable water quality standards.

It must also be demonstrated that concentrations of toxic substances will not cause any adverse impacts beyond the ZID. Toxic pollutants and pesticides can exert a multitude of adverse lethal and sublethal effects on marine organisms. Any pollutants and pesticides being discharged from the treatment plant must therefore be identified and quantified. Wet and dry weather analyses of treatment plant effluent must be conducted to ascertain any concentrations of toxic constituents present. If toxics are found in the effluent, the sources should be identified and if applicable, an industrial pretreatment program must be developed and implemented.

Proposed discharge must comply with VI law.

The proposed discharge must also comply with all applicable provisions of State Law. The Virgin Islands Department of Health regulation Title 19, Section 1404-322, requires a minimum of 85 percent suspended solids removal and a minimum of 95 percent BOD removal. This might preclude the Cruz Bay Wastewater Treatment Plant from being eligible for a 301(h) waiver from secondary treatment (assuming that such a waiver would be allowable under the Clean Water Act).

There must be no significant adverse impact on recreational activities.

It must be demonstrated that the proposed discharge will not have an adverse impact on recreational activities, or public water supplies, and will not result in any additional treatment requirements for other point and nonpoint sources.

To evaluate the above, more extensive monitoring and sampling than was performed for this impact statement would need to be conducted both at reference stations, and at various stations near and at the discharge site. Qualitative and quantitative sampling of marine life, including but not limited to phytoplankton, benthos, epibenthos, finfish, and especially distinctive habitats, is necessary to determine areas of potential impact. If the data demonstrates that the receiving waters or marine communities are already stressed, then a stressed water demonstration must be conducted to determine wheter the discharge will further contribute to, increase, or perpetuate stressed conditions, contribute to further degradation if pollution from other sources increases, and/or retard recovery if pollution from other sources decreases.

Sewage particles can have a negative impact on coral.

The transport and dispersion of diluted wastewater and particulates must be such that water use areas, as well as any areas of biological sensitivity are not adversely affected. Various data including the solid mass emission rate, average facility flow, oceanographic current speeds, current directions, and stratification patterns must be known to determine areas of potential impact, as well as level of potential impact, from effluent transport and dispersion. Coral distribution is limited by light penetration, therefore, an increase in suspended solids concentration in the vicinity of the coral can have negative impacts. The deposition of sewage particles can physically impact upon the corals, smothering them, reducing growth, or inducing diseases. Therefore, the area of potential impact, concentration of suspended solids and solids deposition rate, must be determined to assess any potential impact of the discharge.

Primary treatment is not considered an implementable alternative.

Because insufficient information is available to determine whether primary treatment would meet the marine discharge [301(h)] waiver criteria, and because the statutory deadline for applying for such a waiver is long passed, primary treatment is not considered to be an implementable alternative, and is therefore rejected from further consideration.

## B. WASTEWATER TREATMENT PROCESS ALTERNATIVES

There are five feasible wastewater treatment processes.

Wastewater treatment processes are methods of removing solids and other pollutants from wastewater before it is disposed of as effluent. The processes typically involve the use of a wastewater treatment plant to remove solids and to biologically and/or chemically breakdown other impurities. Of the many wastewater treatment processes available, the five processes listed below have been considered as potentially feasible alternatives for this project.

- Oxidation Ditch
- Intermittent Sand Filter
- Aerated Lagoons
- Rotating Biological Contactors
- Trickling Filters

Each of these processes is described and discussed in terms of advantages, disadvantages, and estimated costs in the following subsections. More detailed cost information for each treatment process alternative is presented in Appendix C.5.

1. Oxidation Ditch Process

**The Oxidation ditch treatment process uses a modified form of extended aeration.**

The oxidation ditch technology uses a modified form of extended aeration to treat wastes. In this system, the wastewater is introduced into aeration channels which are laid out in a shape similar to a race track. Aeration is generally provided by surface aerators which keep the wastewater moving around the channel at a velocity high enough to prevent solids in the wastewater from settling to the bottom.

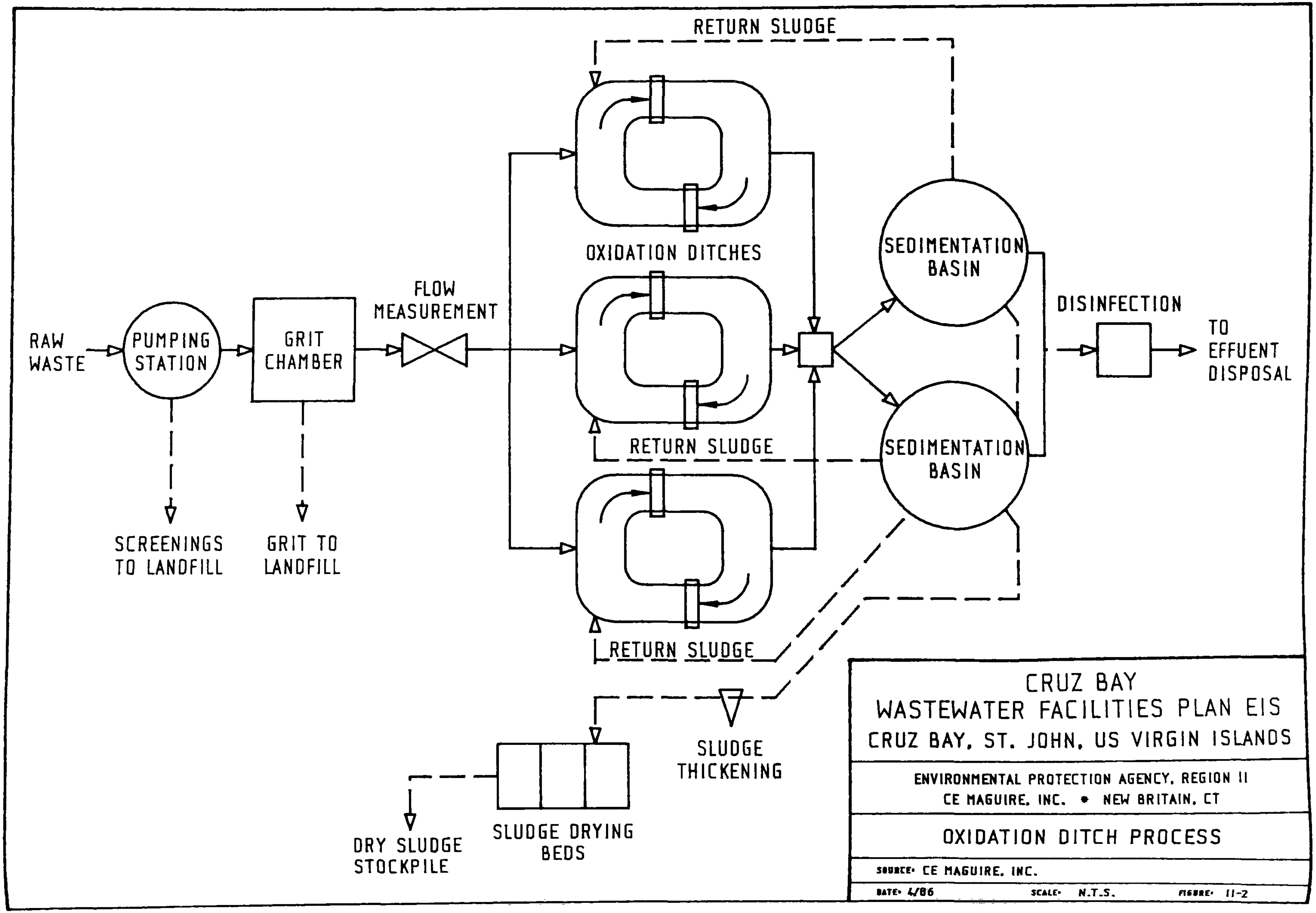
The energy use for this process is moderately high. However, the long detention time results in a low volume of sludge. Furthermore, the sludge is considered stabilized and can be disposed of without undergoing any additional treatment.

This process produces relatively small amounts of sludge.

As shown on the flow schematic in Figure II-2, raw wastewater would be pumped into the aeration channels for treatment following screening and grit removal. Sludge accumulated in the final clarifier would be thickened and subsequently applied to sand drying beds, while screenings and grit would be deposited directly in the sludge disposal site. The clarifier overflow would be disinfected and discharged directly into the effluent disposal system.

**Advantages include ease of construction, relatively low maintenance and process control, and flexibility in sludge handling.**

As with the other alternatives, there are advantages and disadvantages associated with this option. The ease of construction of the treatment facility, and the relatively low maintenance and process control needed, when compared with other systems, make this process attractive. In addition, the ability to store sludge without wasting (removing sludge from the treatment process for disposal) for a long period of time (90 days) allows a great deal of flexibility in handling sludge. This plant requires approximately .6 ha (1.5 ac) of land and 1.4 ha (3.5 ac) for a buffer area.

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OXIDATION DITCH PROCESS

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: N.T.S. FIGURE: II-2

The estimated capital cost for this treatment plant alternative is $3,933,600. Annual operation and maintenance costs for this alternative are estimated to be $97,000.

2. Recirculating Sand Filter Process

**The recirculating sand filter treatment process removes solids from wastewater by filtering it through sand beds.**

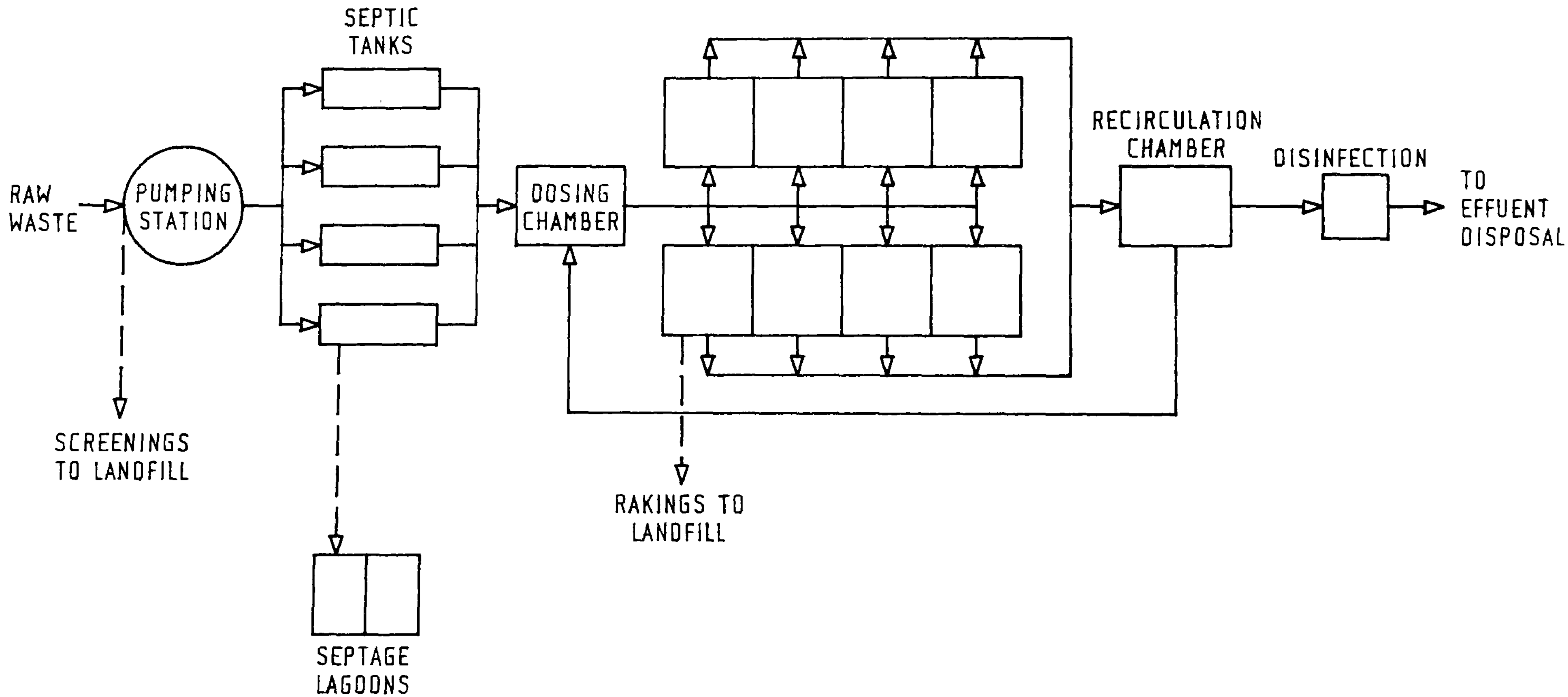
The recirculating sand filter treatment process is a multistage process derived from the intermittent sand filter technology. Wastewater is applied evenly to specially prepared sand filter beds after primary solids removal by septic tanks or lagoons. Wastewater is treated as it percolates through the filtering sand media. Effluent from this phase of treatment is collected by drains in the base of the bed and conveyed to a recirculation chamber where a portion of it is recycled back through the sand filter beds, thereby injecting fresh wastewater into the flow stream and minimizing odor sources. The remaining portion of the sand filtered effluent is piped to a disinfection unit and is then piped into the disposal system. The process is illustrated in Figure II-3.

**This alternative is relatively inexpensive, reliable, requires little operation and maintenance effort, and produces a better than secondary level quality of effluent.**

The primary advantage of this alternative is that it is relatively inexpensive and simple to operate in relation to other alternative technologies considered. In addition, the technology can consistently produce a better than secondary level quality of effluent. It is a very reliable technology and requires relatively little operation and maintenance effort.

The primary disadvantage of this alternative is the amount of land area required. Based on estimated average wastewater flows from the study area, a 1.7 hectare (4.3 acre) site would be required for a recirculating sand filter plant to treat this capacity effectively and an additional 2 ha (5 ac) for the buffer area.

The estimated capital cost for this treatment plant alternative is $2,528,000. Annual operation and maintenance costs are estimated to be $47,000.

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RECIRCULATING SAND FILTER PROCESS

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: N.T.S. FIGURE: II-3

3. Aerated Lagoon Process

Aerated lagoons treat wastewater biologically by utilizing a mechanical or diffused air system.

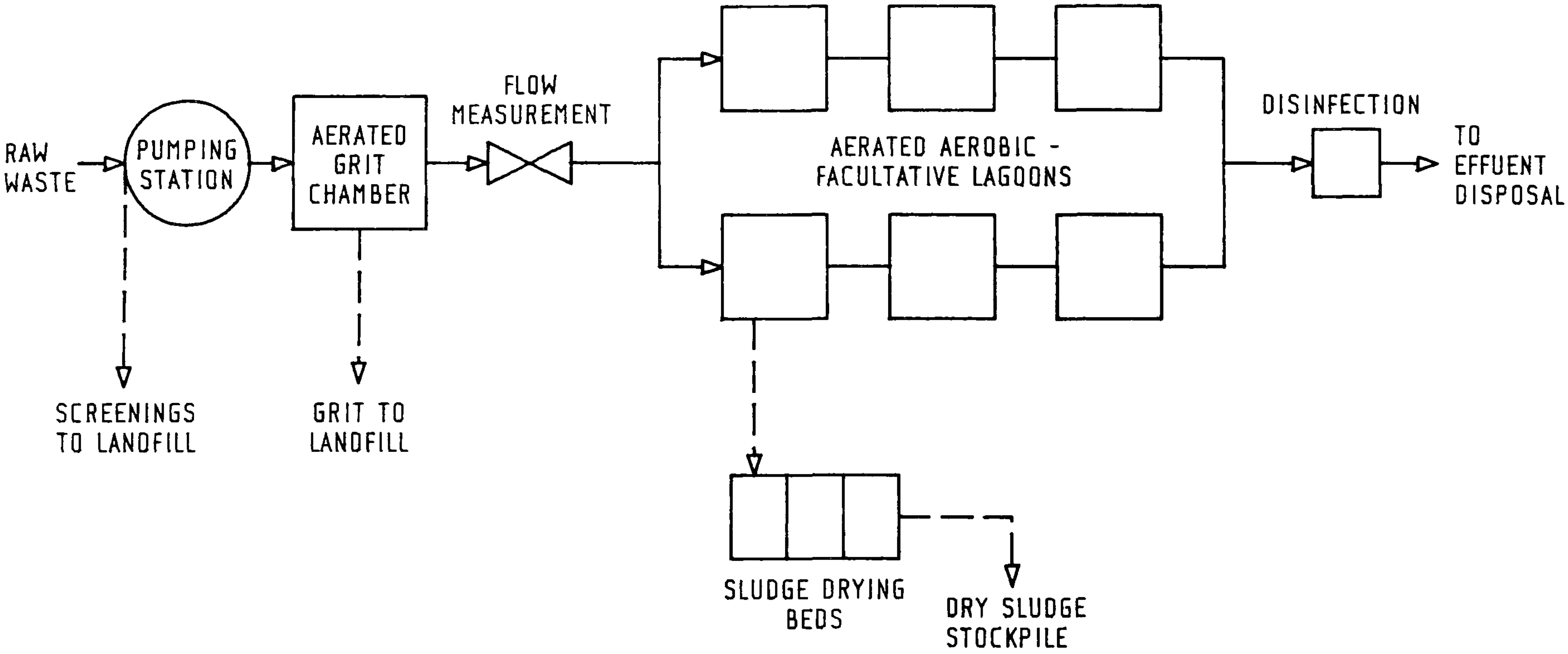
Aerated lagoons are earthen basins designed for the biological treatment of wastewater. The aeration is provided by mechanical or diffused air systems. A diffused air system consists of plastic pipes supported near the bottom of each lagoon. The pipes have holes in the top through which compressed air is pumped. In the facultative lagoons, such as the type proposed in this alternative, both aerobic and anaerobic metabolism occur. A large fraction of the influent sewage ("solids") and the biomass produced settle to the bottom of the lagoon where anaerobic decomposition takes place. To minimize infiltration of untreated wastewater into the ground, lagoons are lined with an impervious flexible lining. The treated effluent would be disinfected and discharged to a disposal site. This process is illustrated in Figure II-4.

This treatment process requires little or no operator expertise for operation and maintenance. Only periodic cleaning of the diffusers is needed to maintain satisfactory operation. Furthermore, sludge disposal requirements are minimal. The sludge can be removed by means of a "mud cat" dredge (a small dredge that floats on the surface of the lagoon while removing sludge) operation which means the lagoon need not necessarily be taken out of service for dredging during sludge handling operations.

This treatment method requires little or no operator expertise for operation and maintenance.

Another advantage of the lagoon system is that it provides for flow equalization. The treatment plant and outfall can be sized for average flow rather than the peak flow sizing that must be utilized for other alternatives. Finally, energy requirements are relatively low compared to other processes considered because of the surface reaeration and photosynthetic activities that take place, and control systems are relatively simple. Therefore, the cost for the electrical/instrumentation and control building are significantly less than for other alternatives.

The major disadvantage of the lagoon system is that it requires a 2.2 ha (5.5 ac) site. Also, this system would require an additional 2.4 ha (6.ac) for buffer area. Other potential problems include the breeding of mosquitos and

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AERATED LAGOON PROCESS

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: N.T.S. FIGURE: II-4

other disease vectors due to the exposed surface of the lagoon. Odor nuisance can also occur. Lagoons also require continual maintenance to prevent the growth of weeds on their banks.

The estimated capital cost of this treatment plant alternative is $2,097,000. Annual operation and maintenance costs are estimated to be $42,000.

4. Rotating Biological Contactor Process

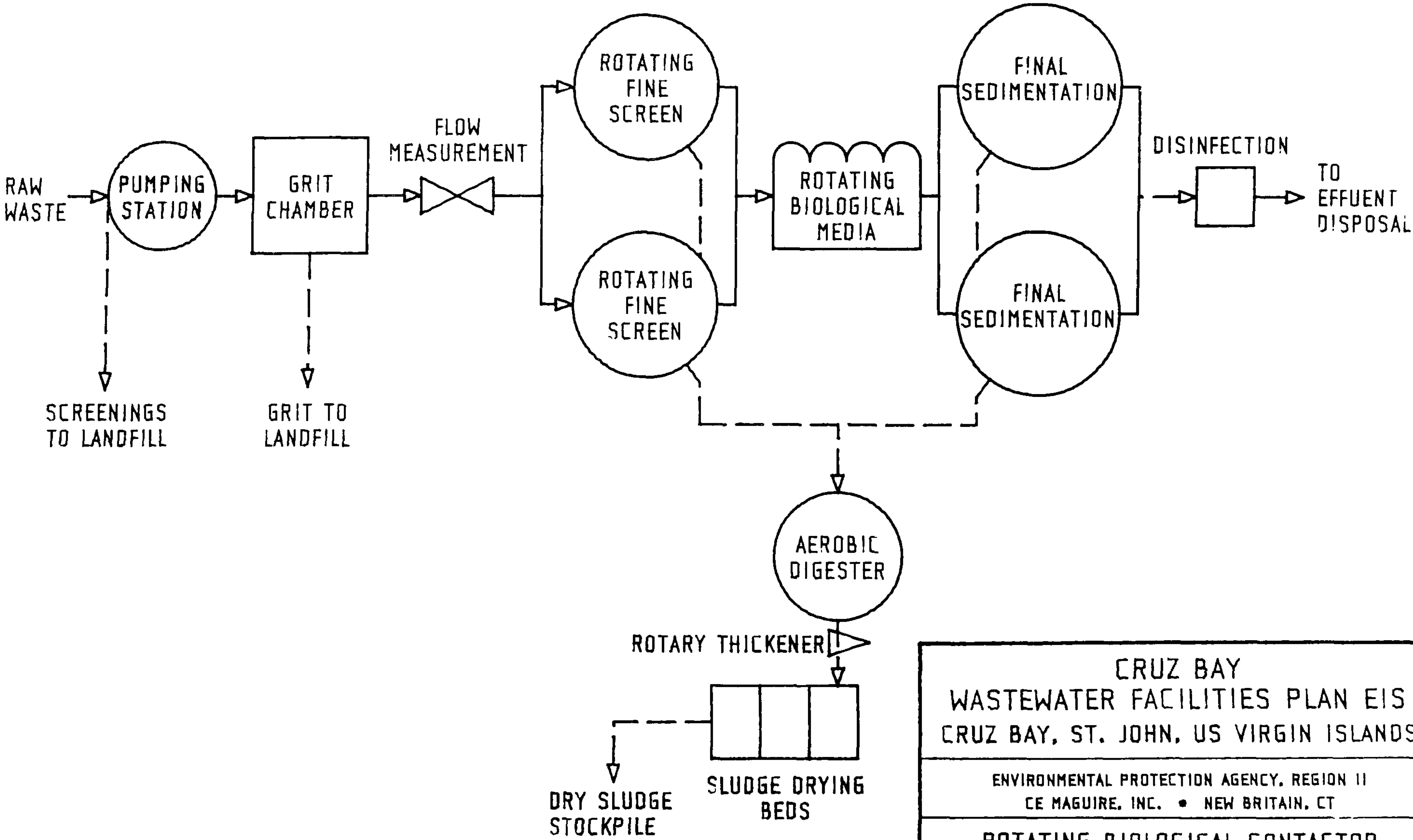
R.B.C.'s have relatively high initial capital costs.

Rotating biological contactors (RBC's) are a relatively new addition to secondary wastewater treatment technology. This process utilizes a series of 3.7 m (12 ft) diameter discs mounted on 7.6 m (25 ft) long horizontal shafts rotating slowly in a tank filled with wastewater. The disc becomes the media onto which microorganisms grow and treat the wastewater. RBC's are similar in theory to trickling filters (discussed later), except that with the latter, wastewater is passed over a fixed filter media (rock or plastic). RBC's can provide a high level of treatment with a minimum of process control.

RBC's offer a high level of treatment with a minimum of process control.

The process flow diagram shown in Figure II-5 indicates that the process involves screening and degritting followed by fine screens. This is different from all the other treatment alternatives in that the fine screens are an additional preliminary treatment process to prevent the RBC disc media from becoming clogged with heavy solids. Clogging would tend to reduce the treatment efficiency significantly, and could even break the horizontal rotating shaft due to the increased weight. The sludge resulting from this process must also be digested to reduce the number of pathogens present.

As the equipment for RBC's and associated tankage are quite expensive, the RBC's have a relatively high initial capital cost. However, their ease of operation and resistance to high strength loads (shock loads) are a few of the reasons why this process is often selected for use. The estimated capital cost for this treatment plant alternative is $3,548,100. Annual operation and maintenance costs for this alternative are estimated to be $110,000. The

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ROTATING BIOLOGICAL CONTACTOR PROCESS

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: N.T.S. FIGURE: II-5

RCB plant would require .5 ha (1.25 ac) of land, and 1.3 ha (3.25 ac) for a buffer zone.

5. Trickling Filter

**Trickling filter systems treat wastewater by filtering it through beds of rocks containing micro-organisms.**

The trickling filter system is a common method of wastewater treatment that has been in widespread use since 1936. The process involves the application of wastewater onto a bed of 2.5 to 12.5 cm (1-5 in) diameter rocks for filtration and aerobic biological treatment. Wastewater is distributed evenly over the bed of rocks by an overhead (usually revolving) distribution arm and filters (trickles) through the rock media. Microorganisms attached to the rocks breakdown the organic material in the wastewater as it trickles through the rock media. This process is illustrated in Figure II-6.

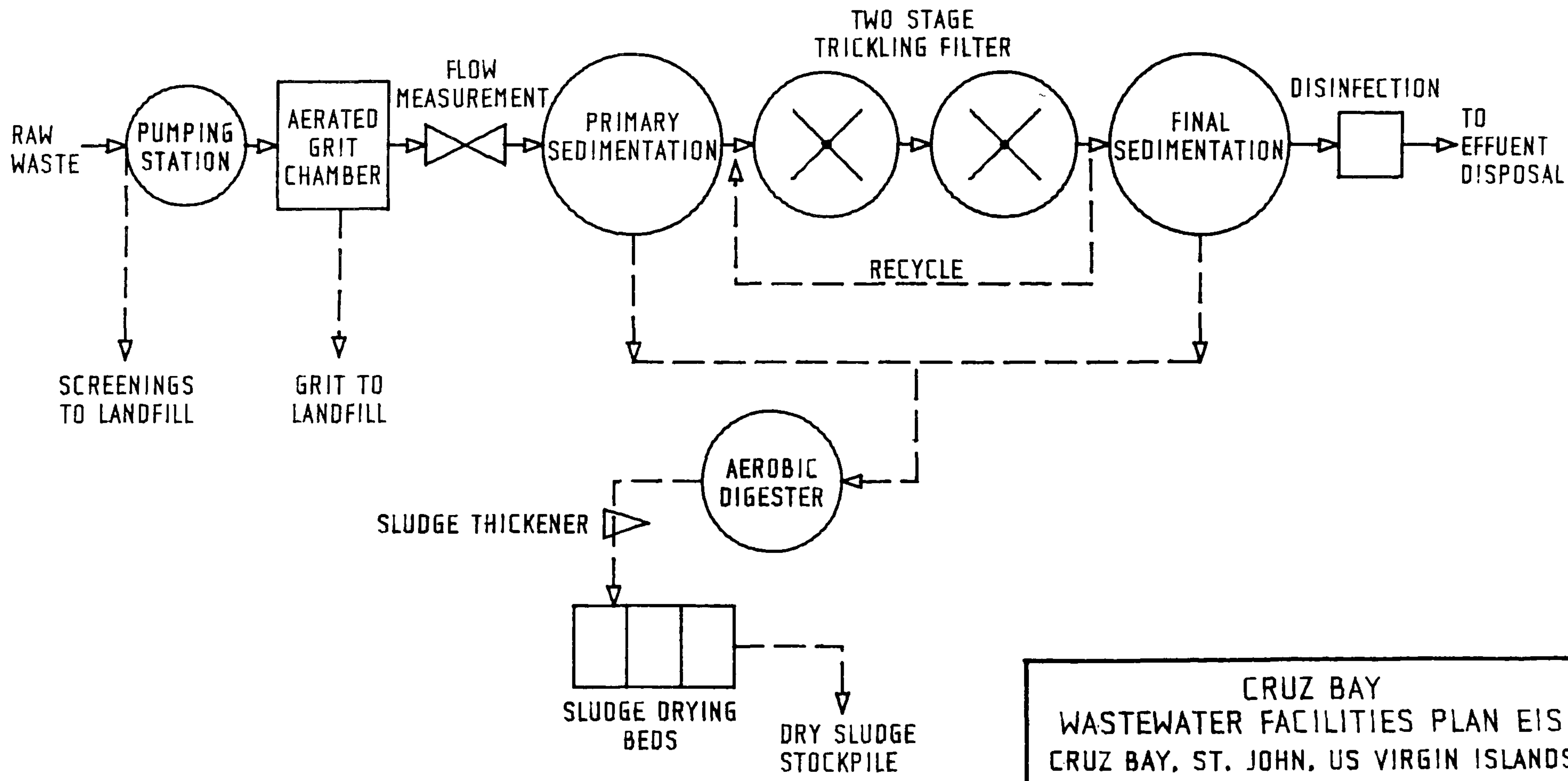
Trickling filters are relatively simple to operate and have a high degree of mechanical reliability. However, they do not produce as high a quality of effluent as other processes considered, such as the oxidation ditch or RBC process. In addition, this process generally requires long recovery time from plant upsets and has potential for disease vector and odor problems. This facility requires a site area of approximately .6 ha (1.5 ac) and an additional 1.2 ha (3 ac) for buffer area. The estimated capital cost for this treatment plant alternative is $6,083,900. The annual operation and maintenance cost for this alternative is estimated to be $108,000.

C. WASTEWATER COLLECTION SYSTEM TECHNOLOGIES AND ROUTINGS

**Wastewater collection systems must be constructed for both the regional and subregional programs.**

A wastewater collection system is a network of pipes (known as interceptors, laterals, and force mains) and pumps used to convey wastewater flows from individual sources to a centralized treatment facility. Both the subregional and regional wastewater management programs would require collection systems.

Two sets of alternatives must be considered for collection systems: (1) types or technologies of wastewater collection systems; and (2) routings for the collection system.




CRUZ BAY
WASTEWATER FACILITIES PLAN EIS
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS

ENVIRONMENTAL PROTECTION AGENCY, REGION II
CE MAGUIRE, INC. • NEW BRITAIN, CT

TRICKLING FILTER PROCESS

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: N.T.S. FIGURE: II-6

## 1. Technology Alternatives

The following four collection system technology alternatives have been considered for this project:

- conventional gravity sewers
- pressure sewers
- vacuum sewers
- small diameter gravity sewers

Each of these technologies is described and discussed in terms of its advantages, disadvantages, and estimated costs in the following subsections:

### a. Conventional Gravity Sewers

Gravity sewers which may be utilized in conjunction with lift and pumping stations are a traditional method of wastewater collection and conveyance.

The traditional method of wastewater collection and conveyance for community or municipal treatment has been the use of gravity sewers. This method relies upon gravity flow and, therefore, must follow natural drainage patterns. Because of the need to maintain downward slope, installation may require construction at substantial depths, which can result in high construction costs, especially when ground water and large amounts of rock are encountered. In conjunction with gravity sewer installation, lift stations or pumping stations are used to raise wastewater from lower to higher elevations.

This method requires little operation and maintenance and is not vulnerable to power failures.

A primary disadvantage of gravity sewers is that high excavation and pump station expenses may be involved.

Advantages of gravity sewers are that they require little operation and maintenance and are not vulnerable to power failures. Due to the fact that the study area is comprised of a single major drainage basin, flows could, in many cases, easily be collected by gravity sewers constructed along natural drainage ways. The principal disadvantage of this collection method is that excavation and pump station expenses may be involved, contributing to higher construction and capital costs if topography is not amenable to gravity flow. A typical cost for a 20 cm (8 in) gravity sewer is $240/m ($80/ft) installed.

### b. Pressure Sewers

Pressure sewer systems utilize grinder pumps. Small diameter pipes convey wastewater.

Pressure sewer systems utilize grinder pumps and small diameter pipe to convey wastewater. The grinder pump, located in a basement, underground sump, or other central collection point for one or a group of buildings, discharges a finely ground wastewater slurry into the pipe under pressure.

The major advantage of the pressure sewer is that the direction of flow is independent of ground slope and depth of installation is decreased. Consequently, it is generally less expensive and easier to install than gravity sewer pipe, given variable topography. It should also be noted that a pressure system is not subject to infiltration, unlike gravity sewers.

The principal disadvantages of this system are its vulnerability to power failures (which are not unusual on St. John) and mechanical breakdowns, its long detention times under low flow conditions creating odor nuisance, as well as its relatively high operation and maintenance cost.

The costs involved in the pressure sewer alternative are typically $4,000 to $6,000 for each grinder pump and $99/m ($25/ft) installed for the pressure sewer main.

### c. Vacuum Sewers

Vacuum sewer systems utilize negative pressure.

The vacuum sewer system utilizes negative pressure (vacuum) to transport wastewater. A valve separates the collection system (under a constant vacuum) from the house plumbing (atmospheric pressure). This valve is pneumatically operated and will open when a predetermined depth of wastewater is reached in the inlet pipe and a proper vacuum is reached in the main. When the valve opens, the wastewater is admitted to the system. The maximum individual obtainable total lift is approximately 4.5 m (15 ft). However, greater lifts are possible through the use of successive stages.

Vacuum sewers are used primarily for sewering low lying development.

As with pressure sewers, this system may have initial capital cost advantages over a gravity system; however, continuous maintenance requirements, replacement costs for mechanical devices, operating costs, and standby power requirements can nullify these initial capital cost advantages. Vacuum sewers are primarily of value for sewering lowlying development complexes.

The costs of a vacuum sewer system typically include the inlet valve at $300 each, the vacuum sewer main at $130/m ($40/ft) installed and the vacuum station at $50,000 each.

d. Small Diameter Gravity Sewers

Small diameter gravity sewers are similar to conventional gravity sewers. However, they may be used in much flatter terrain because most solids in the effluent are removed prior to conveyance.

This collection system technology is similar to conventional gravity sewers in that wastewater flows entirely by the force of gravity through the system. The main difference between these technologies is that the small diameter sewers require the use of on-site septic or settling tanks for the initial removal of solids before the effluent enters the collection system. As most of the solids are removed, the collection pipes may be smaller in diameter (generally no more than 10 cm (4 in)) and may be used in much flatter terrain than the conventional gravity sewers.

The primary advantage of this technology is that it is relatively free of mechanical components, yet it may be used in relatively flat or very gently sloping terrain. Primary disadvantages are that individual settling tanks would be required and that the solids or sludge would have to be periodically removed from each individual settling tank. Operating and maintenance costs would, therefore, be greater for this collection system technology alternative than for the other alternatives considered.

2. Routing Alternatives

*Alternative routings for an expanded wastewater collection system are limited.*

The findings of the needs analysis conducted for this project indicate that there are clusters of development in the study area which are not served by the existing wastewater treatment system, but are in need of this service. Alternative routings for expanding this system to meet these needs were considered. Given the routing of the existing collection system, the location of the clusters in need of service, and the preference to follow existing roadways or right-of-ways rather than cutting across undisturbed property, available routing alternatives are very limited.

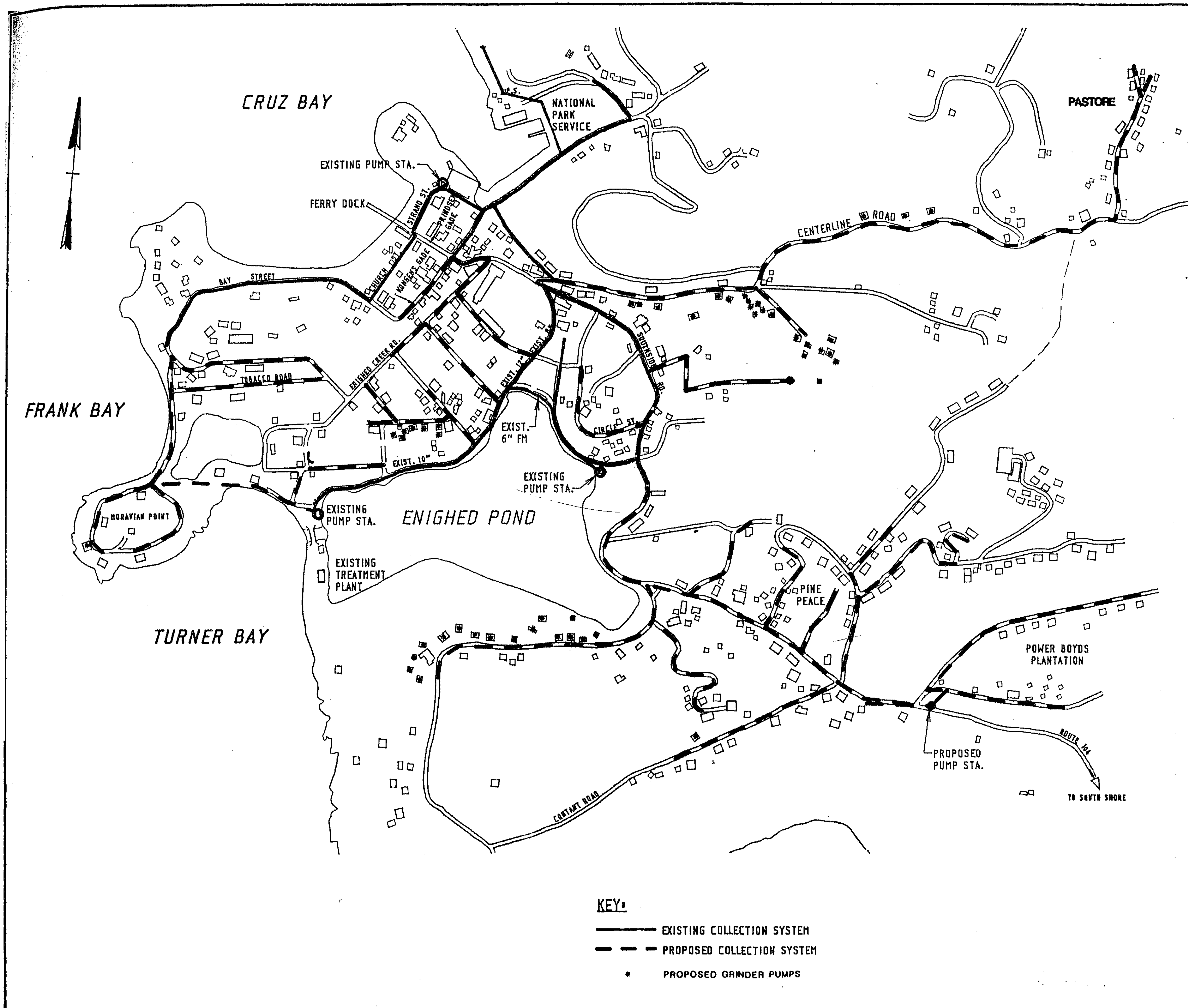
The routing which is considered to best meet these criteria is illustrated in Figure II-7. Proposed interceptors extend from the existing collection system east along Center Line Road; southeast through Enighed, Contant, and Pine Peace; and southwest to Moravian Point. Proposed collector sewers branching off from these interceptors would be routed through the streets of Enighed, Contant, Pine Peace, Power Boyd's Plantation, Bethany, and Pastory.

The proposed collection system will require one new pumping station to be located near Power Boyd's Plantation. This is necessary to convey the wastewater from this area over the ridge line. All existing pump stations will be upgraded where necessary.

*It may be costly to extend sewers to some portions of the study area,...*

*... but these areas are in need of sewer service.*

Alternatives to portions of this routing were considered, but would involve either not serving houses determined to be in need of service or laying sections of the collection system in undisturbed and private property. In particular, the alternatives of extending or not extending sewers into the Power Boyd's Plantation area and the cluster of development adjacent to the upper portion of Center Line Road (east of Cruz Bay Proper) were considered. The relative isolation of these clusters from the concentrated development in the core study area would make it relatively costly to extend sewers into the areas. However, based on the severity of the need for improved wastewater treatment in these areas, the cost of extending sewers to these areas appears warranted.




CRUZ BAY
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PROPOSED WASTEWATER COLECTION SYSTEM

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: 1" = 500' FIGURE: II-7

The configuration of the proposed collection system is preliminary, subject to comments on the Draft EIS and any changes necessary during the design of the system.

D. WASTEWATER EFFLUENT DISPOSAL TECHNOLOGY ALTERNATIVES

There are two feasible alternatives.

1.) Spray irrigation on land, and
2.) Ocean outfall

Wastewater effluent disposal technologies are methods of disposing of wastewater after it has been treated to remove pollutants. The following two technologies have been considered as potentially feasible alternatives for this project:

- spray irrigation on land
- ocean outfall

Other effluent disposal alternatives include aquifer recharge and domestic reuse. These were initially considered, but were eliminated from further consideration due to the extremely high costs which would be incurred in developing adequate, reliable treatment processes. Operation and maintenance costs would also be concurrently high.

1. Spray Irrigation

Spray irrigation disposes of wastewater effluent by spraying the effluent over a large tract of land.

Disposal of wastewater effluent by spray irrigation involves the application of effluent to a tract of land by means of sprinklers at a controlled rate. Effluent is absorbed into the soil and taken up by vegetation. This method is currently used by Caneel Bay Plantation Inc. on St. John in order to dispose of wastewater effluent from the hotel/ restaurant operation and to irrigate lawns.

General requirements for spray irrigation include:

1.) adequate soil to absorb effluent,
2.) relatively flat or gently sloping terrain, and
3.) isolation and protection from possible human contact.

It is estimated that approximately 9 ha (23 ac) would be required to adequately dispose of the projected 758 $m^3$pd (200,000 gpd) of wastewater effluent. The actual disposal site should be surrounded by a 30 m (100 ft) wide buffer area in order to avoid possible impacts to surrounding areas. The entire spray irrigation site, including the buffer area, would be approximately 13 ha (33 ac). While there are no specific Virgin Island regulations regarding spray irrigation systems, the following general requirements would need to be considered:

- adequate soil to absorb effluent
- relatively flat or gently sloping terrain and

isolation and protection from possible human contact

Based on these requirements and the physical characteristics of the study area, there are only two feasible spray irrigation sites.

The first of these sites is in a ravine behind the National Park Service maintenance garage, just north of Cruz Bay proper. This site is adjacent to the alternative treatment plant site #3 and would therefore be most appropriate for use in conjunction with wastewater treatment at site #3.

The other site is the Caneel Bay Resort, located approximately one mile north of the northern study area boundary. Caneel Bay currently uses its effluent to spray irrigate its lawns. The resort's groundskeepers have indicated that they would be interested in receiving up to 100% of the wastewater for this purpose. However, there may be some difficulties in implementing such a system in respect to any unforeseen legal/jurisdictional or contractual/financial issues between private and public entities.

Other sites for spray irrigation were investigated, but were considered not feasible due to land capacity constraints.

A primary advantage of spray irrigation is that it allows the reuse of water in a water scarce environment.

A primary advantage of the spray irrigation method of effluent disposal is that it would provide a secondary benefit of reusing water in an environment where water is an extremely limited resource. If properly managed, a spray irrigation site could be used to cultivate ornamental plants or fodder for livestock.

Another advantage to this type of treatment alternative is the lack of impacts on coastal and marine resources normally associated with an ocean outfall alternative. Furthermore, a spray irrigation system is generally less expensive to construct than an ocean outfall, because of the higher cost of underwater construction. Advantages of pumping wastewater to the Caneel Bay Resort are that it is an option available to all treatment facility types and that it is inexpensive to construct (approximately 1.5 million dollars).

Disadvantages include special procedures to maintain the quality of the effluent, higher operation and maintenance costs, and potential logistical problems.

A primary disadvantage of this alternative is that special procedures must be incorporated into the treatment process to assure that the effluent is consistently of sufficient quality (i.e., secondary treatment with disinfection and generally no greater than 200 parts per million of chloride) to permit the successful growth of the site's vegetation. Other disadvantages are the operation and maintenance costs would be higher than an ocean outfall, additional land would be required, and there is potential for oversaturation of soils with waste that could cause effluent runoff to downstream waterbodies. Another disadvantage is that both of the sites considered suitable for land application present legal, political, or logistical issues which could make implementation of this alternative complicated.

2. Ocean Outfall

The ocean outfall method involves the dispersion of effluent into offshore waters via an underwater pipe.

Disposal of effluent by means of an ocean outfall involves conveying effluent seaward through an underwater pipe and releasing it offshore in deep water. Effluent is released further through a diffuser at the end of the outfall into underwater currents which further disperse and dilute effluent. The length, route, and depth of the ocean outfall would be designed to avoid environmental impacts to coral reefs, other sensitive marine ecosystems, and coastal recreational and commercial activities. Ocean outfalls are currently used to dispose of effluent from Charlotte Amalie on the Island of St. Thomas, and from Christiansted on the Island of St. Croix.

Turner Bay is considered the most appropriate area for an ocean outfall.

Based on the location of alternative treatment plant sites, and an assessment of the areas ocean currents and coastal and marine resources, Turner Bay is considered the most appropriate site for an ocean outfall. Other areas along the coast of the study area were investigated, but were considered unsuitable because of conflicts with existing land uses and more valuable marine and coastal resources.

Several possible outfall alignments extending seaward from the sand spit separating Turner Bay and Enighed Pond have been considered. A preliminary alignment, based on the findings of the benthic and current study (Appendices D and E) conducted during the preparation of this draft EIS, is presented in Figure II-8. Preliminary findings indicate that an outfall greater than 1,000 m (3,200 ft.) offshore may be needed to avoid impacts to sensitive marine ecosystems and coastal resources.

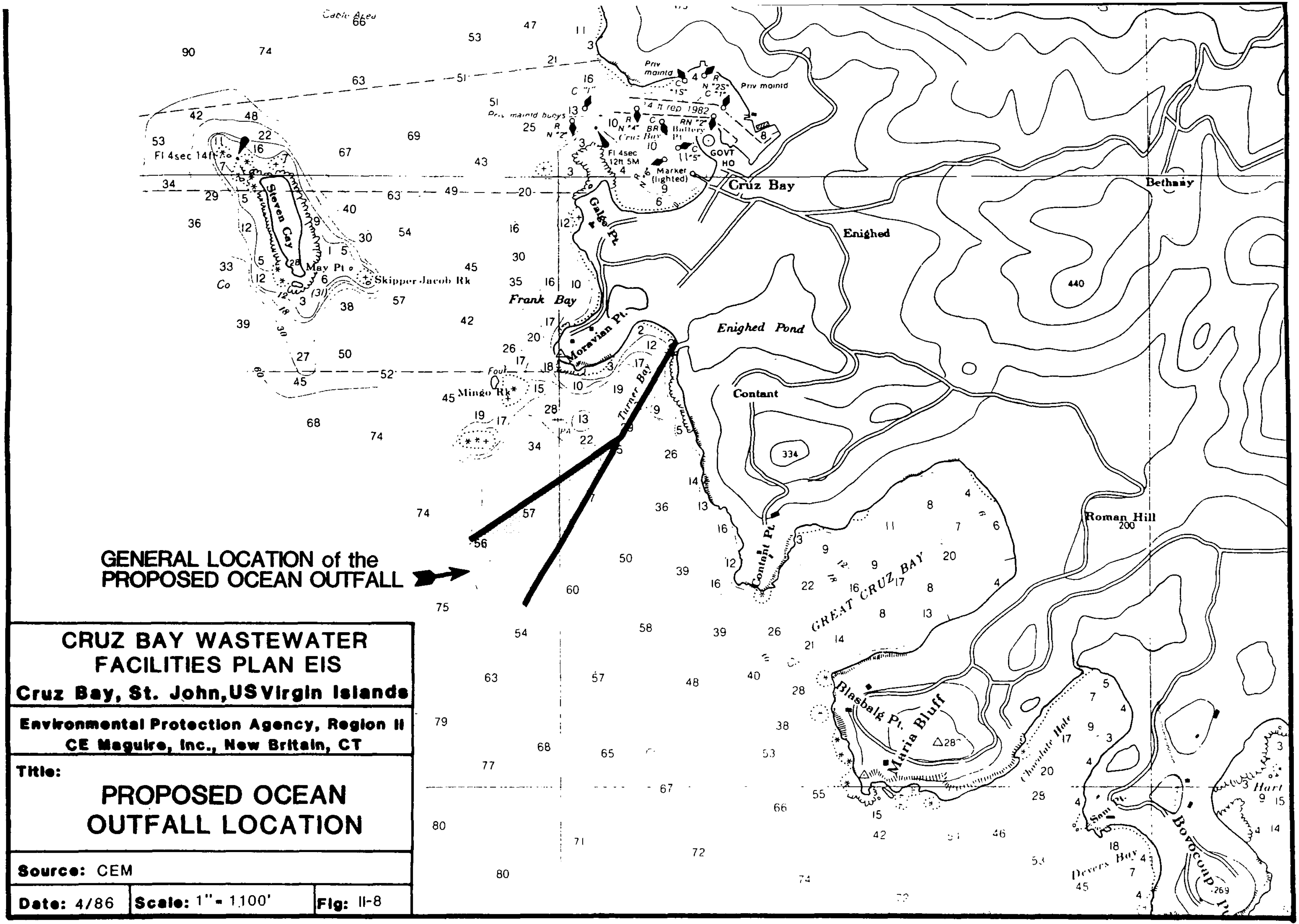
An ocean outfall system avoids all the problems associated with a spray irrigation system.

A primary advantage of the ocean outfall alternative is that it would avoid all the previously discussed problems associated with implementing a spray irrigation system. Other advantages are that operation and maintenance costs would be less than for the spray irrigation alternative, no additional land would be required for wastewater facilities, and no potential land-related impacts such as oversaturation of soils (causing effluent runoff to downstream waterbodies and perhaps erosion) would be involved.

An additional advantage is that an ocean outfall option can be utilized with any of the treatment plant and site locations.

It should be noted that spray irrigation of treated effluent would not be precluded from future implementation. The outfall could still be used during periods when effluent was either not needed or was unsuitable for spray irrigation.

A primary disadvantage of this alternative is that it would involve higher construction costs and more complicated construction techniques than the spray irrigation system. An important disadvantage of an ocean outfall is that there would be some short-term impacts during construction, and the possibility of long-term impacts to marine and coastal resources if not designed properly.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**

**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**

**CE Maguire, Inc., New Britain, CT**

**Title:**

**PROPOSED OCEAN OUTFALL LOCATION**

**Source:** CEM

| **Date:** 4/86 | **Scale:** 1" = 1,100' | **Fig:** II-8 |
|---|---|---|

## E. SLUDGE DISPOSAL ALTERNATIVES

The residue remaining after the treatment process is sludge. There are three feasible sludge disposal methods.

The two products of wastewater treatment are treated wastewater effluent and sludge. Sludge is the residue which remains after the treatment process has removed impurities from wastewater. The following sludge disposal methods have been considered as potentially feasible alternatives for this project. They are:

- removal of sludge to an existing treatment facility
- landfilling
- land application

Other methods of sludge disposal were judged to be inappropriate.

Other methods of sludge disposal, such as sludge lagoons, composting, incineration, and ocean disposal, were judged to be inappropriate (due to cost or environmental impacts) and were eliminated from detailed consideration as alternatives. Sludge incineration would involve extremely high energy requirements and costs, and ocean disposal of sludge is significantly less environmentally sound than other alternatives.

### 1. Removal to an Existing Facility

The first alternative involves removing the sludge from the treatment plant to a disposal facility on St. Thomas.

The first sludge disposal considered feasible would involve removing sludge from the treatment plant and transporting it by a special truck (via ferry) to an existing sludge disposal facility on St. Thomas (probably at the regional facility on Long Point Peninsula, which is presently under design). The primary advantage of this alternative is that it would not involve any land use or other environmental impacts associated with sludge disposal on St. John. The primary disadvantage is that purchasing a truck and transporting the sludge on a continuous basis would involve significantly greater costs than the other feasible alternatives considered.

### 2. Landfilling

The second feasible alternative would involve removing sludge from the treatment plant and transporting it to the St. John municipal landfill in Adrian for final disposal. This is the method currently used by DPW for disposing of sludge from the existing Cruz Bay treatment

Landfill disposal involves disposing of sludge at the existing municipal landfill on St. John.

plant. The primary advantage of this alternative is that it would be relatively inexpensive and simple to transport sludge to the landfill on St. John, as compared with transporting it to St. Thomas. The primary disadvantage is that precautionary measures must be taken to assure against public health, odor, aesthetic, or other impacts associated with sludge disposal. Assurance against public health impacts, such as an increase in the amount of flies, is particularly important as the Island's clinic is located directly above (approximately 200 m (660 ft) from) the landfill. Another important disadvantage is that in the future this landfill may not have adequate capacity to dispose of sludge in an environmentally sound manner.

This alternative is recommended in the Interim Sludge Management Plant for the US Virgin Islands study prepared for VIDPW by deJongh/URS Associates in 1985.

3. Land Application

Land application of stabilized sludge is another viable alternative.

The third feasible alternative considered involves applying stabilized sludge to a tract of land to be used as soil conditioner or fertilizer. A primary advantage of this alternative is that it would provide a secondary value for the sludge through reuse. This alternative could also be relatively inexpensive, depending on the distance and accessibility of a potential land application site from the treatment plant.

The primary disadvantage is that a relatively large amount of land, up to 20 ha (50 ac) which is isolated and protected from human contact, would be required for the land application site. Another disadvantage is that not all types of sludge are suitable for land application. It may be more feasible to dispose of the sludge at the landfill until periodic testing determines that it is suitable for land application. Testing should then be carried out on a continuing basis to insure that the sludge remains suitable for land applications.

F. TREATMENT PLANT SITE ALTERNATIVES

Each of the wastewater treatment technologies considered for this project would require a rela-

Three feasible treatment plant sites have been identified given the existing conditions of the study area.

tively flat .6-2.2 ha (1.5-5.5 ac) site. Proximity to areas served by the treatment system and proximity to potential effluent disposal sites are other important requirements. Given these requirements and the existing conditions of the study area, three feasible treatment plant sites were identified.

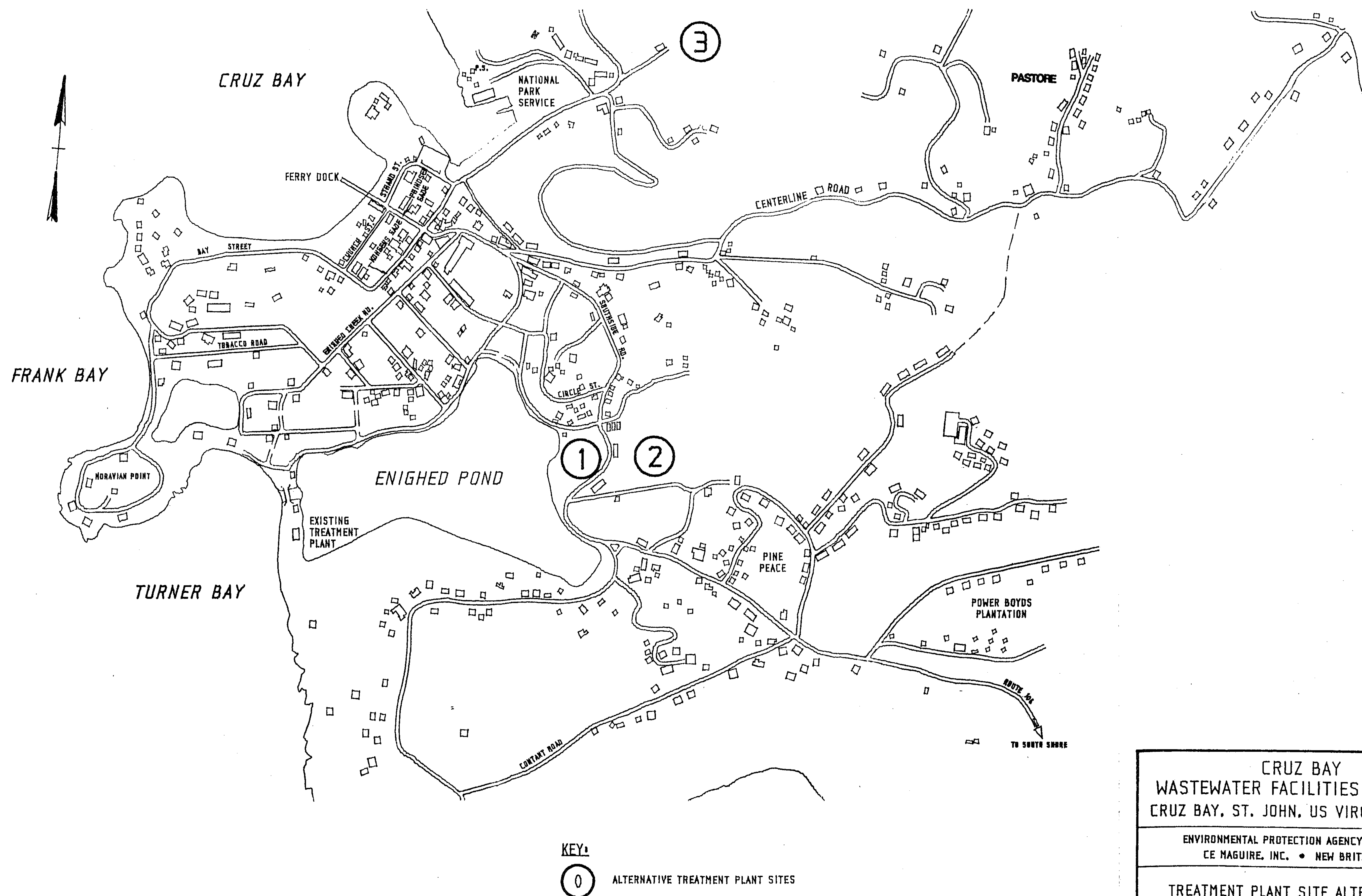
The existing treatment plant site was originally considered as a feasible site alternative. However, use of this site for a new treatment plant would require the filling of up to 1.2 ha (3 ac) of Enighed Pond in order to provide an adequate plant site. Other disadvantages of this site are that it is in the 100 year flood zone and is relatively unprotected from storms, wave action, and may create a conflict with the Virgin Island Port Authority (VIPA) plan to develop a commercial port in Enighed Pond (McComb Eng., 1985). Any port alternative would require removal of the access bridge to existing site, thereby eliminating the only means of accessing the plant.

Other sites were initially considered, but were eliminated from further consideration because they did not meet these or other requirements. For example, one site, located in an abandoned quarry just east of Power Boyd's Plantation, was initially examined, but considered unsuitable due to steep terrain consisting of solid exposed rock, the proximity of the site to a major (and ecologically valuable) gut, and the distance of the site from the concentrated areas of development in the core study area. Another site, located east of (directly across the road from) the Virgin Grand Hotel site at the head of Great Cruz Bay, was eliminated from further consideration due to its distance from the concentrated development and service area of the core study area, as well as the cost of pumping sewage to the site over a ridge extending from Contant to Bethany. The effluent would also have to be pumped back over again for disposal. The remaining three sites are discussed in more detail below and are shown in Figure II-9.

1. Site #1 - East of Enighed Pond

Site #1 is located on the site of the old town landfill.

The first feasible site considered is located on the eastern bank of Enighed Pond. Portions of the site are currently used for an existing pump station, storage of gravel for construction of the Virgin Grand Hotel, and storage of junk cars and other mechanical debris. The site, which was once part of Enighed Pond, is

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TREATMENT PLANT SITE ALTERNATIVES

SOURCE: CE MAGUIRE, INC.

DATE: 4/86 SCALE: 1" = 500' FIGURE: II-9 characterized by filled land and is primarily barren of vegetation except for bermuda grass (Cynodon dactylon) and mangroves along the shore of the Pond.

Primary advantages of this site are that it offers a sufficient amount of flat, easily accessible land, it is already disturbed, it is not presently used for any long-term activity, it is located on publicly-owned and publicly zoned land, and it would not be in conflict with VIPA's plans.

Primary disadvantages of the site are that it is near existing residential and commercial development, it is desired by some residents for recreational use, it is in the 100 year floodplain, and it is located on fill material which may require further soil stabilization prior to construction.

2. Site #2 - Above the Power Station

Site #2 is located behind the VIPA auxiliary power generating station, just east of site #1.

A second feasible site considered is located east of Site #1 and directly behind the VI Water and Power Authority (WAPA) auxiliary power generating station. The site is characterized by moderately sloping, undeveloped, dry evergreen woodland. A gut which drains to Enighed Pond forms the northern boundary of the site.

Primary advantages of this site are that it is above the 100 (and 500) year floodplain, it offers a larger tract of land which can accommodate the aerated lagoon or recirculating sand filter plant alternatives, and it would not conflict with VIPA plans.

Primary disadvantages of site #2 are that it is privately-owned (making it more expensive than Site #1), it is zoned for residential use, making it one of the few large tracts of lands still available for residential development by the local population, it is only partially disturbed, it is not as flat as the other sites therefore requiring more site preparation, and it is near residential and commercial development.

3. Site #3 - Behind NPS Garage

The third feasible site considered is located in a valley behind the U.S. National Park Service (NPS) maintenance garage, just north (inside) of the NPS boundary. The site is bisected by a small gut and is characterized mainly by dry evergreen woodland, except for moister vegetation in the gut. The soils that cover this site have fewer limitations for building foundations than the other soils in the study area.

Site #3 is located behind the U.S. National Park Service maintenance garage.

Primary advantages of this site are that it is relatively isolated from development and in a convenient location for effluent disposal by land application either on-site or at Caneel Bay. Also, there would be adequate land available for either the aerated lagoon or recirculating sand filter alternatives. A treatment plant at this site could still utilize an ocean outfall if land application was not possible.

The primary disadvantage is that it may not be possible to use the site because of restrictions on the use of NPS land for non-park related activities. These include restrictions such as the requirement that the NPS must charge fees and lease rates for use of park lands at rates comparable to the private sector, restrictive land use covenants stipulated in the deeds of ownership, the NPS policy of not considering projects if there are other viable alternatives, and the possibility of long delays or blockage from using a NPS site if lawsuits against such a project were brought to bear by various conservation groups.

## G. OVERALL WASTEWATER TREATMENT SYSTEM ALTERNATIVES

Analysis of the various alternatives has yielded six feasible overall treatment system alternatives.

Previous sections of this chapter have identified and evaluated alternatives for the various components of an overall wastewater treatment system. Specifically, alternatives have been considered for a wastewater management program, treatment process, collection system technology and routing, effluent disposal technology, sludge disposal method, and treatment plant site. The purpose of this section is to identify and evaluate overall treatment system alternatives which incorporate one alternative of each of these components.

A further screening of component alternatives has been made based on the relative advantages and disadvantages of each of the alternatives discussed in this chapter. This screening has yielded the selection of feasible alternatives, which are presented in Table II-1. This table also summarizes the reasons that each of these alternatives passed the second level of screening. (More detailed discussions of the relative advantages and disadvantages of each alternative are presented in the previous sections of this chapter.)

**Each of these six alternatives includes a new treatment plant and expanded collection system for the core study area.**

Comparative analysis of these feasible component alternatives has resulted in the development of six feasible overall treatment system alternatives. The six overall system alternatives are structured to function under the second subregional management program which recommends using a collection system for the core study area and various on-site technologies for the extended study area as described in Appendix C.4 (on-site systems). In the core area, each of the six overall system alternatives includes a new 200,000 gallon per day (gpd) treatment plant, at a new site, to replace the existing plant and site. A new wastewater collection system is proposed to extend from the existing sewer system. The proposed wastewater collection system includes the addition of approximately 6,873 m (22,680 ft) of sewers to the existing public wastewater collection system. In addition to the portions of Cruz Bay and Enighed served by the existing system, the proposed system would serve Pine Peace, Power Boyd's Plantation, portions of Contant and Pastore; and portions of Cruz Bay and Enighed that are not currently served.

The existing system is comprised of 2,600 m (8,600 ft) of sewers, including 1,282 m (4,232 ft) of 20 cm (8 in) diameter gravity sewer, 803 m (2,651 ft) of 25 cm (10 in) diameter gravity sewer, 409 m (1,349 ft) of 15 cm (6 in) diameter force main, and 110 m (364 ft) of 5-10 cm (2-4 in) diameter force main. The existing system also includes three pump stations (two ejector stations and one influent pump station).

In addition to this system, the following additions are proposed:

- 6,621 m (21,850 ft) of 20 cm (8 in) diameter gravity sewer
- 145 m (480 ft) of 10 cm (4 in) diameter force main
- 106 m (350 ft) of 5 cm (2 in) diameter pressure sewers

## TABLE II-1

## FEASIBLE ALTERNATIVES

| COMPONENT | FEASIBLE ALTERNATIVES | REASON SELECTED |
| --- | --- | --- |
| Management Program | . Subregional System | Allows most appropriate solution to the wastewater needs of each area. |
| Treatment Process | . Aerated Lagoon<br>. Oxidation Ditch<br>. RBC<br>. Recirculating Sand Filter<br>. Trickling Filters | Other alternatives require more land than is available at the four feasible treatment plant sites. |
| Collection System Technology | . Gravity Sewers<br>. Pressure Sewers | Most cost-effective, yet technically and environmentally sound. |
| Collection System Routing | . As shown in Figure II-7 | Least impacts, yet serves clusters in greatest need. |
| Effluent Disposal Technology | . Spray Irrigation<br>. Ocean Outfall | Most cost-effective, yet environmentally sound. |
| Sludge Disposal Method | . Landfill (short-term)<br>. Land Application (long-term) | Most cost-effective, yet technically and environmentally sound, provided proper mitigation is assured, allows option to use sludge for fertilizer or soil enhancer if tests indicate that this would be environmentally sound. |
| Treatment Plant Sites | . Site #1<br>. Site #2<br>. Site #3 | Other sites considered were too rugged or too distant from the service area and potential effluent disposal sites. |

- one additional pump station to lift flows from the Power Boyd's Plantation area into the Cruz Bay drainage basin

- 50 grinder pumps for use in residences that are located below the sewer line.

The proposed system would include using the existing pump stations. The capacity of the influent pump station would be expanded, but the ejector stations would not be altered. The proposed wastewater collection system is shown in Figure II-7 and presented in more detail in Appendix C.5, Table C.5-1. Each alternative also recommends one of two effluent disposal systems either ocean outfall or land application.

Land application effluent disposal at Caneel Bay may not be an implementable sub-alternative.

All of the alternatives would also include the disposal of sludge at the St. John municipal land-fill until testing indicates whether or not land application of the sludge is possible. A sub-alternative to these disposal systems is effluent disposal through land application at the Caneel Bay Resort. It could be substituted into any of the feasible overall system alternatives. This sub-alternative would have significant positive impacts on those environmental characteristics and features that would be negatively affected by the utilization of either the land application or ocean outfall alternatives. In addition, the force main effluent pipe to Caneel Bay would cost considerably less than the ocean outfall system, in the range of 1.5 to 1.8 million dollars, depending on the plant site select-ed (See Appendix C.5). Although this effluent disposal subalternative has received much public support and initial positive reaction from the Caneel Bay Resort, it may be difficult to implement due to potential legal, political, and contractual complications. Therefore, it was not included with following alternatives in this Draft EIS. However, should additional support further commitments, and official approvals of this alternative be presented during the draft EIS comment period, it could be reconsidered as a viable alternative in the final EIS.

Given this common base, the feasible overall treatment system alternatives are distinguished as follows:

- Alternative A: Aerated lagoon treatment plant at site #3 with land application effluent disposal.
- Alternative B: Aerated lagoon treatment plant at site #3 with ocean outfall effluent disposal.
- Alternative C: Aerated lagoon treatment plant at site #2 with ocean outfall effluent disposal.
- Alternative D: Recirculating sand filter treatment plant at site #2 with ocean outfall effluent disposal.
- Alternative E: Rotating biological contactor treatment plant at site #1 with ocean outfall effluent disposal.
- Alternative F: Oxidation ditch treatment plant at site #1 with ocean outfall effluent disposal.

Table II-2 summarizes the advantages and disadvantages of the six alternatives.

The advantages and disadvantages of these six alternatives, are summarized in Table II-2. This table shows the degree of impact each alternative is likely to have in terms of cost-effectiveness, environmental soundness, implementability and land lost to other types of future development. More detailed cost information for the feasible alternatives is presented in Appendix C.5.

## H. PROPOSED WASTEWATER ALTERNATIVE

Alternatives E and F have been selected as the feasible alternative.

Based on the criteria presented in Table II-2 and comments from the public and regulatory agencies, Alternatives E and F, as shown in Figures II-10, and II-11, were selected as the most feasible wastewater treatment plans for Cruz Bay. Although alternatives E and F are the most costly in dollars of the six alternatives, they are the least costly in terms of impacts on the environment, amount of land lost to future development, and are the most implementable options for Cruz Bay.

TABLE II-2

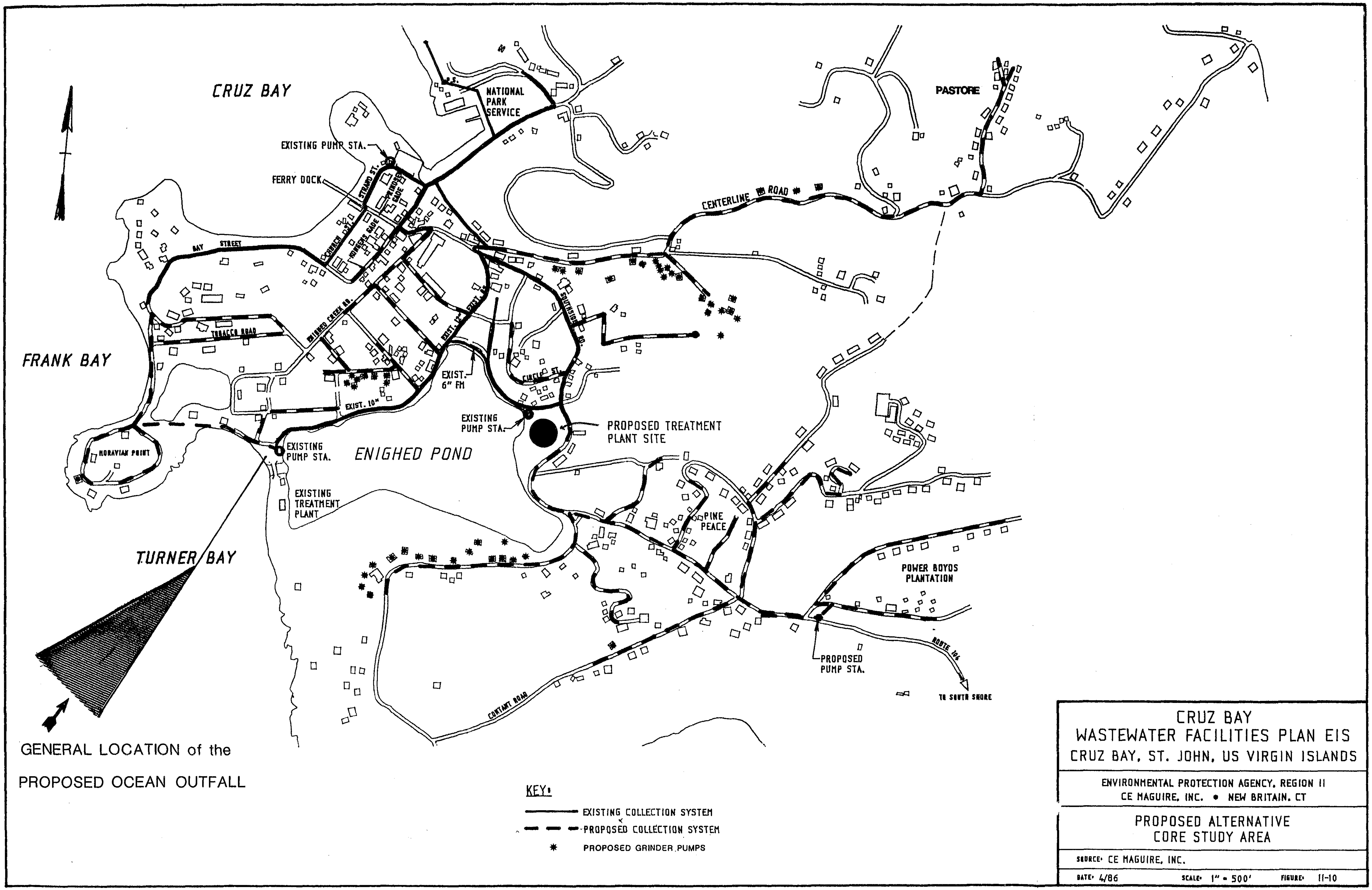
COMPARISON OF FEASIBLE OVERALL WASTEWATER TREATMENT SYSTEM ALTERNATIVES

| FACTORS | ALTERNATIVE A | ALTERNATIVE B | ALTERNATIVE C | ALTERNATIVE D | ALTERNATIVE E | ALTERNATIVE F |
|---|---|---|---|---|---|---|
| Monetary Cost ($1,000 of dollars) | | | | | | |
| Capital Cost*: | 10,735 | 10,131 | 9,958 | 10,226 | 10,312 | 10,698 |
| Annual O&M Cost*: | 260 | 250 | 257 | 262 | 316 | 303 |
| Total Present Worth***: | 9,908 | 10,072 | 9,975 | 10,311 | 11,265 | 11,514 |
| Environmental Impact | | | | | | |
| Cultural Resources: | 0 | 0 | 0 | 0 | 0 | 0 |
| Flood Prone Areas: | 0 | 0 | 0 | 0 | -- | -- |
| Ecosystems | | | | | | |
| Terrestrial: | -- | - | - | - | 0 | 0 |
| Coastal: | ++ | ++ | ++ | ++ | ++ | ++ |
| Marine: | + | - | - | - | - | - |
| Soils/Erosion: | -- | -- | -- | -- | ++ | ++ |
| Endangered species: | 0 | 0 | 0 | 0 | 0 | 0 |
| Air Quality, Noise and Aesthetics: | ++ | ++ | + | + | + | + |
| Water Quality | | | | | | |
| Groundwater: | -- | 0 | 0 | 0 | 0 | 0 |
| Surface Water: | - | ++ | ++ | ++ | ++ | ++ |
| Marine Water: | + | - | - | - | - | - |
| Economy: | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Projects: | 0 | 0 | - | - | - | - |
| Other Factors | | | | | | |
| Implementability: | -- | -- | - | - | ++ | ++ |
| Land Lost for Future Development: | 0 | 0 | -- | -- | - | - |
| Reliability: | ++ | ++ | ++ | + | 0 | + |

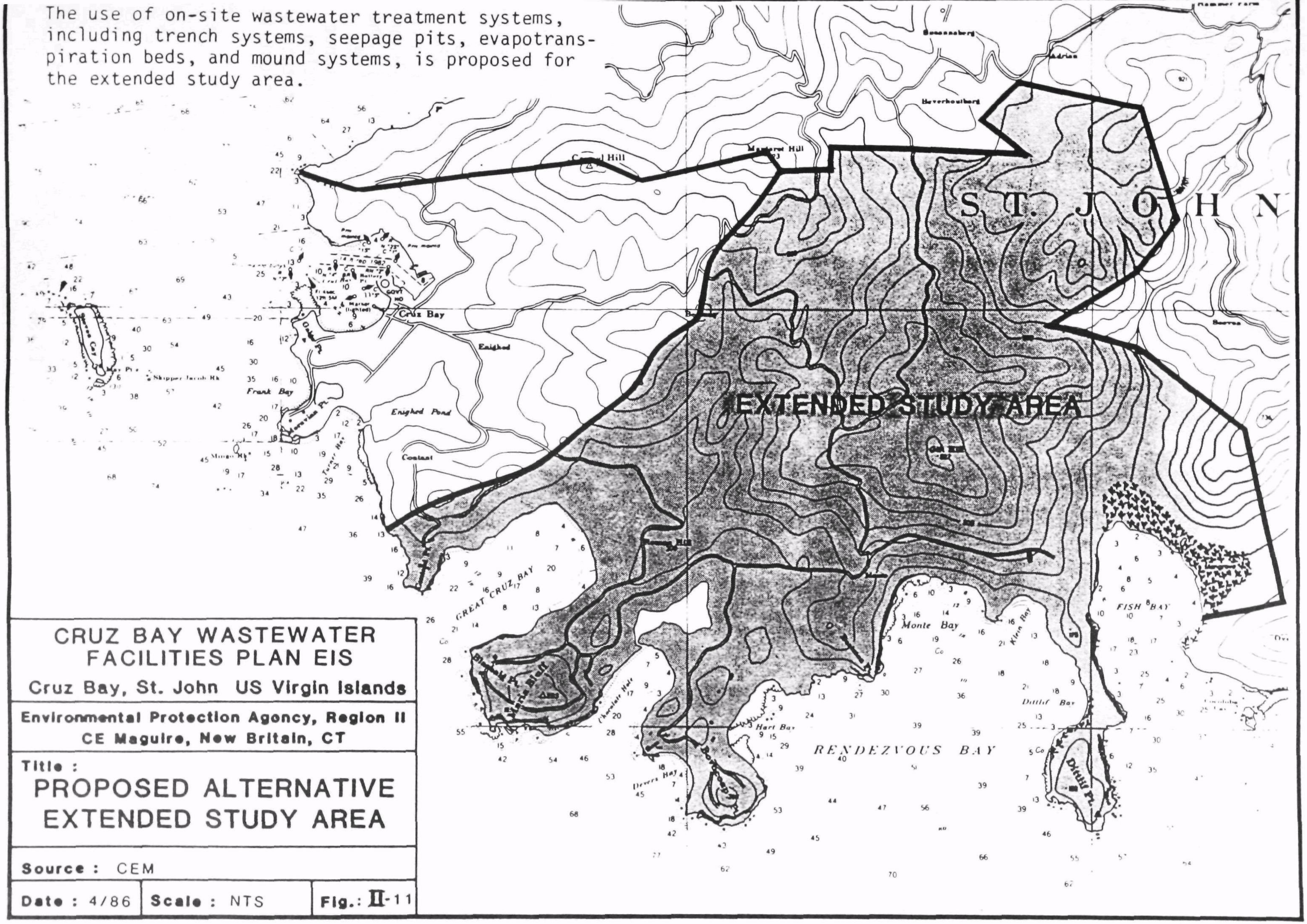
Legend:
++ potentially significant beneficial impact/factor
+ minimal beneficial impact/factor
0 neutral or no impact/factor
- minimal adverse impact/factor
-- potentially significant adverse impact/factor

*From Table C.5-10, Appendix C.5
**From Table C.5-11, Appendix C.5
***From Table C.5-9, Appendix C.5

Source: CE Maguire, Inc. May, 1986.


CRUZ BAY
FRANK BAY
TURNER BAY
ENIGHED POND
NATIONAL PARK SERVICE
EXISTING PUMP STA.
FERRY DOCK
STRAND ST.
BAY STREET
TOBACCO ROAD
ENIGHED CREEK RD.
MORAVIAN POINT
EXISTING PUMP STA.
EXISTING TREATMENT PLANT
EXIST. 10"
EXIST. 6" FM
EXISTING PUMP STA.
PROPOSED TREATMENT PLANT SITE
CIRCLE ST.
CENTERLINE ROAD
PASTORE
PINE PEACE
POWER BOYDS PLANTATION
PROPOSED PUMP STA.
ROUTE 104
TO SOUTH SHORE
CONTANT ROAD
GENERAL LOCATION of the PROPOSED OCEAN OUTFALL
KEY:
EXISTING COLLECTION SYSTEM
PROPOSED COLLECTION SYSTEM
PROPOSED GRINDER PUMPS
CRUZ BAY
WASTEWATER FACILITIES PLAN EIS
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS
ENVIRONMENTAL PROTECTION AGENCY, REGION II
CE MAGUIRE, INC. • NEW BRITAIN, CT
PROPOSED ALTERNATIVE
CORE STUDY AREA
SOURCE: CE MAGUIRE, INC.
DATE: 4/86
SCALE: 1" = 500'
FIGURE: II-10

The use of on-site wastewater treatment systems, including trench systems, seepage pits, evapotranspiration beds, and mound systems, is proposed for the extended study area.




CRUZ BAY WASTEWATER FACILITIES PLAN EIS

Cruz Bay, St. John US Virgin Islands

Environmental Protection Agency, Region II

CE Maguire, New Britain, CT

Title :

PROPOSED ALTERNATIVE EXTENDED STUDY AREA

Source : CEM

Date : 4/86 | Scale : NTS | Fig.: II-11

Alternative E, comprised of a Rotatating biological contacter and Alternative F, comprised of an oxidation ditch processing plant, both at Site #1 and with an outfall into Turner Bay, are the most feasible alternatives.

The components which form Alternatives E and F are a rotating biological contactor treatment plant and an oxidation ditch treatment plant, respectively, both capable of processing 200,000 gallons per day of wastewater. Also, both facilities would be located at site #1 (across the street from the WAPA power generating plant) and both would utilize an ocean outfall effluent disposal system. These alternatives also include the proposed wastewater collection system for the core study area as described in the previous section and illustrated in Figure II-10, in addition to continued use of individual on-site systems for the extended study area. These on-site systems include, but are not limited to trench systems, seepage pits, evapotranspiration beds, and mound systems.

Other alternatives would have greater adverse environmental impacts than the selected alternatives.

Although Alternatives A-D are less costly than Alternatives E and F, they would incur greater environmental impacts. In addition, Alternatives A or B would present a major implementation issue due to the complications involved with proposing any type of project in a National Park area. Also, Alternatives C or D may pose some implementability issues as well as displacing 10 acres of land that would be lost to residential and other types of future development.

The selection of the most feasible alternatives is preliminary.

EPA will identify the selected plan after evaluating all public comments on this draft EIS.

It should be noted that the identification of Alternatives E and F as the most feasible wastewater treatment options is preliminary, and does not represent the ultimate selection of a wastewater treatment plan for Cruz Bay. After receiving and evaluating all public comments on this draft EIS, EPA will prepare a final EIS which will identify the selected project alternative. Because each of the alternatives presented in the draft EIS would require a substantial capital investment by the Government of the Virgin Islands, the final EIS will address possible scenarios for phasing the implementation of the selected project, consistent with the goals and requirements of the Clean Water Act. Although EPA may decide to award grant assistance for implementing major portions of the selected project, issuance of this EIS does not constitute a commitment on the part of EPA to fund the project in whole or in part.

# III. AFFECTED ENVIRONMENT

# III. AFFECTED ENVIRONMENT

This chapter discusses aspects of the environment that will be affected by the project.

The purpose of this chapter is to describe the various environmental characteristics and features which may be affected by this project. This information will provide a basis for identifying and analyzing the impacts associated with each of the feasible alternatives identified in the previous chapter.

For the purpose of discussion, the various elements of the affected environment are divided into three separate categories:

- Existing conditions within the study area, including environmental, demographic, physical, and socio-economic characteristics;

- Environmental, physical and infrastructure constraints to development; and

- Anticipated future conditions, including population and water use projections.

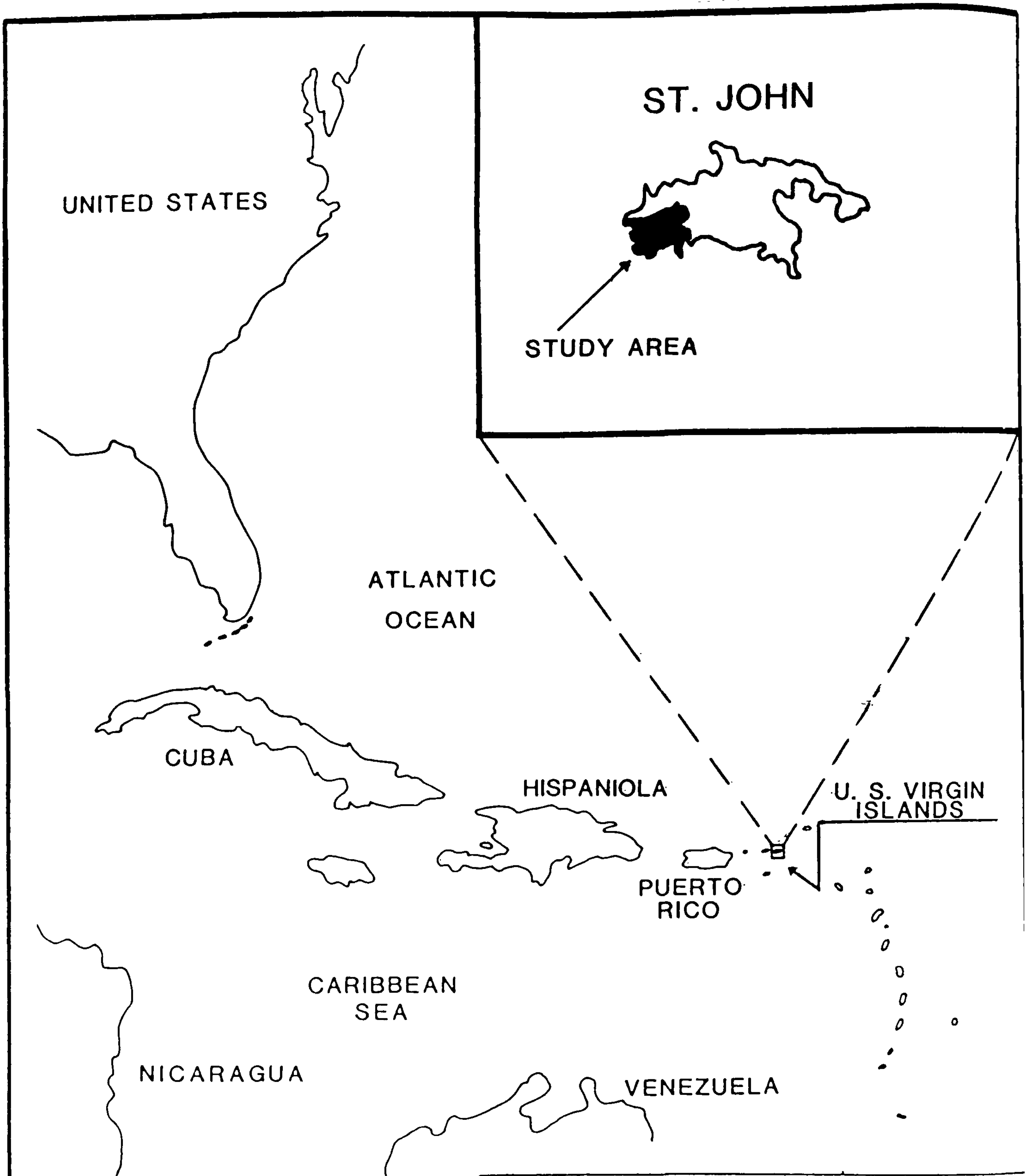
## A. EXISTING CONDITIONS

### 1. Location

St. John is located at the Northern end of the Lesser Antilles archipelago in the Caribbean Sea.

The Island of St. John is located at the northern end of the Lesser Antilles archipelago in the Caribbean Sea, as shown in Figure III-1. It is the northeastern point in the triangle formed by the U.S. Virgin Islands (VI). The Island is approximately 5 kilometers (km) (3 miles (mi)) east of St. Thomas, 60 km (37 mi) north of St. Croix, 50k (31 mi) east of Puerto Rico, and less than 3k (2 mi) southwest of Tortola, in the British Virgin Islands. The approximate area of St. John is $32k^2$ (20 $mi^2$).

The study area includes approximately 760 hectares (ha) (1900 acres (ac)) of land (roughly 15 percent of the Island's total area) in the southwestern portion of St. John, as shown in Figure III-2. This area includes a core study area of approximately 196 ha (490 ac) which is the major population center and the focus of facility planning for this study. The study area boundary is defined by the VI National Park Boundary, except at the northwestern limit where the boundary extends into the National Park to follow the drainage divide. This portion of the National Park has been included in the study area because it is part of the Cruz Bay drainage basin and because several residences are located there.



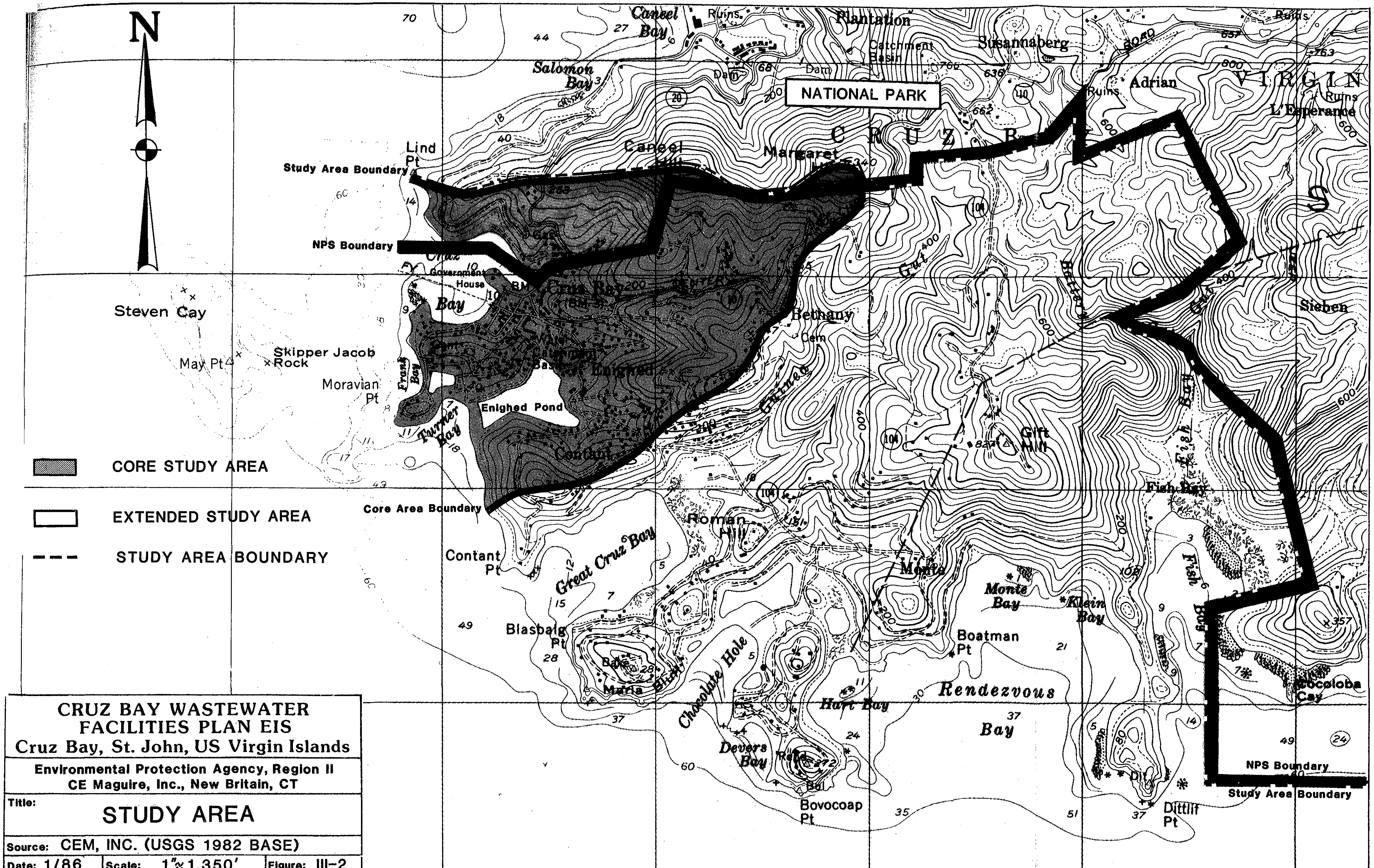

CRUZ BAY WASTEWATER
FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title:
**LOCATION OF STUDY AREA**

Source: CE MAGUIRE, INC.

Date: 2/86 | Scale: N.T.S. | Figure: III-1




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: STUDY AREA

Source: CEM, INC. (USGS 1982 BASE)

Date: 1/86 | Scale: 1"≈1,350' | Figure: III-2

## 2. Climate and Meteorology

St. John is in a semi-arid climate characterized by low rainfall, consistently warm temperatures, and an almost constant breeze.

St. John has a semi-arid climate.

The average annual rainfall in the study area is 100-112 centimeters (cm) (40-45 inches (in)). The amount of rainfall varies greatly according to seasons -- more than half of the average occurs during August-November, while very little occurs during December-June. This relatively low amount of rainfall during the winter months is accompanied by generally clear skies. The orographic effect (a meteorological condition in which mountains form a barrier to air currents, causing moist air to be lifted to higher elevations and resulting in precipitation) of cool air being forced upward over the mountains of St. John by the tradewinds generally causes more rain on the lee side of the mountains than on the windward side.

Rainfall varies greatly according to seasons.

The temperature in the study area generally ranges from 21 Centigrade (C) (70 Fahrenheit (F)) to 32C (90F). Unlike rainfall, there is little seasonal variation in temperature. The climate is cooled by the almost constant easterly tradewinds which pass through this section of the Caribbean. Windspeed ranges from 3-9.4 kilometers per hour (kph) (5-15 miles per hour (mph)).

The steady wind, clear skies, and shallow soils which are characteristic of the study area combine to cause a high rate of evapotranspiration. Evapotranspiration is the return of water to the atmosphere through the combined processes of direct evaporation by the sun and transpiration by vegetation.Over 90 percent of the rainfall in the study area is returned to the atmosphere by this process. Therefore, very little of the inland rainfall reaches the sea as runoff except during major storms.

There is a high rate of evapotranspiration.

Tropical storms strike St. John once or twice each year, but the estimated frequency of actual hurricanes is once in every eighteen years. Storms bring heavy rainfall and often cause destructive flooding along the coast and in the drainageways, known locally as "guts".

## 3. Physiography and Topography

The physiography of the study area is characterized by very rugged terrain, a jagged coastline, numerous bays and coastal lagoons/ponds, and deep intermittent stream valleys or guts. The area's highest point, Margaret Hill, rises 255m (840 ft) above sea level.

The topography of the study area is shown in Figure III-2, a United States Geological Survey (USGS) base map with 40 ft. contour intervals.

Two features of the study area's physiography that are significant to the subject project are steep slopes and flood prone areas. They warrant more detailed discussion.

a. Steep Slopes

Steep slopes serve as a constraint to development because they present potential problems with erosion, instability, drainage, and access. This feature is discussed further as a constraint to development in Appendix B, Constraints Analysis.

A 50% or larger gradient is considered a constraint to development in the study area.

Slopes of over 15 percent gradient are typically considered "steep slopes" (as a constraint to development) in the continental United States. However, due to the predominance of steeply sloping hillsides and severe relief found in the study area, a more accurate delineation of this constraint is slopes of greater than 50 percent. This delineation was selected because development generally occurs on land with slopes of up to (but no greater than) 50% in the study area. The location of greater than 50 percent slopes in the study area is shown in Figure III-3. Approximately 68 hectares (ha) (170 acres (ac)), or 9 percent of the study area is occupied by steep slopes.

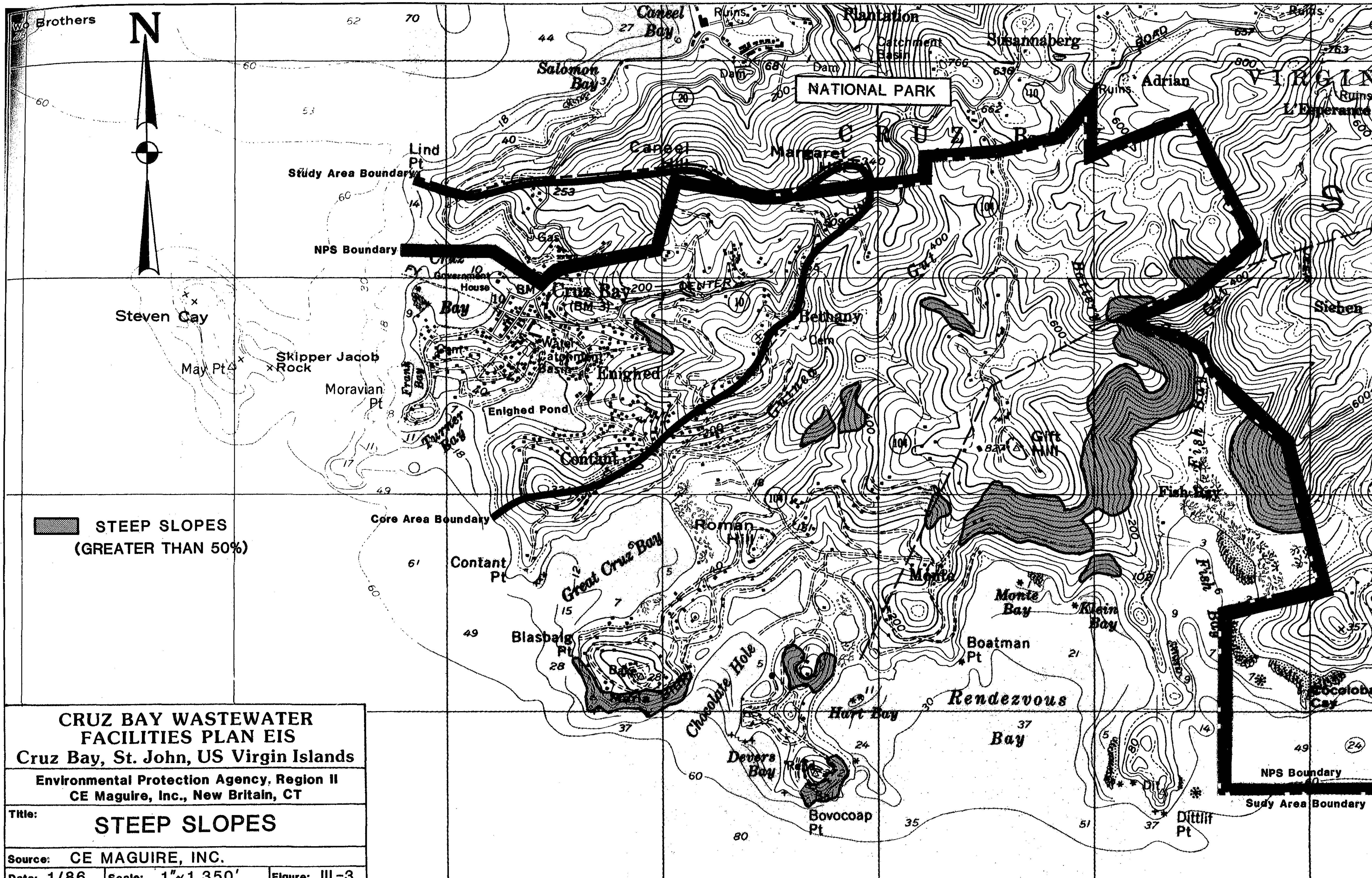
b. Flood Prone Areas

Much of the flat land along the coast and in the mouths of guts of the study area is prone to inundation during a 100-year flood. A 100-year flood is a flood of the magnitude which is expected to occur once in 100 years. This land is shown in Figure III-4. Flood prone areas cover approximately 72 ha (180 ac), or 9% of the study area.

Much of the lower land along the coast is prone to inundation during a 100 year flood.

Typically, the flood prone area is a coastal fringe between 0 and 5 feet (ft) above mean sea level (msl). The area at the head of Fish Bay, combined with areas around Chocolate Hole, Great Cruz Bay, Enighed Pond, and Cruz Bay constitute the majority of the study area's flood prone land. Areas of development which would be particularly affected by a 100-year flood include:

- The police station and shops surrounding the ferry dock in downtown Cruz Bay;



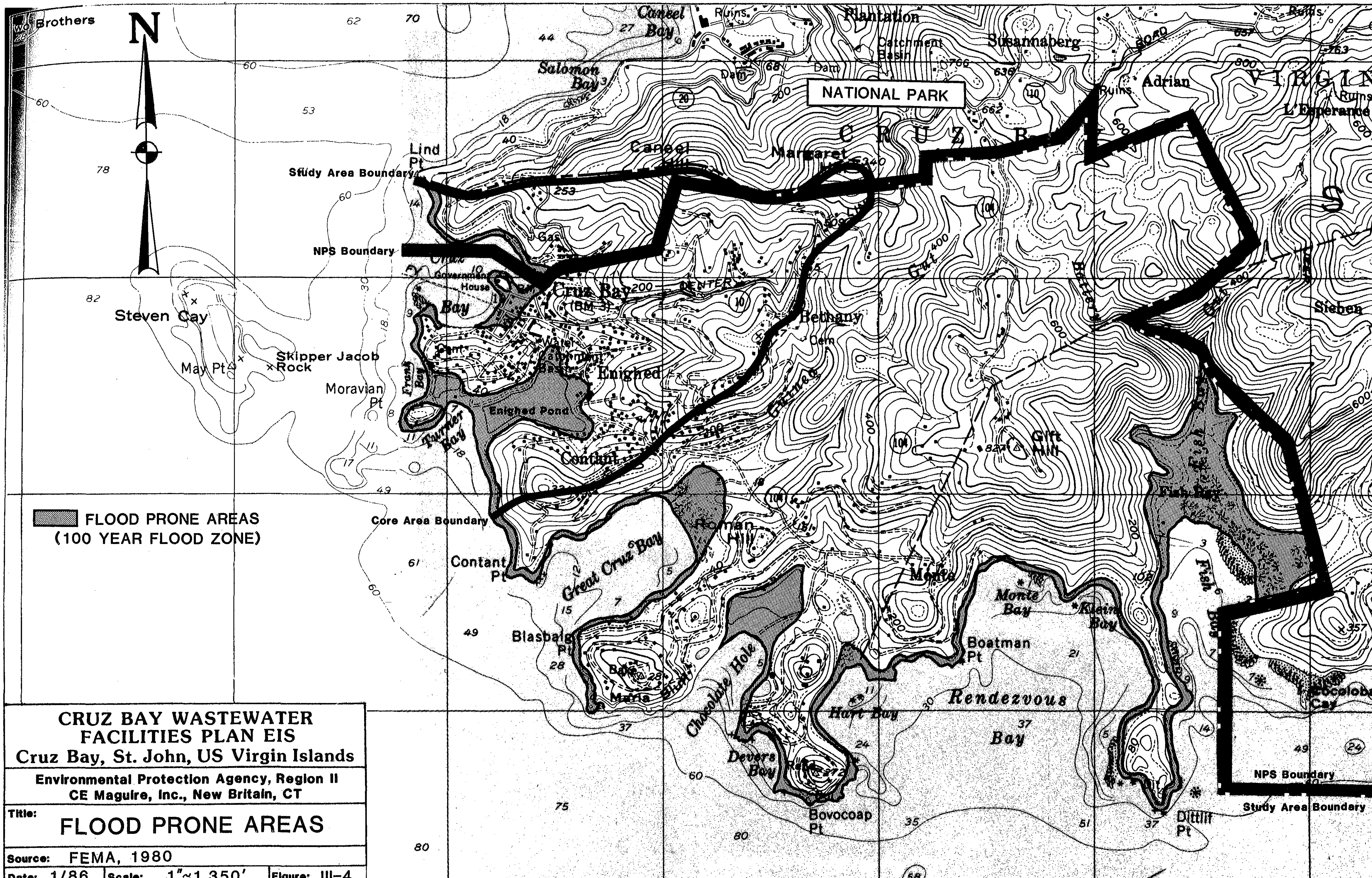

CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: STEEP SLOPES

Source: CE MAGUIRE, INC.

Date: 1/86 | Scale: 1"≈1,350' | Figure: III-3




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** FLOOD PRONE AREAS

**Source:** FEMA, 1980

**Date:** 1/86 **Scale:** 1"≈1,350' **Figure:** III-4

- Five homes on Moravian ("Moorehead") Point which would be cut off from the rest of St. John;

- The existing pump station and wastewater treatment plant on the berm separating Enighed Pond from Turner Bay, and;

There are four areas of development which would be affected by a 100-year flood.

- The Virgin Grand Hotel complex being constructed at the head of Great Cruz Bay.

Other flood prone areas are within the various guts located in the study area. Flash flooding will occur in these guts during periods of long duration or high intensity rainfall. This occurs in particular along Centerline Road itself where many of the houses are built directly on the floor of a gut. An additional flood prone area with similar characteristics is the gut near Serendip Apartments that flows into Enighed Pond. Flood prone areas are discussed further as a constraint to development in Appendix B.

4. Geology

St. John is a volcanic island.

St. John is a volcanic island rising from a 200m (660 ft) deep shelf which extends from Puerto Rico to the British Virgin Islands. The Island was formed by the folding and uplifting of volcanic extrusive material on the floor of this shelf. The geology of the Island and the study area in particular are discussed separately in the sections entitled bedrock, surficial materials, and soils.

a. Bedrock

The most detailed information on bedrock formations on St. John is from a 1966 report by T. W. Donnelly, entitled "Geology of St. Thomas and St. John, U.S. Virgin Islands". According to Donnelly, the study area is underlain by bedrock of the Louisenhoj and Water Island Formations as shown in Figure III-5.

The bedrock underlying the study area is very hard.

The Louisenhoj Formation consists primarily of breccia (fractured rock), water-laid tuff (compacted volcanic fragments), and intermittent layers of limestone. The Water Island Formation is formed of volcanic flows and breccia. Both formations are characterized by fine-grained, extrusive igneous basal rock with very low permeability. As such, the bedrock underlying the study area is very hard, and difficult to excavate.

Eroded bedrock has created "alluvial fans" which are more permeable and suitable for excavation than its parental bedrock.

b. Surficial Materials

The prominent valleys in the study area are formed by Guinea Gut and Battery/Fish Bay Gut. (Streams and other surface water features will be discussed under Section 5, "Water Resources".) Exposed parental bedrock has been eroded over the years by runoff and/or human activities. The eroded material has been carried into the valleys by runoff, accounting for the generally deeper soils in the valleys than on hillsides.

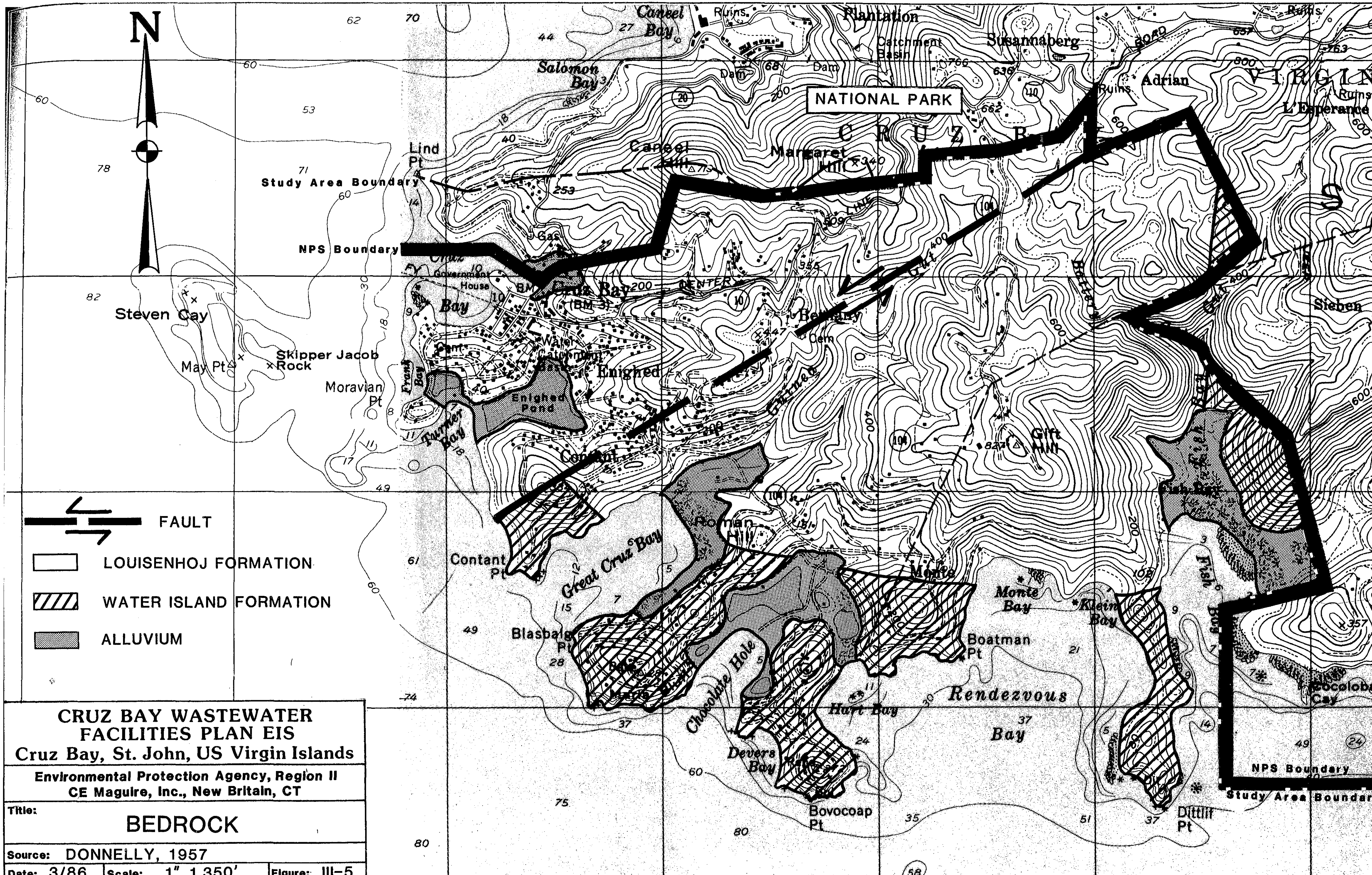
Alluvial deposits from these erosive processes have accumulated at the mouths of Guinea and Fish Bay Guts. These deposits are as deep as 150 cm (60 in) and cover the flat areas at the Great Cruz Bay and Fish Bay, as shown in Figure III-5. Other alluvial deposits are located around Enighed Pond, and in the area of the ponds inland of Chocolate Hole and Hart Bay. The alluvium consists of unconsolidated rock fragments and clayey-loamy soil. This material is more permeable and suitable for excavation than its parental bedrock.

c. Soils

The soils in the study area are derived from basal volcanic bedrock parent material. The soil layer over bedrock is generally very shallow, in most places no more than 50 cm (20 in), and in many places barren bedrock is exposed. Soils are deeper in valleys and alluvial plains.

The overwhelming majority of the study area is characterized by soil which has severe limitations for sewage disposal and building foundations.

According to the U.S. Soil Conservation Service (SCS) (1970), the overwhelming majority of the study area (more than 80 percent) is overlain by soils of the Cranmer Series, as shown in Figure III-6. These soils are characterized by shallow and well-drained gravelly clay loam. They generally cover the moderately to steeply sloping hillsides of the study area. Cranmer soils have severe limitations for sewage disposal and building foundations, due primarily to their shallowness and slope. They are quickly saturated during periods of rainfall, as the shallowness of these soils makes their water storage capacity low. These characteristics of the Cranmer and other soil series are shown in Table III-1.




# CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: BEDROCK

Source: DONNELLY, 1957

Date: 3/86 | Scale: 1" 1,350' | Figure: III-5

TABLE III-1

SOIL CHARACTERISTICS

| Soil Series | Description | Limitations for On-site Sewage Disposal | Limitations for Building Foundations | Approximate Acreage in Study Area | % of Total Study Area |
|---|---|---|---|---|---|
| Cranmer and Others | | severe | severe | 1,660 | 87.6 |
| Cranmer (CrE, CrF, CsF, CrC, $CsE_2$) | gravelly clay loam, clay, gravelly clay | | | | |
| Jaucus (JuB) | sand | | | | |
| Volcanic Rock | rock | | | | |
| Tidal Flat (TF) | sand, silt, mud | | | | |
| Isaac (ISE, IsDz) | gravelly clay loam, clay, clay loam | severe | moderate | 120 | 6.3 |
| San Anton (SaA) | clay loam, gravelly clay loam | moderate | severe | 94 | 5.0 |
| Pozo Blanco (PbC) | clay loam, silty clay loam, loam | moderate | moderate | 22 | 1.1 |

Source: U.S. Soil Conservation Service, Soil Survey of the U.S. Virgin Islands, 1970.

Other important soil series present in the study area are Pozo Blanco, San Anton, and Isaac soils. These soils are generally deeper than the Cranmer soils and, therefore, have a greater water storage capacity. They have moderate to severe limitations for on-site sewage disposal systems and building foundations, as shown in Table III-1. They are located on or near the coast, often in the alluvial plains (Figure III-6).

Jaucus sand, volcanic rock, and tidal flats also cover small portions of the study area's surface.

5. Water Resources

Water resources in the study area consist of ground water, surface water, marine water, and public water supply. Each of these features will be discussed in terms of quantity, quality, use, and other characteristics relevant to this project.

a. Groundwater

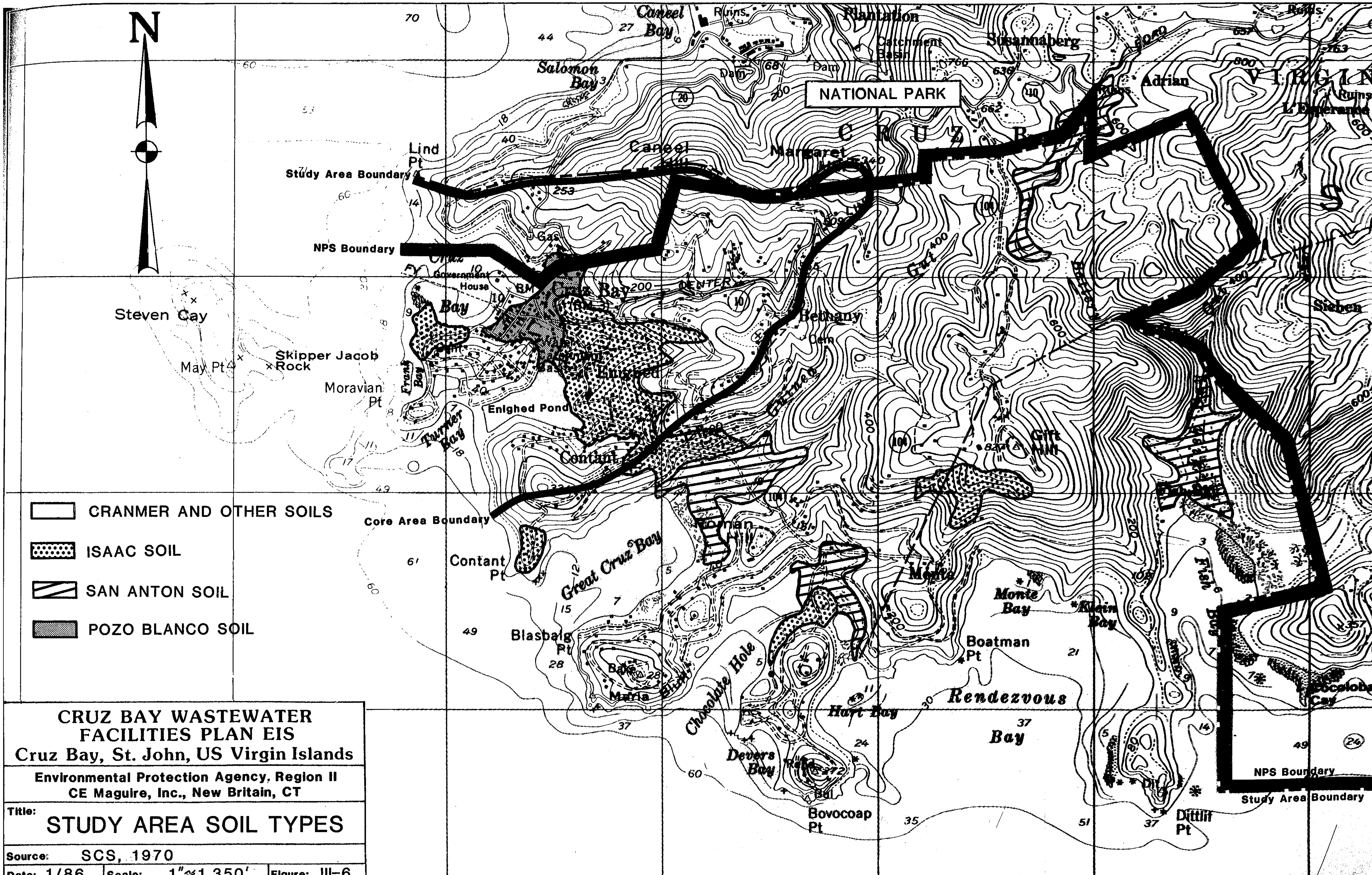
Groundwater resources in the study area are limited to the aquifers which underlie three coastal alluvial deposits and to the inland well fields located just outside the study area, as shown in Figure III-7. The quality of groundwater in the coastal aquifers is likely contaminated by salt water intrusion due to the aquifers' proximity to the sea.

The study area's groundwater resources are limited.

There is a significant groundwater supply in Adrian, outside the northeast border of the study area, as shown in Figure III-7. Wells extract water from this aquifer for the public water supply. Use of this groundwater for public consumption is discussed further in Subsection d., "Water Supply".

The absence of other groundwater resources within the study area is due primarily to the shallowness of the soils, the extremely high evapotranspiration rate, and the low permeability of the bedrock.

Most of the soil layer in the study area is too thin to store groundwater permanently. Water which seeps into the soil during or after rainfall is most often quickly evaporated by the sun or transpired by vegetation. Water which is not lost through evapotranspiration is unable to pass into the bedrock, and, therefore, flows down gradient to guts or the sea as subsurface or surface flow. The poor water storage capacity of soils and underlying bedrock in the study area is evident from observing the high runoff on slopes and in guts during and immediately after high intensity and/or long duration rainfall events.




# CRUZ BAY WASTEWATER FACILITIES PLAN EIS

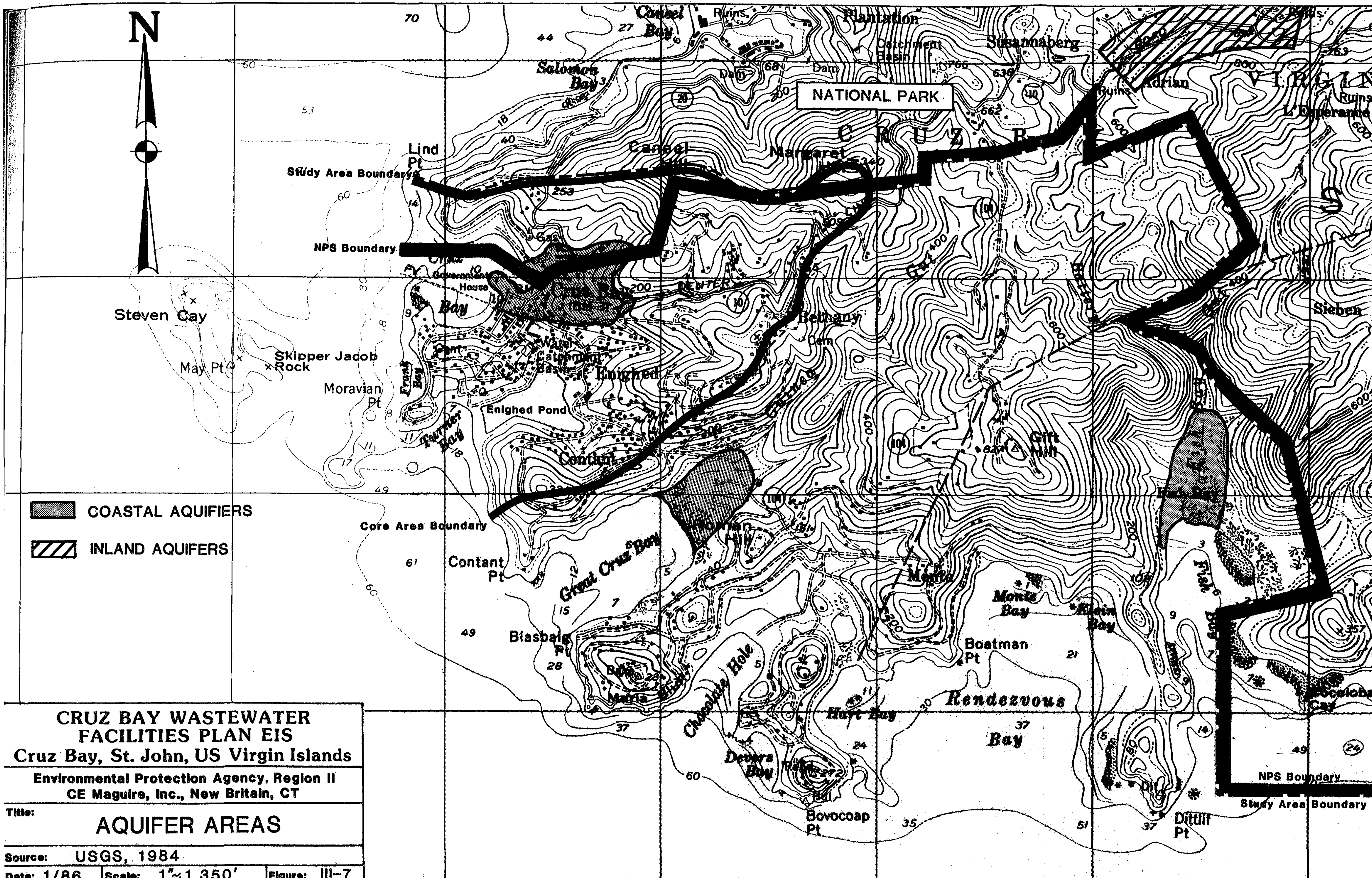
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: STUDY AREA SOIL TYPES

Source: SCS, 1970

Date: 1/86 | Scale: 1"≈1,350' | Figure: III-6




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** AQUIFER AREAS

**Source:** USGS, 1984

**Date:** 1/86 | **Scale:** 1"≈1,350' | **Figure:** III-7

b. Surface Water

Surface water features in the study area consist of intermittent streams, coastal ponds, and lagoons, as shown in Figure III-8. The amount of surface water is limited due to the low amount of rainfall and the high evapotranspiration rate on St. John.

Surface water is limited due to the amount of rainfall and high evapotranspiration rate.

There are no permanent streams in the study area. Water flows in the guts only during and after periods of heavy rainfall. During periods of very heavy rainfall, guts overflow and water flows down streets and hillsides as surface runoff.

The major guts in the study area are the Fish Bay/Battery Gut, which flows into Fish Bay, the Guinea Gut which flows into Great Cruz Bay, and an unnamed gut which generally follows Center Line Road (Route 10) to Cruz Bay and discharges into the easternmost cove in Cruz Bay, known locally as "The Creek". Surface water runoff from the subdrainage basin surrounding Monte flows into Rendezvous Bay or Chocolate Hole, and runoff from the subdrainage basin surrounding Enighed flows primarily into Enighed Pond and Turner Bay.

Surface water features, lagoons or coastal ponds provide important ecological functions.

Six lagoons or coastal ponds are located along the coast of the study area, in the vicinity of Hart Bay, Chocolate Hole, and Turner Bay. These surface water features provide important ecological functions, such as sediment trapping, flood control, and fish and wildlife habitat.

Each of these ponds contains high concentrations of salt water with the exception of the pond directly north of Hart Pond, which contains a less saline brackish water. The saline ponds are fed by the sea, either through subsurface intrusion or high seas during storms. These ponds, particularly Enighed Pond and the pond at the head of Chocolate Hole, may have been inner bays at one time, cut off by a natural process of sediment and vegetation build-up on a sandbar or reef. During periods of drought (in the late winter and spring), these ponds may become "hypersaline", an effect caused by evaporation of the water and consequent accumulation of the excess salt in the pond basin.

Enighed Pond is important to the study because wastewater effluent flows into it from various sources.

Enighed Pond is of particular importance to this study because overflows from failing on-site septic systems used by many homes on the surrounding hillsides flow into this pond, as does the discharge from the existing public wastewater treatment plant (see Figure II-1 in the previous chapter). The soil discharges poorly treated wastewater effluent into the pond. Therefore, the Pond is quite turbid, with the water quality degraded and eutrophication taking place. Residents once fished from this Pond but no longer do so because of the potential health threat from eating fish caught in this Pond.

The Pond does support biota of surprisingly high diversity. This ecosystem is discussed in Section 6 of this chapter.

Water quality is not regularly monitored in the surface water features.

A narrow channel connects Enighed Pond to Turner Bay, providing minimal tidal flushing that carries some of the wastewater effluent from the Pond into Turner Bay.

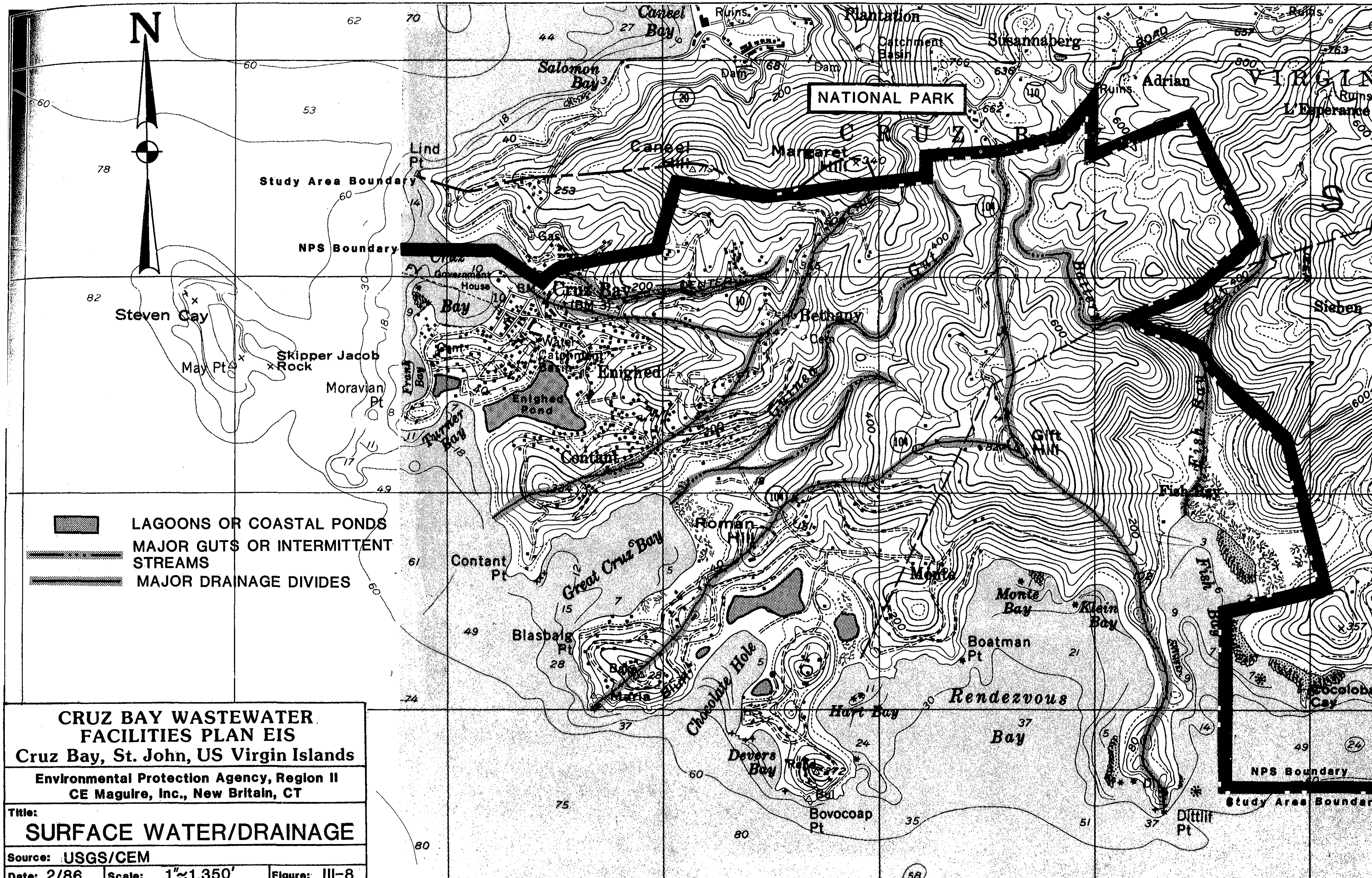
Neither the Pond nor the channel is regularly monitored for water quality.

c. Marine Water

Marine water is interrelated with groundwater and surface water.

Marine water is the third essential component of the interrelationship between water resources in the study area. Water from the sea affects groundwater and surface water through subsurface intrusion and coastal flooding. It is, in turn, affected by both ground and surface water as the eventual recipient of runoff. For the purpose of this discussion, "Marine Water" may be defined as water in the bays and nearshore waters (generally less than 1 km (.62 mi) offshore) surrounding the study area.

The bays which cut into the coastline of the study area are Fish Bay, Rendezous Bay (which includes Klein Bay, Monte Bay, and Hart Bay), Devers Bay, Chocolate Hole, Great Cruz Bay, Turner Bay, Frank Bay, and Cruz Bay. The bays on the south coast of the study area receive little use by humans and are more likely to have excellent water quality and habitat value for marine life. Great Cruz Bay serves as an anchorage for many yachts and is currently disturbed by the construction of a large hotel complex at the head of the Bay. The construction impacts, particularly sedimentation, are not major and are not expected to have a long-term effect on the quality of water in this bay.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
Cruz Bay, St. John, US Virgin Islands

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** SURFACE WATER/DRAINAGE

**Source:** USGS/CEM

**Date:** 2/86 | **Scale:** 1"≈1,350' | **Figure:** III-8

Cruz Bay, the most active bay in the study area, contains various contaminants from run off.

Cruz Bay is the most active, in terms of human use. It serves as sheltered anchorage for many yachts and other boats; a docking for ferries from St. Thomas, cruise ships, supply ships, and VI National Park ships; and an approach and landing area for the sea plane from St. Thomas and other nearby Islands.

Water quality in Turner Bay is of particular importance to this study because effluent from the existing wastewater treatment plant that works its way into Enighed pond is introduced to Turner Bay via connecting the channel from Enighed Pond. The VI Department of Conservation and Cultural Affairs (DCCA) has conducted monthly water quality sampling in Turner Bay since 1973 in order to monitor the impact of this discharge. A record of the quality of these water samples is contained at the back of the Benthic Survey report in Appendix D. Water quality in Turner Bay does not consistently meet the VI coastal water quality standards. For example, some of the samples taken contained fecal coliform, nitrate, and nitrite levels which were above the maximum levels allowed by the standards.

A detailed study of marine currents has been conducted for this project.

Marine currents in the nearshore and offshore waters surrounding the study area flow in variable directions and are very strong. A detailed study of current velocity, direction, and dispersion rates has been conducted as part of this project. A comprehensive presentation of the study's findings is presented in Appendix E.

The quality of marine water off-shore of the study area is very good.

The high velocity and dispersion rate of the marine currents serves to dilute the wastewater effluent that is discharged directly to the sea by several homes near the shore in Turner Bay and off Moravian Point.

d. Water Supply

The primary source of drinking water for residents and commercial establishments is from roof top catchment and cistern storage systems.

Residents and commercial establishments in the study area obtain drinking water primarily from rooftop catchment and cistern storage systems. These systems are required in all new homes by the VI building code. Each 30.3$m^2$ (100 $ft^2$) of rooftop may supply .019$m^3$ (5 gallons (gal)) per day, according to (Grigg, 1985, p.7). The quality of this water is generally acceptable to residents for drinking.

In addition to rainwater catchment, water is barged from the desalination plant in St. Thomas (300,000 gallon capacity per barge). Water is also pumped from the wells of the aquifer underlying the Adrian area. Residents prefer the taste of rain water to the desalinated or well water, but must rely on the latter sources during droughts.

Water is also barged from the desalination plant in St. Thomas.

The water imported from St. Thomas is mixed with the water pumped from the Adrian aquifer and stored in four municipal water tanks near the center of Cruz Bay. The combined capacity of these tanks is 3030$m^3$ (800,000 gal).

This water is distributed to residents in concentrated areas of Cruz Bay through a network of pipes. This water distribution system is operated by the VI Department of Public Works (DPW) and constitutes the only public water supply in the study area.

The VI Water and Power Authority (WAPA) operates the desalination plant located in Krum Bay on St. Thomas. DPW must purchase water from WAPA and transport it by barge to St. John. Consumers pay DPW \$14.50/3.79 $m^3$ (1,000 gal) for this water, although the cost to DPW is greater. In fiscal year 1984, an estimated 246,212$m^3$ (6.5 million gal) of water was brought to St. John this way. While the desalination plant produces a relatively reliable supply of water, the high cost to DPW plus the cost of barging it to St. John make this an impractical water supply source.

It is less expensive to pump water from the Adrian wells and pipe this water approximately 3.2 km (2 mi) to the municipal storage tanks. Approximately 379$m^3$pd (100,000 gpd) of water is currently being pumped from the Adrian wells. However, this source is unreliable in both quantity and quality. Over pumping of these wells could cause groundwater contamination through salt water intrusion. The well pumps are therefore shut off completely by DPW during severe droughts.

e. Water Use

Water in the study area is primarily used for public consumption by residents. Other uses are commercial (plumbing in shops and other businesses) and institutional (plumbing for the public school and government offices and a supply for the fire department to fight fires).

Public consumption is the primary use of water in the study area.

Table III-2 shows the estimated amount of current water use in the study area by categories of use. These estimates reflect very conservative water use by residents of the study area, due to the limited water supply. Residents are forced to conserve,

## TABLE III-2

## EXISTING WATER USE

| | 1985-86 | % of Total Use |
|---|---|---|
| **Residential** | | |
| Population (persons) | 1,869* | 51 |
| Use per capita per day (gpcd) | 25 | |
| Total Residential Water Use | 47,400** | |
| **Hotels** | | |
| # Rooms | 84 | 14 |
| Use per room (gprd) | 150 | |
| Total Hotel Water Use gpd | 12,600 | |
| **Restaurants** | | |
| # Tables | 188 | 20 |
| Use per table per day (gptd) | 100 | |
| Total Rest. Water Use (gpd) | 18,880 | |
| **Workers** | | |
| # Workers | 490 | 8 |
| Use per worker per day (gpwd) | 15 | |
| Total Worker Water Use (gpd) | 7,350 | |
| **Schools** | | |
| # Students | 400 | 7 |
| Use per student (gpsd) | 15 | |
| Total School Water Use (gpd) | 6,000 | |
| Total Water Use | 92,203 | TOTAL 100 |

*520 Served by existing sewer system.
**13,000 gpd flow to existing sewer system.

gprd = gallons per room per day
gptd = gallons per table per day
gpwd = gallons per worker per day
gpsd = gallons per student per day

using rainwater for potable and cooking purposes and water from the public water supply for washing or supplementing potable water when necessary. Those who are not served by the public water supply are particularly conservative in their water use, especially during droughts.

## 6. Ecosystems

Ecosystems on St. John may be divided into three groups:

. terrestrial,
. coastal, and
. marine.

Ecosystems are interrelated communities of plants, animals, bacteria, and other physical and chemical features which occur in any given environment. The diversity and character of ecosystems in the study area have been shaped by climatic, meteorological, geologic and hydrologic conditions. The extremely dry climate and thin soils, for instance, are responsible for the predominantly scrub-covered or nearly barren hillsides, while the deep "gut" valleys provide a protected environment for more dense, moist vegetation. An unusually dry fall may diminish the success of a moist forest ecosystem and promote the spread of a dry scrub ecosystem in its place.

Ecosystems on St. John may be divided into three distinct groups: terrestrial ecosystems, littoral or coastal ecosystems, and marine ecosystems. The following discussion will focus on the location, habitat value, and general status of the various ecosystems within each of these groups. Terrestrial and coastal ecosystems are shown in Figure III-9.

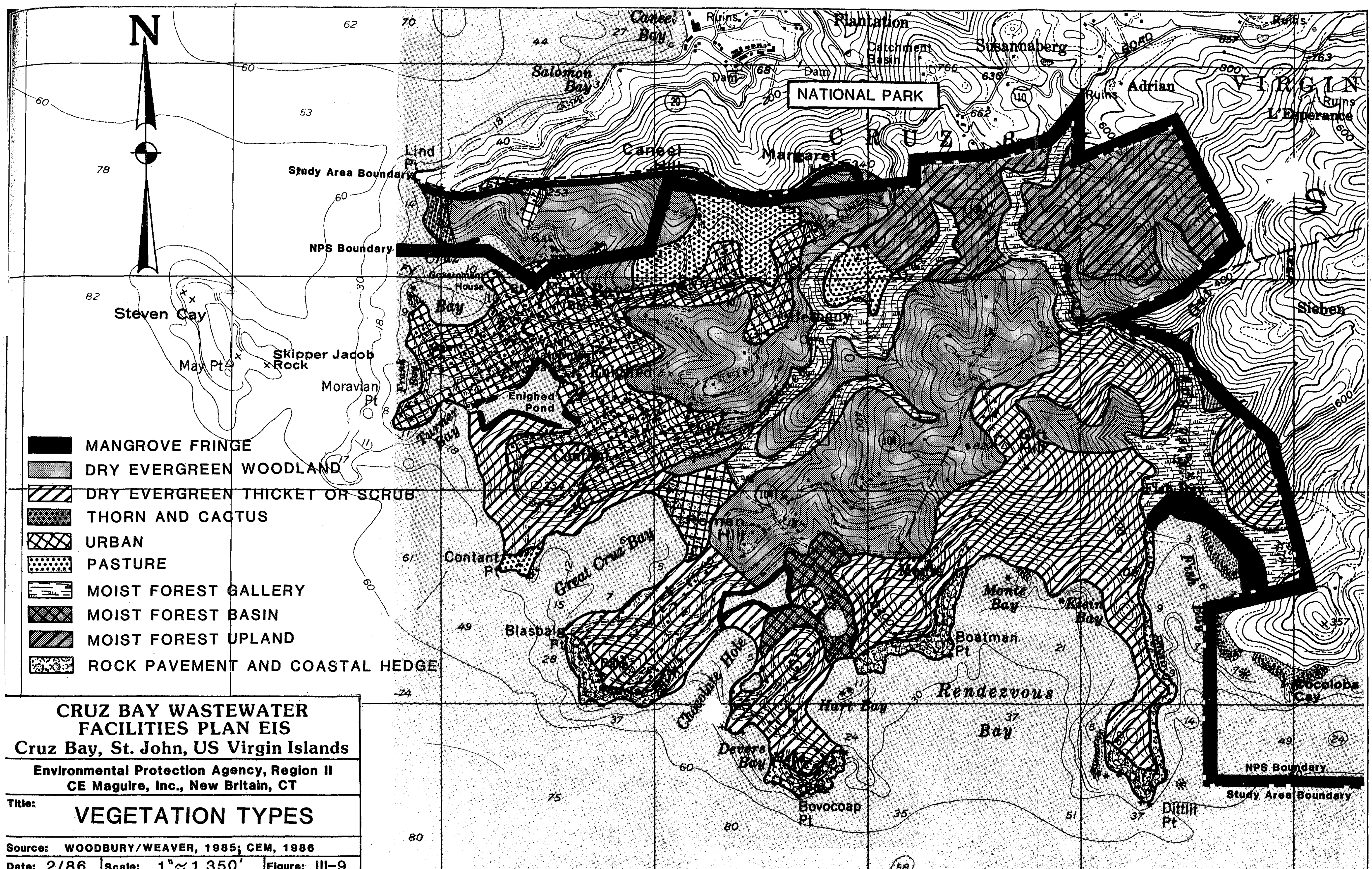
### a. Terrestrial Ecosystems

Terrestrial ecosystems are defined by vegetation types.

A recent study by the U.S. National Park Service (NPS) identified and analyzed vegetation types on St. John (Woodbury and Weaver, 1984) The categories identified in the NPS report are considered ecosystems because they correspond with animal habitats. Terrestrial ecosystems in the study area are categorized by the following vegetation types:

- Dry Evergreen Woodland
- Dry Evergreen Thicket or Scrub
- Thorn and Cactus
- Upland Moist Forest
- Basin Moist Forest
- Gallery Moist Forest
- Pasture
- Urban

Figure III-9 shows the location of these ecosystems.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
Cruz Bay, St. John, US Virgin Islands

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

Title: VEGETATION TYPES

Source: WOODBURY/WEAVER, 1985; CEM, 1986

Date: 2/86 | Scale: 1" ≈ 1,350' | Figure: III-9

(1) Dry Evergreen Woodland

The dry evergreen woodland is the most well-represented of all the ecosystems in the study area.

The dry evergreen woodland ecosystem is predominantly characterized by dense stands of relatively short (usually less than 10m (33 ft.) in height) evergreens located on hillsides which are well-drained and covered by a thin layer of soil. This is the most well-represented of all the ecosystems in the study area. It is located primarily in the center of the study area, although it extends to the shore on the northern side of Cruz Bay. Species diversity in this ecosystem is relatively low due to stresses associated with its dry and unprotected character. Dominant plant species include the common sea grape, Coccoloba uvifera, the shrub Oplonia spinosa, the vine Tragia volubilis, and the herb Talinum triangulare. Dominant animal species include the indian mongoose (Herpestes auropunctatus). and various reptiles. Other animals present include the feral goat, donkey, pig, common rat, norway rat, house mouse, bat, and possibly, the white tailed deer. The dry evergreen woodland is generally not a suitable habitat for the various species of shorebirds which inhabit St. John.

(2) Dry Evergreen Thicket or Scrub

Because of shallow soils and exposure to wind and salt spray, the vegetation is short.

This ecosystem is characterized by dense stands of scrub vegetation, usually less than 3m (10 ft) tall. Many of the dominant trees and bushes have very small leaves and long thorns. This ecosystem is well represented in the study area; particularly on coastal hillsides, but also on the eastern slopes of Gift Hill. The shallow soils and exposure to wind and salt spray account for the shorter, tougher character of vegetation than in the dry evergreen woodland ecosystem.

Dominant species of vegetation include the sea grape, Coccoloba uvifera and various scrubs of the Croton-Acacia association. While the mongoose and various reptiles may thrive in this ecosystem, the scrub cover type generally provides neither the cover nor the access necessary for larger mammals such as the deer or donkey.

The thorn and cactus ecosystem on Lind Point provides habitat for few animals.

(3) Thorn and Cactus

This ecosystem is characterized by short dry scrub and cactus growing from rocky slopes above the shoreline. Only a small portion of the study area, the tip of Lind Point, is characterized by the thorn and cactus ecosystem. Dominant species of vegetation include the scrub Picteria aculeata and the cacti Pilocereous royenii and Optunia (Consolea) rubescens. This dry, rocky environment provides habitat for few animals, but reptiles, such as the dwarf gecko Spaerodactylus macrolepis may thrive.

The upland moist forest ecosystem is characterized by well-developed stands of relatively tall, broad-leafed trees.

(4) Upland Moist Forest

This ecosystem is located in the high, gently sloping interior land in the northeastern part of the study area and is characterized by well-developed stands of relatively tall broad-leafed trees. The gentle slopes allow more retention of rain water than in previously discussed ecosystems, providing habitat for more water-dependent species. Portions of this area were evidently not affected by the early settlers' clear-cutting for agriculture. According to Woodbury and Weaver, "this forest is variable ranging from degraded in stages of recovery, through almost pure stands of the cinnamon or bay rum tree, to an almost virgin stand with few or no introduced species." (1985, p. 12). Larger mammals which need water frequently would be more successful here than in previous ecosystems, as would various species of birds due to the presence of both an emergent and continuous canopy of trees (providing surveillance and cover potential).

Basin moist forest ecosystems are located in low elevations near the coast.

(5) Basin Moist Forest

This ecosystem is generally characterized by three layers of trees: a lower layer at 5-10m (16-33 ft) above ground level, a middle layer at 15m (50 ft), and an emergent canopy rising up to 20-25m (65-80 ft). Most of the trees are evergreens. What distinguishes it most from the upland moist forest, however, is its location in low elevations near the coast. The basin moist forest ecosystem occupies only a small portion of the study area near Hart Bay and Chocolate Hole. The ecological significance of this ecosystem is enhanced by its proximity to the coastal ponds surrounding these two bays. As the ponds provide a valuable feeding habitat for many species of birds, the nearby multistoried canopy of the basin moist forest is likely to provide a valuable nesting habitat. This ecosystem also provides adequate habitat for many mammal and reptile species.

(6) Gallery Moist Forest

The gallery moist forest ecosystem is highly dependent on rainfall.

This ecosystem is characterized by the tallest (up to 30m (100 ft) tall) and most water-dependent terrestrial vegetation in the study area. Confined to major guts, the gallery moist forest is also shaded and well-protected from the wind. Most of the trees are young, however, due to occasional destructive flooding. Both the canopy and understory are relatively dense, providing cover for large and small animals. This ecosystem, like the other moist forests, is more suitable to large, water-dependent mammals than other ecosystems. Due to its varied cover and distribution in the study area, the gallery moist forest is also likely to provide suitable habitat for a wide diversity of wildlife species. However, more than any one other ecosystem its condition and health depends on periodic rainfall.

(7) Pasture

Pasture land is characterized by moderate slopes.

The two small tracts of pasture land in the study area are characterized by moderate slopes with an extremely short herbaceous cover, typically bermuda grass (Cynodon dactylon) with occasional Acacia scrubs. These areas are no longer in active agricultural use.

(8) Urban

Much of the western portion of the study area is urban land, covered primarily by buildings and infrastructure. This category has little ecological value.

b. Littoral/Coastal Ecosystems

The Woodbury and Weaver study addressed two very small but important ecosystems associated with the study areas littoral zone: the mangrove fringe and rock pavement/coastal hedge. Another ecosystem which will be addressed in this subsection is the sandy beach.

The Mangrove fringe, rock pavement/coastal hedge and the sandy beach are three other ecosystems.

(1) Mangrove Fringe

The mangrove fringe is the most sensitive of all ecosystems to impacts resulting from human activities occurring in the study area. Fringes are located on the shore of Fish Bay, along the north shore of Cruz Bay, the pond at the head of Chocolate Hole, and degraded or incompletely zoned fringes surrounding Enighed Pond.

The underwater roots of mangrove trees are often encrusted with marine shellfish. Submerged mangrove root areas also serve an important function as nurseries for juvenile fish and other marine organisms.

In addition to their function as landbuilders, mangrove communities protect coastal areas from erosion with their prop roots acting as sediment traps, while slowing down water velocity. They are particularly important in limiting shoreline damage caused by hurricanes. They also help protect marine water quality by trapping sediment and contaminants associated with runoff water.

(2) Rock Pavement and Coastal Hedge

The steep rocky promontories in the study area are characterized by a mixture of barren bedrock and very short (usually less than 1m (3.3 ft)) brush cover. Exposure to the prevailing wind and salt spray stress these plants and limit their height to 1m (3.3 ft). This ecosystem is found on the east and southeast faces of Dittlif Point, Boatman Point, Bovocoap Point, and Maria Bluff/Blasbalg Point.

Most of the brush, or hedge, consists of the species Coccoloba uvifera, the common sea grape. Various species of cacti are also present. The hedge provides excellent nesting habitat for shore birds such as the sandwich tern, roseate tern, royal tern, and laughing gull.

(3) Sandy Beach

The sandy beach ecosystem includes the primarily vegetation-free, sandy fore-beach and the vegetated berm. This ecosystem is found at the heads of Hart Bay, Chocolate Hole, Great Cruz Bay, Turner Bay, Frank Bay, and the west cove of Cruz Bay.

Beaches in the less disturbed areas of Hart Bay and Chocolate Hole may provide nesting habitat for the hawksbill turtle (Eretmochelys imbricata). Other species of sea turtle (See Section 7 of this Chapter) tend to be more selective in terms of nesting habitat, but have been known to nest in more remote beaches on St. John, outside of the study area. Hawksbills generally nest in the vegetated berm rather than the sandy fore-beach.

Various crabs and shorebirds also inhabit the beaches in the study area.

c. Marine Ecosystems

**A detailed study of benthic-marine communities offshore of the study area has been conducted.**

A detailed study of benthic-marine communities offshore of the study area has been conducted for this project. Detailed findings of this study are included in Appendix D and summarized in this subsection.

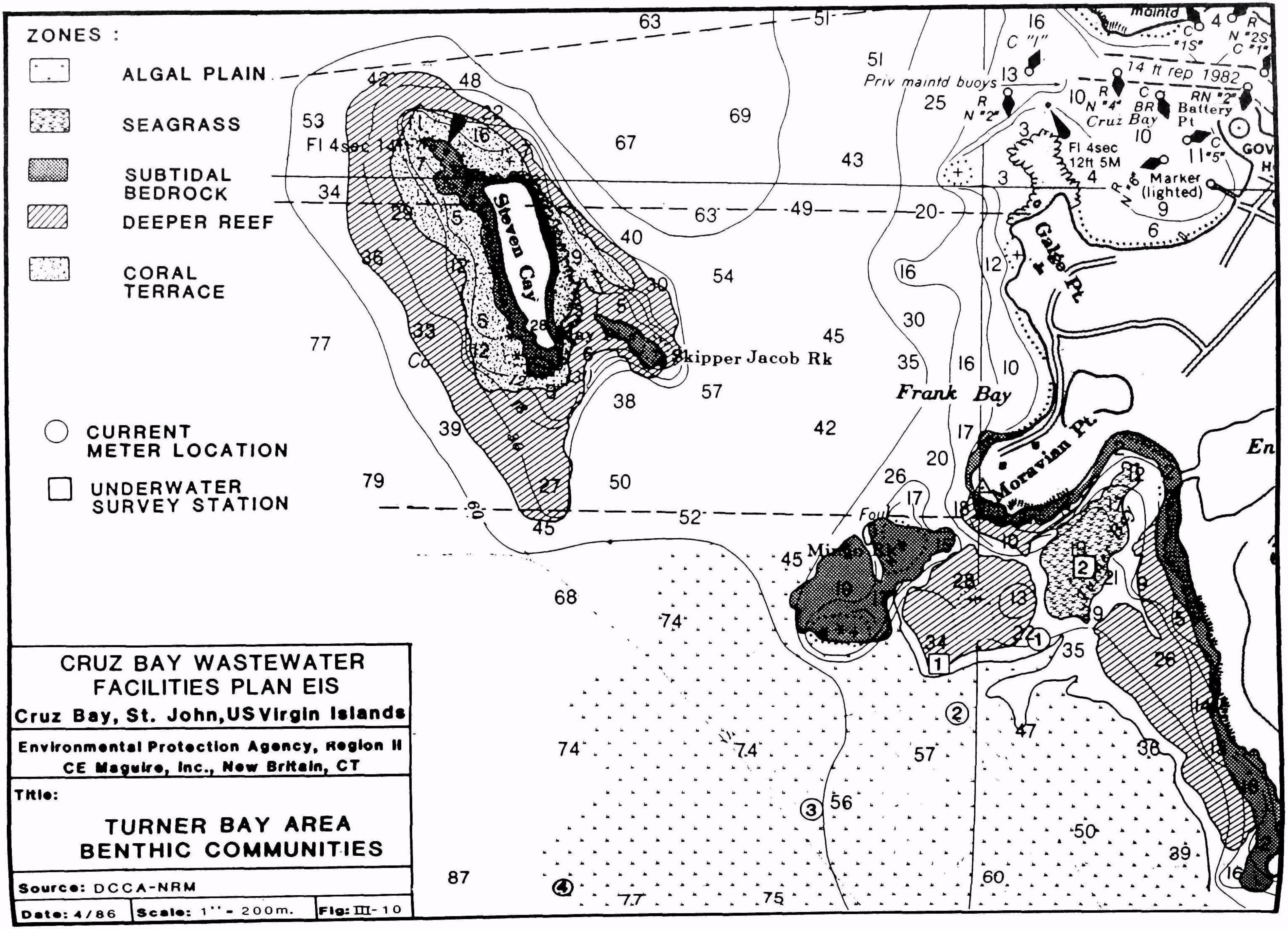
The two distinct marine ecosystems that have been identified are the coral reefs and the grass beds as shown in Figure III-10.

(1) Coral Reefs

The clear nearshore waters surrounding St. John support an abundant growth of coral. Deep reefs surround nearly the entire south coast of the study area. In Hart Bay, Monte Bay, and part of Fish Bay there are shallow reefs of mixed corals closer to the shore. Coral communities off the west coast are dominated by a large reef near Moravian Point and Turner Bay. The above-referenced study focuses on this reef because it is close to the existing treatment plant and, therefore, may be impacted by this project.

**Coral reef communities are among the most complex and productive ecosystems.**

Coral reef communities are among the most complex and productive ecosystems. They support a higher density of organisms than other marine habitats and the widest variety of species. Coral species common in the littoral waters surrounding the study area include elk horn coral (Acropora palmata), various sea fans (Gorgonacea spp.), soft corals (Alcyonacea spp.), brain coral (Daploria scrigosi), finger coral (Porites porites furcata) and fire coral (Millepora alcicrovis).


ZONES :
ALGAL PLAIN
SEAGRASS
SUBTIDAL BEDROCK
DEEPER REEF
CORAL TERRACE
CURRENT METER LOCATION
UNDERWATER SURVEY STATION
Steven Cay
Skipper Jacob Rk
Frank Bay
Moravian Pt.
Galge Pt.
Cruz Bay
Battery Pt
Priv maintd buoys
14 ft rep 1982
Fl 4sec 12ft 5M
Marker (lighted)
CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title:
TURNER BAY AREA BENTHIC COMMUNITIES
Source: DCCA-NRM
Date: 4/86
Scale: 1" = 200m.
Fig: III-10

Coral reef communities support many tropical and reef fishes as well as sponges, brittle stars, annelids, a wide variety of arthropods and other invertebrates. Large numbers of larvae released by organisms inhabiting coral reefs join floating planktonic species, and serve as the foundation of the food chain for larger organisms.

Beyond its habitat value, the coral reef ecosystem is valuable for protecting the shoreline from wave action and stabilizing the benthic slope.

(2) Grass Beds

Beds of turtle grass (Thallassia testudinum) and manatee grass (Cymodecea manatorum) are located in large patches surrounding the study area. One large patch is situated in Turner Bay. The grasses, usually less than 1m (3.3 ft) in height, grow in depths of up to 9m (30 ft) where light penetration is sufficient for photosynthesis to take place.

The grass bed ecosystem provides an important feeding habitat for marine turtles.

The grasses are sometimes interspaced with patches of reef or sandy bottom. They may be accompanied by the algae Holicystis osterhontii, Canterpa spp., and Padina spp.

This ecosystem provides an important feeding habitat for marine turtles, including the hawksbill (Eretmochelys imbricata), leatherback (Dermochelys coriacea), and green (Chelonia mydas) turtles.

Other species which may be present in this ecosystem include the queen conch (Strombus gigas), Helmut shells (Cassias tuberosa and Grithium litteratum), sea cucumber (Holothuria mexicana), and sea urchins (Tripneustes esculentus and Litechinus variegatus). Many species of fish visit and feed in this ecosystem.

7. Rare and Endangered Species

In compliance with Section 7 of the Endangered Species Act, EPA initiated consultation with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) in order to identify threatened and endangered species which may be affected by this project. The following information is based directly on the results of these consultations.

Several species of both flora and fauna which are present in the study area are considered endangered, threatened, rare or endemic.

Endangered species are those which are in immediate danger of extinction throughout all or most of their range, and threatened species are those which are likely to become endangered in the near future (Dowhan and Craig, 1976). Rare species are those which do not occur commonly in a given area, and, therefore, generally include both endangered and threatened species. Endemic species are those which occur only in a specific area of the world. In addition to these classifications, both the United States and the Virgin Islands maintain lists of endangered and threatened species, as shown in Appendix F. These lists differ somewhat according to the status of the species in the United States in contrast to its status in the Virgin Islands.

a. Vegetation

Two species of vegetation which occur in the study area are listed as endangered by the Institute of Tropical Forestry in Puerto Rico: Zanthoxylum thomasianum and Tillandsia lineatispica. The former, commonly known as prickly ash, is found on the eastern slopes of Gift Hill. The latter is a small herbaceous shrub which is found in the same area. In addition to these, Erythrina eggersii, a small leguminaceous shrub found in Fish Bay Gut, is being proposed as a Category 3 species. Inclusion in Category 3 means that the species should be recognized as threatened, but more study is required to determine its actual population status.

Two species which are found on Maria Bluff have recently been listed by Woodbury and "are believed to be extremely limited in distribution" (R. Boulon, DCCA, January 21 Letter to EPA). These are Byrsonima sp. and Psidium sp. Significant habitat for species of vegetation are shown in Figure III-11.

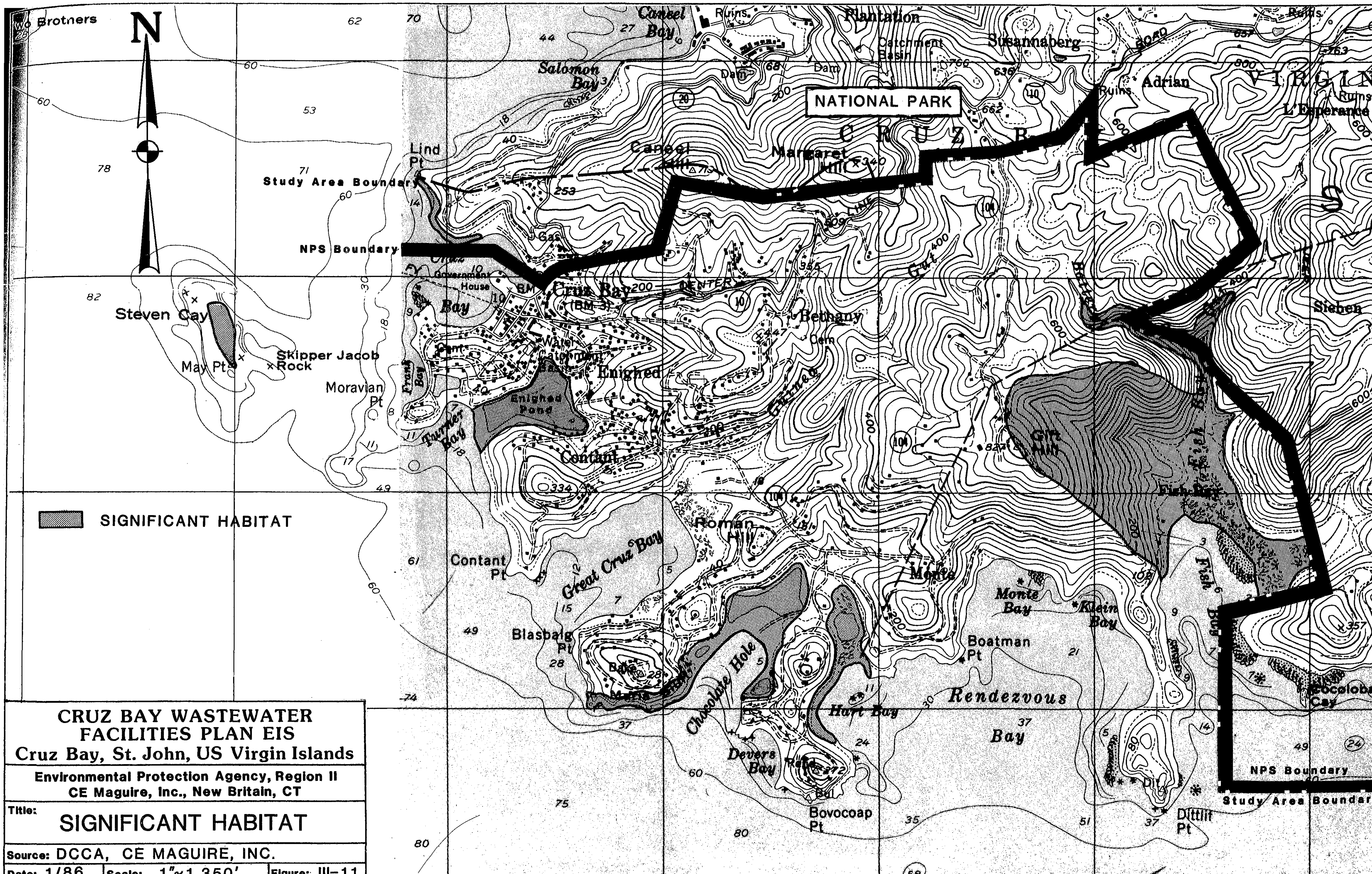
b. Wildlife

Most of the threatened or endangered species of wildlife in the study area are birds. The following terrestrial birds are considered locally endangered:

There are seven endangered species of birds in the study area.

(1) White Crowned Pigeon (Columba leycocephala), found on the east side of Fish Bay;

(2) Puerto Rican (Stolid) Flycatcher (Myiarchus stolidus) found in the lower parts of the Fish Bay watershed;




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** SIGNIFICANT HABITAT

**Source:** DCCA, CE MAGUIRE, INC.

**Date:** 1/86 | **Scale:** 1"≈1,350' | **Figure:** III-11

(3) Puerto Rican Screech Owl (Otus nupides), may be found in the upper parts of Fish Bay and Battery Gut;

(4) Antillean Nighthawk (Chordeiles gundilachii), may be found in the study area; and

(5) Peregrine Falcon (Falco perigrinus), may be found in the study area.

Locally endangered marine birds found in the study area are the brown pelican (Pelicanus occidentalis), and the roseate tern (Sterna dougalli).

Both species roost and nest in numerous places along the shore. The pelican is also on the Federal Endangered Species list, while the tern is proposed for the Federal Threatened Species list.

**Marine turtles which inhabitat waters around St. John are also endangered.**

Three species of marine turtles have been observed offshore of the study area. The federally endangered hawksbill turtle (Eretmochelys imbricata), feeds on nearshore reefs and may nest on south coast beaches. The federally endangered leatherback turtle (Dermochelys coriacea) and the federally threatened green turtle (Chelonia mydas) feed on nearshore grass beds. The loggerhead turtle (Caretta caretta) and the olive ridley turtle (Lepidochelys olivacea) have not been observed in the vicinity of the study area in many years.

The federally endanged humpback whale (Megaptera novaengliae) has been observed offshore of St. John in the winter and spring.

Finally, the locally endangered common iguana (Iguana iguana) was at one time frequently observed in the Great Cruz Bay/Chocolate Hole area, but may now be eliminated by its predator, the Indian mongoose.

8. National Park/Protected Land

The majority of the Virgin Islands National Park land is on St. John, occupying most of its northern shore, central interior, and south central/eastern shore. Over two- thirds of the Island is part of the National Park, and is, therefore, protected under NPS regulations.

a. National Park Service (NPS)

Though the Park headquarters is located at Redhook on St. Thomas, the operations office is located on

Over two thirds of the island is protected by the National Park Service (N.P.S.).

St. John at Cruz Bay Creek. The maintenance activities are also located near Cruz Bay Creek, just east of the operations office.

The park boundaries are shown in Figure III-12. As mentioned above, the Park's umbrella shape covers most of St. John's northern shore, central interior and south central/eastern shore. The boundaries of the National Park will be changing if proposed additions and deletions in the Virgin Islands Development Concept Plan are implemented by congressional legislation. These proposed additions/deletions are also shown in Figure III-12.

The NPS has governing powers on all federally-owned lands within the park boundaries, as well as offshore water areas, though these offshore water zones also fall under the supervision of the Army Corps of Engineers, the VI government and the U.S. Coast Guard.

The National Park Service cooperates with the VI government in matters pertaining to traffic control, street rights-of-way, public health and safety laws, water resource regulations, wildlife and environmental statutes. Also, all acts of the VI government and U.S. Code of Federal Regulations apply to lands and waters within the National Park Boundaries.

Regulations through various permits and agreements have been established to supplement park operations. Among those are the following regulations and conditions listed in the VI National Park General Management Plan.

Regulations and special conditions listed in the Virgin Islands National Park General Management Plan dictate use of NPS land.

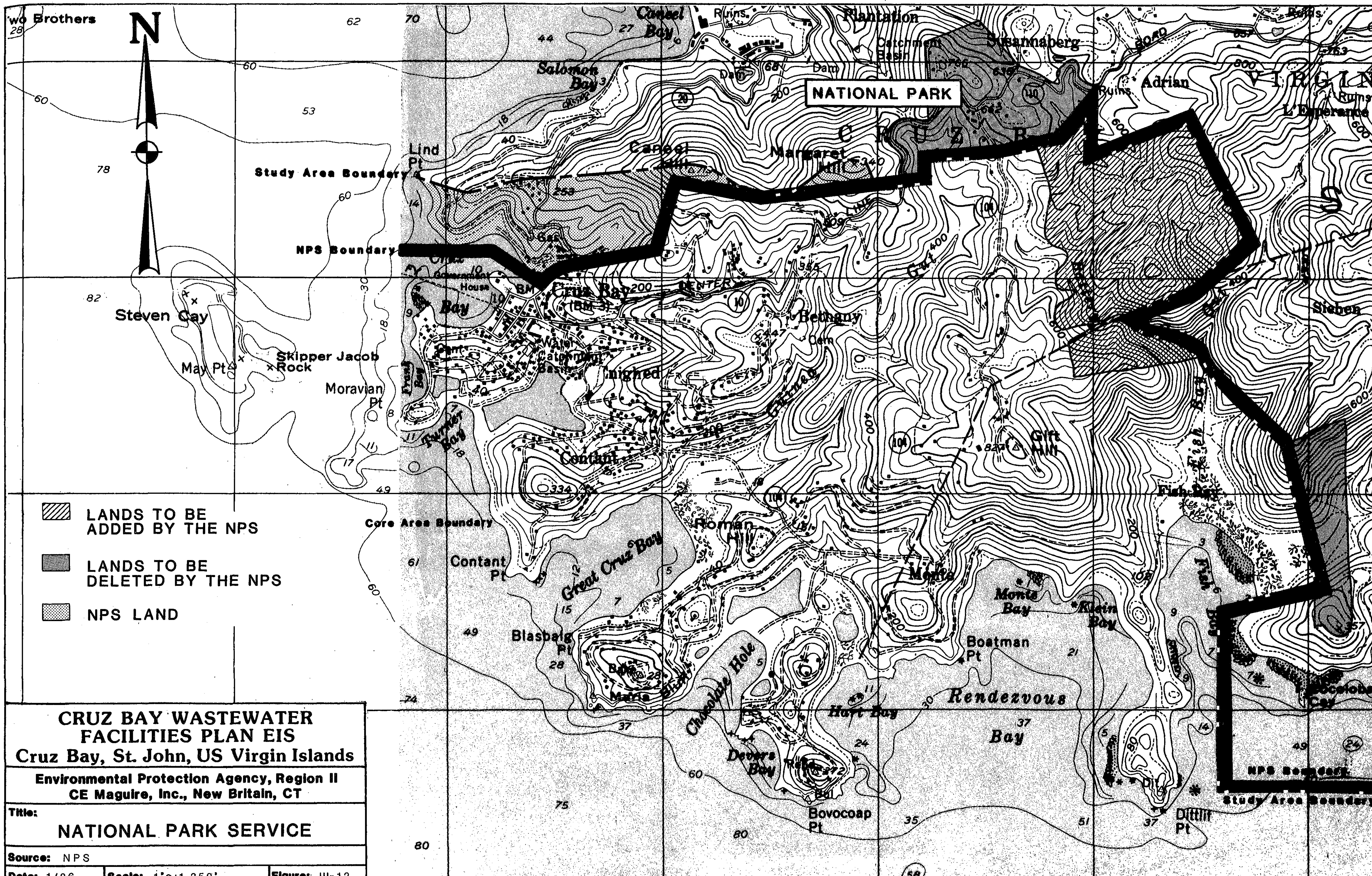
(1) August, 1982 zoning regulations that permit residential development on most privately owned park lands,

(2) Act 806 (1962) which specifies road maintenance and improvements by the park service, but allows ownership and jurisdiction to remain with the VI government,

(3) Various concessionaire contracts for related visitor services,

(4) The Cruz Bay playing field (baseball diamond) near the NPS visitor center,

(5) Seaplane ramp in Cruz Bay for connecting service with St. Croix and St. Thomas,




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** NATIONAL PARK SERVICE

**Source:** NPS

**Date:** 1/86 | **Scale:** 1"≈1,350' | **Figure:** III-12

(6) Department of Conservation and Cultural Affairs bulkhead use in Cruz Bay Creek,

(7) Telephone Company utility rights-of-way, and

(8) Radio tower usage agreements with various private and public agencies.

b. Coastal Zone Management

The areas designated in the proposed Coastal Zone Management Plan are shown in Figure III-13. Most of the southern section within the study area is designated for Residential Low Density and Protection. The area surrounding the ponds just north of Chocolate Hole and Hart Bay are designated for preservation. The Cruz Bay area, the Frank Bay area and the site of the Virgin Grand - St. John Hotel are proposed for Conservation, Recreation and Traditional Uses. Both the Chocolate Hole/Hart Bay area and the Cruz Bay/Enighed Pond area are designated as "Areas of Particular Concern" (APC). The Virgin Islands CZM Act of 1978 requires that the CZM Program especially recognize APC's by making "provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic values." (Section 306(c)(a)).

The Enighed Pond area is designated as an area of particular concern.

Water Dependent and Related Commercial - Marine Facilities are proposed for Enighed Pond after dredging operations take place. The Enighed Pond area is an APC because of its sensitivity, i.e., ecological value and the potential for adverse impacts due to development. The second APC is the area northeast of Chocolate Hole designated for preservation, conservation, recreation or traditional uses.

A Coastal Zone Management (CZM) permit is required for any development occurring in CZM zones.

A CZM permit is required for any development occurring in these zones. The permit is granted on the condition that the proposed development is consistent with the type of land use proposed for that zone by the Virgin Islands' CZM Act of 1978. Residential development is not considered consistent with "preservation" and "conservation" zones shown in Figure III-13. Only certain levels of development are consistent with the "Protection, Residential Low Density" zones.

The north shore of Fish Bay, though originally planned for protection and residential low density, is currently zoned for beach and resort activities according to the Virgin Islands Government Zoning, September 1983.

9. Cultural Resources

**Valuable cultural resources in the study area should be protected.**

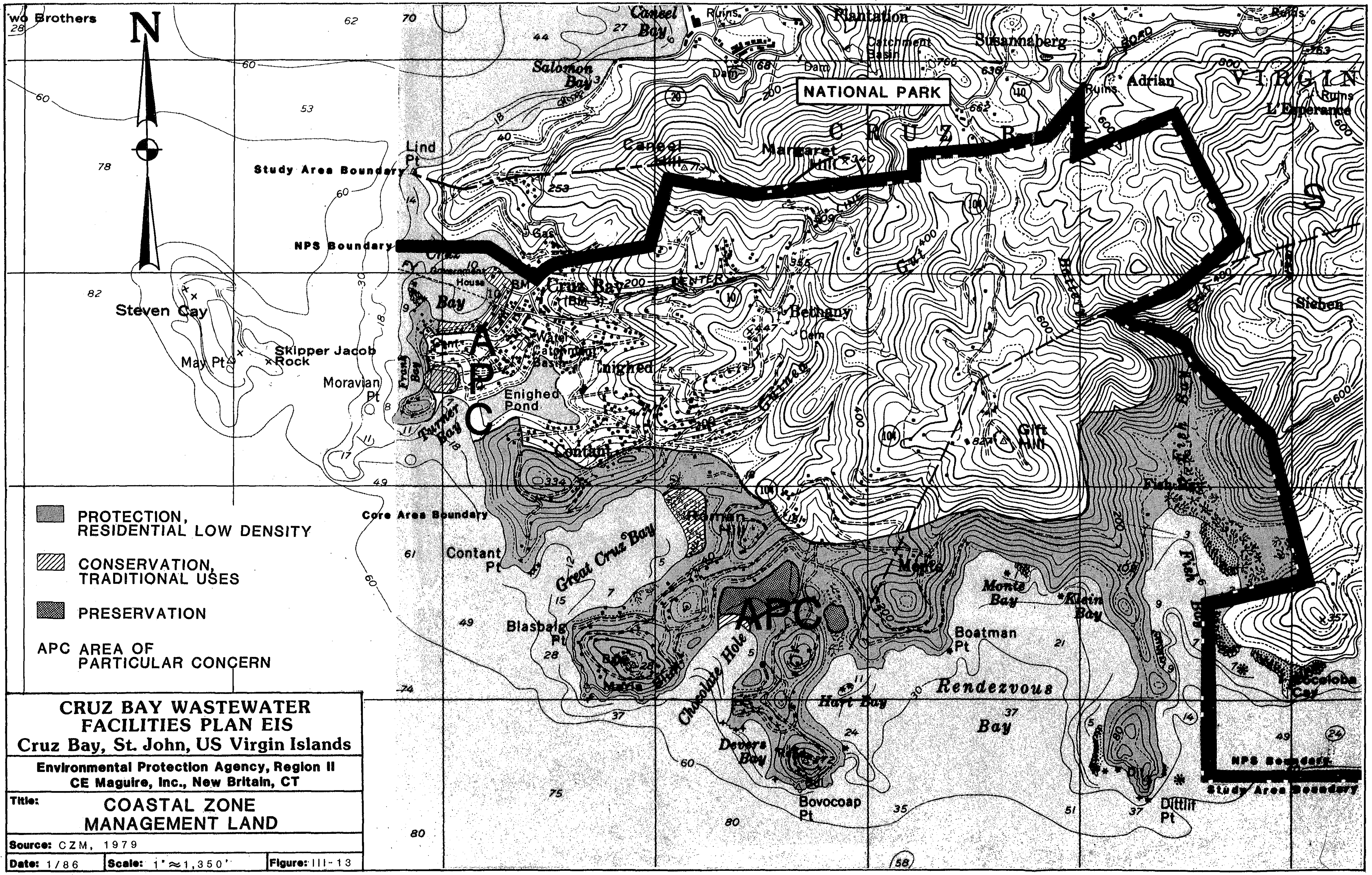
A Stage 1A Cultural Resource Survey was conducted by MAAR Associates in June and July, 1985. It covered the area known as the core (or original) study area. The expanded study area was also studied under a Stage 1A Cultural Resource investigation (February, 1986). A "Stage 1A" survey is a preliminary investigation of existing records that is conducted in order to identify the potential for cultural resources in an area. Based on the recommendations of the stage 1A surveys, a stage 1B survey was conducted by MAAR in July, 1986 in order to investigate the projects potential impacts on cultural resources more closely. These surveys are summarized in Appendix J.

The areas of archaeological significance or sensitivity are shown in Figure III-14. They consist mainly of historic and post-emancipation archaeological sites. The stage 1B survey did not find significant cultural resources in sites which would be affected by the construction or operation of proposed wastewater facilities.

10. Air Quality

**The air quality of St. John is excellent.**

The Island of St. John has excellent air quality. Pollutants and other particulates from automobiles have no noticeable effect on the air quality and industry-related pollutants are non-existent because there is no industry on St. John. There is a small auxiliary electrical generating station near Enighed Pond that operates only when there is a transmission problem from St. Thomas. Its infrequent use produces negligible amounts of pollutants. Also, occasional fires occur at the landfill site and are a source of air pollution. The Island is constantly subject to strong easterly tradewinds, which have a great effect on the dispersion/mixing of the few existing pollutants. Future air emission sources will exist from two 1260 Kv emergency generators and a 360 lb/hr incinerator atthe Virgin Grand Hotel near Great Cruz Bay.




▨ PROTECTION, RESIDENTIAL LOW DENSITY

▨ CONSERVATION, TRADITIONAL USES

▨ PRESERVATION

APC AREA OF PARTICULAR CONCERN

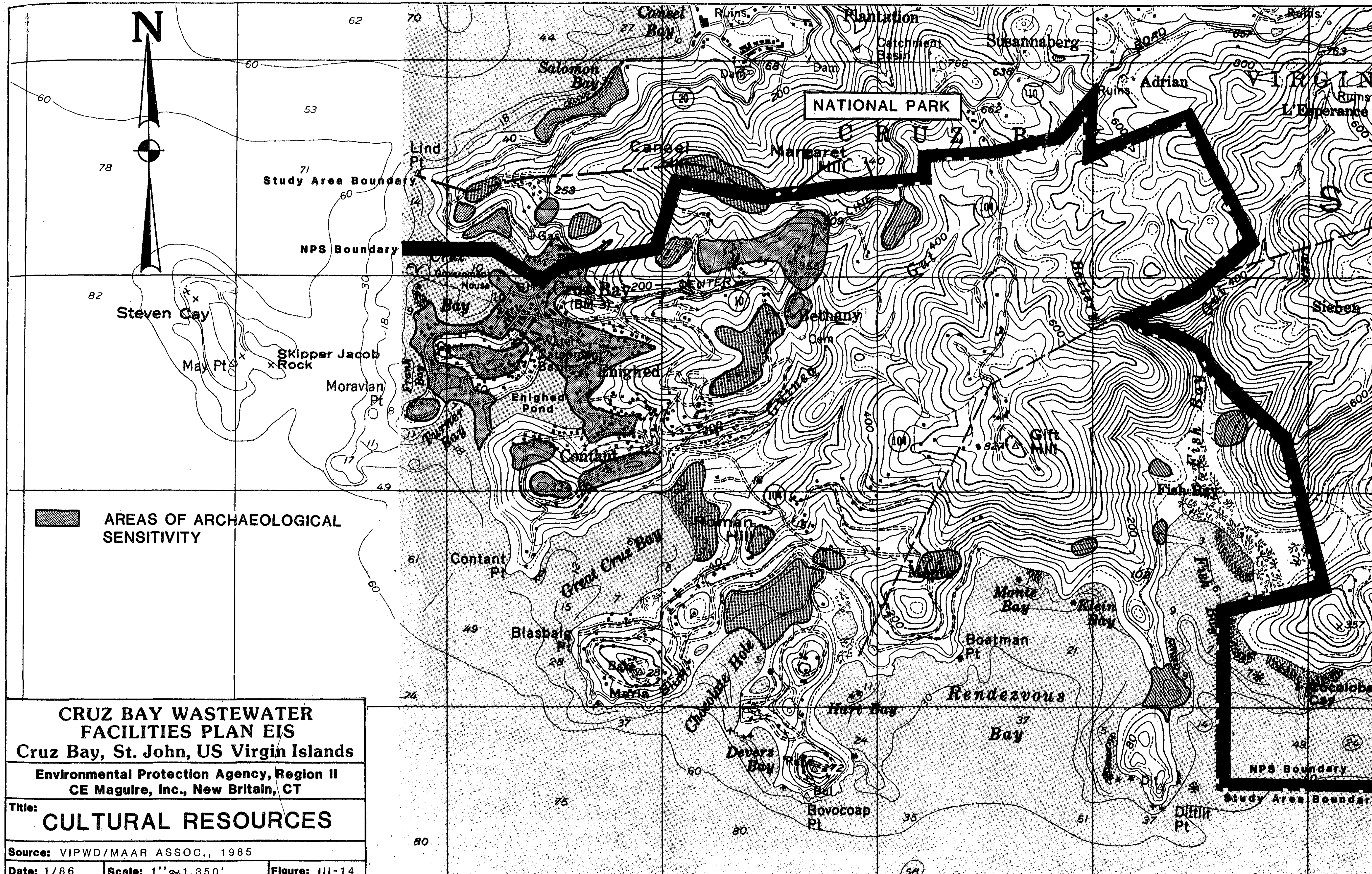
**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** COASTAL ZONE MANAGEMENT LAND

**Source:** CZM, 1979

**Date:** 1/86 **Scale:** 1" ≈ 1,350' **Figure:** III-13




CRUZ BAY WASTEWATER FACILITIES PLAN EIS

Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II

CE Maguire, Inc., New Britain, CT

Title: CULTURAL RESOURCES

Source: VIPWD/MAAR ASSOC., 1985

Date: 1/86 | Scale: 1''≈1,350' | Figure: III-14

11. <u>Noise</u>

Power boats, the sea plane and the few vehicles on St. John are primary sources of noise.

Primary sources of noise on St. John include the Island's few vehicles, powerboats and the seaplane (located in Cruz Bay). The electrical generator near Enighed Pond may also emit significant decibel (dBA) levels, but since it is used only as an emergency backup generator, the noise impacts are minimal. There are various short-term or temporary noise impacts on St. John. The most noteworthy are construction projects, outdoor music concerts, diesel trucks and poorly maintained automobiles and motorcycles.

12. <u>Energy</u>

St. John is supplied with electrical power from an underwater cable across Pillsbury Sound from Redhook, St. Thomas to a point near Moravian Point. As mentioned before, there is also an emergency generator located on the east end of Enighed Pond. Power generation is adequate for St. John's demand, but maintenance should be improved to ensure power generation.

Nearly all of the electricity is used for domestic lighting and appliances. There is no dominant user of electricity on St. John due to the lack of industry, heavy or otherwise. In the future, however, the Virgin Grand Hotel (currently under construction) will in all likelihood be a major user of electricity on St. John.

Gasoline is imported to St. John from St. Thomas and is distributed by several gas stations for private use in cars, trucks, motorcycles, boats, etc.

13. <u>Zoning and Land Use</u>

Zoning and land use regulations are implemented by the Virgin Island Planning Office.

The Virgin Island Planning Office (VIPO) is the principal governmental body responsible for implementing regulations affecting zoning and land use on St. John. Their goals are to protect the National Park lands and other natural resources while maintaining flexibility for improvements to the Islands and their inhabitants so that public service is sustained.

The VIPO has adopted a land use plan in accordance with the recommendations of the Coastal Zone Management Program of 1972, 1978. Zoning and land use patterns are described in the following subsections.

a. Zoning

Residential zones predominate within the study area.

Existing zoning boundaries are shown in Figure III-15. Most of the land within the study area is zoned as R-2 Residential, low-density, one and two family houses, and comprises 368 ha (920 ac). Maximum density allowed is 2 dwelling units (du) per 10,000 square feet ($ft^2$). R-2 zoning is primarily located inland, but also encompasses the Great Cruz Bay, Chocolate Hole and Moravian Point areas.

Lands zoned for residential, low-density use (R-1) comprise the next greatest amount of land area. These lands occupy 234.4 ha (586 ac) and allow for a maximum of 2 du/1/2 acre. R-1 zoning is also located in the interior of the Island, while also encompassing Rendezvous Bay and Fish Bay.

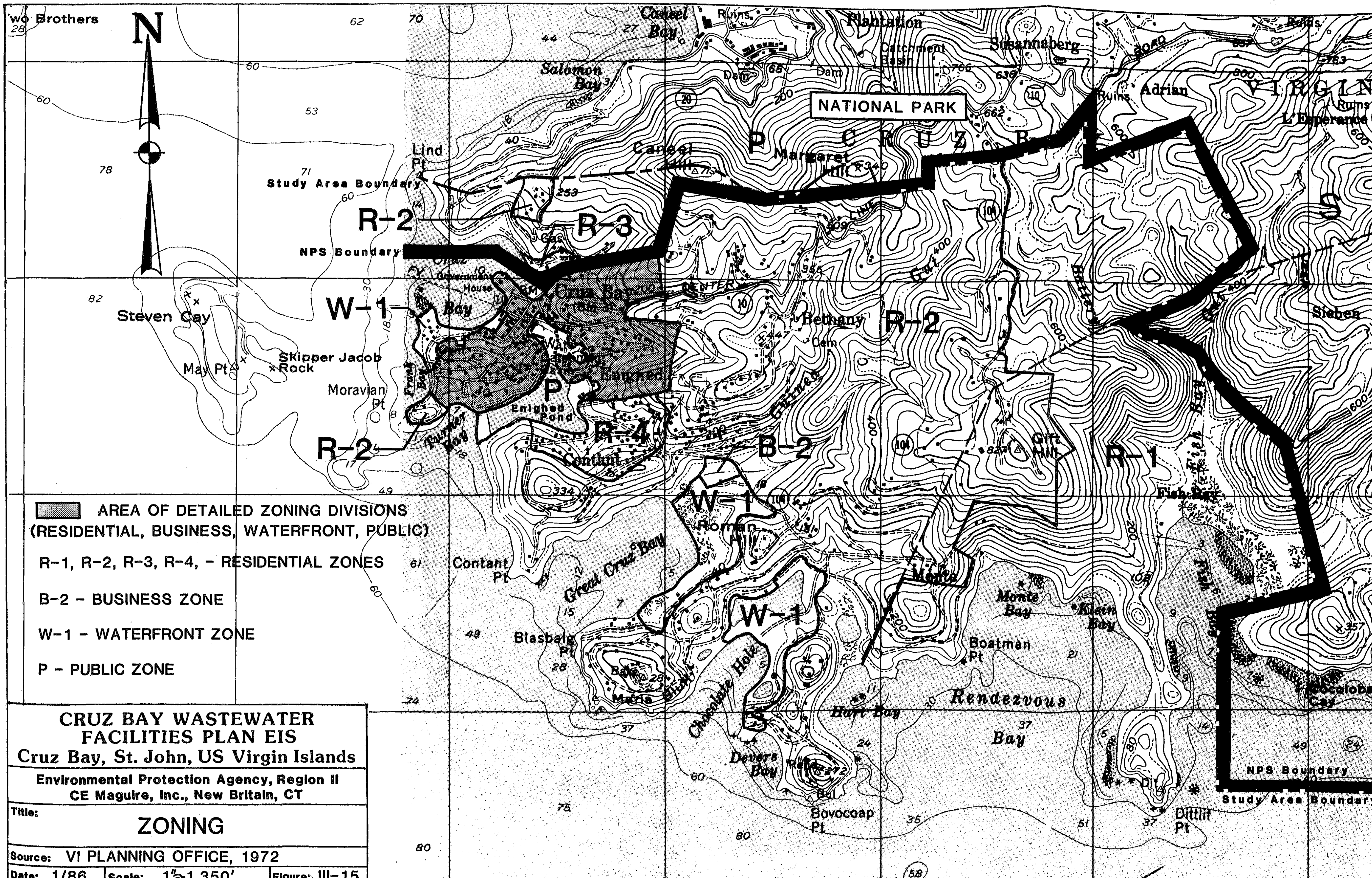
Lands zoned for public use (P) account for the third largest area in the study area. Some residential and commercial activity had once been allowed within the borders of the VI National Park. However, zoning policies are now more restrictive to development. Public lands occupy 52 ha (130 ac) in the study area. These areas are identified as the VI National Park and Enighed Pond.

Waterfront-pleasure (W-1) zoning occupies 36.4 ha (91 ac) within the study area. Its maximum allowable density is 2 du/10,000 $ft^2$. Areas of W-1 zoning include the northeastern shore of Chocolate Hole, the eastern shore of Great Cruz Bay, the southern and southwestern shore of Cruz Bay and the northeastern shore of Frank Bay.

Next are areas of R-3, R-4, medium-density residential areas that occupy 16 ha (40 ac) within the study area. The maximum density allowed within this zone is 80 persons per acre. R-3 zoning exists along the northeast shore of Cruz Bay and R-4 zoning exists in St. John's most heavily populated areas of southern Enighed and northeastern Contant.

Business-secondary/neighborhood zoning (B-2) allows maximum density of 80 persons per acre and occupies 1.6 ha (4 ac) in the study area. It is located northwest of Roman Hill and northeast of Great Cruz Bay along Route 104.

The area shaded in grey on Figure III-15 is a highly detailed mixed area of zoning that includes all of the aforementioned zones.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**
**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

Title: ZONING

Source: VI PLANNING OFFICE, 1972

Date: 1/86 | Scale: 1"≈1,350' | Figure: III-15

b. Land Use

**Park and wooded land use predominates on St. John.**

Figure III-16 shows the distribution of land use on St. John within the study area. Sparsely developed park/wooded lands occupy the greatest amount of land in the study area. Nearly all of it is located inland. There is some housing in these areas, but it is very sparse. Sparsely developed park/wooded lands account for 465.74 ha (1164.36 ac) in the study area.

Residential land accounts for the second greatest percentage of use in the study area. It occupies a total of 274 ha (686 ac). There are two types of residential land use in the area, residential low-density and residential medium-density. Residential low-density accounts for 261 ha (651 ac). It is defined by a maximum of 2 dwelling units per 1/2 acre and is identified throughout the study area.

Residential medium-density accounts for 14 ha (35 ac) and is defined by 80 persons per acre. The area of residential medium-density is located on the southeast shore of Enighed Pond and north of Great Cruz Bay.

Commercial land use in the study area is contained within three areas totalling 11 ha (27 ac). The largest of these is located in the Cruz Bay area. It includes a mixture of hotels/condominiums, office buildings and numerous shops and restaurants. Another area of commercial activity occurs on a small strip east of Enighed Pond. This includes a solar energy distributor and a converted warehouse containing several stores. Finally, there is a proposed area of commercial use, including the Virgin Grand - St. John Hotel, now under construction. It is located on the east coast of Great Cruz Bay.

St. John's government is concentrated in Cruz Bay. The total amount of land in the study area occupied (and proposed) by government/institutional lands is 7 ha (18 ac). These areas include the administrator's residence in Cruz Bay, the customs office, gravel stockpiles and propane tanks in the VI National Park, the school buildings and proposed government center in Enighed along the north shore of Enighed Pond and a small section of land between Turner Bay and Enighed Pond that contains the sewage treatment plant. The smallest land use, .39 ha (.97 ac), in the study area is the Port area near the ferry dock and the docks near the National Park Service and customs office.

There are currently four proposed developments and an ongoing hotel expansion project in the study area. An open market is proposed across from the National Park Service docks, a government center near the existing school, a proposed marine terminal in Enighed Pond and the aforementioned Virgin Grand Hotel. In addition, the Gallows Point hotel complex is being expanded.

14. Economic Characteristics

Due to its low productivity, capacity, and lack of natural resources, St. John is heavily dependent on the importation of goods and services from its neighbors in the West Indies, United States and Europe. (United States and European goods and services are usually imported via St. Thomas.)

The primary influx of money into St. John's economy is from tourism.

Since the 1950's, the primary influx of money has come from tourism. (Documented from George F. Tyson, Jr., references, Cultural Resource Survey, St. John USVI, MAAR Associates, Inc., September, 1985.)

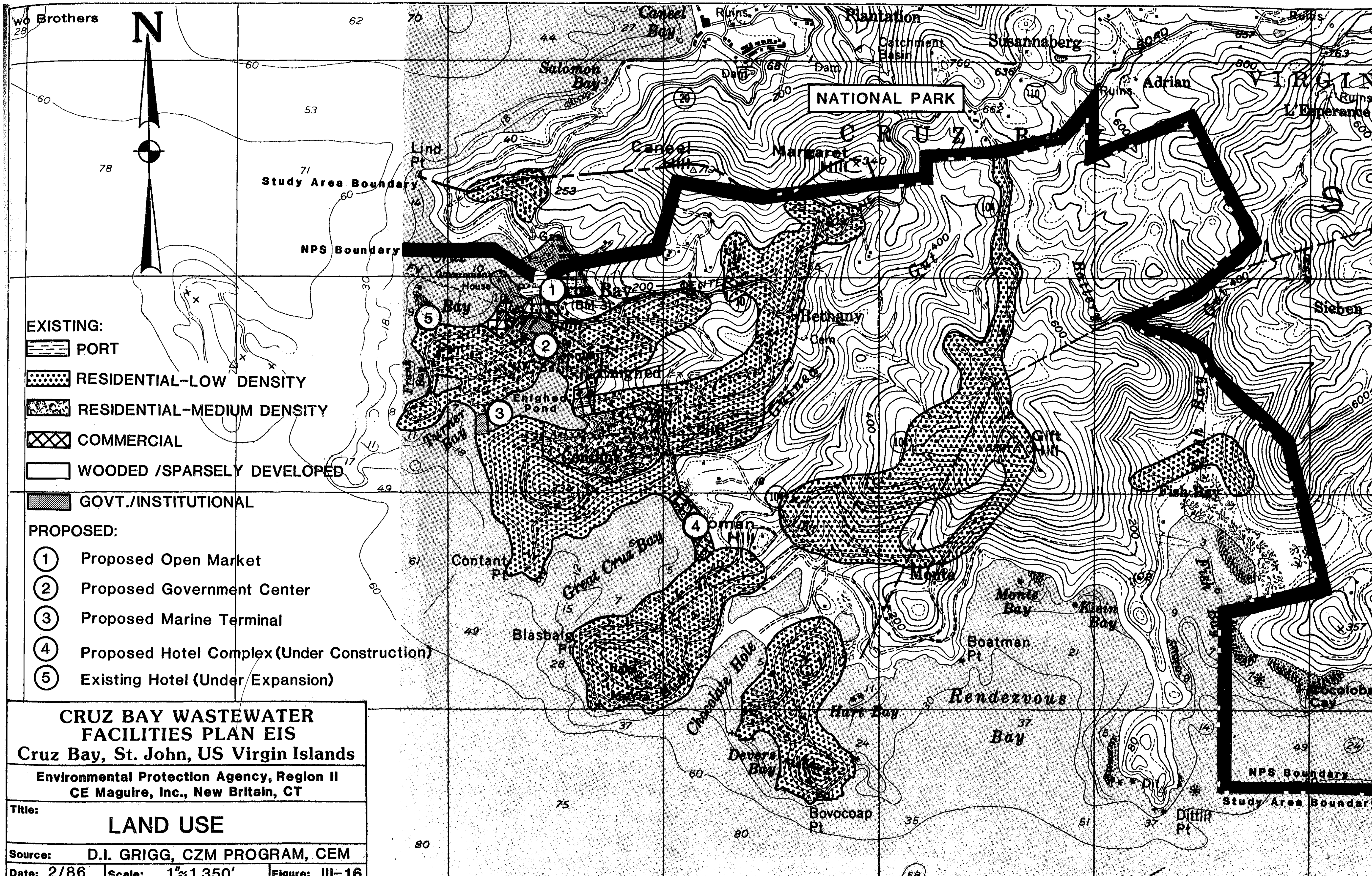
The majority of the working population of St. John is involved in various aspects of the tourism industry. The economy will continue to be dependent on tourism, as evidenced by the increasing amount of rental units and the construction of the Virgin Grand - St. John Hotel.

The majority of commercial activity occurs in Cruz Bay. Shops, restaurants, lodging and pubs comprise the blend of activity on St. John. Cruise ships dock in Cruz Bay and their passengers are taxied to all the local activities.

There are no industrial establishments on St. John. Lack of relatively flat lands, water and population base will likely prevent industry from establishing itself on St. John.

Commercial activity is concentrated in Cruz Bay.

The latest population figures (1980 U.S. Census) for St. John show a population base of 2,490 people. Though the current growth rate fluctuates between 1.2 and 1.6 percent per annum, the rate will probably increase as facilities and services improve on St. John.




CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: LAND USE

Source: D.I. GRIGG, CZM PROGRAM, CEM

Date: 2/86 | Scale: 1"≈1,350' | Figure: III-16

15. Other Projects

On-going territorial and local Government plans call for two major publicly-funded construction related projects in the study area: a marina and a Government center. It is difficult to predict when or if either of these projects will actually be implemented. Further, it is unlikely that the availability of improved public wastewater facilities would influence whether or not these projects are implemented. Nonetheless, the projects must be considered in terms of their relationships to the present wastewater facilities plan.

**A marine and government center are proposed to be constructed in the study area.**

The Virgin Islands Port Authority (VIPA) has recently completed a feasibility study for a proposed project involving the construction of a marine facilities center in Enighed Pond. The proposed plan calls for dredging a 5.5m (18 ft) deep channel from Turner Bay into the Pond, dredging and filling significant portions of the Pond's shoreline, and emplacing docks, utilities, and other facilities which would be required to support the marina. The intent of this project is to establish a new port for commercial shipping and other boat traffic so that Cruz Bay may be used for bathing and other recreational activities.

The second of these projects involves plans by the Virgin Islands Department of Conservation and Cultural Affairs (DCCA) to develop a new Government complex associated with the school in the center of Cruz Bay. This project would incorporate the various Government offices which are currently scattered around Cruz Bay and western St. John. The complex would include the existing school, fire station, library, as well as a proposed multipurpose recreational and cultural facility.

In addition to these two major proposals, other projects with peripheral importance to the wastewater facilities are planned to occur in the study area. One such project is a proposed farmer's and craft's market to be located just inland of the current cargo wharf in the creek area of Cruz Bay. Another is a proposed public housing project in Adrian, outside of the study area. Several privately funded projects, such as real estate development in Fish Bay and The Virgin Grand Hotel complex at the head of Great Cruz Bay, are planned or currently under construction. The latter is fully self contained and includes its own wastewater treatment facilities.

16. Growth Trends

It was not until 1950 that St. John's population grew significantly. Beginning in 1960, the population surged from the tourism market. This was primarily due to the

The greatest population increase occurred in the 1960's.

Seventh-eight percent of the island population lives in the study area.

A detailed study of development constraints in the study area was conducted.

Caneel Bay development and the designation of the VI National Park. Past growth for St. John and Cruz Bay are shown in Table III-3.

Since the United States' purchase of the Virgin Islands, the Cruz Bay area has been the main population center on St. John. The latest 1980 U.S. Census figures show that of the 2,472 residents on St. John, 1,928 (78 percent) people reside in the study area.* The recent Needs Survey (Appendix A) conducted for this project in January, 1986 estimated the study area population at 2,109 residents. Table III-4 shows the existing population calculations as obtained from the survey.

Current population growth trends have ranged from 1.2 percent per annum to 1.6 percent per annum.

## B. ENVIRONMENTAL CONSTRAINTS

A comprehensive study of constraints to development in the study area was conducted as part of this project. Complete results of this study are presented in Appendix B. The results are summarized in this section.

The purpose of the Environmental Constraints Analysis was to identify features which are likely to constrain growth or development in the study area and to analyze the influence each is likely to have on this growth. This analysis is designed to yield an indication of future conditions in the study area.

Table III-5 summarizes the constraining characteristics evoluted in the order of the greatest constraining influence to the least constraining.

The most constraining categories include land zoned "P" for public use, National Park Service land, land designated for preservation or conservation under the CZM program, land characterized by steep slopes, densely developed areas and the limited water supply. The combination of these constraints (considering occasional overlap) covers approximately 390 ac, or slightly over 20 percent of the total study area. Based on the findings of this analysis, it is very unlikely that development would occur within these areas.

*The United States Census identifies the Cruz Bay census tract as one that includes all the areas studied in the recent Cruz Bay Wastewater Facilities Plan Needs Survey, January, 1986 (see Appendix A).

TABLE III-3
POPULATION TRENDS (in # of persons)

| | 1950 | 1960 | 1970 | 1980 |
|---|---|---|---|---|
| St. John | 749 | 925 | 1924 | 2472 |
| Study Area | 280 | 600 | 1500 | 1930 |
| Percentage of St. John's Population in the Study Area | 37% | 65% | 78% | 78% |

Source: US Census Bureau. Study area populations are estimates based on interpolation of census tracts.

TABLE III-4
EXISTING POPULATION CALCULATIONS*

| Section | No. Permanent Dwelling Units (du's)** | Ave. No. Persons Per Permanent du | Population |
|---|---|---|---|
| Cruz Bay | 27 | 3.2 | 86 |
| Enighed | 310 | 3.7 | 1,147 |
| Contant | 94 | 3.2 | 301 |
| Bethany | 68 | 2.6 | 177 |
| Pastore | 51 | 3.1 | 158 |
| Total Core Study Area | 550 | 3.4 | 1,869 |
| Other Areas*** | 100 | 2.4 | 240 |
| Total Study Area | 650 | 3.2 | 2,109 |

*Prepared by CE Maguire, Inc.

**Includes single family homes and number of dwelling units in each multi-unit housing structure. Does not include seasonal homes.

***Estimated from on-site and aerial photo house counts. Number of permanent du's is accurate to within 10 du's. Approximately 70% of the du's in the other areas are permanent, including year-round rental units.

## TABLE III-5

## SUMMARY OF ENVIRONMENTAL CONSTRAINTS*

| Most Constraining Categories | AREA (Approximate acres) | PERCENT OF STUDY AREA |
|---|---|---|
| Steep Slopes | 170 | 9 |
| Development Areas | 40 | 2.1 |
| Zoning "P" | 130 | 6.9 |
| NPS/CZM Land | 155 | 8.2 |
| Flood Prone Areas | 180 | 9.5 |
| Water Supply | na | na |
| Second Most Constraining | | |
| Soil Limitations | 1,660 | 87.6 |
| Significant Habitat | 140 | 7.4 |
| Aquifer Recharge Areas | 100 | 5.3 |
| Cultural Resources | 263 | 13.8 |
| Least Constraining Categories | | |
| Public Sewer System | na | na |
| Power Supply | na | na |
| Roadways, Other Infrastructure | na | na |
| Services | na | na |
| Supplies, Conveniences | na | na |

*Prepared by CE Maguire, Inc.

na = not applicable, non-quantifiable constraints

The second most constraining categories include flood prone areas, areas with severe soil limitations, aquifer recharge areas, areas of significant habitat, and areas of archaeological sensitivity ("cultural resources"). While these areas should be protected due to environmental or cultural value, it is not realistic to predict that development will be completely constrained or prohibited from them in the absence of protective measures. Further, many of these environmentally sensitive areas are overlapped by the constraints in the first category. Portions of the flood prone areas, for instance, are constrained by the "P" zone, National Park land, CZM land, and densely developed areas.

The third and least constraining categories include communication, travel and conveniences available and other infrastructure and services.

Consideration of the realistic influence of the various environmental constraints that have been identified in this report is the first step to projecting the patterns and extent of development which will occur in the study area. This is a crucial step in designing appropriately located and sized wastewater facilities to meet the projected needs of the study area.

## C. FUTURE CONDITIONS

Population and water use are two important future conditions for wastewater facilities planning.

Consideration of environmental constraints to development in association with existing conditions establishes a foundation of information upon which future conditions may be predicted. The two future conditions which are particularly important in wastewater facilities planning are population and water use. The amount of water used by each consumer is assumed to be equal to the amount of wastewater generated by each consumer. EPA regulations require a 20-year planning period (beginning when proposed facilities are expected to become operational) for wastewater treatment facility plans. Future conditions are, therefore, projected to the year 2010.

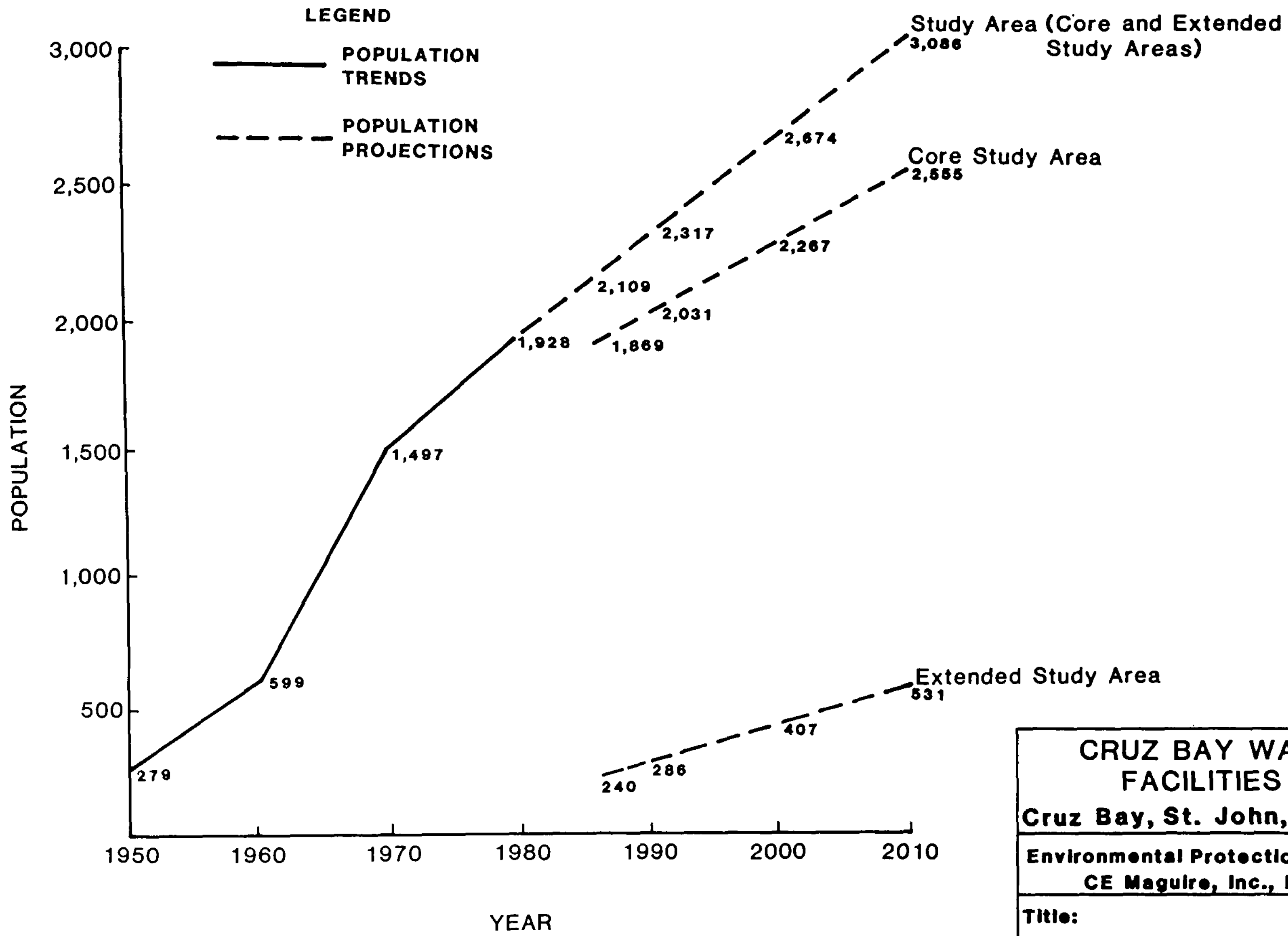
Population is projected (predicted) based on many features, including environmental constraints to development on one hand, and pressure for development on the other. Water use projections are based primarily on two factors: the increase in the number of water consumers and the increase in the amount of water used by each consumer.

### 1. Population Projections

Population projections for the study area to the year 2010 are shown in Figure III-17. Separate projections were made for the core area and extended area because of the different development potential in these areas. In particular, there are fewer constraints in the extended area than in the core area.

The first step to making these projections was to consider the development saturation point of the core and extended study areas based on the environmental constraints analysis. The saturation point is a theoretical estimate of the area's maximum capacity for development. This is important because it establishes the upper limit to which the area's population may increase. The saturation point is determined by multiplying the number of acres of developable (unconstrained) land in each zoning district by the number of persons (or dwelling units times the average of 3.4 persons per dwelling unit) allowed per acre by current zoning regulations and adding this allowance to the existing population.

These calculations yield a theoretical saturation population of approximately 15,000 persons in the core study area. It is extremely unlikely that the core area's population will approach this point by 2010.




**CRUZ BAY WASTEWATER FACILITIES PLAN EIS**

**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**
**CE Maguire, Inc., New Britain, CT**

**Title:** POPULATION

**Source:** CEM, CH$_2$M, HILL, INC., 1983

| **Date:** 4/86 | **Scale:** NTS | **Fig:** III-17 |
|---|---|---|

It is even more unlikely that the extended area's population will approach the saturation point, given the great amount of developable, relatively unconstrained land in the area.

The next step was to establish a realistic growth rate for the next 20 years and apply this to the existing population. Population projections presented in DCCA's Water Management Plan for the Public Water System ($CH_2M$ Hill Southeast, Inc. (for DCCA), 1983) are currently endorsed by VIPO. These projections reflect a 41 percent rate of growth between 1980 and 2000 in a water management district which generally includes the core study area and southern portion of the extended study area. The Comprehensive Plan for Sewage Needs of Cruz Bay assumed that this growth rate could be equally applied to both the core study area and the other portion of the water management district (the southern portion of the extended study area).

Population predictions are based on many factors.

However; interviews with local officials, developers, and citizens; analysis of environmental constraints to development; and assessment of existing conditions indicate that additional growth is more likely to occur in the southern portion of the extended study area (particularly in areas such as Fish Bay, Gift Hill, Monte and Great Cruz Bay) than in the core study area.

Population projections for 1980 to 2000 reflect a 41% rate of growth in the core and extended study area.

Based on this information, it appears most likely that the core study area will continue to experience the same 1.2 percent annual growth rate it has experienced in the recent past. The extended study area is likely to experience a sharply increased growth rate, probably more than 41 percent, over the next 20 years. In this way, the 20-year growth rate in the two portions of the water management district will average approximately 41 percent. Overall, it is projected that the study area's population will reach approximately 3000 persons by 2010. Population projections are shown in Figure III-17.

This growth is more likely to occur in the extended study area.

2. Water Use Projections

The greatest increases in water use in the study area will come from the projected population increase and the projected per capita water use increase.

The projected population increase will cause a commensurate increase in the study area's total residential water use due to the increased number of water consumers. Another substantial increase in total water use is expected due to a projected increase in the amount of water consumed by each resident.

Population and per capital water use increases will account for the greatest increases in water usage.

It is estimated that each resident currently consumes an average of 7.6 $m^3$ (25 gal.) of water each day (deJongh/URS, 1985). This relatively low water use reflects the extremely limited water supply in the study area and the residents' strong efforts to conserve.

DPW has recently announced plans to implement an improved public water supply system for St. John and hopes to begin operating this system in 2-3 years. Implementation of this system would nearly eliminate the water supply constraint and allow residents the freedom to use larger quantities of water. Presumably, the system would generate enough water for residents to wash clothes, dishes and other household items and to shower and flush toilets more frequently. The high cost of water is likely to prohibit excessive or wasteful water use. It is, however, likely that per capita (each person's) water use will increase dramatically once this water supply system is implemented.

The D.P.W. hopes to implement a new water system for St. John in 2-3 years.

Per capita water use is projected to increase from 0.09$m^3$ (25 gal.) per day to 0.19$m^3$ (50 gal.) per day. This projection is supported by the <u>Environmental Laws and Regulations of the Virgin Islands</u>, (VIDCCA, 1979) which states that wastewater facility design should use "an average daily per capita flow of sanitary sewage of not less than 50 gallons per day unless otherwise justified by sound engineering data." (Title 19, Part VI, Chapter 53, Subc. 1404-233). The projection is further supported by similar increases in per capita water use due to the implementation of improved water supplies in other areas of the Caribbean. (CE Maguire, Inc./EPA, 1984, 1985)

Another source of the projected water use increase is non-residential water consumers, including the study area's workforce, student population, hotels, and restaurants. (Projections for total water use are shown in

Table III-6). Non-residential water use projections are taken from the Water Management Plan for the Public Water System. The projected growth rate between 1990 and 2000 was applied to the projections for 2000 in order to calculate the number of workers, hotel rooms, and restaurant tables expected in 2010. The projected 20-year residential growth rate of 27 percent was applied to the existing student population in order to calculate the projected number of students in the study area in 2010. These projections were then multiplied by the estimated water use per unit (persons, rooms, or tables) as use in the Water Management Plan and shown in Table III-6.

Non-residential per unit water consumption is not expected to increase.

No increase in per unit water consumption is projected for non-residential users. This is because most or all of these users currently have an adequate water supply and would, therefore, not be greatly affected by the proposed new public water system. No other non-residential users have been considered in these projections because water use in shops and other commercial or institutional establishments is already considered under the "workforce" category. There are no plans to locate industry on St. John, and therefore, no industrial water use is projected.

As shown in Table III-6, the overwhelming source of water use is residential. Total water use in the study area is projected to be approximately 727m$^3$ (192,000 gal.) per day in design year 2010. This water use estimate was added to the projected infiltration rate of 6,000 to 8,000 gpd to calculate the treatment facility design capacity of 200,000 gpd.

TABLE III-6
EXISTING AND PROJECTED WATER USE
CORE STUDY AREA
CRUZ BAY, ST. JOHN, VI

| Type of Use | 1985/86 | 1990 | 2000 | 2010 | 2040 | Notes* |
|---|---|---|---|---|---|---|
| **Residential** | | | | | | |
| Population (persons) | 1,869** | 2,013 | 2,267 | 2,555 | 3,687 | a |
| Use per capita per day (gpcd) | 25 | 25 | 50 | 50 | 50 | b |
| Total Residential Water Use | 47,400*** | 50,325 | 113,350 | 127,750 | 184,350 | |
| Tot. Res. Wtr. Use Growth Rate | -- | 6% | 125% | 13% | 44% | |
| **Hotels** | | | | | | |
| # Rooms | 84 | 90 | 103 | 117 | 172 | c |
| Use per room (gprd) | 150 | 150 | 150 | 150 | 150 | d |
| Total Hotel Water Use gpd | 12,600 | 13,500 | 15,450 | 17,550 | 25,800 | |
| Growth Rate | -- | 7% | 14% | 14% | 47% | |
| **Restaurants** | | | | | | |
| # Tables | 188 | 207 | 248 | 298 | 515 | e |
| Use per table per day (gptd) | 100 | 100 | 100 | 100 | 100 | f |
| Total Rest. Water Use (gpd) | 18,880 | 20,700 | 24,800 | 29,880 | 51,500 | |
| Growth Rate | -- | 10% | 20% | 20% | 73% | |
| **Workers** | | | | | | |
| # Workers | 490 | 512 | 558 | 608 | 787 | g |
| Use per worker per day (gpwd) | 15 | 15 | 15 | 15 | 15 | h |
| Total Worker Water Use (gpd) | 7,350 | 7,680 | 8,370 | 9,120 | 11,805 | |
| Growth Rate | -- | 4% | 9% | 9% | 29% | |
| **Schools** | | | | | | |
| # Students | 400 | 424 | 477 | 538 | 775 | i |
| Use per student (gpsd) | 15 | 15 | 15 | 15 | 15 | j |
| Total School Water Use (gpd) | 6,000 | 6,360 | 7,155 | 8,170 | 11,625 | |
| Growth Rate | -- | 6% | 13% | 14% | 44% | |
| Total Water Use | 92,203 | 98,565 | 169,125 | 192,470 | 285,080 | |
| Total Water Use Growth Rate | - | 7% | 84% | 109% | 309% | |

*Explanation of "Notes" is on following page.
**520 Served by existing sewer system.
***13,000 gpd flow to existing sewer system.

TABLE III-6 (Cont'd.)

EXISTING AND PROJECTED WATER USE SOURCES AND COMMENTS

a. 1985/86 Core study area population based on count of houses and persons per house from 1/86 needs survey. Projections based on constant 1.2 yearly growth rate (see explanation in Affected Environment chapter, Section C.1.) Projections are unaffected by very high saturation level (over 15,000).

b. 25 gpcd existing and projected 1990 flow based on flow monitoring data from the Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985. Projected increase to 50 gpcd in 2000 based on plans to implement a new water supply in Cruz Bay. VI Environmental Regulations designate 50 gpcd as to flow to be used in wastewater facilities planning.

c. Existing number of hotel rooms is based on a count mode during the 1/86 needs survey. Projections based on 14.3% ten year increase in # hotel rooms (between 1990 and 2000) in VI Water Management Plan, 1983. 14.3% applied to interpolated 1990 population to obtain 2000 population, and again to the 2010 population to obtain the 2000 population.

d. Estimated in Water Management Plan, 1983. No increase in per table water use is projected to occur in response to a new water supply as most non-residential water users currently have their own adequate water supply system.

e. Existing and projected # tables obtained by same method described in "c" (1990 - 2000 projected growth rate for # tables applied to 1990 and 2000 projections).

f. Same as "d".

g. Same as "c", using 1990 - 2000 growth rate for workers. "Workers" represents those who work in the core study area vs. the area's workforce (residents who work in the area and elsewhere).

h. Same as "d".

i. Existing # students based on 1/86 estimate by school principal. Projections based on same growth rates as population projections.

j. Same as "d".

# IV. IMPACTS

## IV. ENVIRONMENTAL IMPACTS OF FEASIBLE ALTERNATIVES

### A. INTRODUCTION

In this chapter, the impacts of feasible alternatives are identified and assessed.

The purpose of this chapter is to address impacts, or consequences, that can be expected to result from the implementation of the feasible alternatives considered for this project. The following six overall system alternatives are structured under the second subregional management program which recommends using a centralized collection and treatment system for the core area and various on-site technologies for the extended study area. In the core study area, each of the alternatives includes a new treatment plant at a new site to replace the existing plant and site. They also include a wastewater collection system that would utilize the existing sewers in addition to extending new sewer lines into previously unserviced areas. Each of the alternatives also recommends either an ocean outfall or land application as a means of disposing of the wastewater effluent. Additionally, there is a possible subalternative to these effluent disposal systems in the form of an effluent force main to the Caneel Bay Resort. All of these alternatives also include disposal of the sludge at the St. John municipal landfill until testing indicates whether or not land application of the sludge is possible. Given this common base, the feasible alternatives are distinguished as follows:

There are six feasible wastewater treatment system alternatives.

- Alternative A: Aerated lagoon treatment plant at site #3 with land application effluent disposal.
- Alternative B: Aerated lagoon treatment plant at site #3 with ocean outfall effluent disposal.
- Alternative C: Aerated lagoon treatment plant at site #2 with ocean outfall effluent disposal.
- Alternative D: Recirculating sand filter treatment plant at site #2 with ocean outfall effluent disposal.
- Alternative E: Rotating biological contactor treatment plant at site #1 with ocean outfall effluent disposal.
- Alternative F: Oxidation ditch treatment plant at site #1 with ocean outfall effluent disposal.

The selection of a preferred alternative is based primarily on the assessment of impacts, costs, and benefits associated with each preliminary alternative. Environmental impacts are predicted by considering the feasible alternatives (Chapter II) in association with the affected environment (Chapter III). Impacts may be positive (enhancing the general environment) or negative (degrading the environment) and are categorized as either short-term (directly related to construction), long-term primary (directly related to the implementation of wastewater facilities), or long-term secondary impacts (indirectly related to the implementation of wastewater facilities). This chapter will address short-term, long-term primary, and long-term secondary impacts separately. Many of the potential negative impacts may be avoided through careful design, construction and location of the facilities. Others require mitigation measures, or methods of minimizing the project's harm to the particular feature of the environment. Where applicable, mitigation measures are recommended at the end of each impact discussion.

B. SHORT-TERM IMPACTS

This section addresses short term impacts resulting from the feasible alternatives.

All feasible alternatives will likely have some short-term impacts on land resources, water resources, ecosystems, cultural resources, air quality, noise, traffic, energy, local economy, and other projects.

1. Land Resources

a. Flood Prone Areas

Construction of wastewater treatment facilities at site #1 would place the facilities in the 100 year flood zone and would require protection from flooding. The two existing pump stations, located at both ends of Enighed Pond, would also require protection from flooding. In addition, under all feasible alternatives small portions of the proposed sewer system would be constructed in areas prone to 100 and 500 year floods.

Construction of sewer lines in flood prone areas will not cause increased flood hazards.

Specifically, proposed interceptors along the shore of Frank Bay and the north shore of Turner Bay would be constructed in the 100 year flood zone and proposed interceptors along the southeast shore of Enighed Pond would be constructed in the 500 year flood zone. Finally, the land portion of an ocean outfall would have to be constructed in the 100 year flood zone.

Care must be taken to protect nearby stream courses, drainage ways and coastal ponds.

The actual construction activity would not cause any reduced flood storage capacity or other increased hazard of flooding. However, particular care must be taken in flood prone areas to avoid short-term impacts to nearby drainageways, streams, and coastal ponds. These impacts and proposed mitigation measures will be discussed under "soils" and "surface water".

During the design phase of this project and prior to project implementation, a coastal zone management program construction permit application must be prepared. A comprehensive flood prone area impacts mitigation program would have to be developed as part of this process.

b. <u>Bedrock/Surficial Geology/Soils</u>

Short term impacts to soil may result, particularly along steep slopes.

No project impacts on bedrock or surficial geology features are expected. However, construction of the proposed wastewater collection system, treatment plant, and land portion of the ocean outfall may cause short-term impacts to soil on or adjacent to construction sites. The most severe impacts to soil would involve erosion from construction, particularly in moderately to steeply sloping areas. Soil erosion impacts are important due to the overall shallow depth of, or in some areas absence of, soil cover in many areas of St. John.

Excavation of soil, required in order to place pipes beneath the ground surface or to establish a foundation for a treatment plant, would expose adjacent soil layers to erosion from surface or groundwater runoff and from human activities. Such impacts would be particularly pronounced with respect to construction of interceptors in steep roadways of Contant, Enighed, and Pastore.

Although construction of a treatment plant at any of the sites considered would be on somewhat level terrain, the area of soil disturbance and exposure would be greater than with construction of interceptors. Soil erosion impacts would be slightly less severe for construction of a treatment plant at Site #3 than for construction at Sites #1 or #2 because a portion of Site #3 is covered by the deep Pozo Blanco soils. These impacts would be slightly more severe for construction at site #2 as this site is located on steeper sloped terrain than found at sites #1 or #3.

There are several measures that can be used to mitigate these impacts.

General measures recommended to mitigate these impacts include minimizing the amount of area exposed to erosion at any given time, storing excavated soils up-gradient of the cut, and using hay bales or fabric fences around the construction area to protect exposed soils from erosion by wind and rainfall. Detailed measures for mitigating short-term soil-erosion and related surface water impacts are presented in Table IV-1.

## 2. Water Resources

### a. Surface Water Quality

Construction in or near surface water features may lead to increased erosion and a resulting increase in siltation of surface waters.

The construction of wastewater facilities near streams or ponds in the study area may have short-term impacts on surface water quality. The most significant potential impact would be increased siltation and turbidity in these surface water features that could occur as a consequence of the previously discussed erosion impacts.

Construction should be scheduled to take place during dry periods.

Specifically, construction of the proposed sewer system along the shore of the small pond inland of Frank Bay and Enighed Pond may impact Enighed Pond. In addition, construction of a treatment plant at site #1 may impact these ponds. Although treatment plant sites #2 and #3 are located in proximity to guts, impacts to surface water quality due to construction would likely be minimal as water flows in these guts only during occasional periods of very heavy rainfall. It is recommended that construction be scheduled to take place during dry periods when the guts carry little or no flow. Other mitigation measures for avoiding short-term surface water quality impacts are presented in Table IV-1.

Another impact that may occur in the short-term stems from the operation of construction equipment near streams or ponds. Oil and/or gasoline leaking from construction equipment may drain into these features causing temporary contamination. By bordering the construction site with hay or fabric fences and maintaining equipment properly, this form of impact can be avoided.

## TABLE IV-1

## MITIGATION MEASURES FOR SOIL AND SURFACE WATER IMPACTS

- The interceptors should be underground so that potential impacts would only occur during construction.

- Wastewater facilities should be located as far away from any waterway as possible, within the requirement of maintaining appropriate grade for gravity flow in sewers.

- In those areas where roads parallel natural drainageways, the pipeline should be placed beneath the road or very close to its edge in previously disturbed areas.

- Stream crossings should be avoided whenever possible.

- Temporary construction easements should be kept to a maximum width of 15 meters (50 feet), and permanent easements should be kept to 8 meters (25 feet).

- Construction roads, pipe storage areas, and spoils storage areas should be confined to the upland side of the trench area so that any erosion will go into the trench rather than being washed into drainageways.

- No more than 30 m (100 ft) of interceptor trench should be excavated at one time, with pipe placement and backfilling taking place immediately after trench excavation.

- Topsoil should be stockpiled separately for future use as top-dressing for those areas to be restored.

- Excess materials resulting from excavating due to sewer pipe placement and treatment plant construction should be saved for use on other parts of system construction.

- Water from dewatering operations (if required) should not be discharged directly to surface waters without first being directed to a temporary sedimentation basin.

- The stream or shore side of the work area around the treatment plant and along the interceptor route should be continuously lined with either hay bales or filter fabric.

- The work area should be restored, graded, dressed with topsoil, seeded, and mulched immediately after construction. Open field areas should be planted with indigenous grasses, and wooded areas should be temporarily seeded with grass to stabilize the area for ultimate colonization by nearby indigenous species.

- Schedule construction near guts to take place during dry periods when there is little or no flow in these guts.

b. Marine Water Quality

The principal short-term marine water quality impacts would be caused by construction of an ocean outfall. Excavation of an underwater trench along the shallow portion of the outfall route (up to a depth of 6 m (20 ft.)) and burial of the outfall pipe in this trench would be required in order to protect this portion of the outfall pipe from wave action and dragging boat anchors. The outfall would need to be anchored on the ocean floor along the deeper portion of the route.

Outfall construction may cause short term marine water quality impacts.

Excavation of the sand and silt required for this underwater trench would cause a short-term increase in the turbidity of marine water in Turner Bay. As there is no evidence of contaminants in the sediments on the floor of Turner Bay, the suspension of these sediments which may be expected during construction would not impact the chemical quality of marine water. Suspended sediments stirred into the water by underwater construction activities can be expected to resettle soon after the activities have stopped.

Recommended measures to mitigate these short-term marine water quality and other impacts related to ocean outfall construction are listed in Table IV-2. Additional details concerning impacts to marine water quality are presented in the Benthic Survey (Appendix D) and the Current Study (Appendix E).

Prior to construction of an outfall, applications must be prepared for a Coastal Zone Management program permit and a US Army Corps of Engineers Section 404/Section 10 permit. A comprehensive marine water quality impact mitigation plan should be developed as part of this permit application, with the necessary measures incorporated into the project construction plans and specifications.

3. Ecosystems

Enighed Pond is the only significant habitat which may be impacted by construction activities.

Short-term project impacts on terrestrial, littoral or coastal region, and marine ecosystems are expected to be minimal. The only significant habitat which may be impacted by construction activities is Enighed Pond. No known threatened or endangered species would be impacted by construction activities, with the possible exception of marine turtles. A Biological Assessment will be prepared to address detailed ecological impacts associated with the selected alternative. This assessment will appear as an appendix to the Final EIS.

## TABLE IV-2

## MITIGATION MEASURES FOR OUTFALL CONSTRUCTION

- Conduct any required dredging work as rapidly as possible (i.e., all equipment and materials should be available on-site at the same time).
- Conduct construction activity during calm water periods.
- Use dredging methods which minimize resuspension of fine sediments and creation of a sediment plume.
- Utilize floating booms or silt curtains to confine turbidity to the immediate vicinity of actual dredging activity.
- Stockpile spoils directly adjacent to excavated trenches and utilize excess spoils for other parts of project construction.
- Minimize the length of exposed open trench at any given time.

a. Terrestrial Ecosystems

Most of the terrestrial ecosystems that might be disturbed exhibit no unusual ecological significance.

The majority of the terrestrial habitats that would be disturbed by the construction of wastewater facilities exhibit no unusual ecological significance. Construction of the proposed wastewater collection system would take place in existing roadways of "urban" areas (see Section A.6.a.(8). of Chapter III), with the exception of the short length of an interceptor sewer along a sandy berm on the north side of Turner Bay. This berm is primarily barren of vegetation and does not appear to provide any unusually valuable habitat for wildlife.

Construction of a treatment plant at either site #2 or #3 would require clearing up to 2 ha (5 ac) of mixed dry woodland and scrub habitat. Due to the abundance of these habitat types throughout the study area, and the proximity of these sites to urban land, the overall ecological impact of construction would not be significant. Construction impacts to terrestrial habitats at site #1 would be further minimized as this site is already disturbed.

The previously mentioned Biological Assessment will address specific impacts of the preferred alternative to terrestrial (and other) ecosystems in more detail. If sensitive plant or wildlife habitat is identified on or near proposed construction sites, plans will be developed to avoid or minimize impacts to these natural resources during construction. The same policy will apply to littoral and marine resources.

b. Littoral Ecosystems

A short term disturbance of the littoral (coastal) ecosystems may result from construction.

The project's primary short-term impacts on littoral (coastal) ecosystems would probably result from construction of a short length of interceptor along a sandy berm on the northern shore of Turner Bay and construction of the land portion of the ocean outfall. Both of these activities would involve short-term disturbance of a section (up to 15 m (50 ft) wide) of previously disturbed beach along Turner Bay. Disturbance to vegetation on the beach can be minimized by keeping construction equipment off the beach to the extent possible, minimizing strip width to be used for burying pipes, and by placing spoils directly adjacent to the trench or off of the beach.

Construction of the land portion of the outfall and construction of a treatment plant at site #1 could impact a narrow, discontinuous fringe of extensively disturbed mangroves on the northern and eastern shores of Enighed Pond. If this site is selected, special care should be taken to protect this mangrove fringe during construction by implementing the erosion-sedimentation control mitigation measures recommended in Table IV-1.

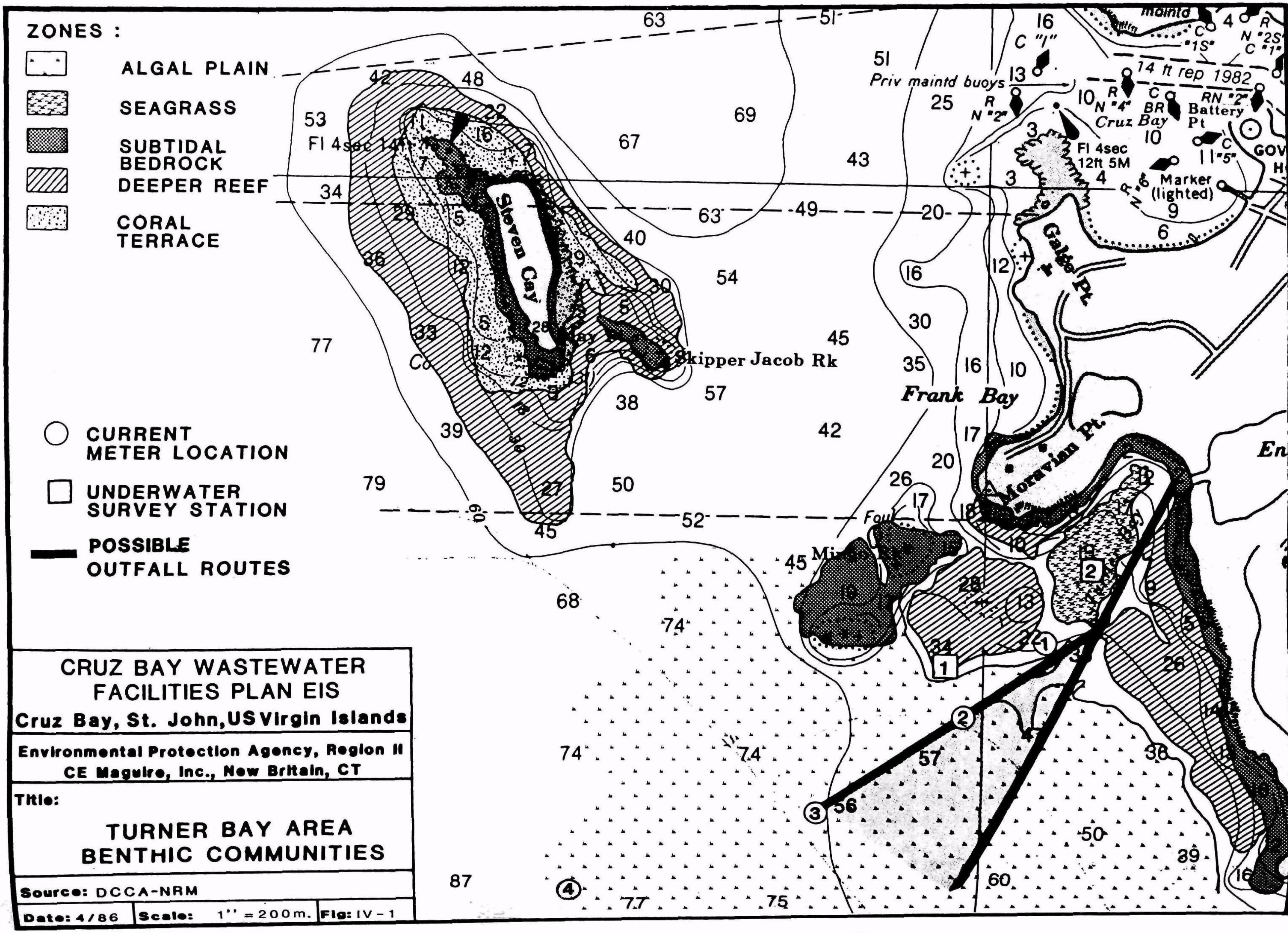
c. Marine Ecosystems

The value of coral reefs and sea grass beds to marine life make it important to minimize disturbance of these habitats.

Short-term and long-term impacts to the coral reefs and seagrass beds in Turner Bay would result from ocean outfall construction. The value of these ecosystems to marine life and their sensitivity make it particularly important to minimize disturbance of these features. A detailed study of marine resources and benthic communities in Turner Bay, in the areas offshore of Moravian Point (the proposed outfall area) and surrounding Steven Cay, has recently been conducted in order to evaluate potential impacts in detail. Figure IV-1 shows the location of various marine resources in relation to the proposed outfall location. Complete findings of the Benthic Survey are presented in Appendix D.

Mitigation measures should be followed in order to reduce impacts to reef communities.

Outfall construction is proposed along a route which has been identified as involving the least potential impact to reefs and seagrass beds (see Figure IV-1). Construction along this route would require no reef removal. However, the construction activity would impact reefs by increasing the turbidity of the marine water and by covering reefs with sediments stirred up during the placement and securing of the pipe on the sandy bottom. Such sedimentation could negatively impact the reef(s) by limiting sunlight and oxygen availability to both the reef(s) and dependent marine organisms which are supported by this ecosystem. The mitigation measures listed in Table IV-2 should be followed in order to reduce both short-term and long-term impacts to reef communities.




CRUZ BAY WASTEWATER FACILITIES PLAN EIS

**Cruz Bay, St. John, US Virgin Islands**

**Environmental Protection Agency, Region II**

**CE Maguire, Inc., New Britain, CT**

**Title:** TURNER BAY AREA BENTHIC COMMUNITIES

**Source:** DCCA-NRM

**Date:** 4/86 | **Scale:** 1" = 200 m. | **Fig:** IV-1

Construction of the outfall along the recommended route would also involve short-term impacts to the turtle grass beds in Turner Bay. Excavation of a narrow trench would be required to bury the 30 cm (10 in) diameter outfall in areas where water depth is more than 6 m (20 ft). Turbidity and sedimentation due to outfall construction could impact turtle grass beds in a similar manner as discussed with regard to the coral reefs. Therefore, similar mitigation measures (Table IV-2) should be implemented for construction in and near the turtle grass ecosystems.

Special care should be taken to avoid disturbing marine turtles in the construction area.

Special care should be taken to avoid disturbing marine turtles which feed on these grasses. Although no turtles have been reported in the Turner Bay area in recent years, the outfall construction crew should be made aware of their endangered/threatened status and work should be temporarily halted if any are observed in the immediate vicinity of the construction area.

4. Cultural Resources

Stage 1A and 1B Cultural Resource Surveys were recently completed for the study area (MAAR Associates, 1985 and 1986). Numerous areas of land around Cruz Bay and Enighed Pond were identified by the Stage 1A Survey as potentially sensitive archaeological sites (See Appendix J). Portions of the proposed outfall line, where it crosses the berm and beach at Turner Bay, have been identified as such areas. In addition, treatment plant sites #1 and #3 are also located in areas identified as having potential for the presence of cultural resources.

No significant cultural resources were found in the vicinity of proposed facilities.

The best mitigation measure to avoid disrupting to potential cultural resources (ruins, artifacts, etc.) during construction of these facilities is to identify the specific locations of these resources and plan accordingly so that sewer alignments and plant site layout will avoid impacting them. To accomplish this, a more indepth study of cultural resources (a Stage 1B Survey) was performed in the areas most likely to be impacted by construction of wastewater facilities. As summarized in Appendix J, the Stage 1B Survey found no significant cultural resources in the vicinity of the proposed treatment plant, collection system, or ocean outfall sites.

Should artifacts or other cultural resources be uncovered during construction, however, work should be stopped so that these artifacts may be properly studied and removed. If removal is not feasible, then construction plans may need to be revised to avoid impacting the resource, depending on the value and sensitivity of the resource. For this purpose, it is recommended that a professional, local archaeologist be available on an on-call basis during the construction phase of this project.

5. Air Quality

The construction of any wastewater facility would result in the generation of a variety of airborne contaminants.

The construction of any wastewater facility would result in the generation of airborne particulate matter, including dust from clearing, excavating, and filling activities. In addition, a small amount of smoke, odor, and exhaust emissions would be generated from diesel-powered construction equipment. Minor additional quantities of carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen ($NO_x$) and nitrogen dioxide ($NO_2$) could also be generated as a result of interrupted roadway traffic flow patterns.

In order to reduce potential airborne contaminants, a variety of methods should be implemented.

A variety of methods should be used to reduce potential airborne contaminants generated during construction activities. These include minimizing the amount of surface area exposed at any given time, covering loaded trucks, and removing dirt from paved roadways. Because of the limited duration of construction activity at any given location, and because of the local climatic conditions which provide good dispersion of air pollution, short-term air quality impacts are expected to be negligible.

6. Economy

A number of positive impacts on the Cruz Bay areas economy will result from the construction of wastewater facilities.

Construction of wastewater facilities for each of the feasible alternatives would cause positive impacts on the economy of the Cruz Bay area. This impact would be in the form of a modest increase in money injected into the area's economy through the following channels:

- The acquisition and/or lease of construction equipment and supplies (some of which may be purchased locally),
- The creation of 10-20 construction crew jobs for qualified local residents,
- The creation of jobs for "support" industries (such as material and equipment supply and various services), and
- The induced spending or spillover into other parts of the local economy as a result of this initial boost.

It should be noted that the positive economic impact of wastewater facility construction may not be noticeable as it is likely to occur in the wake of a major construction project for the Virgin Grand Hotel in Great Cruz Bay. Construction of wastewater facilities is therefore expected to continue as a positive force in the local economy rather than create a new surge to this economy.

It is not expected that the construction required for any of the feasible alternatives will have any negative impacts on the area's economy.

7. Other Projects

Construction of wastewater treatment facilities for this project may disrupt construction of other projects planned for the Cruz Bay area by overburdening the area's limited services, transportation and supplies. While construction of the Virgin Grand Hotel should be completed by the time work is initiated on the wastewater treatment facilities, construction of a proposed marine terminal project in Enighed Pond could coincide with the facility construction.

Construction of other major projects in the Cruz Bay Area may be disrupted due to the construction of wastewater facilities.

Careful coordination should be maintained with the Virgin Islands Port Authority (VIPA) regarding plans for the marine terminal project to assure that adequate resources are available for construction activities. If construction of both projects does coincide, it may be prudent to schedule certain phases of each project with respect to the other. For example, as VIPA plans call for the dredging of a 5 m (16 ft) deep channel as an inlet through Turner Bay to Enighed Pond, it may be wise to schedule the ocean outfall construction and dredging of this channel to occur at the same time. Specific impacts of the selected alternative on the VIPA project will be addressed in the Final EIS.

## C. LONG-TERM PRIMARY IMPACTS

Implementation of the feasible alternatives considered is likely to involve long-term direct impacts on land resources, water resources, ecosystems, cultural resources, air quality, noise, energy use, land use, the local economy, and other projects that are planned.

1. Land Resources

a. Flood Prone Areas

Impacts to the sewer system in flood prone areas would be minimal.

Portions of the proposed collection system, the land portion of the outfall, and all of treatment plant site #1 are located in the 100 year flood zone. The collection system and land portion of the outfall would be buried, and therefore their presence would cause no long-term impact to flood hazards. These pipes and accompanying access covers would be protected from infiltration during floods by watertight seals. The two existing pump stations, located at either end of Enighed Pond, would need to be protected from flooding. No new pump stations would be required in flood prone areas.

Location of a treatment plant at site #1 would cause a slight decrease in the flood storage capacity of the area surrounding Enighed Pond. The 0.8 to 2ha (2-5ac) treatment plant site would be surrounded by an artificial berm built up to an elevation of approximately 3.3m (10 ft) in order to protect facilities against a 100 or 500 year flood. Treatment plant sites #2 and #3 are not in the 100 year flood zone, and therefore no flood protection would be necessary.

b. Soils

Long term soil impacts may result from a treatment plant at Site #1 or from a spray irrigation effluent disposal system.

There may be long-term soil impacts from locating a treatment plant at either site #1 or from operating a spray irrigation effluent disposal system at Site #3. Site #1 is covered primarily by fill-soils and might require that the plant site soils be stabilized in some manner. If site #1 is selected as the preferred treatment plant site, the actual characteristics of these soils in regard to structural stability would be determined through borings and soil samples. Mitigation measures should be developed as required during the design phase of this project, depending on the findings of the borings and soil samples on this site.

Operation of a spray irrigation effluent disposal system would involve periodically loading the soil with water and nutrients. Oversaturation or unevenly distributed irrigation of these soils could cause erosion. Furthermore, if there was a failure by the treatment process to remove contaminants from the wastewater, it could cause the transfer of these contaminants into the soil. In particular, the high chloride content of wastewater introduced by the desalinated water used in Cruz Bay is difficult to remove through the wastewater treatment process. Filtration of chlorides and other contaminants into soils through spray irrigation would degrade the quality of these soils for growing vegetation. Filtration of the nitrate and other nutrients into these soils from properly operated facilities would generally improve the quality of these soils for supporting vegetation growth, however.

Erosion may result from oversaturation or unevenly distributed irrigation.

Long-term soil erosion and contamination impacts associated with spray irrigation may be mitigated through careful surveillance of the actual irrigation procedure, alternating portions of the spray irrigation site to be irrigated, proper maintenance of irrigation equipment, and careful testing of effluent for levels of contaminants. If unacceptable levels of any contaminant are found, the spray irrigation process should be discontinued until the proper level of treatment may be obtained. The Caneel Bay Resort has the capacity to store excess effluent while treatment facilities are repaired or improved.

If spray irrigation becomes the preferred alternative of effluent disposal, a comprehensive spray irrigation management plan should be developed. More detailed impacts and mitigation measures would be addressed in this plan.

## 2. Water Resources

### a. Groundwater

Groundwater may be impacted by the spray irrigation effluent disposal option.

No long-term impacts to groundwater are expected to occur from the operation of the collection system, ocean outfall, or treatment plant. These facilities would be watertight sealed in order to avoid infiltration of wastewater or effluent into groundwater.

The spray irrigation effluent disposal option could impact groundwater in the coastal alluvium of the Caneel Bay area. The amount of ground water stored in this alluvial layer is not known, but it is likely that this water is saline due to saltwater intrusion from the sea.

Some of the sprayed effluent may augment the groundwater reserve.

Some of the effluent sprayed on Caneel Bay's lawns would be expected to pass through the soil layer and augment the groundwater reserve. The introduction of contaminants carried by the effluent to the spray irrigation site should be avoided, as discussed under long-term impacts to soil. Effluent-borne contaminants such as chloride could impact groundwater as significantly as it would soils, therefore, a spray irrigation management plan would be required to address groundwater impacts and mitigation measures in more detail.

b. Surface Water Quality

Implementation of any of the feasible action alternatives is likely to result in an overall positive long term impact to surface water quality.

An overall positive long term impact to surface water quality would be expected to result from the implementation of any of the feasible alternatives. The elimination of poorly treated effluent discharges to streams and coastal ponds will reduce the turbidity and the amount of contaminants in these surface water features. For example, increased clarity in the now murky Enighed Pond may be expected to occur as a long-term positive impact.

Operation of the collection system, outfall, and treatment system would not be likely to cause any adverse impact to surface water. Reduced nutrient loads in coastal ponds may result from implementation of improved wastewater treatment.

Operation of a spray irrigation effluent disposal system could impact streams in the vicinity of the Caneel Bay lawns. Most of the effluent would be expected to be absorbed by surface vegetation and soils, or pass into the alluvium as groundwater. During periods of heavy rainfall, however, effluent could flow over saturated soils as surface runoff into nearby streams. This overflow would probably cause a change in the water quality of these streams even though the effluent would be heavily diluted by the time it reached the stream. Nonetheless, this potential impact could be mitigated by surrounding the spray irrigation site with runoff collection ditches that would contain excess runoff until the site's soil is less saturated. When the soil dries out, the runoff collected in the ditch could then be pumped back up to the grassed areas. Surface water quality impacts and mitigation measures would be addressed further in the previously mentioned spray irrigation management plan.

c. Marine Water Quality

Operation of an ocean outfall could impact marine water quality offshore of Moravian Point. Marine benthic and current studies have recently been conducted in this area in order to evaluate potential ocean outfall impacts. The benthic study includes water quality sampling data for this area. Reports of these studies are presented in Appendix D (Benthic Survey) and Appendix E (Current Study).

Initial dilution of treated effluent in the waters of the Pillsbury Sound would be sufficient under normal operation.

An outfall pipe would have to be greater than 1,000 m (3,200 ft.) long in order to avoid potential impacts of discharging effluent near reefs surrounding Mingo Rock and Steven Cay. At this length, treated effluent would be discharged (through the diffuser section at the end of the outfall) into water approximately 18 m (60 ft.) deep.

Treated effluent is composed primarily of fresh water and would rise through the denser saltwater until mixing brings the plume into equilibrium with the seawater. This process is known as initial dilution. Preliminary estimates suggest that initial dilution in these waters would be in excess of 100:1. With this level of dilution, water quality criteria for these waters would not be exceeded under normal operating conditions. Even during a period of equipment failure, water quality would not be significantly degraded beyond the zone of initial dilution because the treatment system is designed to provide adequate treatment during such breakdowns (i.e., the passive elements of preliminary bar screen removal and sand filtration prior to disinfection).

The settling of effluent particles would likely cause a very slight increase in benthic productivity in areas of deposition. This effect is not considered significant because of the low solids content of the effluent and because of the widespread dispersion anticipated from the proposed outfall site. These assumptions and impacts are under more detailed study and will be described more fully in the Final EIS.

3. Ecosystems

The implementation of any of the feasible action alternatives would cause a positive impact to the littoral and aquatic ecosystem of Enighed Pond. The decreased turbidity and contaminant load described under "water resources" may increase the value of this pond as habitat for fish and other aquatic species. A more healthy mangrove fringe would provide an improved habitat for shore birds and aquatic life. The expected decrease in nutrient loading to Enighed Pond (due to the elimination of poorly treated effluent runoff) may decrease the value of this habitat for some aquatic species. This is not considered a significant adverse impact, however, because other species would thrive under the changed conditions.

Long-term positive impacts to the surrounding ecosystem would result from project implementation.

The location of a treatment plant at site #1 would not cause long-term loss of habitat but would at sites #2 or #3. Treatment plant site #1 is in a location that is not considered a valuable plant or wildlife habitat. Locating a treatment plant at either site #2 or #3 would cause the loss of up to 4 ha (10 ac) of mixed dry woodland/scrub which is an ecosystem of relatively low habitat value and high availability compared to other ecosystems represented in the study area.

The proposed alignment of the ocean outfall pipe would not have any long-term impacts on the corals or seagrass beds. Corals that may have been disturbed during outfall construction may grow back while any seagrasses disturbed may or may not be reestablished. The findings of the benthic and current studies indicate that, if properly located, the continuous discharge of treated effluent through the ocean outfall would have minimal impact on marine ecosystems. For the diffuser to be properly located it must be placed well beyond reefs to allow the ocean currents to carry contaminants away from these valuable marine habitats. The greatest potential for impact from an ocean outfall would be from chlorine if it is used to disinfect the effluent. Dilution ratios have been calculated for this and other contaminants in the current study in order to assure that the diffuser is located far enough from reefs so as to avoid any impact on them. The proposed outfall location and surrounding marine ecosystems are shown in Figure IV-1.

Location of the treatment plant at site #1 would have the least long term impact to the natural environment.

The discharge of treated effluent may create a slightly improved habitat for fish and other marine species that thrive in a nutrient-rich environment, but only in the direct vicinity of the effluent discharge.

4. Air Quality

Potential air quality impacts of the feasible alternatives are all related to sewage odors which may emanate from pump stations and treatment facilities. Sewage odors such as hydrogen sulfide could be severe in the vicinity of the pump stations if odor controls were not used. This problem would be particularly bad during times of low flow when sewage would become very septic as it sits in the pump station's wet wells. If saltwater contamination of the water supply was significant, the higher sulfide concentration would magnify the odor problem. Such odor problems would be of particular concern because of the close proximity of the pump stations to residential areas.

For these reasons odor controls will be required at all pump stations. Such controls would typically include the filtration of pump station air through activated carbon filters. Odor controls at the treatment plant site should be of a similar nature but of larger scale. Adequate ventilation of the influent headworks and the emplacement of buffer zone vegetation and a berm surrounding the plant site will mitigate this potential adverse impact.

Elimination of poorly functioning wastewater treatment systems will improve air quality.

The continued disposal of sludge at the sanitary landfill may also increase odors in the Adrian area, where this landfill is located. Careful odor controls, including pretreatment of sludge before disposal, should be assured in order to mitigate this potential impact. In addition, the possibility of using sludge to enhance gardens should be pursued if tests indicate that this would be environmentally sound.

An overall positive air quality impact is likely to occur by the elimination of poorly functioning on-site wastewater treatment throughout much of the core study area. This would eliminate odors that are generated by failing septic systems or latrines, particularly during and after periods of rainfall.

5. Noise, Energy and Traffic

Additional noise is not expected. Impacts on energy and traffic generation will be minimal.

Noise, energy and traffic impacts that may occur due to the implementation of any of the feasible action alternatives would probably be minor. The noise of pump stations and machinery at the treatment plant would probably not be significantly greater than the noise of machinery used for Cruz Bay's existing wastewater facilities. The operation of a new pump station near Power Boyd's plantation would introduce a new source of noise to this area, but this and other related long-term noise impacts could be mitigated by assuring that all equipment is well-muffled.

Long-term energy impacts are not likely to result from the energy consumption of treatment facility machinery. The Cruz Bay area's energy supply is considered adequate to meet the needs of this facility. However, emergency power generators should be installed at the treatment plant and pump stations so that the treatment process would not be interrupted during any temporary power shortage or failure.

The only traffic directly generated by new wastewater facilities would be trips to and from the treatment facility by the plant operator(s) and septage disposal trucks which would use the facility. This would not be considered a significant impact.

6. Land Use

The wastewater treatment process planned for site #1 is the least land intensive.

Location of a treatment plant at any of the three sites considered may cause long-term land use impacts. A plant at site #1 would mean that up to 2 ha (5 ac) of land at this site could not be used for marine terminal facilities or public recreational facilities. At this time there are no formal plans to develop or use this site for these or any other purposes. A plant at site #2 would displace up to 4 ha (10 ac) of land which could be used for moderate density (R2 zone) housing by the local residents. Use of this site for wastewater facilities would only be consistent with the following adjacent land uses: an auxiliary power generating station and a hardware supply store. There is no existing residential development in the immediate vicinity of site #2. A treatment plant at site #3 would displace up to 4 ha (10 ac) of land while a land application disposable system would displace an additional 9.2 ha (23 ac). Because this land is part of the National Park Service, it has no potential future active land use. There may be a conflict with land use regulations imposed upon the National Park Service (NPS) as to how this land can be utilized.

Use of spray irrigation effluent disposal on the Caneel Bay Resort's lawns would be consistent with the present land use because the resort currently uses effluent to irrigate their lawns. Based on information received during a meeting and subsequent conversations with the resort's groundskeepers, the resort could easily accept the projected 758 $m^3$ (200,000 gal) per day of properly treated municipal effluent without having any constraints on land use.

Long-term land use impacts can best be avoided through good communication with those involved with existing or planned land uses that may be affected by this project. This communication should be continued throughout the project's design phase.

7. Economy

An island-wide user fee is expected to be charged to facility users by the Public Works Department.

The primary long-term economic impact that would probably result from any of the feasible action alternatives is the implementation of a standard wastewater treatment system user fee to be paid by each unit using this system. While no such fee is collected for sewer service in Cruz Bay at present, the Virgin Islands Public Works Department (PWD) is in the process of implementing a system to bill for and collect this fee. The current sewer user fee for the Virgin Islands is $44 per sanitary unit per year and $33 for each additional unit per year. The DCCA defines a sanitary unit as "a commode or urinal similar device used for the purpose of receiving organic wastes". A flat annual rate of $44 is charged for commercial establishments. DPW may decide to restructure these fees, however.

Payment of this fee will probably be negligible to some users of the system, yet it may be seen as a burden to others. Some residents have indicated that they would be quite willing to pay such a fee if it guaranteed proper operation and maintenance of the wastewater facilities. Collection of these fees is necessary in order to fund the ongoing operation and maintenance of wastewater facilities. DPW is expected to implement a plan for assuring proper use of these fees as part of the new fee collection program.

D. LONG-TERM SECONDARY IMPACTS

The implementation of new wastewater facilities is not expected to induce development significantly.

Secondary impacts are indirect consequences caused by the implementation of an improved wastewater treatment system. These impacts are typically associated with the induced development which may occur due to the presence of new wastewater facilities. Prediction and assessment of secondary impacts is assisted by the results of the Constraints Analysis (Appendix B) which was conducted for this project. This analysis identified and mapped the constraints to development in Cruz Bay and is thus useful as a model of the patterns and extent to which future development may occur.

It is unlikely that the implementation of wastewater facilities in the study area will induce development significantly because development is currently taking place in the core area with little regard for the inadequacy of the present system. Therefore, any secondary impacts are expected to be minimal. The implementation of a new water supply is expected to have a greater development-inducing effect than the implementation of wastewater facilities. The primary constraint to development on St. John at present is the lack of an adequate potable water supply.

It is assumed that a new water supply will be implemented shortly after 1990, the year that the recommended wastewater facilities are expected to be operational. In all likelihood, the development-inducing effects of the new water supply will overshadow those of the wastewater facilities. For the purpose of this study, the focus will be on the potential secondary impacts caused by the implementation of wastewater facilities.

Location of the proposed collection system will, most likely, affect the pattern of future development.

Each of the feasible action alternatives would likely involve the same secondary impacts of minimal induced development, as each involves a centralized, subregional treatment system. Development is likely to increase within the study area over the next two decades, regardless of the presence of a new wastewater treatment facility. While the location of the proposed collection system may induce growth to occur at a slightly greater rate in the core area than in the extended area, any overall induced increase is likely to be minimal. Comparatively, the no action alternative could slightly constrain development in the long-term, causing growth to occur at a slower rate than it would otherwise. These basic impacts are important determinants in the more specific secondary impacts on water resources, ecosystems, air quality, noise, and land use.

1. Water Resources

Any slight increase in development resulting from the implementation of wastewater facilities would cause an increased demand for potable water in the study area. While the existing water supply is insufficient, the assumed future water supply would, no doubt, be sufficient to meet this increased demand. Should the implementation of this new water supply be delayed, however, water consumers in the study area should continue to use prudent water conservation practices and/or seek an interim water supply supplement (such as barging more fresh water from St. Thomas.)

Increased development will involve more surface cover causing more rapid runoff during heavy rainfall.

Another possible secondary impact on water resources is the decreased opportunity for rainwater to seep into the soil due to an increase in total area of impervious surfaces in the study area. Increased development involves the construction of structures and infrastructure on land which was once available for rainfall to permeate through the surface into the soil beneath. The increased amount of impervious surfaces may cause more rapid runoff, drier soils, and increased potential for erosion. It is very unlikely that such impacts would be significant, however, due to the high level of impermeability of existing soils in the study area.

The no-action alternative would involve no significant secondary impacts on water resources.

2. Ecosystems

The natural environment will not be unduly stressed by the amount of induced development.

Development induced by the implementation of any of the feasible alternatives may slightly decrease the total area of habitat for various species of plants and animals in the study area. This would have less affect on various species of plants and animals because the core study area is considerably more developed than the extended study area. Although development is likely to occur more rapidly in the extended study area than in the core study area, this development would not be induced by wastewater facilities, because the extended study area would not be served by a centralized collection and treatment system.

3. Air Quality and Noise

Both air quality and noise would be affected by increased development, primarily due to the increased number of motor vehicles, generators, and other machines. However, it is not likely that any induced increase in development would cause significant air quality or noise problems. This is because a very small amount of induced growth, if any, is anticipated and because air quality is very good and noise levels very low in the study area. Similarly, the no-action alternative would not involve secondary air quality or noise impacts.

4. Land Use

Projections regarding future land use in the study area are discussed in the Constraints Analysis (Appendix B) and Sections B and C of the Affected Environment Chapter.

Any induced growth would occur mostly as in filling within already developed areas.

Although the extent of development is not likely to be influenced significantly by the implementation of any of the feasible overall alternatives, the patterns in which future development occurs could be influenced. Development would be more likely to occur along proposed collector sewer routes, for instance, than in remote areas. Sewers have been proposed only for portions of the detailed study area which exhibit significant wastewater disposal problems and which cannot use on-site disposal systems in a safe and cost-effective way. All induced growth expected will occur as infilling within these problem areas. The sewer service areas have been designated as developable by the existing zoning regulations and they specifically exclude areas constrained by significant habitat or other environmentally sensitive features. All areas outside the proposed sewer service areas will use on-site disposal systems or privately funded collection and treatment facilities in accordance with local and territorial regulations.

The no-action alternative would likely create some degree of constraint on the long-term natural growth of development in the detailed study area. Without new wastewater facilities, the potential for future development would be relatively limited and growth would occur at a decreasing rate over the long-term. Additionally, the no-action alternative might impact the patterns of future land use by encouraging development to occur in more remote, sparsely populated areas where individual on-site wastewater treatment systems can function more effectively.

# V. COORDINATION

## V. COORDINATION

The project team has sought to coordinate its efforts in preparing this EIS with each agency, organization, and individual that has a potential interest in this project. The following groups have been contacted or consulted during the course of the project. Extensive or notable coordination with certain groups is discussed in footnotes.

### Federal Governmenent

Department of Agriculture

- Soil Conservation Service
- Farmers Home Administration
- Forest Service

Department of Commerce

- National Oceanic and Atmospheric Administration
  - National Marine Fisheries Service
  - National Ocean Survey
  - Office of Ecology and Conservation
- Office of Environmental Affairs

Department of Defense

- Army Corps of Engineers

Department of Housing and Urban Development

Department of the Interior

- Fish and Wildlife Service
- National Park Service*
- Geological Survey

Department of Transportation

- Federal Highway Administration

Executive Office of the President

- Office of Economic Opportunity

*Over two-thirds of St. John, and a small portion of the study area, are covered by the Virgin Islands National Park, which is administered by the National Park Service (NPS). Project preparation included communication with NPS officials at the local, regional, and national levels.

Territorial Government

Attorney General's Office

Budget Director

Bureau of Corrections

Community Action Agency

Consumer Services Administration

Department of Agriculture

Department of Commerce

Department of Conservation and Cultural Affairs

- Bureau of Libraries, Museums and Archaeological Services
- Division of Fish and Wildlife
- Division of Natural Resources Management*
- Office of Coastal Zone Management

Department of Education

Department of Health

Department of Housing and Community Renewal

Department of Labor

Department of Public Works**

Department of Social Welfare

Department of Tourism

Disaster Preparedness Office

*The Division of Natural Resource Management (NRM) is responsible for water quality issues, including wastewater discharge. A four-member NRM team conducted the benthic study in conjunction with this project. Members were Marcia Gilnack, Kurt VanGelder, Marc Pacifico, and Cliff Crook.

**The Department of Public Works (DPW) is responsible for the planning, financing, operation, and maintenance of public wastewater facilities in the Virgin Islands. It is expected that DPW will be the project grantee. Therefore, the project team has maintained close contact with DPW officials throughout the course of the project.

Employment Security Agency

Federal Programs Office

Fire Service

Office of the Governor of the Virgin Islands

Office of the Legislature of the Virgin Islands

Office of Property and Procurement

Public Services Commission

Urban Renewal Board

Virgin Islands Commission on Aging

Virgin Islands Commission on Youth

Virgin Islands Housing Authority

Virgin Islands Port Authority*

Virgin Islands Police Department

Virgin Islands Planning Office

Virgin Islands Water and Power Authority

Local Government

Honorable Noble Samuels, Administrator of St. John

Senator Cleone Creque Maynard, St. John Representative to the Legislative of the Virgin Islands

Tax Assessor's Office

Other Groups

Allen-Williams, Inc.

AT Kearney, Inc.

Caneel Bay Foundation

Caribbean Fisheries Management Council

*The Virgin Islands Port Authority (VIPA) is considering plans to develop a marine terminal facility in Enighed Pond.

Caribbean Research Institute

deJongh Associates

Forst Centrum Corporation

Island Resources Foundation

League of Women Voters

Rock Resorts

Tradewinds monthly newspaper

URS Company

Virgin Islands Conservation Society

Virgin Islands Daily News

Virgin Islands Taxi Commission

# VI. LIST OF PREPARERS

# LIST OF PREPARERS

The project team for this EIS consisted of staff members of CE Maguire, Inc., under the technical direction of EPA Region II Environmental Impacts Branch Personnel. The EPA personnel involved in this project and their areas of responsibility are listed as follows:

| | |
|---|---|
| Barbara J. Pastalove | Chief, Environmental Impacts Branch (EIB) |
| William P. Lawler, P.E. | Project Officer, EIB |
| Carol A. Stein | Environmental Engineer, EIB |
| Laura A. Lombardo | Environmental Engineer, EIB |
| Henry Smith | Life Scientist, EIB |
| Antony J. DiLodovico | Chief, Caribbean Construction Grants Section |
| Henry A. Mazzucca, P.E. | Environmental Engineer, Caribbean Construction Grants Section |

The staff members and subcontractors of CE Maguire, Inc. who prepared this document and their areas of responsibility are listed as follows:

CEM Staff:

| | |
|---|---|
| Robert H. Wardwell | Project Administrator |
| Clinton L. Webb | Project Manager, Public Participation, Principal EIS Writer |
| Dean A. Slocum | Planner, Principal EIS Writer and Report Preparation Coordinator |
| Richard M. Berlandy, P.E. | Principal Project Engineer |

| | |
|---|---|
| Andrew P. Kuchta | Planner, EIS Writer, Needs Analysis, Constraints Analysis |
| Jared T. Wibberley | Principal Environmental Planner, EIS Editor |
| Jennifer Aley | Assistant Environmental Planner, Newsletter, EIS Editor |
| Frances Lyss | Typing, Project Coordination |
| Andrew DeBoer | Report Graphics, CADD |
| Karen Cruanes | Report Graphics |
| Michael Garafalo | Report Graphics |
| Lorraine Kelly | Word Processing |
| Paulaine Dupervil | Word Processing |
| Philip Pallotti | Document Reproduction, Districution |
| James Mathews | Document Reproduction |
| Gerri Farina | Document Reproduction, Distribution |

Subcontractors:

| | |
|---|---|
| Ocean Surveys, Inc. | Current and Hydrographic Surveys |
| MAAR Associates, Inc. | Stage 1B Cultural Resource Survey |

# APPENDICES

# APPENDIX A

## NEEDS ANALYSIS

APPENDIX A

# NEEDS ANALYSIS

## INTRODUCTION

The first step to developing a plan for solving an area's wastewater treatment problems is to determine the actual nature and extent of these problems. For this purpose, the project team undertook a detailed survey and analysis of wastewater treatment needs in the Cruz Bay study area. A door to door survey, in combination with an assessment of the potential for effective on-site wastewater treatment, was conducted in order to determine what means are used to treat and dispose of wastewater in the area and how effective these means are. This report describes the methods and findings of the needs survey.

### Methods

The four primary sources for identifying wastewater needs are:

1. Meetings with concerned and involved individuals and organizations

2. Existing data and records

3. New data

4. The "public"

Although each of these data sources was utilized in gathering information, the analysis contained herein is based primarily on new data gathered through a door-to-door survey.

Meetings held with The Virgin Islands Department of Public Works (DPW), Virgin Islands Planning Office (VIPO), the Administrator of St. John, The Tax Assessor, other interested individuals, and the public produced a general indication of Cruz Bay's wastewater needs. The decision to conduct a door-to-door survey of needs was based on the following factors:

- The lack of utilities records, street maps, updated property maps and the doubtful accuracy of those that did exist,

- the need to obtain background and "inside" information from St. John residents, i.e. existing problems, past problems, etc,

- the relatively small area of Cruz Bay and the surrounding areas, and

- The need to update and expand upon existing maps and information.

The first step in developing the survey was to define the objectives of the needs assessment. It was decided that the survey would show an inventory of the wastewater treatment and disposal systems and their deficiencies (if any existed) currently utilized by each occupied structure in the Cruz Bay area.

The second step was to define the study area. The original study area included land within the drainage basin(s) of the existing public sewer system. The study area was then modified to include adjacent areas just outside the original, or "core" study area. Representative sampling would occur in the extended study area to identify neighborhoods with sewage deficiencies. The rationale behind the extended study area was to see if connections to a new public sewer system line could be possible and later analyzed for cost-effectiveness.

The next step was to develop a draft questionnaire that was easy to implement and understand, in agreement with an EPA suggested format, and met the objective previously stated. The draft was reviewed by EPA and comments were incorporated into the final questionnaire (Attached).

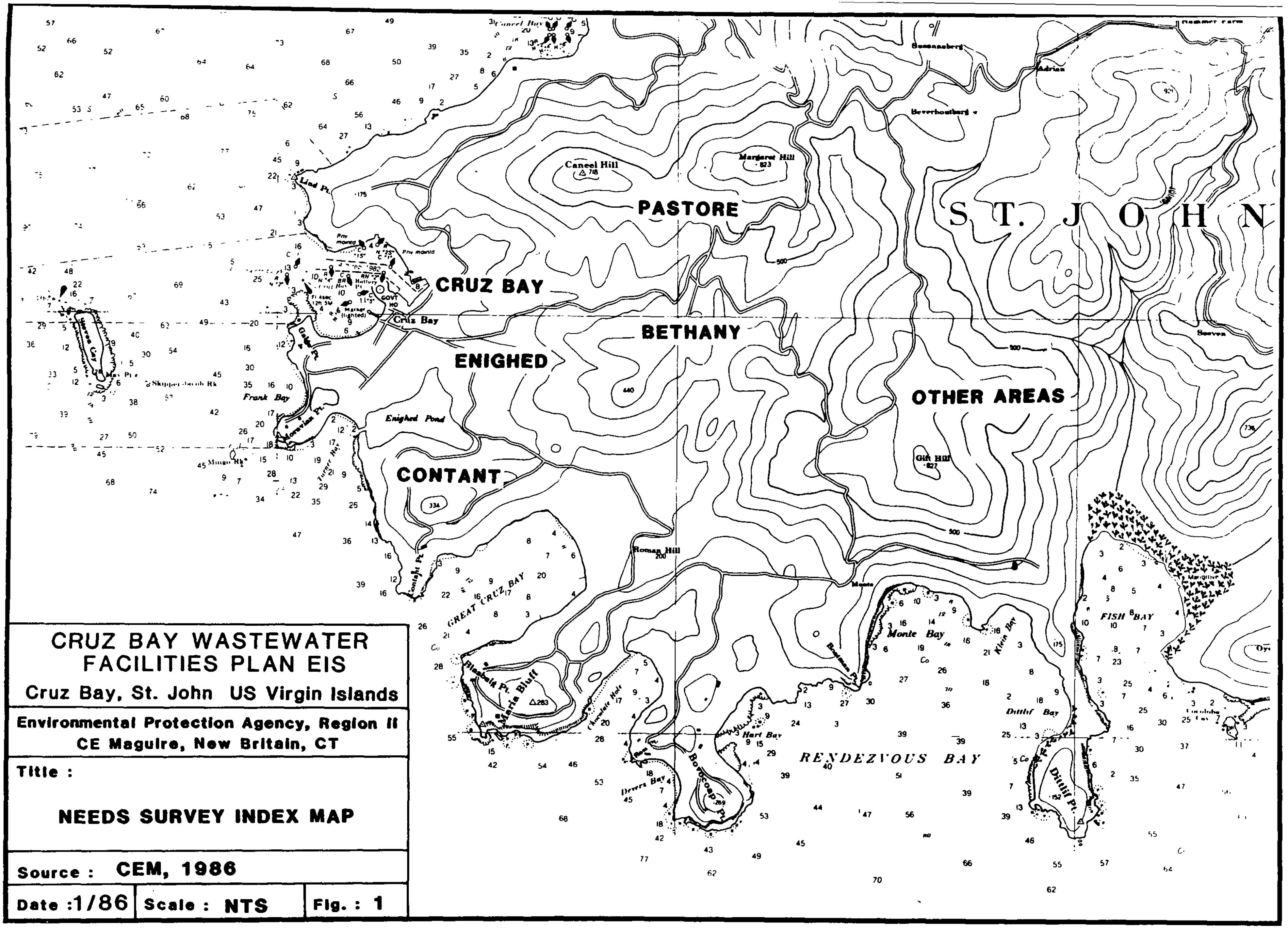
The survey crew consisted of three (3) CE Maguire employees who were aware of the nature and purpose of the survey and could consistently and accurately interpret responses to the questionnaire.

Notices were placed in the local newspaper explaining the nature and purpose of the survey and asking for the cooperation of the residents. The survey was also publicized on local radio and television stations.

The project team chose to survey six areas in and around the Cruz Bay area. They were (1) Cruz Bay, the approximate central business district (CBD) area; (2) Enighed, the area bordering north and east of Enighed Pond where the existing sewage treatment plant is located; (3) Contant, the area south of Enighed Pond; (4) Bethany, the interior area east of Enighed and Pastore; (5) Pastore, a pocket development off Center Line Road and west of Bethany, and (6) other areas, which encompass all adjacent areas not mentioned above, including some of the Virgin Islands National Park Land Grant, Great Cruz Bay, Chocolate Hole, Gift Hill, etc. Figure 1 shows the location of these areas.

A combination of three (3) maps (A 1972 1:200 scale map prepared by DPW, a 1985 update of this map by de Jongh/URS associates for DPW, and the 1982 USGS topographic map), showing the location of structures and streets, was used to organize the door-to-door survey. A field survey was also conducted to update these maps so they could reflect existing conditions.

Residences were surveyed on January 13 through 17, mainly between the hours of 1 and 7 p.m. Non-residential structures, such as stores, businesses, and public institutions were surveyed exclusively during the workday hours of January 13-17. These structures were also recorded on the maps and the "number of residents" question was substituted with "number of employees".




CRUZ BAY WASTEWATER FACILITIES PLAN EIS

Cruz Bay, St. John US Virgin Islands

**Environmental Protection Agency, Region II**
**CE Maguire, New Britain, CT**

**Title :**

**NEEDS SURVEY INDEX MAP**

**Source : CEM, 1986**

| **Date :1/86** | **Scale : NTS** | **Fig. : 1** |
|---|---|---|

In summary, responses were obtained from 235 of the 566 structures contained in the communities surveyed, for a 50 percent response rate (Table 1).

TABLE 1
SUMMARY OF SURVEY RESPONSES
NEEDS SURVEY OF JANUARY 13-17, 1986
ST. JOHN, U.S. VIRGIN ISLANDS

| | Number of Structures | Number Visited | Percent Visited | Number of Responses | Percent Responses |
|---|---|---|---|---|---|
| Cruz Bay | 93 | 33[1] | 35 | 26 | 79 |
| Enighed | 259 | 225[1] | 87 | 108 | 48 |
| Contant | 85 | 85 | 100 | 43 | 51 |
| Bethany | 52[2] | 52 | 100 | 29 | 56 |
| Pastore | 46 | 46 | 100 | 15 | 33 |
| Other[3] | 31[4] | 31 | 100 | 14 | 45 |
| TOTALS | 566 | 472 | 82 | 235 | 50 |

[1]Structures with known public sewer system connections were not interviewed.

[2]Much of the Bethany area lies outside the core study area and some lies outside the study area. The number shown is less than the actual total number of structures in Bethany.

[3]The category "others" represents communities or areas surveyed outside the core study area. These areas include Power Boyd's Plantation, Great Cruz Bay, Chocolate Hole, Gift Hill, Altair, Roman Hill, Balsbarg, and Susannaberg. The category also includes the few structures within the core area that are within the Virgin Islands National Park boundaries.

[4]The number of structures surveyed outside the core study area is a representative sample of the total number of houses in "other".

## Findings

The following analysis, presented on a community basis, is the result of the analysis of the door-to-door survey results and the observations of the survey team.

1. CRUZ BAY

The Cruz Bay area consists of the approximate Central Business District (CBD) area located immediately south and east of Cruz Bay. This area serves as the focal point for local government activities on St. John.

Development characteristics in the Cruz Bay CBD area is comprised of the following uses indicated in Table 2.

TABLE 2
DEVELOPMENT CHARACTERISTICS - CRUZ BAY

| Type of Use | Number of Structures | Remarks |
|---|---|---|
| Year-round Residential | 92 | None |
| Seasonal Residential | 1 | None |
| TOTAL | 93 | |
| Single-family | 11 | None |
| Two-family | 2 | None |
| Multiple Dwelling | 6 | None |
| Commercial | 31 | Cruz Bay includes CBD area |
| Other | 43[1] | Cruz Bay area is identified under constraints analysis |
| TOTAL | 93 | |

[1]Includes churches, offices, storage garages, administrative offices, schools, fire station, police station, etc.

The methods of wastewater disposal for these structures is summarized in Table 3, and Figure 2.

TABLE 3
WASTEWATER DISPOSAL METHODS - CRUZ BAY

| Disposal Method | Number of Structures Surveyed | Percent of Total | Remarks |
|---|---|---|---|
| Public Sewer System | 62 | 67 | Cruz Bay has the largest number of public sewer hookups |
| Cesspool | 0 | 0 | None |
| Latrine | 0 | 0 | None |
| Septic Tank/ Leaching System | 25 | 27 | Some businesses share septic tanks |
| Direct Discharge | 0 | 0 | Some businesses do not have water facilities |
| Unknown | 2 | 2 | None |
| TOTALS | 93 | 100 | |

As shown in Table 3, sixty-seven (67) percent of the structures in this area are connected to the public sewer system. Most did not have any problems except for occasional odors. However, since the centralized treatment plant serving these structures is not capable of adequately treating wastewater flows in accordance with its discharge permit, all of these structures are considered to be "in need". The septic tank users reported, for the most part, that they had no problems. However, proprietors and residents on the street where Fred's and Lime Tree Restaurants are located indicated that they had severe problems with sewage treatment. The general consensus by those surveyed in the Cruz Bay CBD area was that sewage definitely is a problem, that there should be more sewer lines throughout the area, and that many people would like to connect to a public sewer system. The structures in the "other" category did not have water facilities.

2. Enighed

The community of Enighed has the largest concentration of people and structures in the Cruz Bay area. Development in the Enighed area is shown in Table 4.

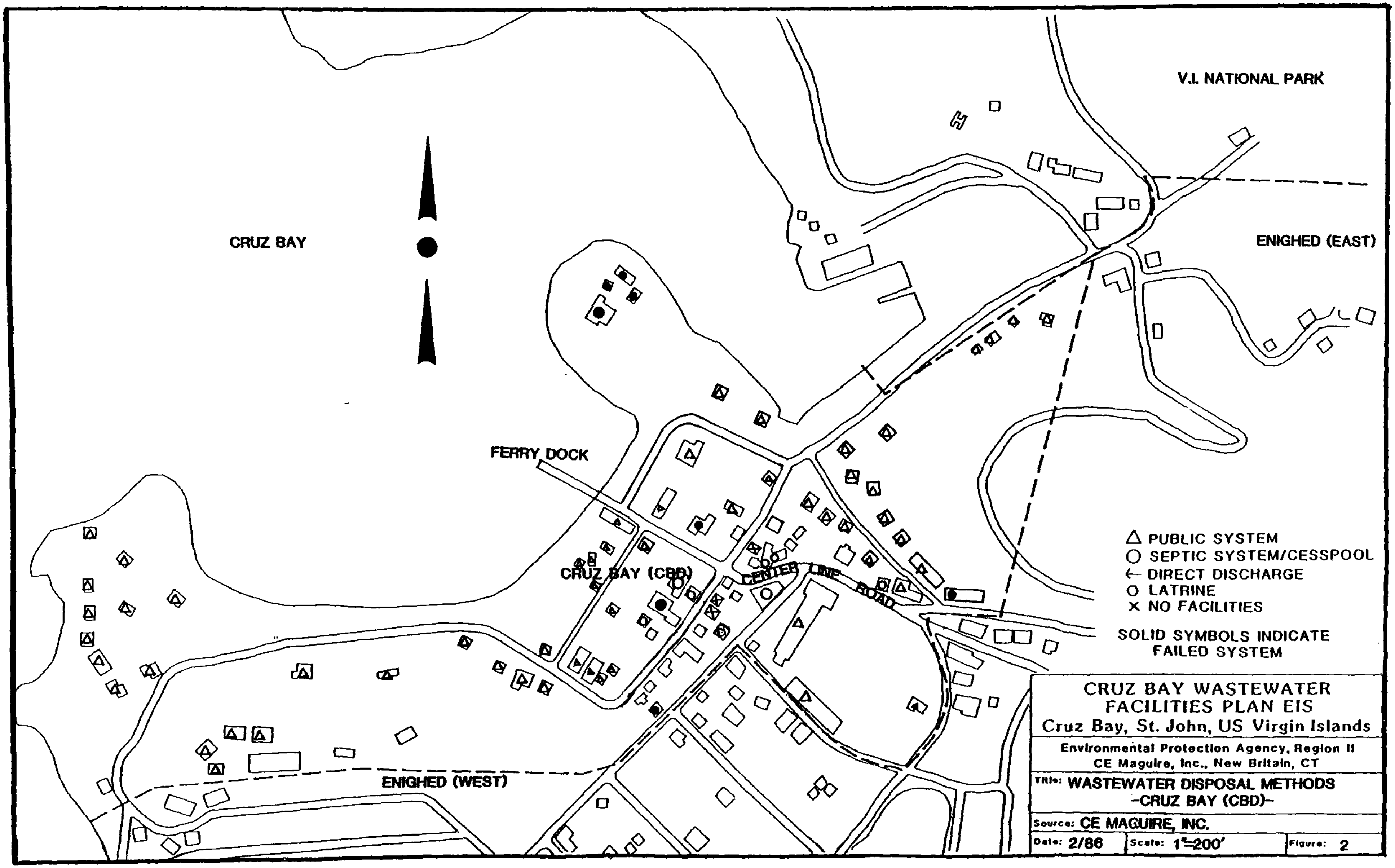
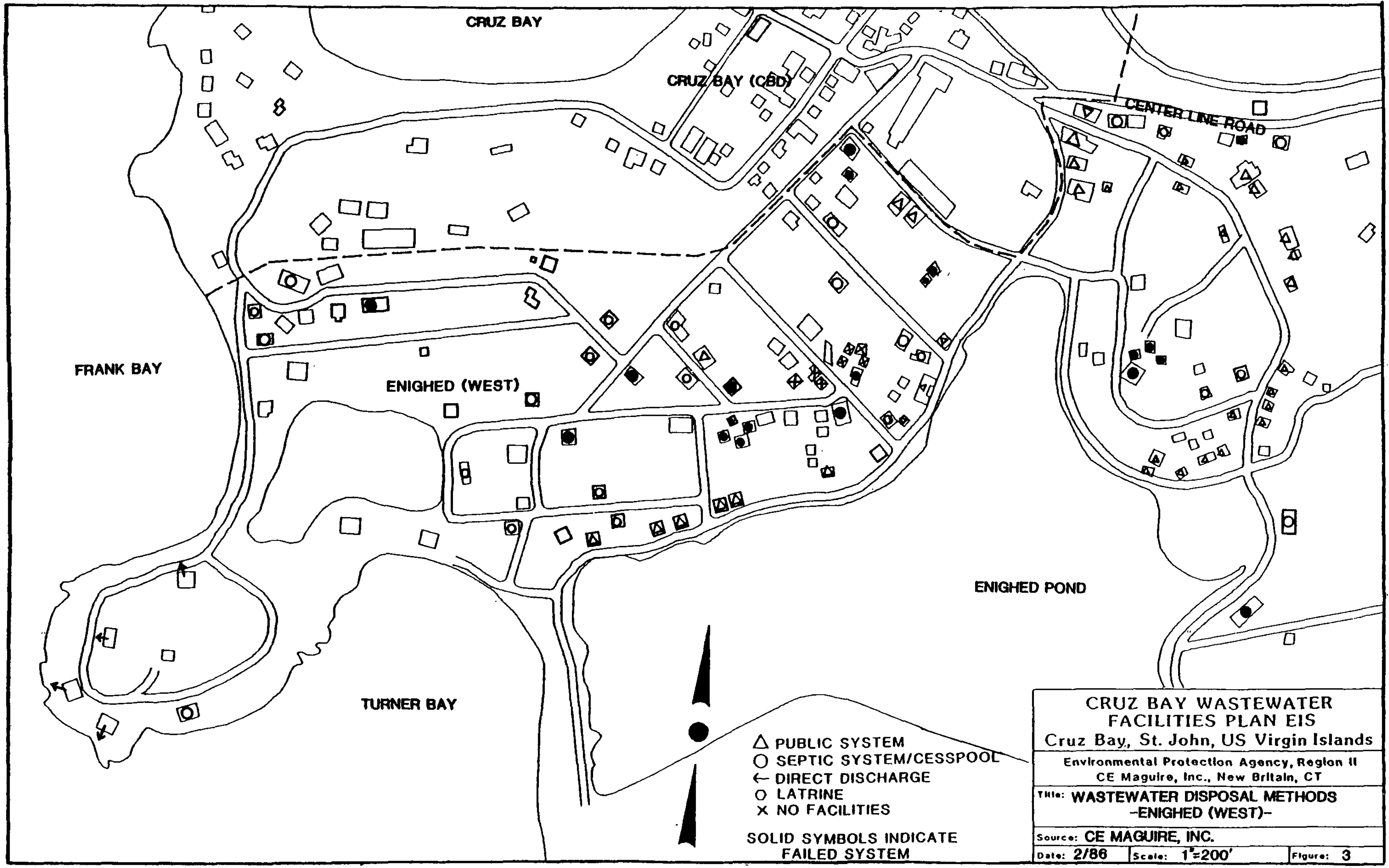

V.I. NATIONAL PARK
CRUZ BAY
ENIGHED (EAST)
FERRY DOCK
CRUZ BAY (CBD)
CENTER LINE ROAD
ENIGHED (WEST)
△ PUBLIC SYSTEM
○ SEPTIC SYSTEM/CESSPOOL
← DIRECT DISCHARGE
O LATRINE
X NO FACILITIES
SOLID SYMBOLS INDICATE FAILED SYSTEM
CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title: WASTEWATER DISPOSAL METHODS -CRUZ BAY (CBD)-
Source: CE MAGUIRE, INC.
Date: 2/86
Scale: 1"=200'
Figure: 2

TABLE 4
DEVELOPMENT CHARACTERISTICS - ENIGHED

| Type of Use | Number of Structures Surveyed | Remarks |
|---|---|---|
| Year-round Residential | 242 | None |
| Seasonal Residential | 17 | Mostly homes on coastal hill-sides |
| TOTAL | 259 | |
| Single-family | 188 | High density residential |
| Two-family | 31 | High density residential |
| Multiple Dwelling | 29 | High density residential |
| Commercial | 11 | Most commercial structures are connected with the public sewer system |
| Other | 0 | None |
| TOTAL | 259 | |

As shown in Table 4, nearly all of Enighed's residents live year-round in the area, compounding the reported and observed deficiencies. Table 5 and Figures 3 and 4 show the wastewater treatment methods used in Enighed.


CRUZ BAY
CRUZ BAY (CBD)
CENTER LINE ROAD
FRANK BAY
ENIGHED (WEST)
ENIGHED POND
TURNER BAY
PUBLIC SYSTEM
SEPTIC SYSTEM/CESSPOOL
DIRECT DISCHARGE
LATRINE
NO FACILITIES
SOLID SYMBOLS INDICATE FAILED SYSTEM
CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title: WASTEWATER DISPOSAL METHODS -ENIGHED (WEST)-
Source: CE MAGUIRE, INC.
Date: 2/86
Scale: 1"=200'
Figure: 3

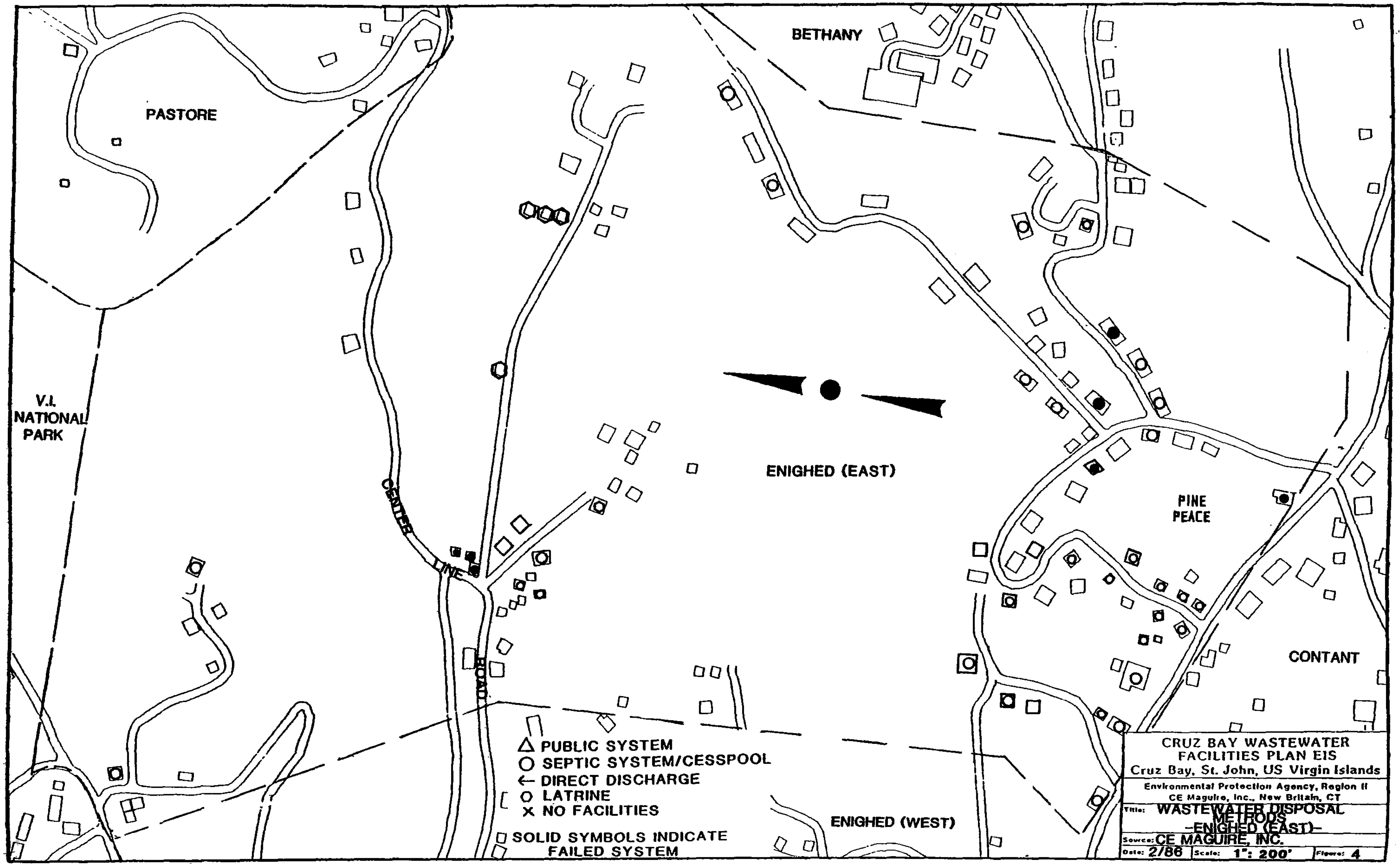

BETHANY
PASTORE
V.I. NATIONAL PARK
ENIGHED (EAST)
PINE PEACE
CONTANT
CENTER LINE ROAD
ENIGHED (WEST)
△ PUBLIC SYSTEM
○ SEPTIC SYSTEM/CESSPOOL
← DIRECT DISCHARGE
○ LATRINE
X NO FACILITIES
SOLID SYMBOLS INDICATE FAILED SYSTEM
CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title: WASTEWATER DISPOSAL METHODS -ENIGHED (EAST)-
Source: CE MAGUIRE, INC.
Date: 2/86
Scale: 1": 200'
Figure: 4

TABLE 5
WASTEWATER DISPOSAL METHODS - ENIGHED

| Disposal Method | Number of Structures Surveyed | Percent of Total | Remarks |
|---|---|---|---|
| Public Sewer System | 30 | 11 | None |
| Cesspool | 2 | 1 | None |
| Latrine | 3 | 1 | None |
| Septic Tank/ Leaching System | 199 | 78 | Green discoloration of Enighed Pond |
| Direct Discharge | 3 | 1 | From Moravian Point to the sea. |
| Other | 17 | 6 | Many small structures (homes) do not have water facilities |
| Unknown | 5 | 2 | None |
| TOTALS | 259 | 100 | |

The most problematic area in Enighed is known as "Pine Peace", located east of Enighed Pond. It is a highly congested area with small structures and a relatively large population. During periods of rain, untreated sewage runs down the steep hill from Pine Peace, according to local officials and residents that the survey team interviewed. However, in the course of the survey, only one resident of Pine Peace mentioned a problem after rainfalls. The other residents mentioned no problems except for occasional odors.

Public sewer system connections in Enighed were confined primarily to commercial buildings. Many small structures did not have water facilities and only a few had sewage disposal in the forms of latrines and direct discharges. The majority of the structures in Enighed utilized septic systems with many used for the disposal of laundry water (graywater) into the systems. Graywater from the remaining structures is used for watering private gardens whenever possible.

3. Contant

The community of Contant lies on the south side of Enighed Pond, on Contant Point. It is primarily a residential zone, as shown in Table 6.

TABLE 6
DEVELOPMENT CHARACTERISTICS - CONTANT

| Type of Use | Number of Structures Surveyed | Remarks |
|---|---|---|
| Year-round Residential | 83 | None |
| Seasonal Residential | 2 | None |
| TOTAL | 85 | |

| | | |
|---|---|---|
| Single-family | 70 | Condominium complex being constructed on the peak of Contant Point |
| Two-family | 9 | None |
| Multiple dwelling | 2 | None |
| Commercial | 1 | Greena's Grocery |
| Other | 3 | Church buildings |
| TOTALS | 85 | |

Most of Contant's residents occupy their homes year-round and 70 of its 85 structures are single-family homes. At the peak of Contant Point, there are fifteen (15) lots being developed for condominium construction. One structure is presently being built with the other 14 pending. A developer indicated that these condos would use septic systems. Present wastewater disposal methods are shown in Table 7 and Figure 5.

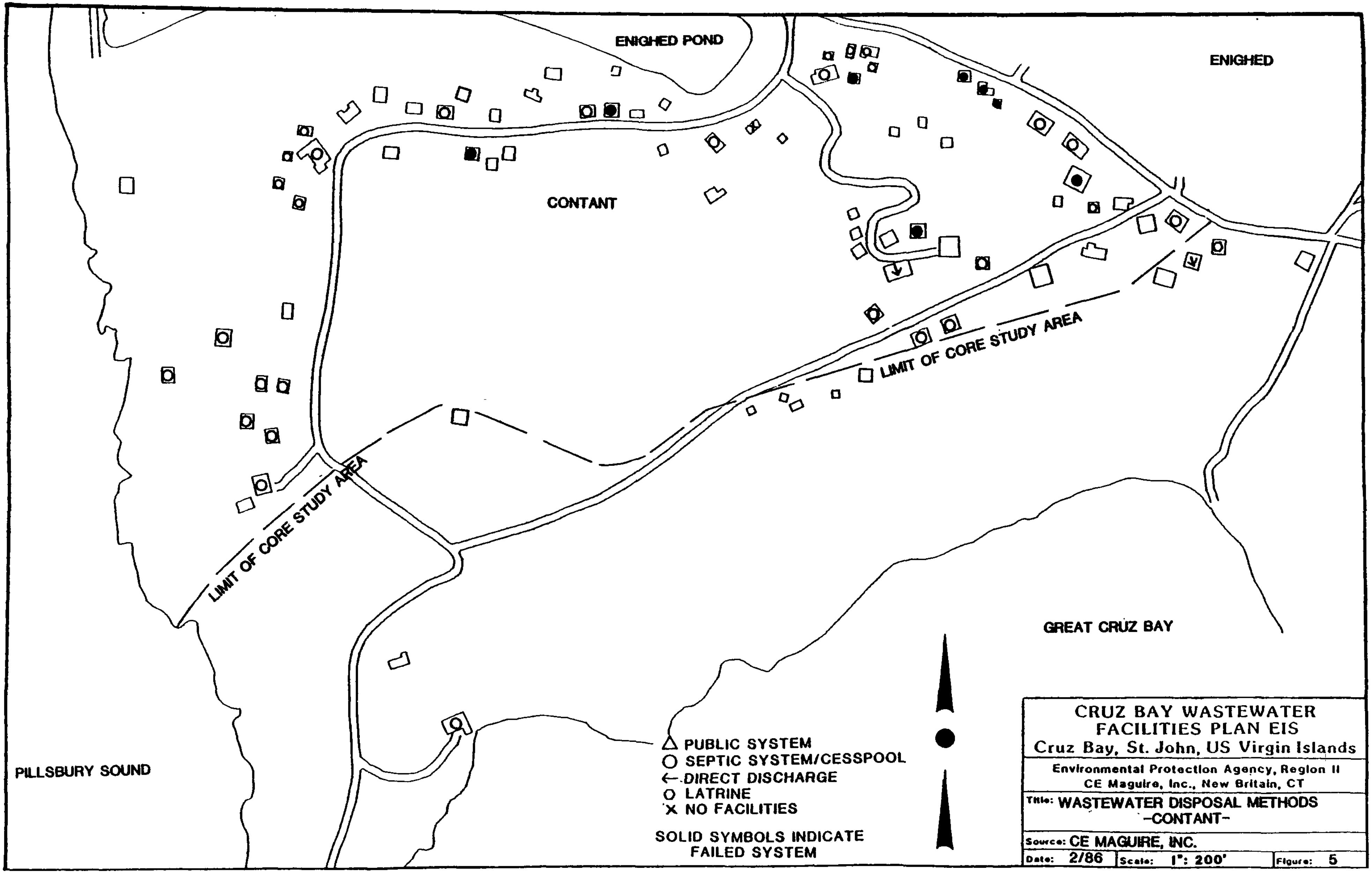

ENIGHED POND
ENIGHED
CONTANT
LIMIT OF CORE STUDY AREA
LIMIT OF CORE STUDY AREA
GREAT CRUZ BAY
PILLSBURY SOUND
△ PUBLIC SYSTEM
○ SEPTIC SYSTEM/CESSPOOL
← DIRECT DISCHARGE
○ LATRINE
X NO FACILITIES
SOLID SYMBOLS INDICATE FAILED SYSTEM
CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title: WASTEWATER DISPOSAL METHODS -CONTANT-
Source: CE MAGUIRE, INC.
Date: 2/86
Scale: 1": 200'
Figure: 5

TABLE 7
WASTEWATER DISPOSAL METHODS - CONTANT

| Disposal Method | Number of Structures Surveyed | Percent of Total | Remarks |
|---|---|---|---|
| Public Sewer System | 0 | 0 | None |
| Cesspool | 0 | 0 | None |
| Latrine | 1 | 1 | None |
| Septic Tank/ Leaching System | 81 | 95 | None |
| Direct Discharge | 2 | 3 | Discharge into Enighed Pond |
| Other | 1 | 1 | One structure (home) had no facilities |
| Unknown | 0 | 0 | None |
| TOTALS | 85 | 100 | |

Approximately 95 percent of the structures in Contant have septic systems, 3 percent discharge directly, and one structure did not have any water facilities.

The division of problems was clear in the Contant community. Homes at or near the peak of Contant Point had no sewage problems and were adamantly opposed to being connected to a public sewer line, if one was to be built. The residents occupying the structures at the base of Contant Point and those near the Contant-Enighed border reported frequent problems and favored a public sewer line near their homes.

4. Bethany

The Bethany area of Cruz Bay is located entirely inland. The surveyed area was primarily comprised of single-family homes, a few two-family and multiple dwellings, and one commercial building (the Upper Deck Restaurant), as shown in Table 8.

TABLE 8
DEVELOPMENT CHARACTERISTICS - BETHANY

| Type of Use | Number of Structures Surveyed | Remarks |
|---|---|---|
| Year-round Residential | 48 | None |
| Seasonal Residential | 4 | None |
| TOTAL | 52 | |

| | | |
|---|---|---|
| Single-family | 29 | Including Upper Deck Condominiums |
| Two-family | 7 | None |
| Multiple Dwelling | 5 | None |
| Commercial | 1 | Upper Deck Restaurant |
| Other | 1 | Microwave Tower Station |
| TOTALS | 52 | |

Wastewater disposal methods for Bethany are shown in Table 9 and Figure 6.

TABLE 9
WASTEWATER DISPOSAL METHODS - BETHANY

| Disposal Method | Number of Structures Surveyed | Percent of total | Remarks |
|---|---|---|---|
| Public Sewer System | 0 | 0 | None |
| Cesspool | 2 | 4 | None |
| Latrine | 0 | 0 | None |
| Septic Tank/ Leaching System | 48 | 92 | Very few/no problems |
| Direct Discharge | 0 | 0 | None |
| Other | 2 | 4 | Some structures (homes) have no facilities |
| Unknown | 0 | 0 | |
| TOTALS | 52 | 100 | |

More than 90 percent of the structures in Bethany have septic systems and the remaining structures have cesspools or no facilities. The area does not seem to possess any wastewater disposal problems and most of the surveyed residents are of the opinion that extending the sewer lines to Bethany would be a waste of time, effort and money. Generally residents felt that sewage is not a problem in Bethany, because of the large lot sizes. A few of the surveyed residents said that they had separate graywater disposal systems.

5. Pastore

The Pastore community is a pocket development stemming from three spurs off Center Line Road just west of the Bethany area. Most are single-family structures, as shown in Table 10, with some two-family and multiple dwellings and the one "other" structure being the Jehovah's Witness Church on Center Line Road.

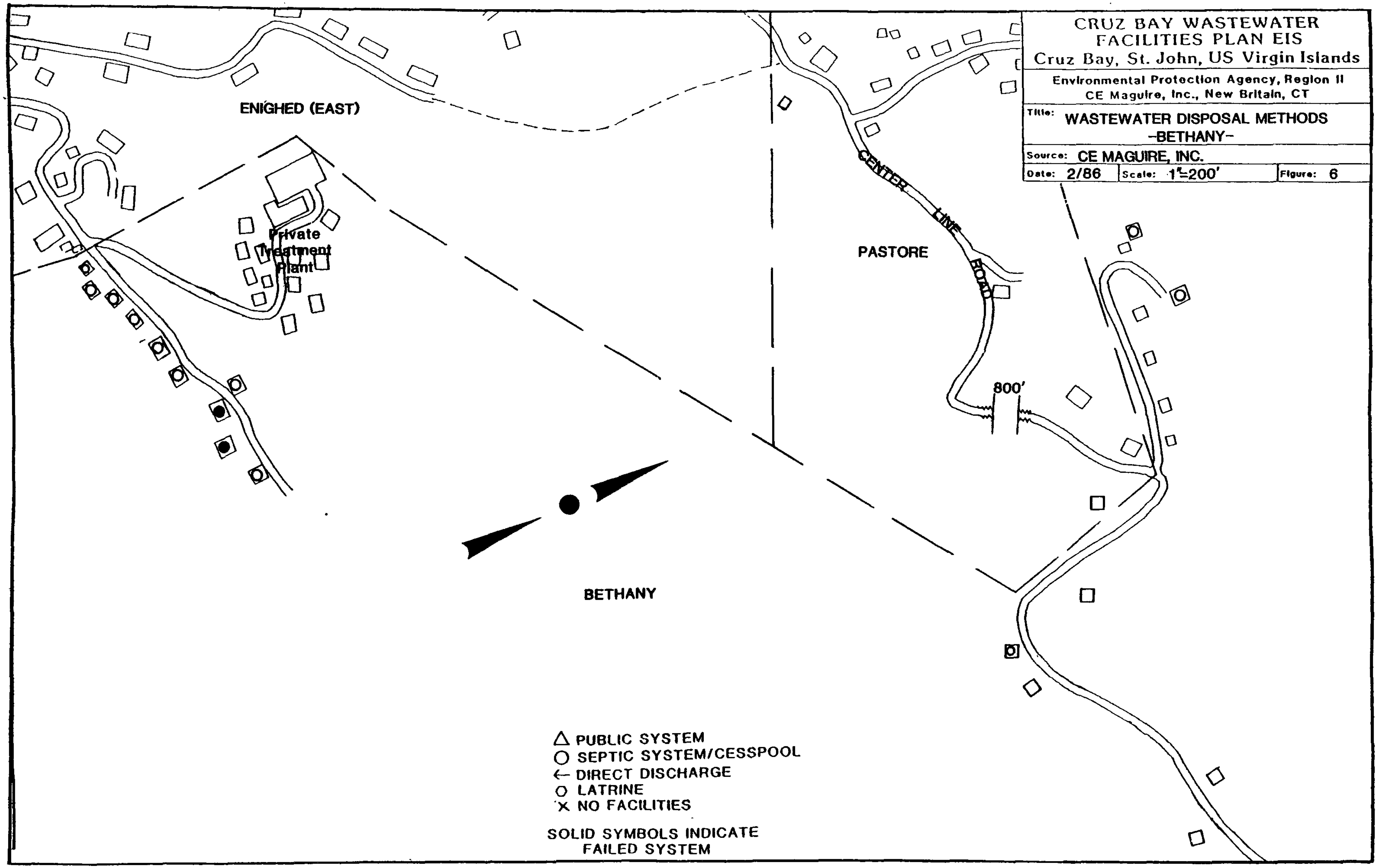

CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands
Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT
Title: WASTEWATER DISPOSAL METHODS -BETHANY-
Source: CE MAGUIRE, INC.
Date: 2/86
Scale: 1"=200'
Figure: 6
ENIGHED (EAST)
Private Treatment Plant
PASTORE
CENTER LINE ROAD
800'
BETHANY
PUBLIC SYSTEM
SEPTIC SYSTEM/CESSPOOL
DIRECT DISCHARGE
LATRINE
NO FACILITIES
SOLID SYMBOLS INDICATE FAILED SYSTEM

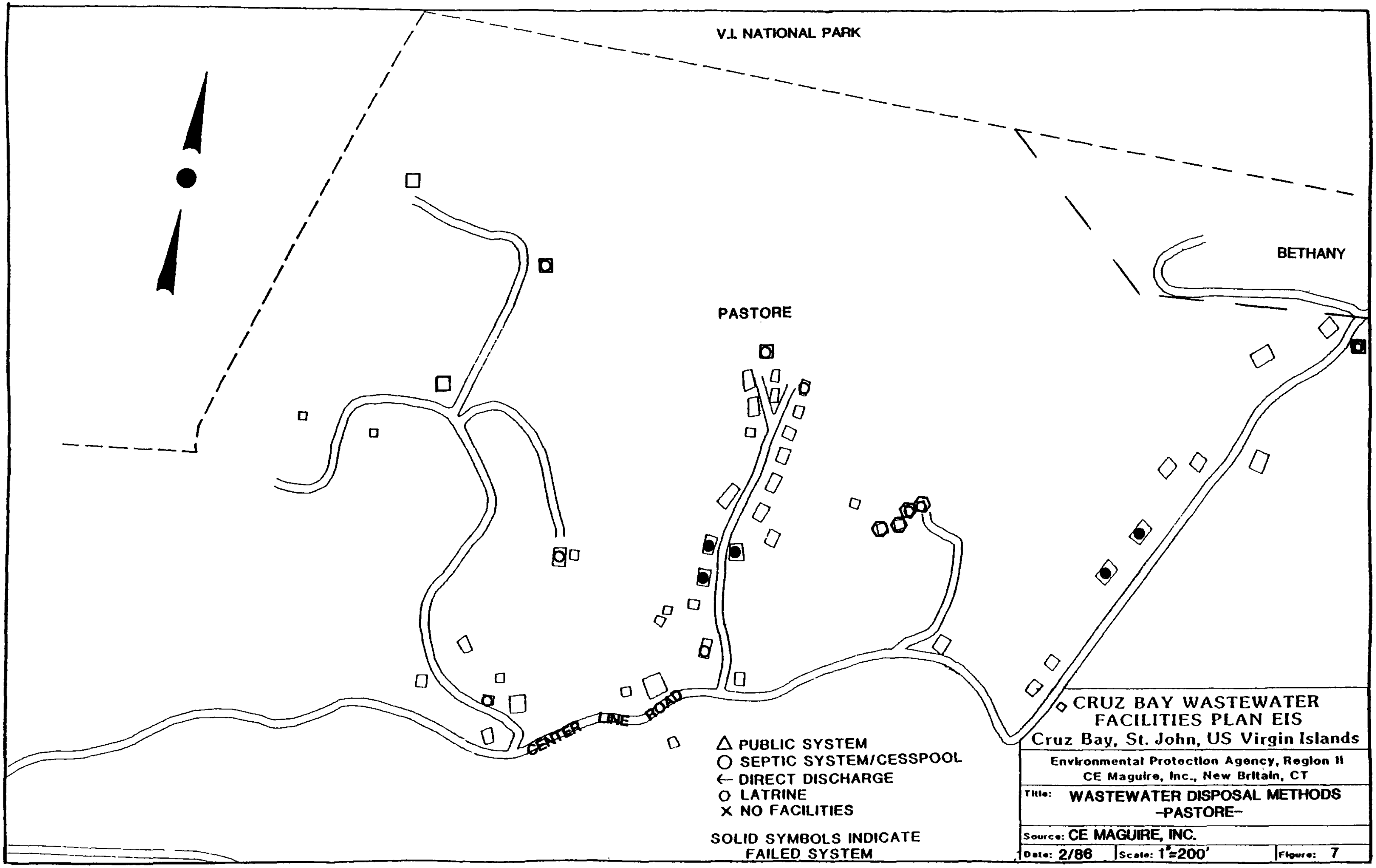
TABLE 10
DEVELOPMENT CHARACTERISTICS - PASTORE

| Type of Use | Number of Structures Surveyed | Remarks |
|---|---|---|
| Year-round Residential | 43 | None |
| Seasonal Residential | 3 | None |
| TOTAL | 46 | |
| Single-family | 36 | None |
| Two-family | 6 | None |
| Multiple dwelling | 3 | Three small structures (homes) without water facilities |
| Commercial | 0 | None |
| Other | 1 | Jehovas Witness Church |
| TOTALS | 46 | |

Table 11 and Figure 7 identify the wastewater disposal methods in Pastore.

TABLE 11
WASTEWATER DISPOSAL METHODS - PASTORE

| Disposal Method | Number of Structures Surveyed | Percent of Total | Remarks |
|---|---|---|---|
| Public Sewer System | 0 | 0 | None |
| Cesspool | 0 | 0 | None |
| Latrine | 3 | 7 | None |
| Septic Tank/ Leaching System | 43 | 93 | Occasional rainfall problems |
| Direct Discharge | 0 | 0 | None |
| Other | 0 | 0 | None |
| Unknown | 0 | 0 | None |
| TOTALS | 46 | 100 | |




CRUZ BAY WASTEWATER FACILITIES PLAN EIS
Cruz Bay, St. John, US Virgin Islands

Environmental Protection Agency, Region II
CE Maguire, Inc., New Britain, CT

Title: WASTEWATER DISPOSAL METHODS -PASTORE-

Source: CE MAGUIRE, INC.

Date: 2/86 | Scale: 1"=200' | Figure: 7

Septic systems represent over 90 percent of the wastewater disposal methods in Pastore. The residents surveyed mentioned that very infrequent odor problems occurred after rainfall, but in general, were satisfied with their own systems. Three of the surveyed structures in Pastore had latrines for their disposal system. These were located in a secluded area in the eastern section of Pastore, near the Bethany border.

6. Other Areas

Table 12 shows the development characteristics identified from a representative sample of areas not mentioned above, but could possibly be candidates for a public sewer system line.

TABLE 12
DEVELOPMENT CHARACTERISTICS - OTHER

| Type of Use | Number of Structures Surveyed | Remarks |
|---|---|---|
| Year-round Residential | 20 | None |
| Seasonal Residential | 11 | Multiple homeowners |
| TOTAL | 31 | |
| Single-family | 26 | Sparse density except for Power Boyd's section |
| Two-family | 4 | None |
| Multiple Dwelling | 0 | None |
| Commercial | 0 | None |
| Other | 1 | None |
| TOTALS | 31 | |

These other areas were sparsely populated with the exception of the Power Boyd's Plantation, area on located east of the Contant-Enighed border near Great Cruz Bay. More than one-third of the homes surveyed are seasonal homes. Other areas surveyed and observed included Great Cruz Bay, Chocolate Hole, Gift Hill, Altair, Roman Hill, Balsberg, Fish Bay and Susannaberg. Also included is the area within the Virgin Islands National Park just north of Cruz Bay. Two major developments occurring in the outside areas include a 40-50 unit condominium development in Fish Bay and the Virgin Grand Hotel near Great Cruz Bay. There is also some development that is currently being finished on Gift Hill (condominiums). Each of these developments will include its own wastewater treatment system.

All the structures connected to the public sewer system in the "other" category are in the National Park. The Superintendent of the Virgin Island National Park informed the survey team that there were no plans to extend the existing sewer lines further into the Park. Table 13 shows the disposal methods surveyed/observed in the other areas.

TABLE 13
WASTEWATER DISPOSAL METHODS - OTHER

| Disposal Method | Number of Structures Surveyed | Percent of Total | Remarks |
|---|---|---|---|
| Public Sewer System | 13 | 42 | Structures within Virgin Islands National Park borders |
| Cesspool | 0 | 0 | None |
| Latrine | 1 | 3 | None |
| Septic Tank/ Leaching System | 17 | 55 | Outside the core study area |
| Direct Discharge | 0 | 0 | None |
| Unknown | 0 | 0 | None |
| TOTALS | 31 | 100 | |

In general, most of the outside areas, with the exception of the National Park, have problem-free septic systems and do not desire a connection to the public system. An area that may benefit from a public sewer line extension is the aforementioned Power Boyd's area. All of the homes in this area use a common latrine. There are frequent odor problems and the risk of resultant health problems exists.

## Summary

The summary of development characteristics is presented in Table 14.

Development in the Cruz Bay area is predominantly residential with eighty-three (83) percent falling in the categories of single-family, two-family and multiple dwellings. Approximately 93 percent of the area is composed of year-round structural occupancy. Based on personal observation, seasonal occupancy occurs more frequently as one travels further away from the Cruz Bay CBD area.

The most utilized method of wastewater disposal, as indicated in Table 15, is the septic system, comprising seventy-three percent. The second most often used method is the public sewer system connection, amounting to nineteen percent. Four percent of the structures did not have any water facilities, and cesspool, latrine, and unknown represented one percent each.

As previously discussed, the needs survey conducted in conjunction with this report identified wastewater disposal problems of varying degree in all of the areas surveyed.

A further compounding factor is the inadequate operation of the existing wastewater treatment plant and the number of additional applications from those who want connections to the public sewer system. Based upon the findings of the needs survey and the increased potential for wastewater flows, the areas of Pine Peace in Enighed and Power Boyd's outside the core study area are in the greatest need for an improved method of wastewater treatment. The Cruz Bay CBD, nearly all of Enighed and the western and low-lying sections of Contant are also in need of improved or new wastewater disposal facilities.

TABLE 14

SUMMARY OF DEVELOPMENT CHARACTERISTICS

| Community | Total Number of Structures | Year-round Residential | Seasonal Residential | Single-Family | Two-Family | Multiple Dwelling | Commercial | Other[1] |
|---|---|---|---|---|---|---|---|---|
| CRUZ BAY | 93 | 92 | 1 | 11 | 2 | 6 | 31 | 43 |
| ENIGHED | 259 | 242 | 17 | 188 | 31 | 29 | 11 | 0 |
| CONTANT | 85 | 83 | 2 | 70 | 9 | 2 | 1 | 3 |
| BETHANY | 52 | 48 | 4 | 38 | 7 | 5 | 11 | 1 |
| PASTORE | 46 | 43 | 3 | 36 | 6 | 3 | 0 | 1 |
| OTHER | 31 | 20 | 11 | 26 | 4 | 0 | 0 | 1 |
| TOTAL | 566 | 528 | 38 | 369 | 59 | 45 | 44 | 49 |
| PERCENTAGES | 100 | 93 | 7 | 65 | 10 | 8 | 8 | 9 |

[1] Includes churches, offices, storage garages, administration offices, schools, fire station, police station, etc.

TABLE 15

SUMMARY OF WASTEWATER DISPOSAL METHODS

| Community | Total Number of Structures | Public Sewer System | Cesspool | Latrine | Septic Tank | Direct Discharge | Other[1] | Unknown[1] |
|---|---|---|---|---|---|---|---|---|
| CRUZ BAY | 93 | 62 | 0 | 0 | 25 | 0 | 4 | 2 |
| ENIGHED | 259 | 30 | 2 | 3 | 199 | 3 | 17 | 5 |
| CONTANT | 85 | 0 | 0 | 1 | 81 | 2 | 1 | 0 |
| BETHANY | 52 | 0 | 2 | 0 | 48 | 0 | 2 | 0 |
| PASTORE | 46 | 0 | 0 | 3 | 43 | 0 | 0 | 0 |
| OTHER | 31 | 13 | 0 | 1 | 17 | 0 | 0 | 0 |
| TOTAL | 566 | 105 | 4 | 8 | 413 | 5 | 24 | 7 |
| PERCENTAGES | 100 | 19 | 1 | 1 | 73 | 1 | 4 | 1 |

[1]Structures with no water facilities

QUESTIONNAIRE ON WASTEWATER TREATMENT
SYSTEMS IN CRUZ BAY, ST. JOHN, USVI

his survey is being conducted to obtain information that will help us to develop a easible plan for solving Cruz Bay's wastewater treatment and disposal problems. For his to be successful, we would like one member of each household to answer each uestion on this questionnaire. Thank you for your cooperation.

. What is your name and address or specific location on St. John?

. How many people live in your house? (Write number in space provided.)

. When is your house occupied?____ year round ____ seasonally (state number of months

. What type of building do you live in? (Check one of the follow.)

a.______ single family
b.______ two family
c.______ multiple dwelling
d.______ commercial
e.______ other(please specify) ________________________________

. What type of wastewater system is used by your household?

a.______ public sewer system
b.______ cesspool
c.______ latrine
d.______ septic tank/leaching system
e.______ direct discharge to water or land
f.______ other (please explain)
g.______ unknown

. How well does this system work?

a.______ no problems at all
b.______ only occasional problems (please define)* ________________________
c.______ only problems during and/or after rainfall*
d.______ frequent problems (please define)*
e.______ doesn't work at all
*type of problem?______slow draining of fixtures ____ odors ____ liquid on ground
______ other (explain)

'. In your opinion, which of the following is the best way to dispose of treated wastewater?

a.______ discharge treated effluent to ocean via an outfall pipe
b.______ apply treated effluent to agricultural land
c.______ use treated effluent as raw water feed to water reuse plant
d.______ other (please explain) ________________________

}. Please express any comments or suggestions which you feel may help us to develop a wastewater management plan that will serve you best.

}. Would you like to serve on a Citizens' Advisory Committee for this project?

__________ Yes __________ No

Thank you again for your cooperation.

There will be advertised public meetings in the next few months to discuss the findings of this survey and other progress on this project. You are encouraged to attend these meetings.

# APPENDIX B

## CONSTRAINTS ANALYSIS

APPENDIX B

## CONSTRAINTS ANALYSIS

### INTRODUCTION

Environmental constraints are physical, legal, and other limitations to the extent or pattern to which development may occur in an area. The purpose of this report is to identify the environmental constraints present in Cruz Bay, St. John, U.S. Virgin Islands, to project the influence each constraint may realistically have on future growth, and to analyze the collective influence of constraints on growth. This information is used as a planning tool to determine the amount of developable land within the Cruz Bay project area and to plan appropriate capacity and layout of the proposed wastewater facilities.

The environmental constraints addressed in this report present various types of limitations to growth in Cruz Bay. These constraints may be grouped into the following categories:

- Physical characteristics, including excessively steep slopes, flood hazard, and dense development, which make an area difficult, costly, imprudent, or dangerous to develop.

- Legal characteristics, including National Park Service (NPS) or Coastal Zone Management (CZM) regulations and local zoning regulations, which present legal restrictions to development.

- Natural characteristics, including soil conditions, aquifer recharge areas, significant habitat, cultural resource sites, and prime agricultural land, which should be protected from development due to their environmental sensitivity or value.

- Other characteristics, including infrastructure and services, which serve as temporary constraints but may be altered to accommodate more growth.

Each of these constraints will be discussed separately and presented graphically in order to analyze the influence each has individually on growth. The conclusion of this report will address the combined influence of environmental constraints and the resultant prospect for growth in Cruz Bay.

### ENVIRONMENTAL CONSTRAINTS

1. STEEP SLOPES

In most areas of the continental United States, slopes of greater than 15 percent are considered "steep slopes" for planning and development constraint purposes. EPA has found in recent studies in the Caribbean[1] that 30 or 40 percent slope is a more realistic boundary for a constraint to development. This determination was based on the scarcity of relatively flat to moderately sloping land, pressure for development, and unique construction methods practiced in the Caribbean Islands.

These factors are evidently more intense in the present study area as it is not uncommon to find houses perched on 40 or 45 percent slopes along the coastal hillsides. Therefore, 50 percent slope has been determined as the realistic level beyond which development is not likely to occur in the study area.

Slopes of 50 percent or greater cover a total of approximately 170 acres (ac), or 9 percent, of the study area.

Construction of buildings on excessively steep slopes presents problems to construction and long-term structural stability. Foremost among these problems are issues of drainage, soil erosion, slope stability, and accessibility. Development on slopes of 30-50 percent may be physically and economically risky as well as environmentally threatening. However, based on the history of development in the study area, it is not realistic to draw the line of constraint at less than a 50 percent slope.[2] While greater than 30 percent slope may be considered a limit for desirable development conditions (and, therefore, an impediment to development), 50 percent slope or greater is considered to be the definite limit of the absolute constraint to development. Therefore, all land in the study area characterized by 50 percent slope or greater is considered to be constrained from development.

2. FLOOD PRONE AREAS

Flood prone areas are the areas which would be inundated by a 100-year flood[3], according to the Federal Emergency Management Agency. In the study area, approximately 180 ac of coastal fringe and alluvial plain are considered flood prone. Typically, the flood prone area is a coastal fringe between 0 and 5 feet (ft) above mean sea level (msl), although in the lower reaches of Fish Bay Gut, the flood hazard exists up to an elevation of almost 40 ft. msl. This area at the head of Fish Bay, combined with areas around Chocolate Hole, Great Cruz Bay, Enighed Pond,

[1]Culebra Wastewater Facilities Plan EIS, 1985 (Culebra, Puerto Rico) and Mangrove Lagoon/ Turpentine Run Wastewater Facilities Plan EIS, 1984 (St. Thomas, US Virgin Islands).

[2]It is not the purpose of this report to recommend measures to restrict development, but rather to establish the most realistic model possible for the true development constraints.

[3]A 100 year flood is a flood of the magnitude which is expected to occur with a frequency of once every 100 years.

and Cruz Bay constitutes the great majority of the study area's flood prone land. Areas of development which would be particularly affected by a 100-year flood include:

- The police station and shops surrounding the ferry dock in downtown Cruz Bay;

- Five homes on Moravian ("Moorehead") Point which would be cut off from the rest of St. John;

- The existing pump station and wastewater treatment plant on the berm separating Enighed Pond from Turner Bay, and;

- The Virgin Grand Hotel complex being constructed at the head of Great Cruz Bay.

Flood prone areas are not suitable for development. This is primarily because (1) the potential for flood presents a serious economic and physical hazard to properties in flood prone areas, (2) the location of structures in these areas serves to reduce the normal capacity of a floodplain to contain stream-fed flood waters, thereby causing an increase in the elevation of flooding, and (3) saturation and flushing of flooded septic systems is a public health hazard and may cause contamination to mangrove swamps or other environmentally sensitive areas within the flood prone area.

Much of the flood prone areas in the study area are protected from development by the Virgin Islands' Coastal Zone Management Program. Development does exist in these areas in Cruz Bay, Great Cruz Bay, and Fish Bay, however. While flood prone areas should be protected from development (for reasons stated above), pressure for development and desirability of relatively flat, coastal land on St. John makes it unrealistic to consider flood prone areas an absolute constraint to development. Instead, these areas apparently serve more as impediments to development, causing developers to first look elsewhere for developable plots. As unconstrained areas which are very suitable for development are quickly dwindling in the study area, it may be expected that development may encroach further on the flood prone areas in the future.

## 3. <u>DEVELOPED AREAS</u>

Most of the development in the study area is located on the western/southwestern shore and adjacent slopes, in the communities of Cruz Bay, Enighed, Contant, Pine Peace and Power Boyds Plantation. Other areas with scattered development include Roman Hill, Monte, Fish Bay, Gift Hill, and Bethany.

Two areas in particular have been developed to, or near to, the point of saturation, based on current zoning. These areas, Cruz Bay and Pine Peace/Contant, comprise approximately 39 ac, or 2.1 percent of the study area.

These areas are characterized by such dense development that it would be very difficult to fit in more homes (especially given existing zoning regulations). The dense development in these areas is, therefore, considered a realistic constraint to further development.

4. U.S. NATIONAL PARK SERVICE AND COASTAL ZONE MANAGEMENT LAND

Approximately two-thirds of St. John is part of the Virgin Islands National Park. The study area includes approximately 113 ac (6 percent of the study area) of National Park land. This overlapping into the National Park occurs along the northern border of the study area. The U.S. National Park Service maintains and enforces strict regulations against development within Park boundaries in order to preserve the natural environment of the area. Therefore, the National Park Service's regulations over the National Park land within the study area is considered a realistic and definite constraint to development on this land. Other lands in the study area which are subject to definite land use regulations are those which are protected under the Virgin Islands Coastal Zone Management (CZM) Program. This program, administered by the Department of Conservation and Cultural Affairs, designates certain zones in which development is prohibited or restricted.[4]

A CZM permit is required for any development occurring in these zones. The permit is granted on the condition that the proposed development is consistent with the type of land use proposed for that zone by the Virgin Islands' CZM Act of 1978. Residential development is not considered consistent with "preservation" and "conservation" zones, and only certain levels of development are consistent with the "Protection, Residential Low Density" zones. Therefore, the "preservation" and "conservation" zones are considered areas in which direct, realistic constraints exist to residential development and the "protection" zones are considered areas in which development is regulated.

[4]The Program has also designated two "areas of particular concern" (APC's) within the study area. These areas include (1) the Cruz Bay/Enighed Pond area and (2) the Great Cruz Bay/Chocolate Hole area, as shown in Figure 5. The Virgin Islands CZM Act of 1978 requires that the Program especially recognize APC's by making "provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic values". (Section 306 (c)(a)).

## 5. ZONING

Zoning designations in the study area consist of residential, business, waterfront, and public zones. The residential (R1, R2, R3 and R4), business (B2), and waterfront (W1) zones all allow various degrees of residential development, as shown in Table 1.

The public (P) zone does not allow residential or commercial development except under special, strictly regulated conditions. Therefore, the approximately 130 ac of land zoned P in the study area may be considered constrained from development. Additional, but less direct, constraints to development are presented by the maximum density regulations of the residential, business and waterfront zones.

TABLE 1

ZONING DESIGNATIONS

| Approx. Acres in Study Area* | Zone | Description | Max. Density Allowed |
|---|---|---|---|
| 586 | R1 | Residential - low density | 2 dwelling units (du) per 1/2 acre |
| 920 | R2 | Residential - low density - one- and two-family | 2 du/10,000 square feet ($ft^2$) |
| 40 | R3,R4 | Residential - medium density | 80 persons/acre |
| 4 | B2 | Business - secondary/ neighborhood | 80 persons/acre |
| 2 | W1 | Waterfront - pleasure | 2 du/10,000 $ft^2$ |
| 130 | P | Public | -- |

*Not including area of detailed zoning divisions surrounding Cruz Bay.

While these regulations present realistic and quantifiable constraints to development at present, it is important to note that zoning may be legally changed to accommodate a greater or lesser amount of development. Given the history of zoning variances in the Cruz Bay area, future zoning changes are likely to reflect pressure to accommodate more development.

## 6. SOIL CHARACTERISTICS

Soil characteristics may serve as a constraint to development by presenting severe limitations to the success of on-site sewage disposal or building foundations. However, given the scarcity of developable land, the pressure for development and the construction methods practiced in the study area, these limitations are not considered absolute constraints to development.

As shown in Table 2, the majority of the land in the study area is characterized by soils with severe limitations for both on-site sewage disposal and building foundations. A total of approximately 1,660 ac, or 87.6 percent of the study area is covered by such soils.

TABLE 2

SOIL CHARACTERISTICS

| Soil Series | Description | Limitations* for On-site Sewage Disposal | Limitations for Building Foundations | Approximate Acreage in Study Area | % of Total Study Area |
|---|---|---|---|---|---|
| All Others | | severe | severe | 1,660 | 87.6 |
| Cranmer (CrE, CrF, CsF, CrC, $CsE_2$) | gravelly clay loam, clay, gravelly clay | | | | |
| Jaucus (JuB) | sand | | | | |
| Volcanic Rock | rock | | | | |
| Tidal Flat (TF) | sand, silt, mud | | | | |
| Isaac (ISE, IsDz) | gravelly clay loam, clay, clay loam | severe | moderate | 120 | 6.3 |
| San Anton (SaA) | clay loam, gravelly clay loam | moderate | severe | 94 | 5.0 |
| Pozo Blanco (PbC) | clay loam, silty clay loam, loam | moderate | moderate | 22 | 1.1 |

*Source: US Soil Conservation Service, Soil Survey of the US Virgin Island, August, 1970.

Soil limitations serve as an impediment or indirect constraint to development, but become an increasingly less realistic constraint as development pressure increases and the amount of developable land decreases.

7. AQUIFER RECHARGE AREAS

The aquifer recharge areas in the study area are limited to the land over three coastal/alluvial aquifers. The combined area of these aquifer recharge areas is approximately 97 ac, or 5.1 percent of the study area.

The value of these aquifers for potable water supply is most likely very low, as there are no known wells tapping them. The storage of groundwater is likely to be contaminated by seawater intrusion and recharge from poorly treated wastewater effluent. Nonetheless, these aquifers are a resource that should be protected if possible, especially given the extremely limited fresh water supply on St. John. Therefore, like soil limitations, the aquifer recharge areas in the study area are considered impediments or indirect constraints to development.

8. SIGNIFICANT HABITAT

Significant habitat areas are environments or locations characterized by special physical conditions required for the existence of significant vegetation or animal species, usually species which are endangered, threatened, or of particular concern. The majority of the significant habitat consists of mangrove fringe and coastal pond ecosystems (wetlands) around Fish Bay, Hart Bay, Chocolate Hole, Enighed Pond, and Lind Point. These areas are important habitats for a variety of coastal birds, including the endangered brown pelican (Pelicanus occidentalis). The shrub covered rocks of Steven Cay provide another important habitat for coastal birds. Inland portions of Fish Bay Gut and Battery Gut have been identified by local authorities[5] as likely habitat for three species of vegetation which are either on, or candidates for, the federal endangered species list. The total area of these significant habitat areas is approximately 138 ac, or 7.3 percent of the study area.

In addition to these defined, quantifiable significant habitat areas, there are two general areas which are likely to contain significant habitat for endangered or potentially endangered species of vegetation. These areas are identified as the eastern slopes of Gift Hill and Maria Bluff. While both of these areas are potentially as important as the other significant habitat areas, neither is well-defined nor readily quantifiable.

[5] Ornithologist and endangered species specialist with the DCCA Division of Fish and Wildlife.

Significant habitat does not present a direct constraint to development. However, due to the ecological value of these areas, they should be protected from development. (In many cases, these areas are already protected by zoning, National Park Service, Coastal Zone Management, or other constraints.) Therefore, significant habitat is considered as an indirect constraint to development.

## 9. CULTURAL RESOURCES

"Cultural resources" may be defined for the purpose of this report as areas of archaeological significance or sensitivity. A preliminary survey of such areas in the core study area was conducted in late 1985 as part of the Comprehensive Plan for the Sewage Needs of Cruz Bay. A similar study of the extended study area was conducted in early 1986. Cultural resource areas consist mainly of historic and post-emancipation archaeological sites. Cultural resource areas cover approximately 263 ac of the study area, or 14 percent of this area. A similar cultural resource survey has been conducted to identify cultural resources in the remainder of the study area. Preliminary findings indicate that this area is also rich in cultural resources.

Similar to significant habitat, cultural resources are not direct constraints, but should be protected due to their cultural/historical importance. However, due to the pressure for development and the lack of developable land in the study area, it is unlikely that the presence of cultural resources in an area is likely to constrain or impede development from occurring there. Once the valuable cultural resources in the study area have been clearly defined, land use regulations should be enacted and enforced in order to protect these resources. Without such regulations, however, cultural resources are not considered a realistic constraint to development in the study area.

## 10. PRIME AGRICULTURAL LAND

Land which is of particular agricultural value in a given area is considered "prime agricultural land" or Class I as designated by the U.S. Soil Conservation Service (SCS) on a scale of I-VIII.

None of the soils in the study area are designated as Class I. However, the San Anton soil is considered suitable for cultivating crops (SCS, 1970). There are areas covered by this soil in the study area. However, these soils are already covered by development or in use for other purposes. Active cultivation does not occur in the study area. For these reasons, none of the land in the study area is considered constrained due to prime agricultural status.

## 11. INFRASTRUCTURE, SERVICES, AND OTHER CONSTRAINTS

Another category of features which must be considered as potential constraints to development includes the infrastructure, services, and other unique conditions typical of a small island environment. The infrastructure in the study area, particularly roads, existing sewer system, water supply, and power supply is generally not adequate for projected growth.

Existing public roadways are generally narrow, often steep and sharply winding, and commonly scarred by cracks and potholes. Traffic jams are common in downtown Cruz Bay, particularly after ferry arrivals. The roads in the National Park, in contrast, are in very good condition and appear to have adequate capacity for the traffic (mainly tourist) using them.

The existing public sewer system has been found to be an inadequate means of meeting the wastewater treatment needs of the study area. (These needs are addressed in detail in the Needs Analysis report prepared for this project.)

Similarly, the public water supply is inadequate for serving the study area's water supply needs. Residents obtain water from rooftop rainfall catchment/cistern systems as well as from the public water supply (water pumped from mid-island wells and barged from the desalination plant on St. Thomas.) The quality of potable water is generally not good, and frequent water shortages force residents to be very conservative in water use.

Power is brought to St. John from St. Thomas by means of an underwater cable. This power supply is backed up by a recently implemented auxiliary power generating station, located at the head of Enighed Pond. While power failures are relatively frequent in the St. Thomas power supply, the auxiliary power supply has alleviated this problem for the study area, providing a relatively reliable, constant, and adequate supply for the area's energy needs.

Like the infrastructure, the services available in the study area reflect the small island environment. Special services (i.e., taxis, hourly ferry service to and from St. Thomas) are oriented toward the Island's tourist industry. Other services which more directly affect residents of the study area, such as the community health clinic and the fire and police departments, tend to be characterized by less ample resources. The only public transportation available is the ferries, scheduled sea plane service to and from St. Thomas, and scheduled taxi/bus service to Coral Bay and other locations on St. John. Telephone service is available islandwide and is generally adequate.

Difficulty in obtaining certain supplies, establishing or maintaining contact with the continental United States, and traveling to and from St. John are likely to serve as combined inhibitors to some potential growth from off-island. As the population and demands on resources increase, the above-referenced limitations or issues may become more influential constraints to this service.

The constraints considered in this section are non-quantifiable and are not necessarily permanent. (Infrastructure, services, and supplies may be improved to accommodate further growth.) Given the present status of the infrastructure and services in the study area, only the water supply presents realistic constraint to development. While many other parts of the infrastructure and services do not adequately meet residents' needs, the most significant constraint is the Island's limited water supply.[6] In addition, limitations to supplies, communication, travel, and conveniences are likely to serve as realistic constraints to development from off-island, particularly from the continental United States. The other conditions considered in this section--roads, public sewer system, power supply and services--are not considered to be realistic constraints to development at this time.

## CONCLUSION

The purpose of this constraints analysis, as stated in the Introduction, is to (1) identify the environmental constraints present in the study area, (2) consider the influence each constraint may realistically have on future growth, and (3) analyze the collective influence of constraints on growth. The first two tasks have been accomplished in the previous sections. It is the purpose of this conclusion to address the third.

Table 3 summarizes the constraining characteristics evaluated in the order of the greatest constraining influence to the least constraining.

The most constraining categories include land zoned "P" for public use, National Park Service land, land designated for preservation or conservation under the CZM program, land characterized by steep slopes densely developed areas and the limited water supply. The combination of these constraints (considering occasional overlap) covers approximately 390 ac, or slightly over 20 percent of the total study area. Based on the findings of this analysis, it is very unlikely that development would occur within these areas.

The second most constraining categories include flood prone areas, areas with severe soil limitations, aquifer recharge areas, areas of significant habitat, and areas of archaeological sensitivity ("cultural resources"). While these areas should be protected due to environmental or cultural value, it is not realistic to predict that development will be completely constrained or prohibited from them in the absence of protective measures. Further, many of these environmentally sensitive areas are overlapped by the constraints in the first category. Portions of the flood prone areas, for instance, are constrained by the "P" zone, National Park land, CZM land, and densely developed areas.

[6] Improvement of wastewater facilities alone would not be likely to encourage a significant amount of further development.

## TABLE 3

## SUMMARY OF ENVIRONMENTAL CONSTRAINTS

| MOST CONSTRAINING CATEGORIES | AREA (approximate acres) | PERCENT OF STUDY AREA |
|---|---|---|
| Steep Slopes | 170 | 9 |
| Developed Areas | 40 | 2.1 |
| Zoning "P" | 130 | 6.9 |
| NPS/CZM Land | 155 | 8.2 |
| Flood Prone Areas | 180 | 9.5 |
| Water Supply | na | na |
| SECOND MOST CONSTRAINING CATEGORIES | | |
| Soil Limitations | 1,660 | 87.6 |
| Significant Habitat | 140 | 7.4 |
| Aquifer Recharge Areas | 100 | 5.3 |
| Cultural Resources | 185 | 38* |
| LEAST CONSTRAINING CATEGORIES | | |
| Public Sewer System | na | na |
| Power Supply | na | na |
| Roadways, Other Infrastructure | na | na |
| Services | na | na |
| Supplies, Conveniences | na | na |

*Percent of core study area.

na = not applicable, non-quantifiable constraints

The third and least constraining categories include communication, travel and conveniences available and other infrastructure and services.

Consideration of the realistic influence of the various environmental constraints that have been identified in this report is the first step to projecting the patterns and extent of development which will occur in the study area. This is a crucial step in designing appropriately located and sized wastewater facilities to meet the projected needs of the study area.

# APPENDIX C

## DETAILED FACILITIES PLANNING INFORMATION

# APPENDIX C

## DETAILED FACILITIES PLANNING INFORMATION

This Appendix includes background information relative to wastewater facilities planning and preliminary design for this project. This information is presented in the following sections:

C.1 Water quality data for the existing Cruz Bay wastewater treatment plant and Enighed Pond ("Lagoon #2 and #3"), as presented in Appendix E of deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985.

C.2 Preliminary wastewater facility cost estimates from Appendix F of deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, V.I., 1985.

C.3 Assessment of existing wastewater facilities in Cruz Bay from Chapter III, Section B of deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985.

C.4 Discussion of on-site systems which could be used in the extend study area.

C.5 Detailed cost estimates prepare by CE Maguire, Inc. for wastewater facilities considered feasible in the Draft EIS.

APPENDIX C.1

WATER QUALITY DATA

(Reproduced from deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985)

# LABORATORY TEST REPORT

eqlab

CLIENT: The Jongh Associates
FACILITY: St. John, V.I.
W.O.#: 289-01-01
WWTP-Influent

July 18, 1985

| PARAMETERS | UNITS | DATE SAMPLE COLLECTED/ EQL SAMPLE # | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 6-25-85 | 6-26-85 | 6-27-85 | 6-28-85 | 6-29-85 | 6-30-85 | 7-01-85 |
| | | 10482 | 10503 | 10518 | 10536 | 10545 | 10546 | 10547 |
| Alkalinity | mg/L as $CaCO_3$ | 681 | 367 | 524 | 314 | 628 | 1,048 | 314 |
| Fecal Coliform | MPN/100ml | -- | 2,800 | ≥ 2,400,000 | 16,000 | ≥ 24,000 | 2,400 | 2,400 |
| Total Coliform | MPN/100ml | -- | 3,500 | ≥ 2,400,000 | ≥ 24,000 | ≥ 24,000 | 9,200 | 3,500 |
| BOD5 | mg/L | 2,220 | 3,000 | 3,960 | 2,130 | 1,080 | 1,140 | 840 |
| BOD-Soluble | mg/L | 218 | 345 | 300 | 330 | 360 | 300 | 270 |
| COD | mg/L | 16,420 | 5,990 | 5,120 | 3,310 | 10,395 | 4,020 | 1,300 |
| COD-Soluble | mg/L | 754 | 754 | 713 | 599 | 867 | 674 | 463 |
| Oil & Grease | mg/L | 87.4 | 121 | 66.5 | 27.3 | 232 | 775 | 163 |
| pH | pH Units | 7.34 | 7.31 | 6.91 | 7.02 | 6.54 | 6.55 | 7.00 |
| Dissolved Oxygen | mg/L | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| Color | PtCoCU | 200 | 100 | 130 | 100 | 130 | 133 | 20 |
| Turbidity | NTU | 125 | 170 | 100 | 20 | 106 | 146 | 126 |
| Total Organic Carbon | mg/L | 150 | 68 | 130 | 190 | 320 | 200 | 124 |
| Total Suspended Solids | mg/L | 3,291 | 2,982 | 2,075 | 2,514 | 2,964 | 1,498 | 726 |
| Total Dissolved Solids | mg/L | 1,863 | 1,721 | 1,562 | 2,112 | 1,691 | 2,620 | 1,312 |
| Total Volatile Solids | mg/L | 5,243 | 4,027 | 2,676 | 2,092 | 2,161 | 1,349 | 876 |
| Ammonia-N | mg/L | 61 | 72 | 59 | 48 | 41 | 74 | 56 |
| Nitrate-N | mg/L | 0.78 | 0.27 | 0.41 | 0.24 | 0.59 | 0.60 | 0.02 |
| Nitrite-N | mg/L | 0.12 | < 0.01 | 0.10 | 0.09 | 0.10 | 0.30 | 0.06 |
| Total Kjeldahl Nitrogen | mg/L | 118 | 153 | 203 | 121 | 173 | 150 | 111 |
| Total Phosphorus | mg/L | 13.3 | 21.3 | 18.3 | 9.5 | 21.3 | 18.3 | 7.9 |
| Total Copper | µg/L | -- | -- | -- | 410 | -- | -- | -- |
| Total Chromium | µg/L | -- | -- | -- | < 20 | -- | -- | -- |
| Total Mercury | µg/L | -- | -- | -- | 0.25 | -- | -- | -- |
| Total Zinc | µg/L | -- | -- | -- | 1,074 | -- | -- | -- |
| Total Lead | µg/L | -- | -- | -- | 125 | -- | -- | -- |

ISMAEL MARTINEZ JIMENEZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
LICENCIA NUM. 1486
A 027357

Reported by: Ismael Martinez
Title: Laboratory Manager

Reported by: Elba L. Martínez
Title: Microbiologist

Reported by: José G. Vila
Title: General Manager

ENVIRONMENTAL QUALITY LABORATORIES, INC. BOX 8723, SANTURCE, PUERTO RICO 00910 TELS. 725-5333 725-3708

APPENDIX C.1
(Reproduced from deJongh/URS, 1985)

De Jongh Associates
St. John, V.I.
W.O.# 289-01-01
Station: Lagoon #2

July 18,1985

| PARAMETERS | UNITS | DATE SAMPLE COLLECTED/EQL SAMPLE # | |
|---|---|---|---|
| | | 6-25-85<br>10485 | 6-26-85<br>10505 |
| Fecal Coliform | MPN/100ml | -- | < 20 |
| Total Coliform | MPN/100ml | -- | < 20 |
| BOD5 | mg/L | 1.6 | 6.0 |
| COD | mg/L | 1,190* | 310* |
| pH | pH Units | 8.18 | 8.27 |
| Dissolved Oxygen | mg/L | 8.6 | 7.6 |
| Color | PtCoCU | 15 | < 5 |
| Turbidity | NTU | 3.2 | 0.5 |
| Total Phosphorus | mg/L | < 0.01 | < 0.01 |
| Ammonia-N | mg/L | 1.5 | 1.8 |
| Nitrate-N | mg/L | < 0.01 | < 0.01 |
| Nitrite-N | mg/L | < 0.01 | < 0.01 |

*Contained large amounts of chloride, that although reduced, may interfere positively.

Reported by: Ismael Martínez
Title: Laboratory Manager

Released by: José G. Vila
Title: General Manager

Reported by: Elba L. Martínez
Title: Microbiolgoist

ISMAEL MARTINEZ JIMENEZ
Químico Licenciado
Asociado de Puerto Rico
1486

A 028317

Cl-2

**eqlab**
ENVIRONMENTAL QUALITY LABORATORIES, INC.

De Jongh Associates
St. John, V.I.
W.O.# 289-01-01
Station: Lagoon #3

July 18,1985

| PARAMETERS | UNITS | DATE SAMPLES COLLECTED/EQL SAMPLE # 6-25-85 10486 | 6-26-85 10506 |
|---|---|---|---|
| Fecal Coliform | MPN/100ml | < 20 | 20 |
| Total Coliform | MPN/100ml | < 20 | 50 |
| BOD5 | mg/L | 1.1 | 3.3 |
| COD | mg/L | 740* | 530* |
| pH | pH Units | 7.10 | 8.22 |
| Dissolved Oxygen | mg/L | 5.6 | 5.5 |
| Color | PtCoCU | 10 | 8 |
| Turbidity | NTU | 4.5 | 0.4 |
| Total Phosphorus | mg/L | < 0.01 | 0.02 |
| Ammonia-N | mg/L | 1.5 | 1.8 |
| Nitrate-N | mg/L | 0.11 | < 0.01 |
| Nitrite-N | mg/L | 0.02 | 0.02 |

*Contained large amounts of chloride, that although reduced, may interfere positively.

Reported by: Ismael Martínez
Title: Laboratory Manager

Released by: José G. Vila
Title: General Manager

Reported by: Elba L. Martínez
Title: Microbiologist

ISMAEL MARTINEZ JIMENEZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
1486

C1-3

# LABORATORY TEST REPORT

De Jongh Associates
#2 Estate Staabi
P.O. Box 6155
St. Thomas, V.I. 00801
Attn: Eng. Charles Zombro

eqlab ENVIRONMENTAL QUALITY LABORATORIES, INC.

Date: July 18,1985
Page 1 of 1

| EQ LAB | CLIENT |
|---|---|
| W.O.#: 289-01-02<br>D.S.#: 2512<br>Date Sample ~~Collected~~/Received: July 9/85 | Facility: St.John<br>P.O.#:<br>Date Sample Collected: July 9/85 |
| Sample #: 10627 thru 10631    Source: See Remarks | Description: |

| SAMPLE # | PARAMETERS | RESULTS | UNIT | REMARKS |
|---|---|---|---|---|
| 10627 | Biochemical Oxygen Demand | 390 | mg/L | Influent Line Main Pump Sta |
| | Total Suspended Solids | 153 | mg/L | " " " " " |
| 10628 | Biochemical Oxygen Demand | 30 | mg/L | WWTP-Effluent |
| | Total Suspended Solids | 76.4 | mg/L | " " |
| 10629 | Biochemical Oxygen Demand | 1,320 | mg/L | WWTP-Influent Line |
| | Total Suspended Solids | 1,966 | mg/L | " " " |
| 10630 | Biochemical Oxygen Demand | 285 | mg/L | Influent-Village |
| | Total Suspended Solids | 145 | mg/L | " " |
| 10631 | Biochemical Oxygen Demand | 31.5 | mg/L | Enighed Pond to Bay |
| | Total Suspended Solids | 117 | mg/L | " " " |

ESTADO LIBRE ASOCIADO DE PUERTO RICO — QUIMICO LICENCIADO
Angel L. González Aponte LIC. 2749

!!7331

Reported by: Angel L. González
Title: Chemist

Released by: José G. Vila
Title: General Manager

C.1-4

APPENDIX C.2

## PRELIMINARY COST ESTIMATES

(Reproduced from deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985)

APPENDIX C.2

(Reproduced from deJongh/URS, 1985)

TREATMENT PLANT COST ESTIMATES BASED ON EPA CURVES

TRICKLING FILTER PLANT

| | Escalated Value | Additional Cost | Salvage |
|---|---|---|---|
| Influent Pumping | $40,907 | $8,129 | $3,463 |
| Preliminary Treatment | $11,672 | $0 | $0 |
| Primary Sedimentation | $18,873 | $0 | $959 |
| Trickling Filter | $305,121 | $0 | $15,497 |
| Clarification | $31,762 | $0 | $1,613 |
| Effluent Pumping | $40,907 | $8,129 | $3,463 |
| Chlorination | $16,838 | $3,346 | $1,425 |
| Lab/Maintenance Building | $46,985 | $6,224 | $4,242 |
| Other Sludge Handling | $5,545 | $0 | $282 |
| Aerobic Digestion | $31,754 | $0 | $1,613 |
| Mobilization | $10,069 | $0 | $0 |
| Site Work | $35,784 | $0 | $3,635 |
| Excavation | $44,092 | $0 | $4,479 |
| Electrical | $40,552 | $0 | $4,119 |
| Controls & Instrumentation | $11,445 | $4,549 | $775 |
| Yard Piping | $27,716 | $0 | $2,815 |
| HVAC | $5,319 | $0 | $270 |
| TOTAL | $725,341 | $30,377 | $48,650 |
| Cont. 15% | $108,801 | | |
| Engineering | $296,561 | | |
| Legal & Administrative | $21,760 | | |
| TOTAL | $1,152,463 | | |

O & M Costs

Labor:

| | |
|---|---|
| 1 Chief Operator | $35,000 per year w/ fringes |
| 1 Full time assistant | $25,000 per year w/ fringes |
| Subtotal | $60,000 |

Transportation of Solids to landfill $500 per year

Power Requirements

| | | |
|---|---|---|
| Influent Pump | 3 HP ea say 1 is continuous | 3 hp |
| Clarifier | | 1 |
| Trickling Filter | | 10 |
| Secondary Clarifier | | 1 |

| | | |
|---|---|---|
| Aerobic Digestor | 5 | |
| Effluent Pump | 3 | |
| Total | 23 | |
| Annual Power cost = kw * hours * .175 $/kwh | | $35,259 |
| Total Annual Cost | | $95,759 |

RBC PLANT

| | Escalated Value | Additional Cost | Salvage |
|---|---|---|---|
| Influent Pumping | $40,907 | $8,129 | $3,463 |
| Preliminary Treatment | $11,672 | $0 | $0 |
| Primary Sedimentation | $18,873 | $0 | $959 |
| RBC | $134,359 | $0 | $4,549 |
| Clarification | $31,762 | $0 | $1,613 |
| Effluent Pumping | $40,907 | $8,129 | $3,463 |
| Chlorination | $16,838 | $3,346 | $1,425 |
| Lab/Maintenance Building | $46,985 | $6,224 | $4,242 |
| Other Sludge Handling | $5,545 | $0 | $282 |
| Aerobic Digestion | $31,754 | $0 | $1,613 |
| Mobilization | $10,069 | $0 | $0 |
| Site Work | $35,784 | $0 | $3,635 |
| Excavation | $44,092 | $0 | $4,479 |
| Electrical | $40,552 | $0 | $4,119 |
| Controls & Instrumentation | $11,445 | $4,549 | $775 |
| Yard Piping | $27,716 | $0 | $2,815 |
| HVAC | $5,319 | $0 | $270 |
| TOTAL | $554,579 | $30,377 | $37,702 |

| | |
|---|---|
| Cont. 15% | $83,187 |
| Engineering | $226,744 |
| Legal & Administrative | $16,637 |
| TOTAL | $881,147 |

O & M Costs

Labor:

| | |
|---|---|
| 1 Chief Operator | $35,000 per year w/ fringes |
| 1 Full time assistant | $25,000 per year w/ fringes |
| Subtotal | $60,000 |

Transportation of Solids to landfill $500 per year

Power Requirements

| | | |
|---|---|---|
| Influent Pump | 3 HP ea say 1 is continuous | 3 hp |
| Clarifier | | 1 |
| RBC | | 10 |
| Secondary Clarifier | | 1 |
| Aerobic Digestor | | 5 |
| Effluent Pump | | 3 |
| Total | | 23 |

Annual Power cost = kw * hours * .175 $/kwh $35,259

Total Annual Cost $95,759

Present Worth (Annual * 9.5501) $914,508

OXIDATION DITCH

| | Escalated Value | Additional Cost | Salvage |
|---|---|---|---|
| Influent Pumping | $40,907 | $8,129 | $3,463 |
| Preliminary Treatment | $11,672 | $0 | $0 |
| Aerated Lagoon | $99,890 | $13,232 | $5,073 |
| Clarification | $31,762 | $0 | $1,613 |
| Chlorination | $16,838 | $3,346 | $1,425 |
| Effluent Pumping | $40,907 | $8,129 | $3,463 |
| Lab/Maintenance Building | $46,985 | $6,224 | $4,242 |
| Other Sludge Handling | $5,545 | $0 | $282 |
| Gravity Thickening | $8,006 | $0 | $407 |
| Mobilization | $10,069 | $0 | $0 |
| Site Work | $35,784 | $0 | $3,635 |
| Excavation | $44,092 | $0 | $4,479 |
| Electrical | $40,552 | $0 | $4,119 |
| Controls & Instrumentation | $11,445 | $4,549 | $775 |
| Yard Piping | $27,716 | $0 | $2,815 |
| HVAC | $5,319 | $0 | $270 |
| TOTAL | $477,489 | $43,610 | $36,062 |

| | |
|---|---|
| Cont. 15% | $71,623 |
| Engineering | $195,225 |
| Legal & Administrative | $14,325 |
| TOTAL | $758,662 |

O & M Costs

Labor:

| | |
|---|---|
| 1 Chief Operator | $35,000 per year w/ fringes |
| 1 Full time laborer | $15,000 per year w/ fringes |
| Subtotal | $50,000 |

Transportation of Solids to landfill $500 per year

Power Requirements

| | | |
|---|---|---|
| Influent Pump | 3 HP ea say 1 is continuous | 3 hp |
| Oxidation Ditch | | 8 |
| Secondary Clarifier | | 1 |
| Gravity Thickener | | 2 |
| Effluent Pump | | 3 |
| Total | | 17 |

Annual Power cost = kw * hours * .175 $/kwh $26,061

Total Annual Cost $76,561

COST ESTIMATE FOR ST. JOHN OUTFALL

| ITEM | QUANTITY | UNIT | UNIT COST | TOTAL |
|---|---|---|---|---|
| 12" RCP outfall pipe | 2,000 | LF | $500 | $1,000,000 |
| Mobilization | | LS | | $50,000 |
| Subtotal | | | | $1,050,000 |
| Contingencies | | | 15% | $157,500 |
| Engineering | | | | $428,925 |
| Legal & Administrative | | | | $31,500 |
| TOTAL | | | | $1,667,925 |
| Salvage for outfall | | | | $106,660 |

COLLECTOR SEWERS
COST ESTIMATE

| ITEM | QUANTITY | UNIT | UNIT COST | TOTAL | ADDITIONAL COST | SALVAGE |
|---|---|---|---|---|---|---|
| 8" PVC Gravity Sewer | | | | | | |
| 2 - 6 feet | 23,650 | LF | $19 | $449,350 | 0 | 45645.42 |
| 6 - 9 feet | 700 | LF | $22 | $15,400 | 0 | 1564.347 |
| 4" FM | 600 | LF | $16 | $9,600 | 0 | 975.1776 |
| Manholes | 85 | EA | $2,000 | $170,000 | 0 | 17268.77 |
| Grinder Pumps | 75 | EA | $6,000 | $450,000 | 0 | 0 |
| Pump Stations | 2 | EA | $25,000 | $50,000 | 9936.125 | 4232.372 |
| Pavement Replacement | 2,772 | SY | $25 | $69,306 | 0 | 7040.127 |
| Rock Excavation | 5,817 | CY | $125 | $727,083 | 0 | 73857.85 |
| Mobilization, etc. | | LS | | $20,000 | 0 | 2031.62 |
| Subtotal | | | | $1,960,739 | $9,936 | $152,616 |
| Contingencies | | | 15% | $294,111 | | |
| Engineering | | | | $800,850 | | |
| Legal & Administrative | | | | $58,822 | | |
| TOTAL | | | | $3,114,522 | | |

| O & M | | | | |
|---|---|---|---|---|
| Gravity sewer | 4.725378 | MI | $2,500 | $11,813 per year |
| Grinder pumps | 75 | | $100 | $7,500 per year |

ST JOHN, VI WWTP
CARROUSEL DESIGN CALCULATIONS

DESIGN BASIS:

| | |
|---|---|
| FLOW | 0.04 mgd |
| INFLUENT BOD | 600 mg/l |
| INFLUENT TSS | 400 mg/l |
| EFFLUENT BOD | 30 mg/l |
| EFFLUENT TSS | 30 mg/l |
| SRT | 25 days |
| YIELD | 0.7 lbs SS/lbs BOD removed |
| MLSS | 4000 mg/l |
| O2 COEFFICIENT | 1.55 lbs Ox/lb BOD removed |
| Alpha | 0.93 |
| Beta | 0.97 |
| Css | 9.17 mg/l |

CALCULATIONS:

| | |
|---|---|
| BOD Removal | 196.82 lbs/day |
| Sludge Production | 137.78 lbs/day |
| System Mass | 3444.42 lbs |
| Aeration Volume | 0.103 million gal |
| Hydraulic Retention Time | 61.95 hours |

CARROUSEL BASIN CONFIGURATION:

| | |
|---|---|
| Channel Width | 10 feet |
| Channel Depth | 6 feet |
| Aeration Zone Depth | 6 feet |
| Total Channel Length | 230.1 feet |
| Structure Length | 57.5 feet |
| Structure Width | 40.0 feet |

CLARIFIER SIZING:

USE: 400 gpd/SF
2 Clarifiers

Required Area per Clarifier 100 SF

Clarifier Diameter 11.28379 feet

OXYGEN REQUIREMENTS:

| | |
|---|---|
| Actual O2 Requirement | 12.71155 lbs O2/hour |
| Standard O2 Requirement | 18.17845 lbs O2/hour |

ENERGY REQUIREMENTS:

Hp Required 5.193843 Hp

DESIGN SIZING FOR RBC's FOR CRUZ BAY

| | |
|---|---|
| Design Goal | 30 mg/l |
| S - BOD target | 15 mg/l |

Influent:

| | |
|---|---|
| Flow | 40000 gpd |
| S - BOD | 300 mg/l |
| BOD | 600 mg/l |

Design Factor S - BOD

Loading Rate 2 lbs per 1000 SF

| | |
|---|---|
| Flow in MGD | 0.04 |
| Waste Strength in S-BOD | 300 |
| Weight of Water in lbs per gallon | 8.34 |
| Temperature Correction Factor | 1 |
| Septic Tank Factor | 1 |
| Loading Rate in lbs S-BOD per 1000 SF | 2 |
| | |
| Calculated Minimum Area in KSF | 50.04 |

CLARIFIER SIZING

Use 400 gpd/SF
2 Clarifiers (one Backup)

| | |
|---|---|
| Required Area per Clarifier | 100 SF |
| Clarifier Diameter | 11.3 feet |

SLUDGE PRODUCTION

| | |
|---|---|
| Secondary Clarifier | 342 mg/l |
| | 114.0502 lbs/day |

08/06/85

ST. JOHN WWFP
COLLECTOR DESIGN INFORMATION

| LOCATION | SEWER DIAMETER (in) | TOTAL LENGTH (ft) | LENGTH OF ___ CUT 2-6' | 6-9' | 9-12' | APPROX TOTAL EXCAV(cy) | APPROX ROCK EXCAV(cy) | SLOPE | # OF MANHOLES | # OF PUMPS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pastory | 8 | 850 | 850 | | | 378 | 189 | | 3 | 0 | 20 homes |
| From Pastory to existing sewer near Texaco | 8 | 2950 | 2950 | | | 1311 | 656 | | 11 | 5 | 15 homes |
| Centerline Road Extension | 4" FM | 450 | 450 | | | 200 | 100 | | 1 | 10 | 10 homes, Pump station |
| Power Boyd | 8 | 1850 | 1850 | | | 822 | 411 | | 7 | 5 | 26 homes |
| Power Boyd to Pine Peace | 4" FM | 400 | 400 | | | 178 | 89 | | 1 | 3 | 3 homes, Pump station |
| Rd. east of Pine Peace | 8 | 1300 | 1300 | | | 578 | 289 | | 5 | 0 | 14 homes |
| Pine Peace to existing sewer: Road 1 | 8 | 650 | 650 | | | 289 | 144 | | 2 | 8 | 15 homes |
| Road 1 to Road 2 | 8 | 550 | 550 | | | 244 | 122 | | 2 | 0 | 9 homes |
| Road 2 | 8 | 1300 | 1300 | | | 578 | 289 | | 5 | 4 | 24 homes |
| Road 2 to Road 3 | 8 | 400 | 400 | | | 178 | 89 | | 1 | 0 | 5 homes |
| Road 3 | 8 | 300 | 300 | | | 133 | 67 | | 1 | 0 | 7 homes |
| Road 3 to existing sewer | 8 | 1500 | 1500 | | | 667 | 333 | | 6 | 0 | 5 homes |
| Estate Contant | 4" FM | 200 | 200 | | | 89 | 44 | | 0 | 3 | Pump Station |
| | 8 | 1350 | 1350 | | | 600 | 300 | | 5 | 8 | 22 homes |
| south road in Contant | 8 | 800 | 800 | | | 356 | 178 | | 3 | 3 | 11 homes |
| Estate Enighed | | | | | | | | | | | |
| Circle Street | 8 | 600 | 600 | | | 267 | 133 | | 2 | 5 | 16 homes |
| Circle Street Ext. | 8 | 250 | 250 | | | 111 | 56 | | 1 | 1 | 2 homes |
| to Southside Road | 8 | 750 | 750 | | | 333 | 167 | | 3 | 0 | 20 homes |
| Southside Road | 8 | 300 | 300 | | | 133 | 67 | | 1 | 0 | 4 homes |
| Kongens Gade | 8 | 350 | 350 | | | 156 | 78 | | 1 | 0 | 15 homes |
| Enighed Creek Road to Ejector Stn. 1 | 8 | 750 | 750 | | | 333 | 167 | | 3 | 1 | 4 homes |
| to Influent Pump Stn. | 8 | 150 | 150 | | | 67 | 33 | | 0 | 0 | 2 homes |
| EC 1 | 8 | 250 | 250 | | | 111 | 56 | | 1 | 1 | 4 homes |
| EC 2 | 8 | 450 | 450 | | | 200 | 100 | | 1 | 1 | 15 homes |

ST. JOHN WWFP
COLLECTOR DESIGN INFORMATION

| LOCATION | SEWER DIAMETER (in) | TOTAL LENGTH (ft) | LENGTH OF ___ CUT 2-6' | 6-9' | 9-12' | APPROX TOTAL EXCAV(cy) | APPROX ROCK EXCAV(cy) | SLOPE | # OF MANHOLES | # OF PUMPS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EC 3 | | | | | | | | | | | |
| North | 8 | 150 | 150 | | | 67 | 33 | | 0 | 0 | 2 homes |
| South | 8 | 350 | 350 | | | 156 | 78 | | 1 | 0 | 3 homes |
| EC 4 | | | | | | | | | | | |
| North | 8 | 150 | 150 | | | 67 | 33 | | 0 | 0 | 3 homes |
| South | 8 | 250 | 250 | | | 111 | 56 | | 1 | 0 | 3 homes |
| ECX 1 | | | | | | | | | | | |
| East | 8 | 400 | 400 | | | 178 | 89 | | 1 | 9 | 9 homes |
| West | 8 | 300 | 300 | | | 133 | 67 | | 1 | 0 | 2 homes |
| ECX 2 | 8 | 300 | 300 | | | 133 | 67 | | 1 | 0 | 1 home |
| ECX 3 | 8 | 350 | 350 | | | 156 | 78 | | 1 | 0 | 4 homes |
| South of Bay Street | 8 | 750 | 750 | | | 333 | 167 | | 3 | 5 | 15 homes |
| Tobacco Road | 8 | 700 | 700 | | | 311 | 156 | | 2 | 2 | 10 homes |
| Moravian Point | | | | | | | | | | | |
| Western section | 8 | 700 | 700 | | | 311 | 156 | | 2 | 1 | 4 homes |
| Eastern section | 8 | 450 | 450 | | | 200 | 100 | | 1 | 0 | 2 homes |
| Tobacco Rd to In Pump Stn | | | | | | | | | | | |
| Along Frank Bay | 8 | 600 | 600 | | | 267 | 133 | | 2 | 0 | 3 homes; excav 2.4 + 3 = 5.4 ft |
| Along Small Pond | 8 | 800 | 100 | 700 | | 628 | 450 | | 3 | 0 | 2 homes; excav .4 + 5.4 = 5.8<br>2.8 + 5.8 = 8.6 ft |
| Total | | 24,950 | 24,250 | 700 | 0 | 11361 | 5,817 | | 85 | 75 | |

# APPENDIX C.3

## ASSESSMENT OF EXISTING WASTEWATER FACILITIES

(Reproduced from deJongh/URS Associates, Comprehensive Plan for the Sewage Needs of Cruz Bay, VI, 1985)

## B. Wastewater Facilities

### 1. Collection and Treatment System

The present Cruz Bay Wastewater Treatment Facility, a package plant located about one-half mile south of the center of town, was in use on St. Thomas for six years before being moved (in 1981) to its present location. The plant is situated on a strip of land approximately 100 feet wide between Turner Bay (Caribbean Sea) and the western end of Enighed Pond, a saltwater- interchanging backwater of Turner Bay. In addition to the plant, an operator's office building and influent pump station are located on the treatment plant property (Figure 2). The land around the plant is owned by the Virgin Islands Port Authority. Enighed Pond is also publicly-owned property.

The existing wastewater collection system is over 1.6 miles in length and includes both gravity sewers and force mains, as well as two sewage ejector stations (Figure 2). Sewer and force main sizes range from four to ten inches in diameter. The collection system conveys domestic sewage only (no industrial wastewater or direct stormwater connections). Table 1 shows a sewer line inventory of the existing system.

It is noted that the National Park Service has plans to service the Caneel Bay staff housing (to the north of Cruz Bay) by extending the sewer line from North Shore Road to Lind Point. Portions of this extension are presently under construction. It involves the addition of approximately 1,160 lf of 6"ϕ PVC gravity sewer, 1,630 lf of 8"ϕ PVC gravity sewer, and 300 lf of 2½"ϕ PVC forcemain. These amounts are not reflected in the sewer line inventory shown in Table 1.

Table 1 Existing Sewer Line Inventory

| Location | Force Main 2-4" PVC | 6" PVC | Gravity Sewer 8" PVC | 10" PVC | Manholes |
|---|---|---|---|---|---|
| Ejector Stn.1 | | 502 | | | |
| | | 315 | 147 | | 4 |
| Gas Station | | | 255 | 313 | 4 |
| | | | | 604 | 4 |
| | | | | 598 | 4 |
| Infl. Pump Stn. | 364 | | | 33 | |
| Tennis Courts | | 437 | 385 | 18 | 6 |
| Ejector Stn.2 | | 95 | 345 | | 3 |
| Cemetery | | | 295 | | 4 |
| | | | 655 | | 4 |
| Cruz Bay Dock | | | 665 | | 4 |
| Ejector Stn. 1 | | | 320 | | 2 |
| Centerline and Southside Rd. | | | 400 | | 3 |
| | | | 355 | | 2 |
| to Eject.Stn.2 | | | 410 | | 1 |
| Boat Ramp to Caneel Hsng | | | | 1,085 | 8 |
| Total | 364 | 1,349 | 4,232 | 2,651 | 53 |

NOTE: All sewer length values given in LF

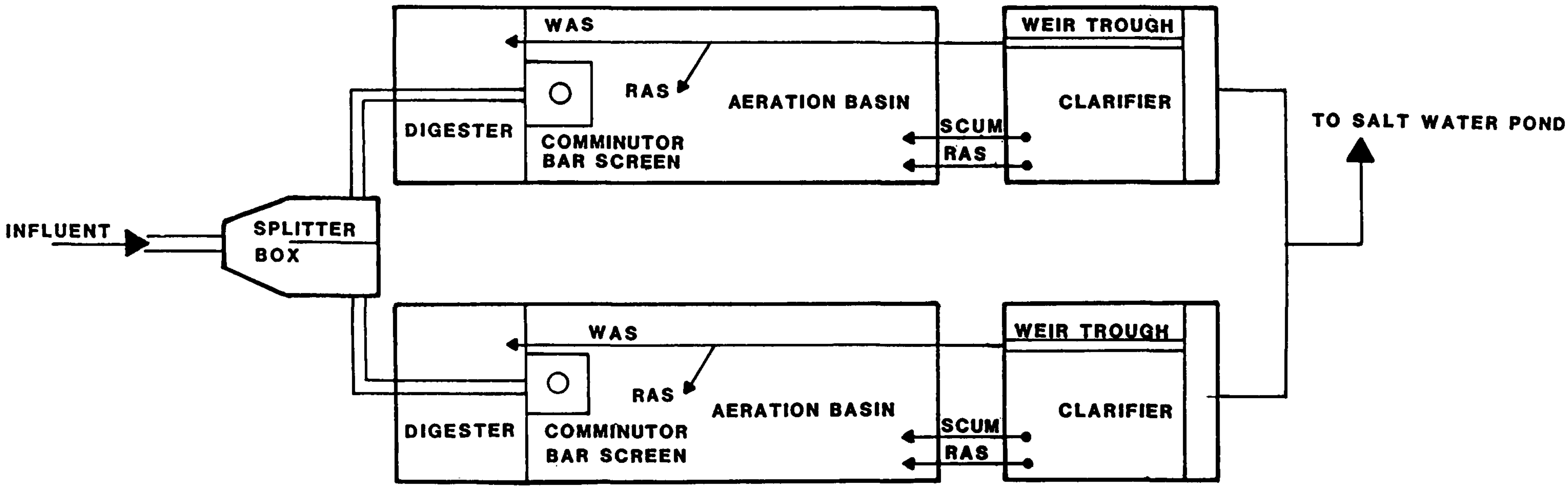
Ejector Station 1 has a 75 gallon per minute (gpm) pumping capacity at 45 feet Total Dynamic Head (TDH); Ejector Station 2, 75 gpm at 15 feet TDH.

At the treatment plant influent pump station, four submersible single-speed pumps, three rated at 175 gpm at 40 feet TDH and the fourth at 65 gpm at 40 feet TDH, are available to move the raw, unscreened wastewater into the treatment plant. These pumps operate according to level switches in the wet well, the number of pumps in operation being proportional to the level of water in the well. Only one pump was observed to be presently operational.

The treatment plant itself is a rectangular, steel, extended-aeration, parallel-train facility with 20,000 gpd capacity ("Aer-O-Flow" System, Clow Corp., Florence, Kentucky). Influent raw sewage is pumped via a 6-inch line to the top of the above-ground plant. After passing through a splitter box, it is routed to one of two comminutor/bar screen units for reduction of large solids, prior to flow into the aeration basins. Three 3-hp blowers in each aeration tank keep solids in suspension, aerating the mixed liquor through diffusers at the bottom of the tank. The blowers may be operated continuously or at timer-set intervals. The design detention time is 20.5 hours (Figure 4).

Following aeration, the mixed liquor flows to two 2,900-gallon final clarifiers. Most of the sludge settling out in the final clarifier units is airlift-pumped to the aeration tanks for further oxidation (return activated sludge), and a portion is wasted to one of two 1,400-gallon aerobic digesters (waste activated sludge).

At present there are no acceptable sludge-handling facilities in the planning area. Sludge is therefore allowed to build up in the digesters, aeration tanks, and final clarifiers. Sludge from the right tank (Turner Bay side) is periodically drained to the left tank (Enighed Pond side), leaving the left tank relatively full much of the time. Three or four times per year, sludge is pumped from the left tank and hauled to the St. John municipal






RAS: RETURN ACTIVATED SLUDGE

WAS: WASTE ACTIVATED SLUDGE

Figure 4

**WASTEWATER TREATMENT PROCESS, EXISTING PLANT**

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landfill. This is done when the suspended solids in the effluent are determined to be greater than 70 to 100 mg/l. Thus, at present only one aeration tank is normally available for effective treatment throughout much of the year.

Supernate in each clarifier flows over a weir and passes through a chlorine contact chamber before final discharge from the plant. Chlorine must be manually added in the form of sodium hypochlorite (liquid or powdered chlorine), as no automatic mechanical chlorination units are installed.

Subsequent discharge of the treated effluent is subterranean (approximately 25 feet downstream of the plant), with upward percolation and resultant overland flow into the west end of Enighed Pond, communicating with Turner Bay.

Enighed Pond was formerly a freshwater pond, completely closed-off to the sea. The present channel was opened in the 1950's, due to perennial odors which occurred as the stagnant water in the pond evaporated during the dry season. The flushing action from the sea has served to alleviate such problems; however, it has also made the pond a saltwater pond.

Through review of background information, onsite inspections, and interviews with responsible individuals, it has been determined that the following operational problems exist at the Cruz Bay treatment plant:

a. Only one of the four pumps (175 gpm) at the influent pump station is presently operational. Two are out of service; the fourth was sent out for repairs more than two years ago and has not been returned.

b. The one operational pump is frequently running for longer periods than necessary, due to a sticking relay in the control system. This results in the pump running dry, which could lead to pump burnout.

c. The influent pumps have an excessively high rated flow of 175 gpm, and the on-off level switches are apparently set too close to each other. Consequently, the pump normally operates only 5 to 10 seconds per pumping cycle, with approximately 5 minutes between cycles. This short operational time contributes to reducing the service life of the pump.

d. Aeration of the basins is not carried out continuously. Instead, it is periodic, resulting in incomplete oxidation of wastewater.

e. No mechanical equipment has ever been installed for automatic chlorination of the effluent, making it necessary to rely upon periodic manual addition.

f. Even though an emergency power generator has been housed at the treatment facility for over two years, it has not been wired into the system and thus has been unavailable for use since its installation.

g. The comminutor/bar screen units are not functioning properly.

h. No sludge dewatering facilities exist, leading to retention of sludge within the plant for longer periods than necessary, and consequent operational inefficiency.

i. Effluent discharge occurs underground, reaching the pond only after percolation to the ground surface and subsequent overland flow.

j. No holding tank or other type of facilities exists at the treatment plant for the possible controlled handling of trucked-in septic tank wastes. Therefore these wastes are instead trucked to the St. John municipal landfill and buried in an environmentally unsound manner.

k. Monitoring of wastewater quality and quantity is performed very infrequently. Recordkeeping is therefore poor, and Daily Monitoring Report submission does not occur. There is also no accurate means available for proper process control. Operation of the plant appears to rely more upon visual observation and timing devices than upon measured control parameters such as flow, loadings, F/M ratios, or upon effective operator attention. The plant is clearly not fitted for efficient operation.

l. Operator training courses are not provided, and the plant operations and maintenance manual is not on file at the treatment plant.

m. Safety hazards exist at the plant. Among these: corroded walkways and absence of railings.

n. The facility is poorly maintained. Steel plates and fittings, for example, are corroded, and would have benefited from regular painting.

There are 40 authorized service connections to the Cruz Bay collection system. Most of these are residences or other types of dwelling units which discharge to the sewer system, such as guest houses or condominiums. There are no industries in the Cruz Bay planning area. The 40 connections serve 123 residences and 17 non-residences. Categories of non-residential hookups include government buildings, banks, schools, churches, stores, restaurants, and a large public restroom.

Based on the established average of 3 persons per unit, the present system services approximately 420 persons. Given the likelihood that some unpermitted connections exist, approximately 500 persons are served by the existing system. (This number increases periodically throughout the year, due to wastewater influx from the public restrooms and tourist-oriented facilities). As has been noted above, the population of the planning area is about 1,030 persons. Since an estimated 500 persons have sewer service, approximately half the residents of Cruz Bay remain unsewered. Virtually all unsewered units are residential.

Of those residences presently without sewer service, most have onsite treatment (septic tanks). Majestic Construction Company, St. John, estimates that they pump-out four septic tanks per month, resulting in a total septage production of approximately 4,000 gallons per month. The decision not to extend sewers into certain areas previously has been dictated largely by topography, these areas being steep and hilly and thus presenting construction difficulties. Due to the nature of the topography and soils in these areas, even the septic systems have presented difficulties, in terms of maintenance and operational efficiency. After heavy rains, many are prone to overflow and flooding around their leach fields. Department of Public Works staff point out that, due to these difficulties, local residents with onsite sewage treatment have expressed a great interest in connecting to the central collection system.

Water usage on St. John is relatively low. Figures supplied by the Caribbean Research Institute in a 1984 study of water usage on St. Thomas, indicate that residents of St. Thomas whose water needs are served only by rainfall, groundwater, and trucked-in desalinated water (as is the case on St. John), use around 30 gallons per capita per day (gpcd). There are indications that per capita usage is even lower on St. John. If per capita consumption is taken as 25 gpd, St. John's 500 sewered residents would be expected to discharge about 12,500 gpd to the treatment plant. These estimates have been supported by field monitoring data, as will be demonstrated below.

The picture that emerges of existing methods of sewage collection and treatment in Cruz Bay is one of an inadequate collection system coupled with a physically decaying treatment plant - a plant that lacks proper sludge-handling and treated effluent disposal facilities, that was installed as only a temporary stop-gap measure, and that is already working at greater than half its capacity amid a growing population and service area. The picture is further complicated by tourism, responsible for heavy seasonal loadings upon the system that could easily push the plant beyond its rated capacity, and by widespread failures in the prevalent treatment methods for wastewater treated on site and not sent to the plant.

## 2. Wastewater Characteristics

During this study, continuous flow monitoring was conducted at the upstream end of the treatment plant influent pump station using a Marsh McBirney Model 265 Velocity Modified Flow Meter for a period of four weeks. Due to the low flows and velocities encountered in the sewer line, the flow meter response and resulting data were at times erratic, but meaningful results were nonetheless obtained. In addition, since the influent pump station is equipped with pump timers, the one operating pump could be calibrated and monitored, allowing corroboration of flow meter results. At the time of calibration, the flow entering the wet well was accurately measured by recording the time required for the wastewater volume in the wet well to increase by a predetermined amount.

Based on the data available, the present average daily flow rate at the plant is approximately 13,000 gallons per day. This figure is in close agreement with the flow rate calculated by population and per capita usage. Average minimum and peak hourly flows are 5,200 gpd and 33,100 gpd, respectively.

Wastewater samples were collected from 6/25/85 to 7/01/85. Continuous samples were collected at a manhole just upstream of the influent pump station for the entire seven-day period. Continuous samples were also taken of the treatment plant effluent for two 24-hour periods on 6/25/85 and 6/28/85. These samples were obtained using Instrumentation Specialties Company (ISCO) samplers (Figure 5).

Grab samples were obtained on 6/25/85 and 6/26/85 for three additional locations: in Enighed Pond near the treatment plant discharge point (Station 6); in Turner Bay near the outlet of Enighed Pond (Station 5); and at the northeast corner of Enighed Pond (Station 8).

The samples were preserved and transported each day of the program to Environmental Quality Laboratories, Inc., in Santurce, Puerto Rico. There, each sample was analyzed in accordance with "Standard Methods for Examination of Water and Wastewater" for a broad range of parameters. Complete analytical results of this program are shown in Appendix E.

Some of the influent data are unusual, in that a number of parameters are extremely high. The sample mean and standard deviation of seven design parameters are shown in Table 2.

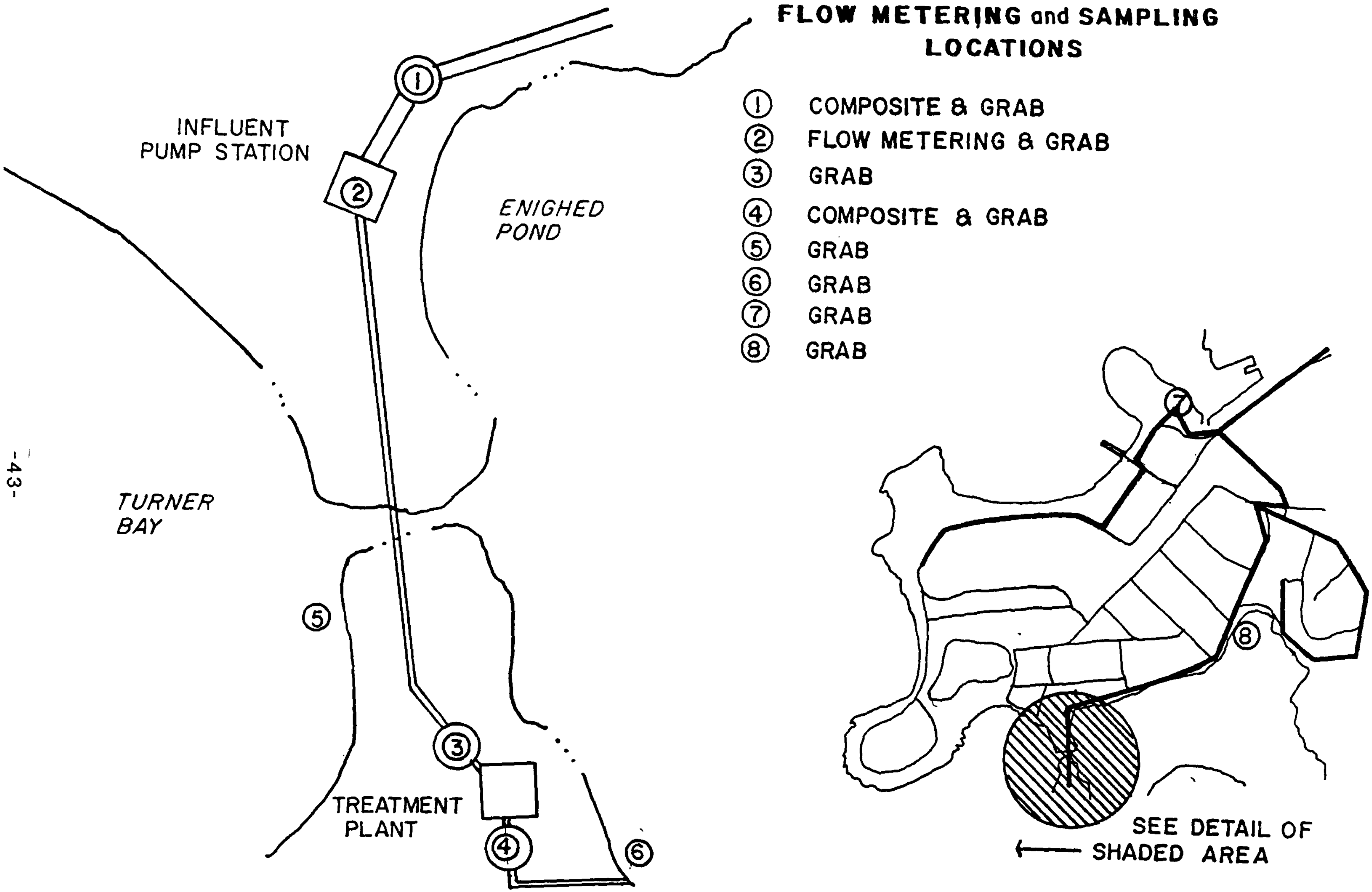


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**Figure 5**

Table 2 Sample Mean and Standard Deviation for Selected Influent Parameters, Cruz Bay Wastewater Facilities

| Influent Parameter | Mean | Standard Deviation* |
|---|---|---|
| BOD5 | 1,939 | 1,311 |
| BOD-Soluble | 303 | 48 |
| COD | 6,651 | 5,147 |
| COD-Soluble | 689 | 129 |
| Total Suspended Solids | 2,293 | 922 |
| Ammonia-N | 60 | 12 |
| Total Kjeldahl Nitrogen | 133 | 58 |

* n = 7
All values given in mg/l

The Soluble BOD and COD values are typical of a domestic sewage of the strength expected in an area with low water consumption. BOD5, COD, and TSS values, however, are abnormally high. Measured values of all three parameters are about six times the values usually encountered in a strong domestic wastewater. Moreover, Soluble BOD is normally about 40 percent of the BOD5--not 16 percent, as is the case here. Finally, the sample standard deviations demonstrate a wide variation in data points for solids.

A comparison of these results to results obtained in the Mangrove Lagoon/Turpentine Run Wastewater Treatment Project in nearby St. Thomas (Spring, 1985), is shown in Table 3.

Table 3 Comparison of Mean Values for Selected Influent Wastewater, Cruz Bay, St. John, and Mangrove Lagoon, St. Thomas

| Influent Parameter | Cruz Bay Average | Mangrove Average |
|---|---|---|
| BOD5 | 1,939 | 532 |
| BOD-Soluble | 303 | 347 |
| COD | 6,651 | 1,408 |
| COD-Soluble | 689 | 708 |
| TSS | 2,293 | 296 |

All values given in mg/l

Again the soluble values are comparable, but wide differences are evident in concentrations of suspended matter.

A possible reason for these unusual results is the periodic pumping of septic tank cleanout into the collection system. Such a shock loading of strong domestic wastewater would produce high levels of solids for a limited period. The fact that influent BOD5 values dropped off gradually from a high of 3,960 mg/l to 840 mg/l within four days tends to support this theory.

In order to further substantiate the above theory, a set of grab samples was taken both at the treatment plant influent and at a manhole considerably upstream within the collection system on 7/9/85 (Figure 5, Stations 3 and 7). The BOD5 and TSS values at the plant influent were 1,320 and 1,966 mg/l, respectively; at the upstream sample station within the collection system, they were 285 and 145 mg/l. It is practical to assume, therefore, that some type of high-BOD material (possibly septage) was injected into the system at some point in between. A check of local septic tank service companies elicited no confirmation of the suspected unallowable practice of dumping septic tank wastes into the system. It has, however, been observed by community members involved in the Facilities Planning Process that the practice does in fact go on.

In addition to the above, influent grab samples were collected on 7/17/85 and 7/24/85, and were analyzed by the Department of Conservation and Cultural Affairs (DCCA), Natural Resources Management (NRM) Lab on St. Thomas. The first sample was analyzed for TSS, and resulted in a value of 495 mg/l. The second sample was analyzed for $BOD_5$ and yielded a value of 680 mg/l. These values compare more closely with typical values than do the average Cruz Bay values which were previously shown in Table 2.

Therefore, for the purposes of this Facilities Plan, the average values for soluble BOD and COD will be used as reported for the preliminary sizing of treatment units. With respect to the artificially high BOD5, COD, and TSS, however, modified values of 600, 800 and 400 mg/l, respectively, will be used. These values are conservative, based on historic data and on recent results from the Mangrove Lagoon/Turpentine Run project. Further in-depth sampling and analysis should be undertaken prior to or during design to verify this data.

3. Infiltration/Inflow

The nature of the climate and physiography of the Cruz Bay area make excessive Infiltration/Inflow (I/I) highly unlikely. The dry climate, combined with generally steep slopes and permeable soils above impermeable bedrock, virtually eliminate the possibility of infiltration caused by groundwater levels rising above the elevations of sewer lines for any prolonged period. Inflow, too, is essentially non-existent. Rainwater from roofs is collected and stored in cisterns. Houses, constructed without basements, have no sump pumps, eliminating another common source of inflow. Storm sewers are plugged and virtually non-operative.

The chance, therefore, of significant inflow from classic sources such as downspouts, sump pumps, or catch basins is quite low.

Wastewater flow monitoring in the Project Planning Area indicates an estimated per capita usage of 25 gallons per day, in conformance with information from other than monitoring sources. A single rainfall event, measuring only 0.12 inches, occurred over the four-week monitoring period; it had no noticeable effect on wastewater flows. Flow meter records frequently exhibited minimum nighttime flows approaching zero.

According to EPA guidelines, I/I is considered nonexcessive, and no further analyses are required if domestic wastewater flow plus infiltration does not exceed 120 gpcd, and if total daily flow during a storm does not exceed 275 gpcd. Since flow monitoring results did not even approach this magnitude, it has been concluded that excessive I/I is nonexistent in the Project Planning Area.

4. Effluent Limitations

The existing treatment plant is authorized to discharge wastewater to Turner Bay by Territorial Pollutant Discharge Elimination System (TPDES) Permit No. V.I. 0039942. The present permit became effective January 18, 1983; it will expire on January 17, 1988. Discharge limitations are shown in Table 4.

Table 4 Discharge Limitations, Existing Permit

| Parameter | 30-day Avg % Removal | Monthly Average | 7-day Average |
|---|---|---|---|
| Flow | — | 0.1 mgd | — |
| BOD5 | 85% | 30 mg/l | 45 mg/l |
| TSS | 85% | 30 mg/l | 45 mg/l |

In addition, discharge pH is to be between 6 and 9 standard units.

These limitations require the equivalent of secondary treatment prior to discharge. Any process considered must be able to provide this level of treatment using Best Practicable Wastewater Treatment Technology.

Turner Bay, the designated receiving water body, is defined as Class B under "Water Quality Standards for the Coastal Waters of the U.S Virgin Islands." As such, the best usage is for propagation of desirable forms of marine life and primary contact recreation. Excerpts from the criteria requirements are shown in Table 5.

Table 5 Class B Ocean Waters, Selected Criteria

| Characteristic | Limit |
| --- | --- |
| Dissolved Oxygen | Not less than 5.5 mg/l |
| pH | Normal range not extended more than 0.1 pH unit. Never less than 7.0 or greater than 8.3 |
| Temperature | Not to exceed 90 degrees F or, as a result of waste discharge, to be greater than 1.5 degrees F above natural |
| Bacteria | Less than or equal to a geometric (log) mean of 70 fecal coliforms per 100 ml. |

Additional details on the standards may be found in the excerpted document.

# APPENDIX C.4

## ON-SITE SYSTEMS

APPENDIX C.4

## ON-SITE SYSTEMS

On-site systems are alternative technologies for treating wastewater on an individual basis. Wastewater discharged from homes or businesses is treated on the property of each discharging source, rather than piped to a regional or subregional facility for treatment. The following four on-site treatment technologies are considered feasible for use in the study area.

- trench systems,
- seepage pits,
- mound systems, and
- evapotranspiration beds.

The purpose of this section is to describe each of these technologies in terms of how they function and under what conditions they function most effectively.

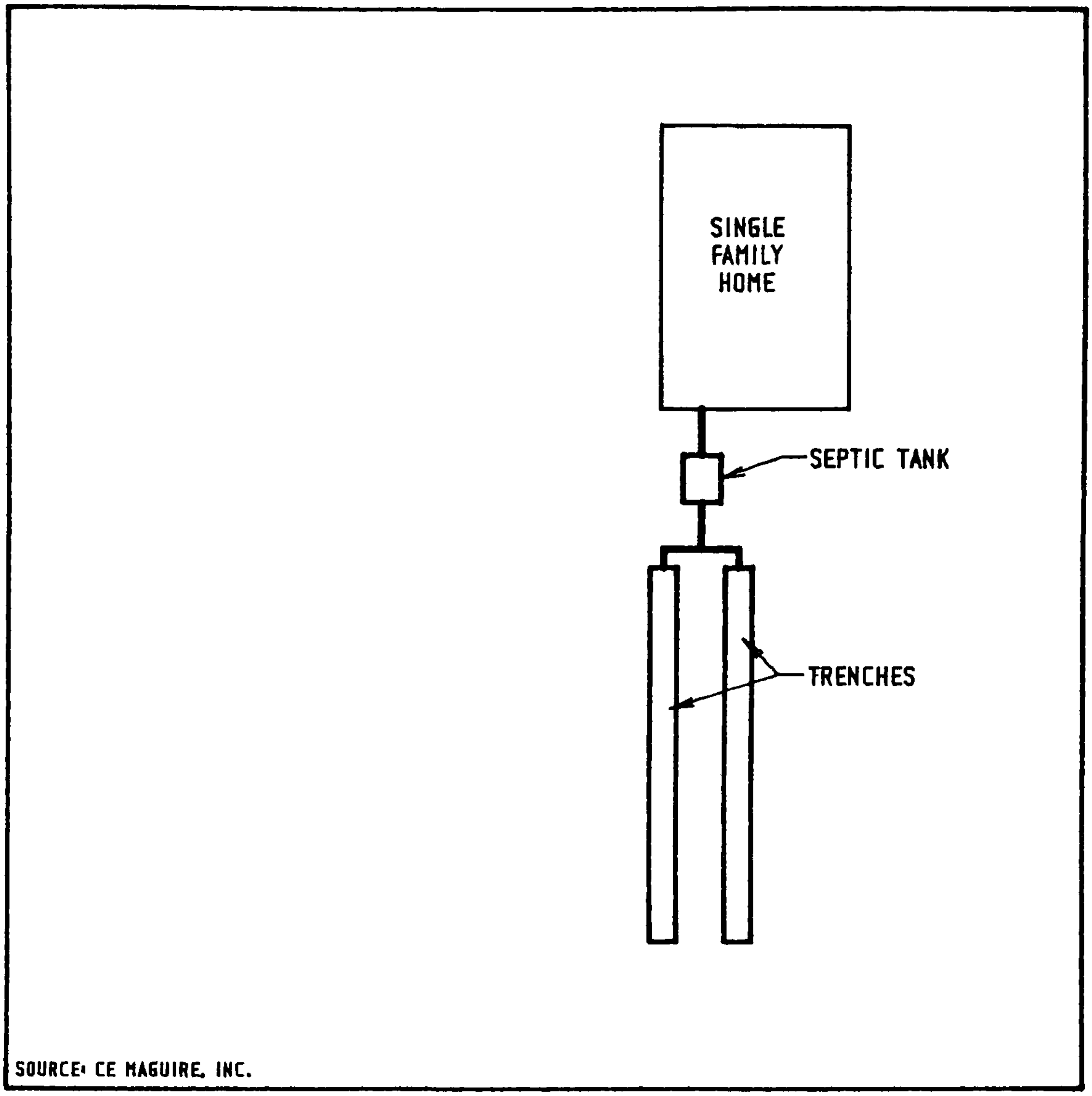
Each of these technologies includes a septic tank as a means of primary treatment. The purpose of the septic tank is to collect and trap solids. These solids would then be periodically removed, typically once every 35 years, and disposed of at a septage lagoon or suitable wastewater treatment facility. Septic tanks used in these systems should have at least a 1900 liters (500 gallons) capacity to be effective.

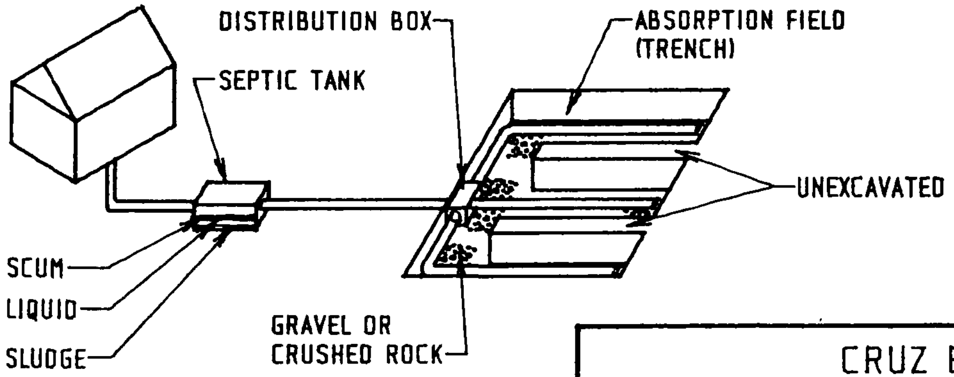
### a. Trench System

This technology disposes of wastewater by dispersing it in trenches through perforated pipe. Wastewater is first piped into a septic tank where solids settle to the bottom and eventually decompose. The fluid effluent is then piped to trenches into which it is dispersed through perforated pipes. The effluent is absorbed into the soil layers surrounding these trenches which leach or remove organic material from the effluent before it enters ground or surface water flow. This process is illustrated in Figure C-1.

The Environmental Laws and Regulations of the Virgin Islands Handbook (1979) requires the following standards for trench systems:

| | |
|---|---|
| . Minimum number of lines per field | 2 |
| . Maximum length of individual lines | 100 feet |
| . Minimum bottom width of trench | 18 inches |
| . Maximum depth of cover of tile lines | 36 inches |
| . Preferred depth of cover | 18 inches |
| . Maximum grade of tile lines 6 .... 6 in. per | 100 feet |
| . Preferred grade of tiles .... 2 in. to 4 in. per | 100 feet |
| . Minimum filter material under tile | 6 inches |
| . Minimum filter material over tile | 2 inches |




SOURCE:
E.P.A. ALTERNATIVE SYSTEMS FOR SMALL COMMUNITIES AND RURAL AREAS, JANUARY, 1980.

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CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS

ENVIRONMENTAL PROTECTION AGENCY, REGION II
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TRENCH SYSTEM

SOURCE: AS NOTED

DATE: 3/86 SCALE: NTS FIGURE: C-1

Source: DCCA, Environmental Laws and Regulations of the Virgin Islands, 1979, T.19, ch. 53, see 1404-91.

In addition, trenches may not be used in filled ground.

Due to these and other characteristics of the trench system technology, trench systems are most effective in areas where soils are moderately permeable and deep (at least 2 m (6.6 ft) over bedrock) and where the water table is no less than 2 m (6.6 ft) below ground level. For instance, properties located along the shore (where the water table is close to the surface) and on steep slopes (where soils are generally very shallow) would not be suitable for the use of trench systems, whereas properties located on alluvial plains or other flat areas underlain by deep, well-drained soil could be suitable.

A typical septic tank and trench system could be expected to cost $2,000 to construct.

b. <u>Seepage Pits</u>

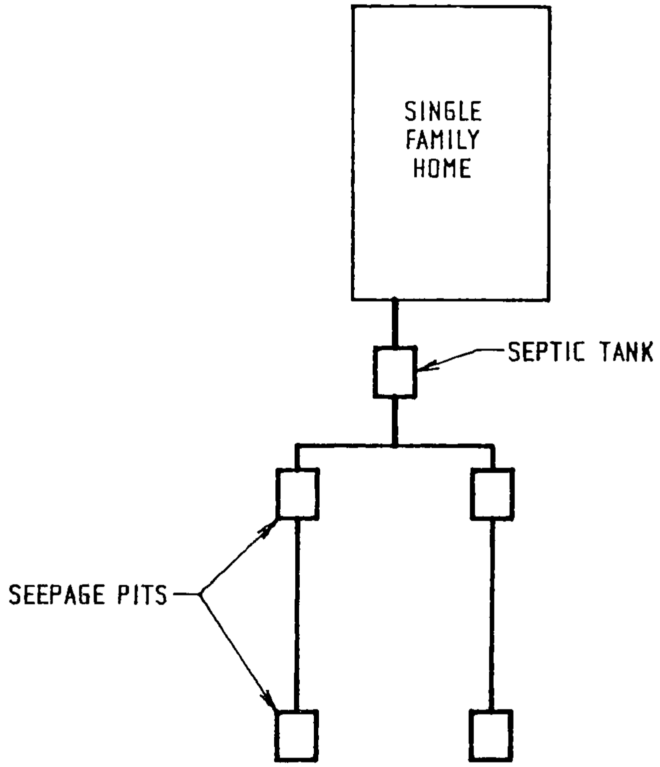
The seepage pit system is similar to the trench system in that it involves the discharge of effluent into layers of soil between the ground surface and water table after primary septic tank treatment. The seepage pit system is distinctive, however, in that it involves the distribution of effluent into one or a series of subsurface pits rather than a long trench. The process is illustrated in Figure C-2.

The following standards are required for seepage pits in the Virgin Islands:

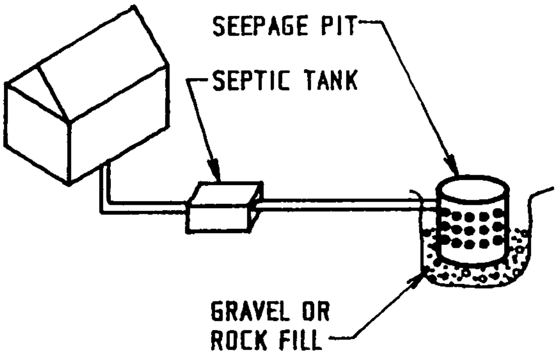
REQUIREMENTS FOR SEEPAGE PIT DESIGN

| CHARACTER OF SOIL | Effective absorption area requirement in sq. ft. of wall area of pit exclusive of curbing, per bedroom |
|---|---|
| Coarse sand or gravel | 20 |
| Fine sand | 30 |
| Sandy loam or sandy clay | 50 |
| Clay with considerable sand or gravel | 80 |
| Clay with small amount of gravel or sand | 160 |
| Heavy tight clay, hardpan, rock or other impervious formations | Unsuitable |

Source: DCCA, Environmental Laws and Regulations of the Virgin Islands, 1979, T 19, ch 53, see 1404-94.




SOURCE: CE MAGUIRE, INC.




SOURCE:
E.P.A., 1980

# CRUZ BAY
# WASTEWATER FACILITIES PLAN EIS
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ENVIRONMENTAL PROTECTION AGENCY, REGION II
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## SEEPAGE PITS

SOURCE: AS NOTED

DATE: 3/86 SCALE: NTS FIGURE: C-2

This system would function most effectively in the same areas described for the use of the trench system. Due to the greater area necessary for the seepage pits, however, this system would be more suitable for larger properties. In contrast, the trench system might be more suitable for properties that only permit a long, narrow on-site system layout due to property lines or topography.

The cost of a septic tank and seepage pit system could be expected to be $2,300.

c. Mound System

The mound system involves primary septic tank treatment and effluent discharge to an above-surface mound of well-drained soil or sand. Leaching of the effluent occurs in this mound rather than in the subsurface soil layers. Because of this, effluent must be pumped into the mound rather than be conveyed via gravity flow as is the case with the other on-site technologies considered. The process is illustrated in Figure C-3.

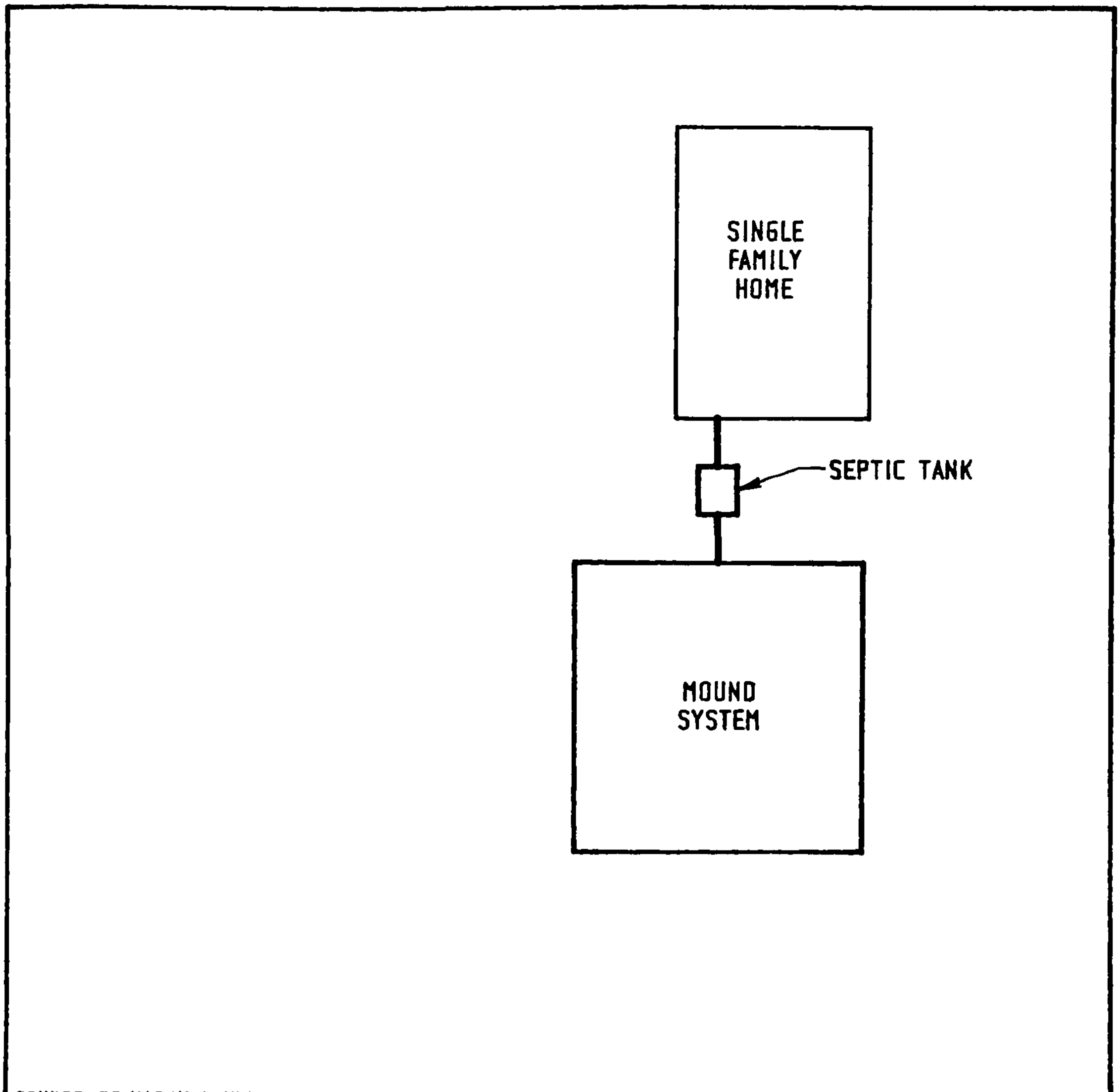
There are no specific requirements for mound systems in the Virgin Islands.

Mound systems are best suited for well-drained areas with a relatively high water table. Properties located in valleys near stream beds or at low elevations near the waterbodies might use these system effectively, for instance.

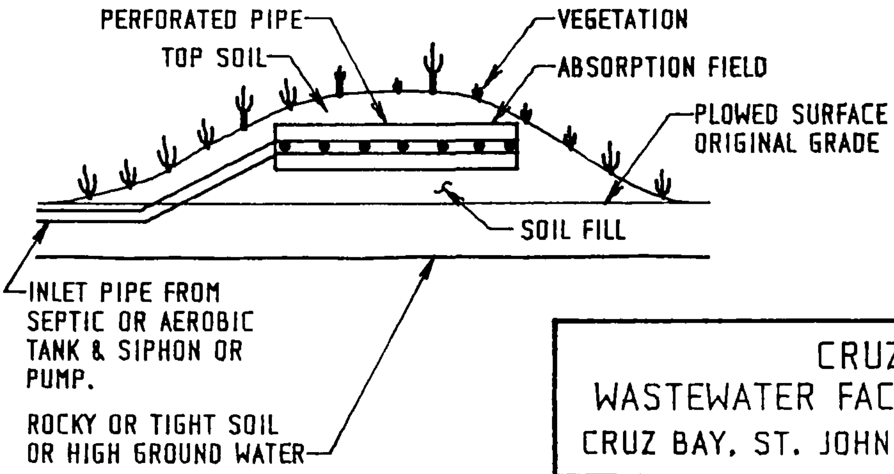
The septic tank and mound system is generally more expensive than the leaching trench or seepage pit systems because it requires a greater amount of earthwork and a pump or dosing chamber. The expected cost of this on-site system is $4,500.

d. Evapotranspiration Beds

The evapotranspiration bed technology disposes of wastewater effluent through the combined natural processes of evaporation and transpiration, rather than soil leaching. After septic tank treatment, effluent is piped to a sand bed that is surrounded by an impermeable lining. Effluent is evaporated out of this pit into the atmosphere or transpired by vegetation on the surface of the pit. The impermeable lining prevents any of the effluent from flowing out of the bed into surface or groundwater. The process is illustrated in Figure C-4.




SOURCE: CE MAGUIRE, INC.




SOURCE:
E.P.A., 1980

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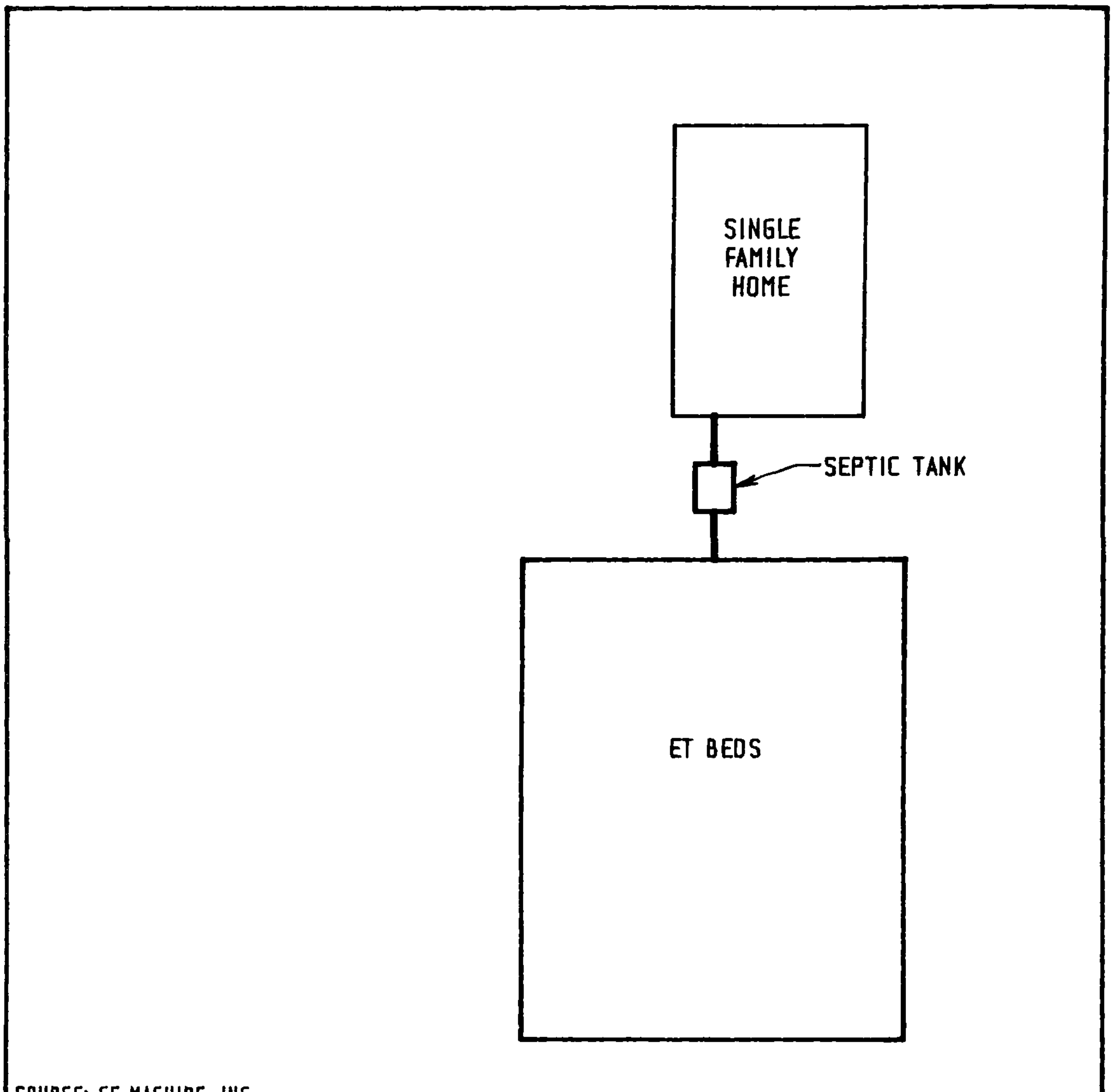
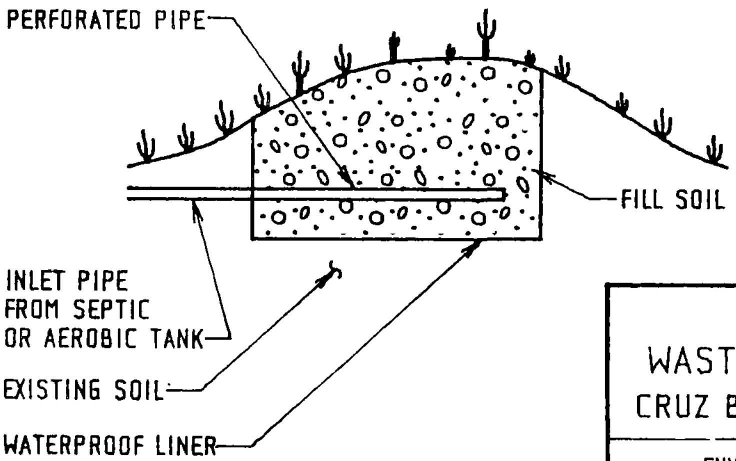
MOUND SYSTEM

SOURCE: AS NOTED

DATE: 3/86 SCALE: NTS FIGURE: C-3




SOURCE: CE MAGUIRE, INC.




SOURCE:
E.P.A., 1980

CRUZ BAY
WASTEWATER FACILITIES PLAN EIS
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS

ENVIRONMENTAL PROTECTION AGENCY, REGION II
CE MAGUIRE, INC. • NEW BRITAIN, CT

# EVAPOTRANSPIRATION BEDS

SOURCE: AS NOTED

DATE: 3/86 | SCALE: NTS | FIGURE: C-4

The Virgin Islands Environmental Laws Handbook does not list standards for evapotranspiration systems with its other wastewater treatment system design standards, but the U.S. Environmental Protection Agency (EPA) discusses conditions and standards under which this system functions best in its On-site Wastewater Treatment and Disposal Systems Design Manual (EPA, 1980).

Evapotranspiration beds are effective in environments where the evapotranspiration rate equals or exceeds the rate of rainfall, causing a water deficit as exists on St. John. Because this technology does not involve subsurface discharge of effluent, soil permeability, depth to water table, and depth to bedrock are not significant factors to be considered in its design.

This system requires more land than the others considered as it focuses on maximizing surface (or near-surface) area to permit evaporation rather than contact area with soil.

This system would be most suitable for areas where the water table is high, there are soil limitations to on-site wastewater treatment and the available land is expansive enough to permit use of this system in an environmentally sound manner. For instance, large properties near the shore or in areas where soil is thin and the water table is high could use evapotranspiration beds effectively.

The cost of the evapotranspiration bed system could be expected to be $10,700.

APPENDIX C.5

DETAILED COST ESTIMATES

TABLE C.5-1
COST EFFECTIVENESS ANALYSIS
WASTEWATER COLLECTION SYSTEM
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.625 PERCENT
ANALYSIS PERIOD= 20 YEARS
1986 ENR CONST. COST INDEX= 4220

| | LOCATION | SIZE | QUANTITY | TYPE | UNIT COST | EXTENSION | SALVAGE VALUE | ANNUAL O&M COST |
|---|---|---|---|---|---|---|---|---|
| | PIPELINES | | | | | | | |
| 1. | CENTERLINE RD. | 8" | 3,000 | GRAV. | $80 | $240,000 | | |
| | | 8" | 900 | GRAV. | $80 | $72,000 | | |
| | | 2" | 350 | PRESS. SW | $25 | $8,750 | | |
| 2. | CIRCLE ST. AREA | 8" | 650 | GRAV. | $80 | $52,000 | | |
| | | 8" | 850 | GRAV. | $80 | $68,000 | | |
| 3. | CONTANT PT. AREA | 8" | 1,390 | GRAV. | $80 | $111,200 | | |
| | | 8" | 770 | GRAV. | $80 | $61,600 | | |
| | | 8" | 900 | GRAV. | $80 | $72,000 | | |
| 4. | ENIGHED CREEK RD. | 8" | 1,050 | GRAV. | $80 | $84,000 | | |
| 5. | ENIGHED POND AREA | 8" | 1,430 | GRAV. | $80 | $114,400 | | |
| | | 8" | 1,030 | GRAV. | $80 | $82,400 | | |
| | | 8" | 300 | GRAV. | $80 | $24,000 | | |
| | | 8" | 250 | GRAV. | $80 | $20,000 | | |
| 6. | FRANK BAY RD. | 8" | 660 | GRAV. | $80 | $52,800 | | |
| 7. | FRANK BAY TO INFLUENT P.S. | 8" | 850 | GRAV. | $80 | $68,000 | | |
| 8. | KONGENS GADE | 8" | 400 | GRAV. | $80 | $32,000 | | |
| 9. | MOROVIAN POINT | 8" | 1,100 | GRAV. | $80 | $88,000 | | |
| 10. | EST. PASTORY | 8" | 900 | GRAV. | $80 | $72,000 | | |
| 11. | PINE PEACE AREA | 8" | 500 | GRAV. | $80 | $40,000 | | |
| | | 8" | 500 | GRAV. | $80 | $40,000 | | |
| | | 8" | 1,790 | GRAV. | $80 | $143,200 | | |
| | | 8" | 330 | GRAV. | $80 | $26,400 | | |
| 12. | POWER BOYDS PLANTATION | 8" | 2,000 | GRAV. | $80 | $160,000 | | |
| | | 4" | 480 | FORCEMAIN | $30 | $14,400 | | |
| | | 8" | 300 | GRAV. | $80 | $24,000 | | |
| 13. | SUBTOTAL SEWERS | | 22,680 LF | | | $1,771,150 | $1,062,690 | $10,739 |

| | LOCATION | SIZE | QUANTITY | TYPE | UNIT | EXTENSION | SALVAGE | O&M COST |
|---|---|---|---|---|---|---|---|---|
| | GRINDER PUMPS | | | | | | | |
| 14. | CENTERLINE RD. | | 24 | | $6,000 | $144,000 | | |
| 15. | CONTANT AREA | | 17 | | $6,000 | $102,000 | | |
| 16. | ENIGHED POND AREA | | 8 | | $6,000 | $48,000 | | |
| 17. | MORAVIAN POINT | | 1 | | $6,000 | $6,000 | | |
| 18. | SUBTOTAL GRINDER PUMPS | | 50 | EACH | | $300,000 | $0 | $5,000 |
| | PUMPING STATIONS | | | | | | | |
| 19. | POWER BOYDS PLANTATION | | 1 | | $150,000 | $150,000 | | |
| 20. | SUBTOTAL PUMP STATIONS | | | | | $150,000 | $54,000 | $4,000 |
| 21. | SUBTOTAL | | | | | $2,221,150 | $1,116,690 | $19,739 |
| 22. | CONTINGENCIES (15%) | | | | | $333,173 | | |
| 23. | ENGIN., LEGAL & ADMIN. COST (30%) | | | | | $666,345 | | |
| 24. | INTREST DURING CONST. (2YRS*8-5/8%* 50%) | | | | | $191,574 | | |
| 25. | TOTAL CAPITAL COST | | | | | $3,412,242 | | |
| 26. | PRESENT WORTH | | | | | $3,412,242 | $213,470 | $185,105 |
| 27. | NET PRESENT WORTH | | | | | $3,383,877 | | |

TABLE C.5-2
COST EFFECTIVENESS ANALYSIS
WPCF DESIGN CRITERIA
CRUZ BAY FACILITIES PLAN EIS

| WASTEWATER QUANTITIES | | INITIAL 1990 | DESIGN 2010 | PERCENTAGE INCREASE |
|---|---|---|---|---|
| Minimum 24 Hr. | GPD | 33,330 | 71,280 | |
| | (P.F.) | 0.33 | 0.36 | |
| Average | GPD | 101,000 | 198,000* | 96% |
| | (P.F.) | 1.00 | 1.00 | |
| Peak Hr. on Maximun Day | GPD | 565,600 | 990,000 | |
| | (P.F.) | 5.60 | 5.00 | |
| Equivalent Population | | 2,978 | 3,847 | 29% |
| **WASTEWATER CHARACTERISTICS** | | | | |
| Average Influent | | | | |
| BOD @0.20 lb/c/d | LB/D | 596 | 770 | 29% |
| TSS @0.22 lb/c/d | LB/D | 655 | 846 | 29% |
| Average Effluent | | | | |
| BOD @ 30 mg/l | LB/D | 25 | 50 | |
| TSS @ 30 mg/l | LB/D | 25 | 50 | |

* This number reflects the water use projection of 192,000 gpd, plus an additional 6000 gpd to account for infiltration into the collection system.

TABLE C.5-3
COST EFFECTIVENESS ANALYSIS
WASTEWATER TREATMENT ALTERNATIVES
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.62 PERCENT
ANALYSIS PERIOD= 20 YEARS
1985 ENR CONST. COST INDEX= 4220

| ITEM | ALTERNATIVE 1 OXIDATION DITCH PLANT | ALTERNATIVE 2 RBC PLANT | ALTERNATIVE 3 TRICKLING FILTER PLANT | ALTERNATIVE 4 RECIRC. SAND FILTER PLANT | ALTERNATIVE 5 AERATED LAGOON PLANT | ALTERNATIVE 6 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|
| CAPITAL COST BREAKDOWN | | | | | | |
| PRELIMINARY TREATMENT | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| Bar Screen | | | | | | |
| Grit Removal | | | | | | |
| Flow Metering | | | | | | |
| PRIMARY TREATMENT | | | | | | |
| Primary Clarifiers | | | 204,000 | | | 204,000 |
| Fine Screens | | 128,000 | | | | |
| Septic Tanks | | | | 270,000 | | |
| Subtotal | 0 | 128,000 | 204,000 | 270,000 | 0 | 204,000 |
| SECONDARY TREATMENT | | | | | | |
| Oxidation Ditches | 1,014,000 | | | | | |
| RBC's | | 426,000 | | | | |
| Trickling Filters | | | 1,692,000 | | | |
| Secondary Clarifiers | 410,000 | 410,000 | 410,000 | | | |
| Aerated Ponds | | | | | 728,500 | |
| Sand Filter Beds | | | | 686,000 | | |
| Dosing Chamber | | | | 35,000 | | |
| UV Disinfection | 31,500 | 31,500 | 31,500 | 48,000 | 4,500 | 38,100 |
| Subtotal | 1,455,500 | 867,500 | 2,133,500 | 769,000 | 733,000 | 38,100 |
| SLUDGE HANDLING | | | | | | |
| Rotary Thickener | 229,000 | 229,000 | 229,000 | | | 229,000 |
| Aerobic Digestors | | 256,000 | 256,000 | | | 256,000 |
| Sludge Drying Beds | 100,000 | 100,000 | 100,000 | | 100,000 | 100,000 |
| Sludge Hauling Vehicle | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 |
| Septage Lagoons | 7,000 | 7,000 | 7,000 | 29,000 | 7,000 | 7,000 |
| Subtotal | 421,000 | 677,000 | 677,000 | 114,000 | 192,000 | 677,000 |
| MISCELLANEOUS | | | | | | |
| Fencing | 10,000 | 10,000 | 10,000 | | | 10,000 |
| Sitework | 195,650 | 175,250 | 309,450 | 123,300 | 100,500 | 99,91[illegible] |
| Pickup Trucks & Maint. Equip. | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |

| ITEM | | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 | ALTERNATIVE 4 | ALTERNATIVE 5 | ALTERNATIVE 6 |
|---|---|---|---|---|---|---|---|
| Tools for Equipt. Repair | | 30,000 | 30,000 | 30,000 | 15,000 | 15,000 | 30,000 |
| Operations Building | | 99,000 | 99,000 | 99,000 | 99,000 | 99,000 | 99,000 |
| Electrical & Instr. Work | | 254,345 | 227,825 | 402,285 | 160,290 | 130,650 | 129,883 |
| Subtotal | | 603,995 | 557,075 | 865,735 | 412,590 | 360,150 | 383,793 |
| TOTAL CONST. COST | | 2,560,495 | 2,309,575 | 3,960,235 | 1,645,590 | 1,365,150 | 1,382,893 |
| CONTINGENCIES (15%) | | 384,074 | 346,436 | 594,035 | 246,839 | 204,773 | 207,434 |
| ENGIN., LEGAL, & ADMIN. COST (30%) | | 768,149 | 692,873 | 1,188,071 | 493,677 | 409,545 | 414,868 |
| INT. DUR. CONST. (2 YRS* 8-5/8%* 50%) | | 220,843 | 199,201 | 341,570 | 141,932 | 117,744 | 119,275 |
| TOTAL CAPITAL COST | | 3,933,560 | 3,548,085 | 6,083,911 | 2,528,038 | 2,097,212 | 2,124,469 |
| OPERATION AND MAINTENANCE COSTS | | | | | | | |
| ANNUAL O&M COSTS | | 97,000 | 110,000 | 108,000 | 47,000 | 42,000 | 82,000 |
| PRESENT WORTH OF O&M COSTS | | 909,648 | 1,031,560 | 1,012,804 | 440,757 | 393,868 | 768,981 |
| SALVAGE VALUE BREAKDOWN | DESIGN LIFE YRS | | | | | | |
| PRELIMINARY TREATMENT | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bar Screen | | | | | | | |
| Grit Removal | | | | | | | |
| Flow Metering | | | | | | | |
| PRIMARY TREATMENT | | | | | | | |
| Primary Clarifiers | 50%@20, 50%@50 | | | 61,200 | | | 61,200 |
| Fine Screens | 50%@20, 50%@50 | | 38,400 | | | | |
| Septic Tanks | 50 | | | | 162,000 | | |
| Subtotal | | 0 | 38,400 | 61,200 | 162,000 | 0 | 61,200 |
| SECONDARY TREATMENT | | | | | | | |
| Oxidation Ditches | 40%@20, 60%@50 | 365,000 | | | | | |
| RBC's | 50%@20, 50%@50 | | 127,800 | | | | |
| Trickling Filters | 40%@20, 60%@50 | | | 609,120 | | | |
| Secondary Clarifiers | 50%@20, 50%@50 | 123,000 | 123,000 | 123,000 | | | |
| Aerated Ponds | 30%@20, 70%@50 | | | | | 321,000 | |
| Sand Filter Beds | 50 | | | | 411,600 | | |
| Dosing Chamber | 50%@20, 50%@50 | | | | 10,500 | | |
| UV Disinfection | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 488,000 | 250,800 | 732,120 | 422,100 | 321,000 | 0 |

*Does not assume cost per year to conduct an ocean monitoring program which would be required if primary treatment could be utilized.

| ITEM | | ALTERNATIVE 1 | ALTERNATIVE 2 | ALTERNATIVE 3 | ALTERNATIVE 4 | ALTERNATIVE 5 | ALTERNATIVE 6* |
|---|---|---|---|---|---|---|---|
| SLUDGE HANDLING | | | | | | | |
| Rotary Thickener | 60%@20, 40%@50 | 55,000 | 55,000 | 55,000 | | | 55,000 |
| Aerobic Digestors | 40%@20, 60%@50 | | 92,200 | 92,200 | | | 92,200 |
| Sludge Drying Beds | 50 | 60,000 | 60,000 | 60,000 | | 60,000 | 60,000 |
| Sludge Hauling Vehicle | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Septage Lagoons | 50 | 4,200 | 4,200 | 4,200 | 17,400 | 4,200 | 4,200 |
| Subtotal | | 119,200 | 211,400 | 211,400 | 17,400 | 64,200 | 211,400 |
| MISCELLANEOUS | | | | | | | |
| Fencing | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sitework | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pickup Trucks & Maint. Eq | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tools for Equipt. Repair | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations Building | 50 | 59,000 | 59,000 | 59,000 | 59,000 | 59,000 | 59,000 |
| Electrical & Instr. Work | 50%@10, 50%@20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 59,000 | 59,000 | 59,000 | 59,000 | 59,000 | 59,000 |
| TOTAL SALVAGE VALUE | | 666,200 | 559,600 | 1,063,720 | 660,500 | 444,200 | 331,600 |
| SALVAGE VALUE PRESENT WORTH | | 127,353 | 106,975 | 203,344 | 126,263 | 84,915 | 63,390 |
| FUTURE EXPENDITURES BREAKDOWN | | | | | | | |
| SLUDGE HANDLING | | | | | | | |
| Sludge Hauling Vehicle | | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 |
| MISCELLANEOUS | | | | | | | |
| Pickup Trucks & Maint. Equip. | | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| Electrical & Instr. Work | | 127,173 | 113,913 | 201,143 | 80,145 | 65,325 | 64,942 |
| FUTURE EXPEND. TOTAL | | 227,173 | 213,913 | 301,143 | 180,145 | 165,325 | 164,942 |
| FUTURE EXPEND. PRESENT WORTH 10 year basis | | 99,325 | 93,527 | 131,666 | 78,763 | 72,284 | 72,116 |
| TOTAL PRESENT WORTH | | $4,815,181 | $4,566,197 | $7,025,037 | $2,921,295 | $2,478,449 | $2,903,177* |

*Estimated costs of a primary wastewater treatment facility are presented for comparison purposes only. As discussed in the Alternatives Chapter, primary treatment is not considered a feasible alternative.

TABLE C.5-4
COST EFFECTIVENESS ANALYSIS
FACILITY LAND REQUIREMENTS
CRUZ BAY FACILITIES PLAN EIS

| | |
|---|---|
| INTEREST RATE= | 8.625 PERCENT |
| ANALYSIS PERIOD= | 20 YEARS |
| LAND APPRECIATION RATE= | 3 PERCENT |
| 1985 ENR CONST. COST INDEX= | 4220 |

| | ALTERNATIVE | PLANT AREA REQ'D ACRES | BUFFER AREA REQ'D* ACRES | TOTAL AREA REQ'D ACRES | SITE AQUISITION COST** | SALVAGE VALUE | PRESENT WORTH OF SALVAGE VALUE | NET PRESENT WORTH |
|---|---|---|---|---|---|---|---|---|
| 1 | ALTERNATIVE 1 OXIDATION DITCH PLANT | 1.5 | 3.5 | 5 | $475,000 | $857,903 | $163,999 | $311,001 |
| 2 | ALTERNATIVE 2 RBC PLANT | 1.25 | 3.25 | 4.5 | $427,500 | $772,113 | $147,599 | $279,901 |
| 3 | ALTERNATIVE 3 TRICKLING FILTER PLANT | 1.45 | 3 | 4.8 | $456,000 | $823,587 | $157,439 | $298,561 |
| 4 | ALTERNATIVE 4 RECIRC. SAND FILTER PLANT | 4.34 | 5 | 9.64 | $915,800 | $1,654,037 | $316,191 | $599,609 |
| 5 | ALTERNATIVE 5 AERATED LAGOON PLANT | 5.44 | 6 | 11.36 | $1,079,200 | $1,949,155 | $372,607 | $706,593 |
| 6 | LAND APPLICATION SITE | 22.7 | 10 | 32.77 | $3,113,150 | $5,622,695 | $1,074,852 | $2,038,298 |

*BASED UPON 100' WIDE BUFFER ZONE SURROUNDING SITE
**LAND VALUE USED= $95,000 /ACRE

TABLE C.5-5
COST EFFECTIVENESS ANALYSIS
WPCF INFLUENT PIPING
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.625 PERCENT
ANALYSIS PERIOD= 20 YEARS
1986 ENR CONST. COST INDEX= 4220

| ITEM | DESIGN LIFE | LENGTH | SIZE | UNIT COST | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|---|---|---|---|
| CAPITAL COST BREAKDOWN | | | | | | | |
| IMPROVEMENTS TO EXISTING INFLUENT PUMP STATION | | | | | 60,000 | 60,000 | 60,000 |
| INFLUENT FORCEMAIN | | | | | | | |
| Site 1 | | 2,100 | 8 | $40 | 84,000 | | |
| Site 2 | | 3,000 | 8 | $40 | | 120,000 | |
| Site 3 | | 3,900 | 8 | $40 | | | 156,000 |
| TOTAL CONST. COST | | | | | 144,000 | 180,000 | 216,000 |
| CONTINGENCIES(15%) | | | | | 21,600 | 27,000 | 32,400 |
| ENGIN., LEGAL, & ADMIN. COST (30%) | | | | | 43,200 | 54,000 | 64,800 |
| INTEREST DURING CONST. (2YRS*8-5/8%*50%) | | | | | 12,420 | 15,525 | 18,630 |
| TOTAL CAPITAL COST | | | | | $221,220 | $276,525 | $331,830 |
| SALVAGE VALUE BREAKDOWN | DESIGN LIFE | | | | | | |
| IMPROVEMENTS TO EXISTING INFLUENT PUMP STATION | 20 | | | | 0 | 0 | 0 |
| INFLUENT FORCEMAIN | 50 | | | | | | |
| Site 1 | | 2,100 | 8 | 40 | 50,400 | | |
| Site 2 | | 3,000 | 8 | 40 | | 72,000 | |
| Site 3 | | 3,900 | 8 | 40 | | | 93,600 |
| TOTAL SALVAGE VALUE | | | | | 50,400 | 72,000 | 93,600 |
| SALVAGE VALUE PRESENT WORTH | | | | | $9,635 | $13,764 | $17,893 |
| OPERATION AND MAINTENANCE COSTS | | | | | | | |
| ANNUAL O&M COSTS | | | | | 10,900 | 30,000 | 23,300 |
| PRESENT WORTH OF O& M COSTS | | | | | $102,218 | $281,335 | $218,503 |
| TOTAL PRESENT WORTH | | | | | $313,804 | $544,096 | $532,440 |

TABLE C.5-6
COST EFFECTIVENESS ANALYSIS
WPCF EFFLUENT PIPING- OUTFALL ALTERNATIVES
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.625 PERCENT
ANALYSIS PERIOD= 20 YEARS
1986 ENR CONST. COST INDEX= 4220

| ITEM | DESIGN LIFE | LENGTH | SIZE | UNIT COST | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|---|---|---|---|
| CAPITAL COST BREAKDOWN | | | | | | | |
| EFFLUENT PUMP STATION | | | | | 200,000 | | |
| EFFLUENT FORCEMAIN | | | | | | | |
| Site 1 | | 2,200 | 8 | $40 | 88,000 | | |
| EFFLUENT GRAVITY SEWER | | | | | | | |
| Site 2 | | 3,100 | 10 | $85 | | 263,500 | |
| Site 3 | | 4,000 | 10 | $85 | | | 340,000 |
| OUTFALL (OCEAN PORTION) | | | | | | | |
| 0-30 Ft. Deep | | 1,000 | 10 | $450 | 450,000 | 450,000 | 450,000 |
| 30-40 Ft. Deep | | 500 | 10 | $500 | 250,000 | 250,000 | 250,000 |
| 40-60 Ft. Deep | | 1,400 | 10 | $600 | 840,000 | 840,000 | 840,000 |
| Over 60 Ft. Deep | | 300 | 10 | $700 | 210,000 | 210,000 | 210,000 |
| Subtotal | | 3,200 | | | 1,750,000 | 1,750,000 | 1,750,000 |
| TOTAL CONST. COST | | | | | 2,038,000 | 2,013,500 | 2,090,000 |
| CONTINGENCIES(15%) | | | | | 305,700 | 302,025 | 313,500 |
| ENGIN., LEGAL, & ADMIN. COST (30%) | | | | | 611,400 | 604,050 | 627,000 |
| INTEREST DURING CONST. (2YRS*8-5/8%*50%) | | | | | 175,778 | 173,664 | 180,263 |
| TOTAL CAPITAL COST | | | | | $3,130,878 | $3,093,239 | $3,210,763 |
| SALVAGE VALUE BREAKDOWN | | | | | | | |
| EFFLUENT PUMP STATION | 50%@20, 50%@50 | | | | 60,000 | | |
| EFFLUENT FORCEMAIN | 50 | | | | | | |
| Site 1 | | 2,200 | 8 | $40 | 52,800 | | |
| EFFLUENT GRAVITY SEWER | 50 | | | | | | |
| Site 2 | | 3,100 | 10 | $85 | | 158,100 | |
| Site 3 | | 4,000 | 10 | $85 | | | 204,000 |

| ITEM | | LENGTH | SIZE | UNIT COST | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|---|---|---|---|
| OUTFALL (OCEAN PORTION) | 50 | | | | | | |
| 0-30 Ft. Deep | | 1,000 | 10 | $450 | 270,000 | 270,000 | 270,000 |
| 30-40 Ft. Deep | | 500 | 10 | $500 | 150,000 | 150,000 | 150,000 |
| 40-60 Ft. Deep | | 1,400 | 10 | $600 | 504,000 | 504,000 | 504,000 |
| Over 60 Ft. Deep | | 300 | 10 | $700 | 126,000 | 126,000 | 126,000 |
| Subtotal | | 3,200 | | | 1,050,000 | 1,050,000 | 1,050,000 |
| TOTAL SALVAGE VALUE | | | | | 1,162,800 | 1,208,100 | 1,254,000 |
| SALVAGE VALUE PRESENT WORTH | | | | | $222,285 | $230,944 | $239,719 |
| OPERATION AND MAINTENANCE COSTS | | | | | | | |
| ANNUAL O&M COSTS | | | | | 9,900 | 0 | 0 |
| PRESENT WORTH OF O& M COSTS | | | | | $92,840 | $0 | $0 |
| TOTAL PRESENT WORTH | | | | | $3,001,433 | $2,862,295 | $2,971,044 |

TABLE C.5-7
COST EFFECTIVENESS ANALYSIS
WPCF EFFLUENT PIPING- LAND APPLICATION ALTERNATIVES
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.625 PERCENT
ANALYSIS PERIOD= 20 YEARS
1986 ENR CONST. COST INDEX= 4220

| ITEM | DESIGN LIFE | LENGTH | SIZE | UNIT COST | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|---|---|---|---|
| CAPITAL COST BREAKDOWN | | | | | | | |
| EFFLUENT PUMP STATION | | | | | 200,000 | 180,000 | |
| EFFLUENT FORCEMAIN | | | | | | | |
| Site 1 | | 3,950 | 10 | $45 | 177,750 | | |
| Site 2 | | 4,650 | 10 | $45 | | 209,250 | |
| EFFLUENT GRAVITY SEWER | | | | | | | |
| Site 3 | | 500 | 10 | $85 | | | 42,500 |
| LAND APPLICATION EQUIPMENT | | | | $414,000 | 414,000 | 414,000 | 414,000 |
| TOTAL CONST. COST | | | | | 791,750 | 803,250 | 456,500 |
| CONTINGENCIES(15%) | | | | | 118,763 | 120,488 | 68,475 |
| ENGIN., LEGAL, & ADMIN. COST (30%) | | | | | 237,525 | 240,975 | 136,950 |
| INTEREST DURING CONST. (2YRS*8-5/8%*50%) | | | | | 68,288 | 69,280 | 39,373 |
| TOTAL CAPITAL COST | | | | | $1,216,326 | $1,233,993 | $701,298 |
| SALVAGE VALUE BREAKDOWN | DESIGN LIFE | | | | | | |
| EFFLUENT PUMP STATION | 50%@20, 50%@50 | | | | 60,000 | 54,000 | |
| EFFLUENT FORCEMAIN | 50 | | | | | | |
| Site 1 | | 3,950 | 10 | $45 | 106,650 | | |
| Site 2 | | 4,650 | 10 | $45 | | 125,550 | |
| EFFLUENT GRAVITY SEWER | 50 | | | | | | |
| Site 3 | | 500 | 10 | $85 | | | 25,500 |
| LAND APPLICATION EQUIPMENT | | | | $116,000 | 116,000 | 116,000 | 116,000 |
| TOTAL SALVAGE VALUE | | | | | 282,650 | 295,550 | 141,500 |
| SALVAGE VALUE PRESENT WORTH | | | | | $54,032 | $56,498 | $27,050 |
| OPERATION AND MAINTENANCE COSTS | | | | | | | |
| ANNUAL O&M COSTS | | | | | 25,800 | 15,900 | 10,000 |
| PRESENT WORTH OF O& M COSTS | | | | | $241,948 | $149,107 | $93,778 |
| TOTAL PRESENT WORTH | | | | | $1,404,241 | $1,326,602 | $768,027 |

TABLE C.5-8
COST EFFECTIVENESS ANALYSIS
WPCF EFFLUENT PIPING- CANEEL BAY
EFFLUENT FORCEMAIN ALTERNATIVES
CRUZ BAY FACILITIES PLAN EIS

INTEREST RATE= 8.625
ANALYSIS PERIOD= 20
1986 ENR CONST. COST INDEX= 4220

| ITEM | DESIGN LIFE | LENGTH | SIZE | UNIT COST | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|---|---|---|---|
| CAPITAL COST BREAKDOWN | | | | | | | |
| EFFLUENT PUMP STATION | | | | | 200,000 | 200,000 | 200,000 |
| EFFLUENT FORCEMAIN | | | | | | | |
| Site 1 | | 8,750 | 10 | $45 | 393,750 | | |
| Site 2 | | 9,450 | 10 | $45 | | 425,250 | |
| Site 3 | | 6,300 | 10 | $45 | | | 283,500 |
| TOTAL CONST. COST | | | | | 593,750 | 625,250 | 483,500 |
| CONTINGENCIES(15%) | | | | | 89,063 | 93,788 | 72,525 |
| ENGIN., LEGAL, & ADMIN. COST (30%) | | | | | 178,125 | 187,575 | 145,050 |
| INTEREST DURING CONST. (2YRS*8-5/8%*50%) | | | | | 51,211 | 53,928 | 41,702 |
| TOTAL CAPITAL COST | | | | | $912,148 | $960,540 | $742,777 |
| SALVAGE VALUE BREAKDOWN | DESIGN LIFE | | | | | | |
| EFFLUENT PUMP STATION | 50%@20, 50%@50 | | | | 60,000 | 60,000 | 60,000 |
| EFFLUENT FORCEMAIN | 50 | | | | | | |
| Site 1 | | 8,750 | 10 | $45 | 236,250 | | |
| Site 2 | | 9,450 | 10 | $45 | | 255,150 | |
| Site 3 | | 6,300 | 10 | $45 | | | 170,100 |
| TOTAL SALVAGE VALUE | | | | | 296,250 | 315,150 | 230,100 |
| SALVAGE VALUE PRESENT WORTH | | | | | $56,632 | $60,245 | $43,987 |
| OPERATION AND MAINTENANCE COSTS | | | | | | | |
| ANNUAL O&M COSTS | | | | | 37,800 | 27,900 | 28,500 |
| PRESENT WORTH OF O& M COSTS | | | | | $354,482 | $261,641 | $267,268 |
| TOTAL PRESENT WORTH | | | | | $1,209,998 | $1,161,936 | $966,058 |

TABLE C.5-9
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE PRESENT WORTH SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH<br>Present Worth 4,815,200 | RBC PLANT<br>Present Worth 4,566,200 | TRICKLING FILTER<br>Present Worth 7,025,000 | RECIRC. SAND FILTER<br>Present Worth 2,921,300 | AERATED LAGOON<br>Present Worth 2,478,500 | 301h PRIMARY PLANT *<br>Present Worth 2,902,177 |
|---|---|---|---|---|---|---|---|
| SITE 1- W/ OUTFALL | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 313,800 | | | | | | |
| Outfall PW | 3,001,400 | | | | | | |
| Subtotal | 6,699,100 | 11,514,300 | 11,265,300 | 13,724,100 | NOT APPLICABLE | NOT APPLICABLE | 9,601,277 |
| SITE 1- W/ LAND APP. | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 313,800 | | | | | | |
| Land Application PW | 1,404,200 | | | | | | |
| Land Appl. Site PW | 2,038,300 | | | | | | |
| Subtotal | 7,140,200 | 11,955,400 | 11,706,400 | 14,165,200 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |
| SITE 1- W/ EFF. FM | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 313,800 | | | | | | |
| Caneel Forcemain PW | 1,210,000 | | | | | | |
| Subtotal | 4,907,700 | 9,722,900 | 9,473,900 | 11,932,700 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |

*Estimated costs for 301(h) Primary Plant Alternative assume the same length of ocean outfall (3,200 L.F.) as for the other (secondary treatment) alternatives. However, implementation of this alternative could require a longer ocean outfall, which would add approximately $700 per additional foot of outfall length. Primary plant costs are presented here for comparison purposes only, because the deadline for applying for marine discharge waivers expired in December 1982.

TABLE C.5-9 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE PRESENT WORTH SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH Present Worth 4,815,200 | RBC PLANT Present Worth 4,566,200 | TRICKLING FILTER Present Worth 7,025,000 | RECIRC. SAND FILTER Present Worth 2,921,300 | AERATED LAGOON Present Worth 2,478,500 | 301h PRIMARY * PLANT Present Worth 2,902,177 |
|---|---|---|---|---|---|---|---|
| **SITE 2- W/ OUTFALL** | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 544,100 | | | | | | |
| Outfall PW | 2,862,300 | | | | | | |
| Subtotal | 6,790,300 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | 298,600 |
| Total PW | | 11,916,500 | 11,636,400 | 14,113,900 | 10,311,200 | 9,975,400 | 9,991,077 |
| **SITE 2- W/ LAND APP.** | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 544,100 | | | | | | |
| Land Application PW | 1,326,600 | | | | | | |
| Land Appl. Site PW | 2,038,300 | | | | | | |
| Subtotal | 7,292,900 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | NOT |
| Total PW | | 12,419,100 | 12,139,000 | 14,616,500 | 10,813,800 | 10,478,000 | APPLICABLE |
| **SITE 2- W/ EFF. FM** | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 544,100 | | | | | | |
| Caneel Forcemain PW | 1,161,900 | | | | | | |
| Subtotal | 5,089,900 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | NOT |
| Total PW | | 10,216,100 | 9,936,000 | 12,413,500 | 8,610,800 | 8,275,000 | APPLICABLE |

*Estimated costs for 301(h) Primary Plant Alternative assume the same length of ocean outfall (3,200 L.F.) as for the other (secondary treatment) alternatives. However, implementation of this alternative could require a longer ocean outfall, which would add approximately $700 per additional foot of outfall length. Primary plant costs are presented here for comparison purposes only, because the deadline for applying for marine discharge waivers expired in December 1982.

TABLE C.5-9 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE PRESENT WORTH SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH<br>Present Worth 4,815,200 | RBC PLANT<br>Present Worth 4,566,200 | TRICKLING FILTER<br>Present Worth 7,025,000 | RECIRC. SAND FILTER<br>Present Worth 2,921,300 | AERATED LAGOON<br>Present Worth 2,478,500 | 301h PRIMARY * PLANT<br>Present Worth 2,902,177 |
|---|---|---|---|---|---|---|---|
| SITE 3- W/ OUTFALL | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 532,400 | | | | | | |
| Outfall PW | 2,971,000 | | | | | | |
| Subtotal | 6,887,300 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | 298,600 |
| Total PW | | 12,013,500 | 11,733,400 | 14,210,900 | 10,408,200 | 10,072,400 | 10,088,077 |
| SITE 3- W/ LAND APP. | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 532,400 | | | | | | |
| Land Application PW | 768,000 | | | | | | |
| Land Appl. Site PW | 2,038,300 | | | | | | |
| Subtotal | 6,722,600 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | NOT |
| Total PW | | 11,848,800 | 11,568,700 | 14,046,200 | 10,243,500 | 9,907,700 | APPLICABLE |
| SITE 3- W/ EFF. FM | | | | | | | |
| Collection System PW | 3,383,900 | | | | | | |
| Influent Sewer PW | 532,400 | | | | | | |
| Caneel Forcemain PW | 966,000 | | | | | | |
| Subtotal | 4,882,300 | | | | | | |
| WPCF Site PW | | 311,000 | 279,900 | 298,600 | 599,600 | 706,600 | NOT |
| Total PW | | 10,008,500 | 9,728,400 | 12,205,900 | 8,403,200 | 8,067,400 | APPLICABLE |

*Estimated costs for 301(h) Primary Plant Alternative assume the same length of ocean outfall (3,200 L.F.) as for the other (secondary treatment) alternatives. However, implementation of this alternative could require a longer ocean outfall, which would add approximately $700 per additional foot of outfall length. Primary plant costs are presented here for comparison purposes only, because the deadline for applying for marine discharge waivers expired in December 1982.

TABLE C.5-10
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE CAPITAL COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | Capital Cost 3,933,600 | Capital Cost 3,548,100 | Capital Cost 6,083,900 | Capital Cost 2,528,000 | Capital Cost 2,097,200 | Capital Cost 2,124,469 |
| **SITE 1- W/ OUTFALL** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 221,200 | | | | | | |
| Outfall | 3,130,900 | | | | | | |
| Subtotal | 6,764,300 | 10,697,900 | 10,312,400 | 12,848,200 | NOT APPLICABLE | NOT APPLICABLE | 8,888,769 |
| **SITE 1- W/ LAND APP.** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 221,200 | | | | | | |
| Land Application | 1,216,300 | | | | | | |
| Land Appl. Site | 3,113,200 | | | | | | |
| Subtotal | 7,962,900 | 11,896,500 | 11,511,000 | 14,046,800 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |
| **SITE 1- W/ EFF. FM** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 221,200 | | | | | | |
| Caneel Forcemain | 912,100 | | | | | | |
| Subtotal | 4,545,500 | 8,479,100 | 8,093,600 | 10,629,400 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |

TABLE C.5-10 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE CAPITAL COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | Capital Cost 3,933,600 | Capital Cost 3,548,100 | Capital Cost 6,083,900 | Capital Cost 2,528,000 | Capital Cost 2,097,200 | Capital Cost 2,124,469 |
| **SITE 2- W/ OUTFALL** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 276,500 | | | | | | |
| Outfall | 3,093,200 | | | | | | |
| Subtotal | 6,781,900 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | 456,000 |
| Total Capital Cost | | 11,190,500 | 10,757,500 | 13,321,800 | 10,225,700 | 9,958,300 | 9,362,369 |
| **SITE 2- W/ LAND APP.** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 276,500 | | | | | | |
| Land Application | 1,234,000 | | | | | | |
| Land Appl. Site | 3,113,200 | | | | | | |
| Subtotal | 8,035,900 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | NOT |
| Total Capital Cost | | 12,444,500 | 12,011,500 | 14,575,800 | 11,479,700 | 11,212,300 | APPLICABLE |
| **SITE 2- W/ EFF. FM** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 276,500 | | | | | | |
| Caneel Forcemain | 960,500 | | | | | | |
| Subtotal | 4,649,200 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | NOT |
| Total Capital Cost | | 9,057,800 | 8,624,800 | 11,189,100 | 8,093,000 | 7,825,600 | APPLICABLE |

TABLE C.5-10 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE CAPITAL COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | Capital Cost 3,933,600 | Capital Cost 3,548,100 | Capital Cost 6,083,900 | Capital Cost 2,528,000 | Capital Cost 2,097,200 | Capital Cost 2,124,469 |
| **SITE 3- W/ OUTFALL** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 331,800 | | | | | | |
| Outfall | 3,210,800 | | | | | | |
| Subtotal | 6,954,800 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | 456,000 |
| Total Capital Cost | | 11,363,400 | 10,930,400 | 13,494,700 | 10,398,600 | 10,131,200 | 9,535,269 |
| **SITE 3- W/ LAND APP.** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 331,800 | | | | | | |
| Land Application | 701,300 | | | | | | |
| Land Appl. Site | 3,113,200 | | | | | | |
| Subtotal | 7,558,500 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | NOT APPLICABLE |
| Total Capital Cost | | 11,967,100 | 11,534,100 | 14,098,400 | 11,002,300 | 10,734,900 | |
| **SITE 3- W/ EFF. FM** | | | | | | | |
| Collection System | 3,412,200 | | | | | | |
| Influent Sewer | 331,800 | | | | | | |
| Caneel Forcemain | 742,800 | | | | | | |
| Subtotal | 4,486,800 | | | | | | |
| WPCF Site | | 475,000 | 427,500 | 456,000 | 915,800 | 1,079,200 | NOT APPLICABLE |
| Total Capital Cost | | 8,895,400 | 8,462,400 | 11,026,700 | 7,930,600 | 7,663,200 | |

C.5-19

TABLE C.5-11
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE O & M COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | O & M Cost 97,000 | O & M Cost 110,000 | O & M Cost 108,000 | O & M Cost 47,000 | O & M Cost 42,000 | O & M Cost 82,000 |
| SITE 1- W/ OUTFALL | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 10,900 | | | | | | |
| Outfall | 9,900 | | | | | | |
| Subtotal | 205,900 | 302,900 | 315,900 | 313,900 | NOT APPLICABLE | NOT APPLICABLE | 287,900 |
| SITE 1- W/ LAND APP. | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 10,900 | | | | | | |
| Land Application | 25,800 | | | | | | |
| Land Appl. Site | 0 | | | | | | |
| Subtotal | 221,800 | 318,800 | 331,800 | 329,800 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |
| SITE 1- W/ EFF. FM | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 10,900 | | | | | | |
| Caneel Forcemain | 37,800 | | | | | | |
| Subtotal | 233,800 | 330,800 | 343,800 | 341,800 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |

TABLE C.5-11 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE O & M COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | O & M Cost 97,000 | O & M Cost 110,000 | O & M Cost 108,000 | O & M Cost 47,000 | O & M Cost 42,000 | O & M Cost 82,000 |
| **SITE 2- W/ OUTFALL** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 30,000 | | | | | | |
| Outfall | 0 | | | | | | |
| Subtotal | 215,100 | | | | | | |
| Total O & M Cost | | 312,100 | 325,100 | 323,100 | 262,100 | 257,100 | 297,100 |
| **SITE 2- W/ LAND APP.** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 30,000 | | | | | | |
| Land Application | 15,900 | | | | | | |
| Land Appl. Site | 0 | | | | | | |
| Subtotal | 231,000 | | | | | | |
| Total O & M Cost | | 328,000 | 341,000 | 339,000 | 278,000 | 273,000 | NOT APPLICABLE |
| **SITE 2- W/ EFF. FM** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 30,000 | | | | | | |
| Caneel Forcemain | 27,900 | | | | | | |
| Subtotal | 243,000 | | | | | | |
| Total O & M Cost | | 340,000 | 353,000 | 351,000 | 290,000 | 285,000 | NOT APPLICABLE |

C.5-21

TABLE C.5-11 - Continued
COST EFFECTIVENESS ANALYSIS
ALTERNATIVE O & M COST SUMMARY
CRUZ BAY FACILITIES PLAN EIS

| | | OXIDATION DITCH | RBC PLANT | TRICKLING FILTER | RECIRC. SAND FILTER | AERATED LAGOON | 301h PRIMARY PLANT |
|---|---|---|---|---|---|---|---|
| | | O & M Cost 97,000 | O & M Cost 110,000 | O & M Cost 108,000 | O & M Cost 47,000 | O & M Cost 42,000 | O & M Cost 82,000 |
| **SITE 3- W/ OUTFALL** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 23,300 | | | | | | |
| Outfall | 0 | | | | | | |
| Subtotal | 208,400 | | | | | | |
| Total O & M Cost | | 305,400 | 318,400 | 316,400 | 255,400 | 250,400 | 290,400 |
| **SITE 3- W/ LAND APP.** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 23,300 | | | | | | |
| Land Application | 10,000 | | | | | | |
| Land Appl. Site | 0 | | | | | | |
| Subtotal | 218,400 | | | | | | |
| Total O & M Cost | | 315,400 | 328,400 | 326,400 | 265,400 | 260,400 | NOT APPLICABLE |
| **SITE 3- W/ EFF. FM** | | | | | | | |
| Collection System | 185,100 | | | | | | |
| Influent Sewer | 23,300 | | | | | | |
| Caneel Forcemain | 28,500 | | | | | | |
| Subtotal | 236,900 | | | | | | |
| Total O & M Cost | | 333,900 | 346,900 | 344,900 | 283,900 | 278,900 | NOT APPLICABLE |

# APPENDIX C.6

## Section 301(h) Background Information

## APPENDIX C.6

### Section 301(h) Background Information

The Clean Water Act of 1977 included provisions under Section 301(h) which allow publicly owned treatment works (POTWs) to apply for a modified National Pollutant Discharge Elimination System (NPDES) permit to discharge effluent receiving less-than-secondary treatment to marine waters. Section (301) (h) provides that the Administrator of the Environmental Protection Agency (EPA), with the concurrence of the State, may issue an NPDES permit to a POTW which modifies the Federal secondary treatment requirements for POTW discharges into certain ocean or estuarine waters if the POTW adequately demonstrates that the modification would not impair the integrity of the marine receiving waters and biota. Regulations implementing section 301(h) were first issued by EPA in June, 1979 (44 FR 34784, 40 CFR Part 125, Subpart G).

Section 301(h) was subsequently amended by the Municipal Wastewater Treatment Construction Grant Amendments of 1981 (P.L. 97-117) and now specifies that: The Administrator, with the concurrence of the State, may issue a permit under Section 402 which modifies the requirements of subsection (b) (1) (B) of this section with respect to the discharge of any pollutant from a publicly owned treatment works into marine waters, if the applicant demonstrates to the satisfaction of the Administrator that:

1) there is an applicable water quality standard specific to the pollutant for which the modification is requested, which has been identified under Section 304(a) (6) of this Act;

2) such modified requirements will not interfere with the attainment or maintenance of that water quality which assures protection of public water supplies and the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife, and allows recreational activities, in and on the water;

3) the applicant has established a system for monitoring the impact of such discharge on a representative sample of aquatic biota to the extent practicable;

4) such modified requirements will not result in any additional requirements on any other point or nonpoint source;

5) all applicable pretreatment requirements for sources introducing waste into such treatment works will be enforced;

6) to the extent practicable, the applicant has established a schedule of activities designed to eliminate the entrance of toxic pollutants from non-industrial sources into such treatment works;

7) there will be no new or substantially increased discharges from the point source of the pollutant to which the modification applies above that volume of discharge specified in the permit;

For the purposes of this subsection the phrase "the discharge of any pollutant into marine waters" refers to a discharge into deep waters of the territorial sea or the waters of the contiguous zone, or into saline estuarine waters where there is strong tidal movement and other hydrological and geological characteristics which the Administrator determines necessary to allow compliance with paragraph (2) of this subsection and section 101(a) (2) of the Act. A municipality which applies secondary treatment shall be eligible to receive a permit pursuant to this subsection which modifies the requirements of subsection (b) (1) (B) of this section with respect to the discharge of any pollutant from any treatment works owned by such municipality into marine waters. No permit issued under this subsection shall authorize the discharge of sewage sludge into marine waters. The 1981 Amendments to the Clean Water Act (P.L. 97-117) provided for submission of 301(h) applications for marine discharge waivers for one year from the date of the Amendments (i.e., until December 29, 1982). Thus, the law precludes submission of new waiver applications.

# APPENDIX D.

## BENTHIC SURVEY

# TURNER BAY BENTHIC SURVEY
# FOR THE PROPOSED OUTFALL ROUTE

PREPARED BY

Department of Conservation and Cultural Affairs

Division of Natural Resources Management

Ambient Monitoring Staff

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May 1986

# TURNER BAY BENTHIC SURVEY
# FOR THE PROPOSED OUTFALL ROUTE

## INTRODUCTION

Biologists from the Department of Conservation, Division of Natural Resources Management (NRM) conducted a benthic survey of Turner Bay, St. John during the weeks of Jan. 13-17 and Feb. 24-28, 1986. This project was done as an intensive survey for the Ambient Monitoring Program to document existing conditions in Turner Bay inconjunction with the EIS being prepared by C.E. Maguire, Inc. for the proposed Wastewater Treatment Facilities Plan.

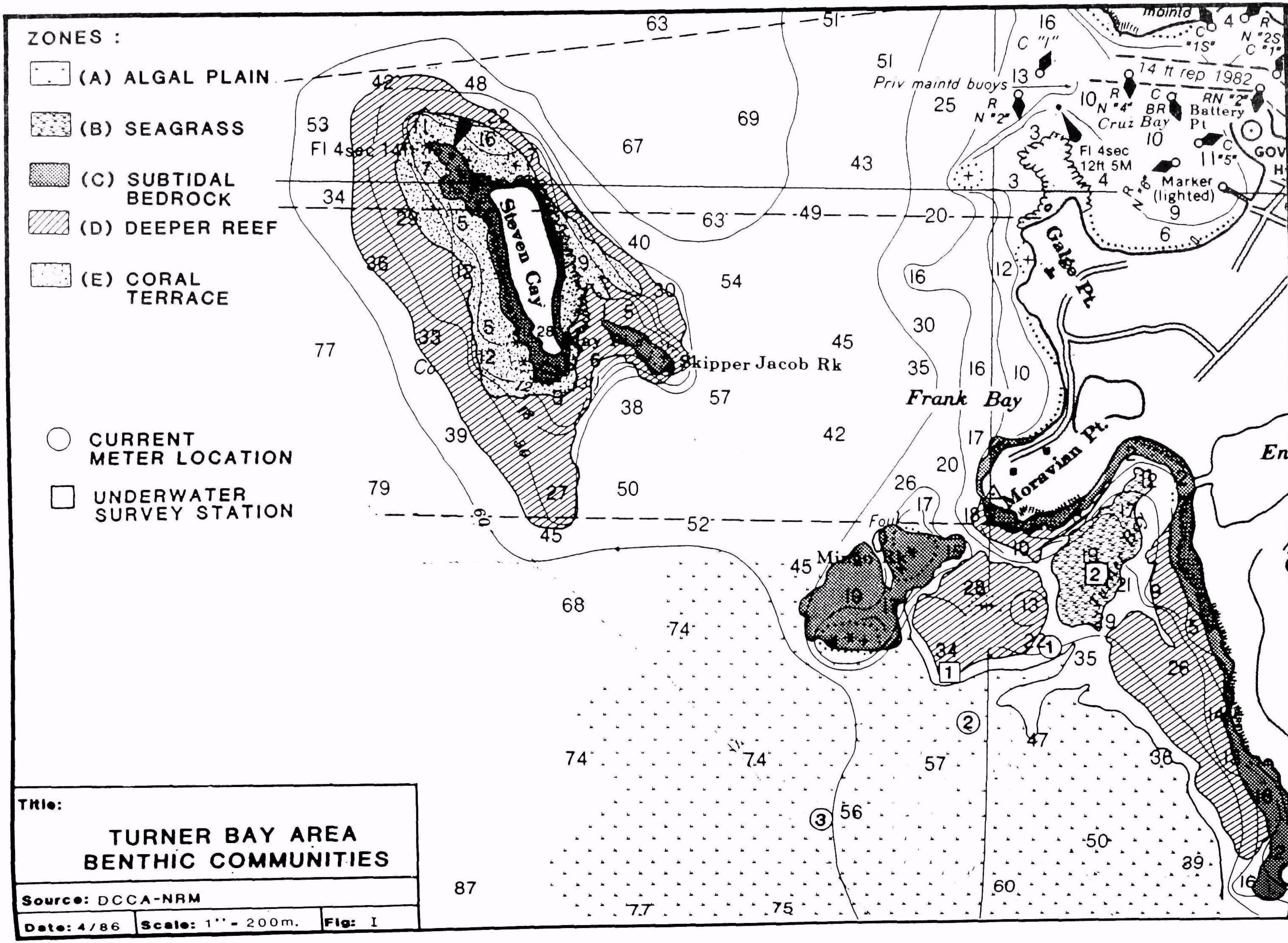
The nearshore waters of Turner Bay, on the west coast of St. John, support important marine resources. The major ecological zones in this area have been mapped using aerial photographs and underwater (U/W) surveying. Each zone is described in detail in the following sections.

## SEAGRASS AREA

Figure 1 shows the extent of seagrass in Turner Bay (Zone B). There is a dense patch of seagrass in the shallow central part of Turner Bay, becoming more patchy eastward. Sand channels (non-colored areas) separate this zone from the coral areas on either side. It appears from previous maps that the extent of seagrass in this area has decreased over the years, which is consistant with seagrass loss observed throughout the Caribbean. This is probably due to the increase load of silt and waste from Eighed Pond and land runoff.

To characterize the seagrass community in Turner Bay, and to establish a long-term monitoring site, Station 2 was marked in 6 meters of water (Fig. 1). Underwater observations and measurements of this community were made within a 25 m. radius of the permanent marker. Twenty seven 10x20 cm. random quadrats were examined around Station 2 for macroalgae, invertebrates and seagrass density. (For more details of methods used, see Rogers 1982). A summary of these observations is given in Table 1. The seagrass community in Turner Bay is a mixed association of two major Caribbean seagrass species, Thalassia testudunum Konig, and Syringodium filiforme Kutzing, and a multispecific assemblage of algae. Algal coverage was generally less than 10%, composed largely of calcified greens (Table 1). The seagrass blades were long, had few epiphytes and had densities typical of other Caribbean seagrass beds (Table 1).

The benthic community at Station 2 appears to be a healthy Caribbean seagrass bed. Seagrass beds are areas of limited distribution with significant economic and ecological importance. Care should be taken to protect this diminishing valuable resource.


ZONES :
(A) ALGAL PLAIN
(B) SEAGRASS
(C) SUBTIDAL BEDROCK
(D) DEEPER REEF
(E) CORAL TERRACE
CURRENT METER LOCATION
UNDERWATER SURVEY STATION
Steven Cay
Skipper Jacob Rk
Frank Bay
Moravian Pt.
Galge Pt.
Cruz Bay
Battery Pt
Mingo Rk
Priv maintd buoys
14 ft rep 1982
Fl 4sec 12ft 5M
Marker (lighted)
Title:
TURNER BAY AREA BENTHIC COMMUNITIES
Source: DCCA-NRM
Date: 4/86
Scale: 1" - 200m.
Fig: I

## Table 1
## Benthic Biota at Station 2, Seagrass Bed

Seagrass

| type | mean number/$m^2$+S.D. (n=27) |
|---|---|
| *Thalassia* plants | 894 + 208 |
| *Thalassia* blades | 2041 + 530 |
| *Syringodium* blades | 1187 + 497 |

Algae observed in order of decreasing abundance

*Lithothamnium sp.* (ca. 5-10%)

*Halimeda spp.*

*Penicillus capitatus*

*Dictyosphaeria cavernosa*

*Udotea sp.*

*Amphiroa sp.*

*Anadyomena stellata*

*Valonia ventriculosa*

*Avrainvillea nigricans*

*Dasya pedicellata*

*Calithamnion sp.*

*Ceramium nitens*

Invertebrates observed in order of decreasing abundance

(Scleractinia) *Manicina areolata* (less than 1% ave. cover)
*Cladocora arbuscula*

(Foraminifera) *Gypsina sp.*

Unidentified sponges

ALGAL PLAIN AREA

As is typical in the deeper coastal waters of the V.I., the outer portions of Turner Bay have an extensive algal plain (Fig. 1, Zone A). These areas are largely covered by carbonate nodules which are formed by coralline algae and encrusting foraminifera. The nodules and an ocassional large sponge provide some limited habitat complexity in what is otherwise a very flat and relatively featureless area. Despite low habitat complexity, algal plains harbor a diverse and productive algal community which support many small invertebrates and fish. Some believe these areas play a significant role as habitat for postlarval settlement of commercial species of fishes (Olsen, Boulon, McCrain 1981).

In order to characterize this area, NRM divers made observations in several locations. Divers swam a transect 16 m. in depth from Contant Point to Zone B. In addition, observations were recorded and U/W photographs were taken in the areas surrounding each of the three current meters (Fig. 1, 2, 3). Table 2 lists the algal species identified at each of these areas. Additional details are presented in the following paragraphs.

In addition to the predominant algal community observed during the transect swim, several (17) large queen conch and milk conch (Strombus spp.) were observed. Other invertebrates observed in smaller numbers were penshells (Pinna carnea), lobsters, crabs, shrimps, anemonies, sponges, and hydrozoans.

The benthic communities in the vicinity of current meter #2 (18 m.) and #3 (21 m.) were similar. The dominant benthic community found in this high current area was a diverse population of large algae (Table 2). Many gorgonians (e.g. Gorgonia spp., Briareum sp.) and sponges (including the large barrel sponge Xestospongia muta) were observed. Other macroinvertebrates observed in lesser abundance were squid (Sepioteuthis sepioidea), queen conch and the trumpet triton (Charonia variegata). Several species of stony corals (Scleractinia) were observed, although the percent live cover of these was estimated as less than 1 %. The following species were observed: Stephanocoenia michelinii, Agaricia spp., Siderastrea siderea, Porites porites, Manicina areolata, Montastraea cavernosa, Dichocoenia stokesi, Millepora alcicornis. Small fish were common in these areas. The following is a list of fish observed during our dives (for the generic names see Table 4) : blue tang, squirrelfish, bicolor damselfish, rock beauty, yellow head wrasse, surgeonfish, reef butterfly, french angelfish, stripped parrotfish, and red hind. The sediments in these areas are coarse with large calcareous nodules. In places, there was only 8 cm. of sediment overlaying the bedrock.

Current meter #1 (10 m. depth) was located on the fringe of a reef and so has a great abundance of large gorgonians and sponges. Several species of scleractinian corals and fish were also observed. A more detailed description of these reefs is given in the Coral Reef Area section.

Table 2
Algae Observed in Zone A, Algal Plain

Chloorophyta (Green algae)

Neomeris annulata
Valonia ventricosa
Valoniopsis pachynema
Chamaedoris peniculum
Dictyosphaeria cavernosa
Anadyomene stellata
Caulerpa prolifera
C. mexicana
C. sertulariodes
C. cupressoides
C. racemosa V. macrophysa
Avrainvillea nigricans
Udotea sp.
Pencillus capitatus
P. dumetosus
Halimeda spp.
Codium spp.

Phaeophyta (Brown algae)

Dictyota spp.
Lobophora variegata
Sargassum spp.

Rhodophyta (Red algae)

Liagora sp.
Galaxaura sp.
Asparagopsis taxiformis
Halymenia sp.
Grateloupia sp.
Gracilaria cylindrica
Eucheuma sp.
Hypnea sp.
Chrysymenia enteromorpha
Champia parvula
Wrangelia argus
Callithmnion sp.
Ceramium nitens
Hypoglossum tenuifolium
Martensia pavonia
Dasya pedicellata
Dictyurus occidentalis
Digenia simplex
Wrightiella tumanowicz
Chondria sp.
Acanthorphora spicifera

Figure 2
Typical view of the Algal Plain habitat at current meter #3.

Figure 3
View of algae in the Algal Plain

CORAL REEF AREAS

There are several reef areas in the vicinity of Turner Bay, St. John (Fig. 1). Much of the biota in the very shallow areas (Zone D) are dominated by only a few species with little or no stony corals. A more diverse benthic community and a higher coverage of coral occur in the deeper areas (Zone C). In an attempt to describe the different reef morphologies, divers took U/W photographs (Fig. 4-8) and observations in these areas. In addition, a permanent coral monitoring station was established at Station 1 (Fig.1). Corals and fish found in reef areas are given in Tables 3 and 4.

Moravian Point

The submarine extension of Moravian Point is marked by a shallow area composed of bedrock and large boulders (Zone C). The biota in this area (ca. depth of 3 m. to surface) is limited due to high currents, wave exposure and high light intensities. Dominating the benthic community here are the encrusting hydrozoan *Millepora alcicornis* and the zoanthid *Palythoa* (Fig. 4).

Moving down the slope to the SE, *Millepora* becomes less dominant. A zone of mixed corals begins to occur (Zone D) with large scleratinian corals dominating. Deeper down the slope (ca. 10 m.) the soft corals (gorgonians and sea fans) become more abundant (Fig. 7). The coral area ends as the slope flattens out to a sandy zone (ca. 18 m.) which separates it from the seagrass area (Zone B).

To establish a monitoring site and to more accurately quantify the benthic components in Zone D, linear transects were marked at Station 1 (Fig. 1). These transects were examined for percentage of live and dead coral, the relative abundance of each coral species, and the bottom topographical complexity, according to the method given in Rogers *et al.*, 1983. Of the thirty linear meters examined, 54.5% was dead coral, 11.0% was live coral and 14.8% was other invertebrates (sponges, Erythropodium, and other gorgonians). The remaining 19.7% was covered by sand. The spatial complexity was calculated to be 1.4. The coral species found in this area and their relative abundances are given in Table C.

Stevens Cay

Figure 1 shows the ecological zones surrounding Stevens Cay. In shallow areas bordering the Cay and the rocks to the southeast, there is a subtidal bedrock community similar to that described in the shallow submarine extension of Moravian Point. Occasional small colonies of Montastraea, Porites, and Siderastrea were observed. Seaward of this zone (Zone E) there was a sandy coral terrace with large coral buttresses. The following corals dominated this zone: Acropora palmata, A. cervicornis, Dendrogyra cylindrus, and Montastraea annularis. Separating Zone C from Zone E on the eastern margin of the Cay was a small ledge fringed with large colonies of Porites porites, P. furcata, and Halimeda. A diverse assemblage of gorgonians and stony corals occurred in the deeper areas around the Cay, similar to that described for Zone D in the previous section.

The benthic communities occurring on the submarine extension of Moravian Point and on Stevens Cay appear to be typically diverse healthy reef communities. Corals can be damaged by an increase in sedimentation and water turbidity which could occur from both the operation and the construction of the wastewater outfall. An ocean outfall should be installed and operated in such a manner as not to affect this community.

Table 3
Corals at Station 1 and Vicinity

Corals found in Coral Transects

| | percentage of live coral |
|---|---|
| *Porites porites* | 19.9 |
| *Montastraea cavernosa* | 19.6 |
| *Agaricia agaricites* | 10.0 |
| *Siderastrea siderea* | 10.0 |
| *Millepora spp.* | 7.9 |
| *Montastraea annularis* | 7.0 |
| *Porites astreoides* | 7.0 |
| *Stephanocoenia michelinii* | 6.7 |
| *Diploria clivosa* | 6.2 |
| *Madracis decactis* | 2.3 |
| *Porites furcata* | 1.2 |
| *Helioseris cucullata* | 1.2 |
| *Manicina areolata* | 0.9 |

Additional corals found in coral area during the study but not recorded in the transects.

*Acropora cervicornis*
*A. palmata*
*Colpophyllia natans*
*Dendrogyra cylindrus*
*Dichocoenia stokesi*
*Diploria labyrinthiformes*
*D. strigosa*
*Eusmilia fastigiata*
*Favia fragum*
*Isophyllastrea rigida*
*Isophyllia sinuosa*
*Meandrina meandrites*
*Mycetophyllia ferox*
*Siderastrea radians*
*Tubastrea aurea*

TABLE 4
Fish Observed In Turner Bay Area
St. John

DASYATIDAE
- Dasyatis americana Hildebrand & Schroeder (Southern Stringray)

CONGRIDAE
- Nystactichthys halis Bohlke (Garden Eel)

MURAENIDAE
- Gymnothorax moringa (Cuvier) (Spotted Morey)

SYNODONTIDAE
- Lizardfishes

HOLOCENTRIDAE
- Holocentrus ascensionis (Osbeck) (Squirrelfish)
- Myripristis jacobus Cuvier (Blackbar Soldierfish)

AULOSTOMIDAE
- Aulostomus maculatus Valenciennes (Trumpetfish)

SPHYRAENIDAE
- Sphyraena barracuda (Walbaum) (Great Barracuda)

SERRANIDAE
- Cephalopholis fulva (Linnaeus) (Coney)
- Epinephelus adscensionis (Osbeck) (Rock Hind)
- E. guttatus (Linnaeus) (Red Hind)
- E. striatus (Bloch) (Nassau Grouper)
- Hypoplectrus nigricans (Poey) (Black Hamlet)
- Serranus tigrinus (Bloch) (Harlequin Bass)
- Petrometopon cruentatum (Lacepede) (Graysby)
- Mycteroperca tigris (Cuvier and Valenciennes) (Tiger Grouper)

GRAMMIDAE
- Gramma loreto Poey (Fairy Basslet)

PRIACANTHIDAE
- Priacanthus cruentatus (Linnaeus) (Glasseye Snapper)

CARANGIDAE
- Caranx ruber (Bloch) (Bar Jack)

LUTJANIDAE

*Lutjanus apodus* (Walbaum)
(Schoolmaster)
*L. griseus* (Linnaeus)
(Gray Snapper)

POMADASYIDAE

*Haemulon aurolineatum* Cuvier
(Tomtate)
*H. chrysargyreum* Gunther
(Smallmouth Grunt)
*H. macrostomum* Gunther
(Spanish Grunt)
*H. album* Cuvier and Valenciennes
(Margate)
*H. flavolineatum* (Desmarest)
(French Grunt)
*H. plumieri* (Lacepede)
(White Grunt)
*H. sciurus* (Shaw)
(Bluestriped Grunt)

SPARIDAE

*Calamus bajonado* (Bloch and Schneider)
(Jolthead Porgy)

SCIAENIDAE

*Equetus punctatus* Bloch & Schneider
(Spotted Drum)

MULLIDAE

*Mulloidichthys martinicus* (Cuvier)
(Yellow Goatfish)
*Pseudupeneus maculatus* (Bloch)
(Spotted Goatfish)

KYPHOSIDAE

*Kyphosus sectatrix* (Linnaeus)
(Bermuda Chub)

EPHIPPIDAE

*Chaetodipterus faber* (Broussonet)
(Atlantic Spadefish)

POMACANTHIDAE

*Holacanthus ciliaris* (Linnaeus)
(Queen Angelfish)
*H. tricolor* (Bloch)
(Rock Beauty)
*Pomacanthus arcuatus* (Linnaeus)
(Gray Angelfish)
*P. paru* (Bloch)
(French Angelfish)

CHAETODONTIDAE

*Chaetodon capistratus* Linnaeus
(Foureye Butterflyfish)
*C. striatus* Linnaeus
(Banded Butterfly)

POMACENTRIDAE

*Abudefduf saxatilis* (Linnaeus)
(Sergeant Major)

Chromis cyanea (Poey)
(Blue Chromis)
C. multilineata (Guichenot)
(Brown Chromis)
Eupomacentrus leucostictus (Muller & Troschel)
(Beaugregory)
E. fuscus (Cuvier and Valenciennes)
(Dusky Damselfish)
E. partitus (Poey)
(Bicolor Damselfish)
E. planifrons (Cuvier)
(Threespot Damselfish)
E. variabilis (castelnau)
(Cocoa Damselfish)
E. microspathodon chrysurus (Cuvier)
(Yellowtail Damselfish)

CIRRHITHIDAE

Amblycirrhitus pinos (Mowbray)
(Redspotted Hawkfish)

LABRIDAE

Bodianus rufus (Linnaeus)
(Spanish Hogfish)
Clepticus parrai (Bloch & Schneider)
(Creole Wrasse)
Halichoeres garnoti (Valenciennes)
(Yellowhead Wrasse)
H. radiatus (Linnaeus)
(Puddingwife)
Hemipteronotus novacula (Linnaeus)
(Pearly Razorfish)
Thalassoma bifasciatum (Bloch)
(Bluehead Wrasse)

SCARIDAE

Scarus iserti (Bloch)
(Striped Parrotfish)
S. taeniopterus Desmarest
(Princess Parrotfish)
S. vetula Bloch & Schneider
(Queen Parrot)
Sparisoma aurofrenatum (Valenciennes)
(Redband Parrot)
S. rubripinne (Valenciennes)
(Yellowtail Parrotfish)
S. viride (Bonaterre)
(Stoplight Parrot)

BLENNIIDAE

Ophioblennius atlanticus (Valenciennes)
(Redlip Blenny)

GOBIIDAE

Corphopterus glaucofraenum Gill
(Bridled Goby)
C. personatus (Jordan & Thompson)
(Masked Goby)

ACANTHURIDAE

*Acanthurus bahianus* Castelnau
(Ocean Surgeon)
*A. chirurgus* (Bloch)
(Doctorfish)
*A. coeruleus* (Bloch & Schneider)
(Blue Tang)

BALISTIDAE

*Balistes vetula* Linnaeus
(Queen Triggerfish)
*Cantherhines pullus* (Ranzani)
(Orangespotted Filefish)

OSTRACIIDAE

*Lactophrys bicaudalis* (Linnaeus)
(Spotted Trunkfish)
*L. triquetar* (Linnaeuus)
(Smooth Trunkfish)

TETRAODONTIDAE

*Canthigaster rostrata* (Bloch)
(Sharpnose Puffer)

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Total number of species 73

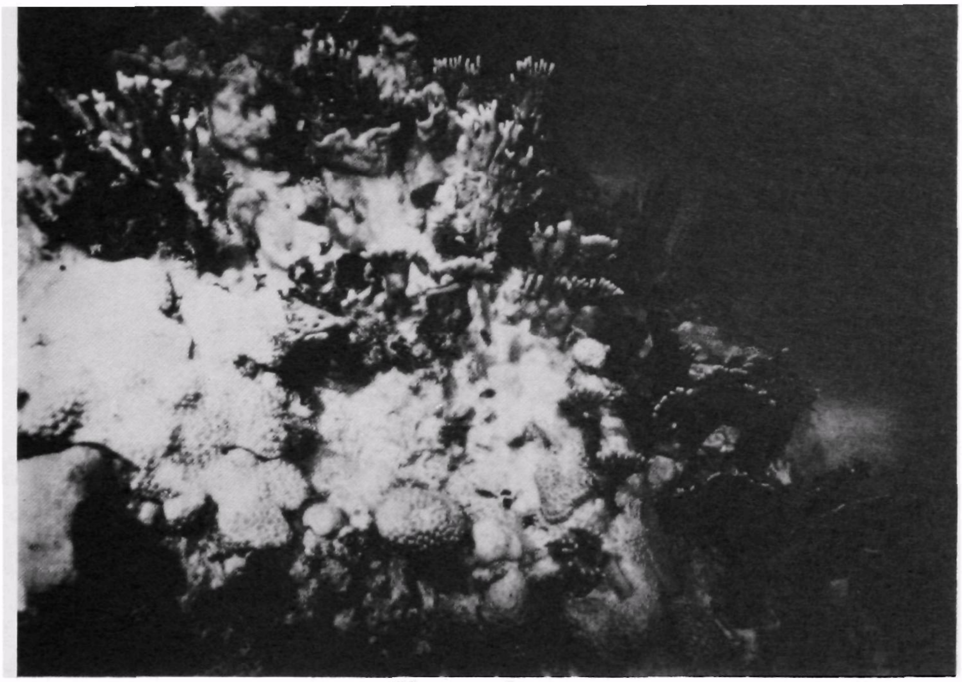

Figure 4
Millepora and Palythoa dominate Zone C in the shallow areas of Morovian Point.

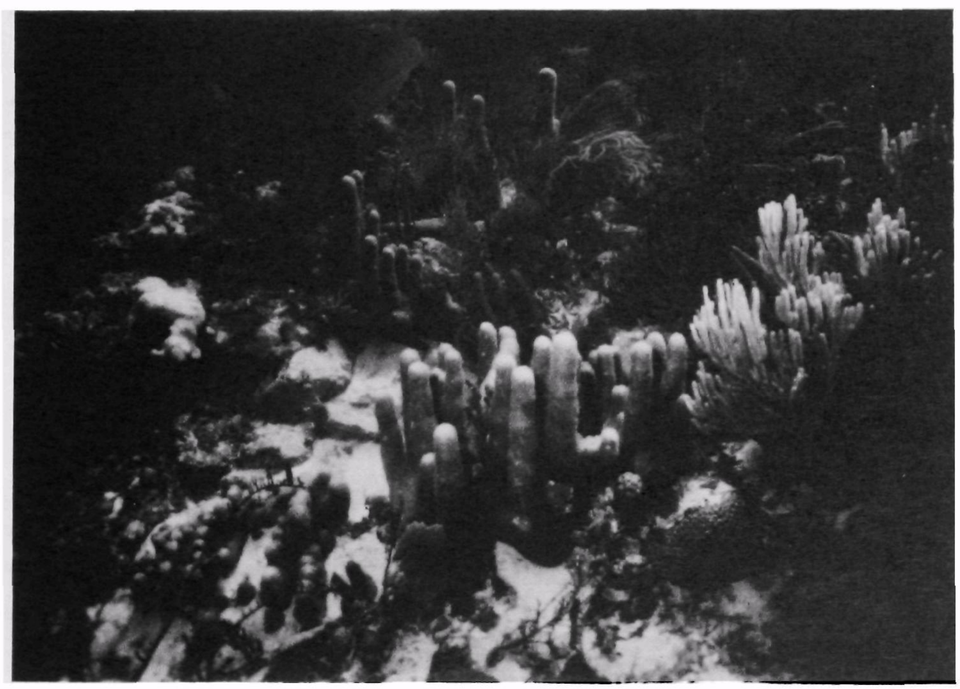

Figure 5
Typical view of the mixed coral community in the deeper reef area. A colony of Dendrogyra and several species of gorgonians are seen here.

Figure 6

The mixed coral zone is a diverse community of several species of gorgorians and stony corals.

Figure 7
Gorgonians dominate the deeper reef areas around Morovian Point.

Figure 8
Corals become less abundant as the reef slopes down to the sand channel.

PROPOSED PIPELINE ROUTE

When selecting an ocean outfall location, one of the major considerations should be the potential impact to the environment and the organisms which inhabit it. Two types of impacts must be considered: the short-term pipeline installation impacts (blasting, trenching, burying the pipe) and the chronic effects of the wastewater effluent. To minimize the environmental impacts of an ocean outfall, priority must be given to the preservation of the critical habitats in the area (seagrass beds and coral reefs). This is especially important in Turner Bay where coral reefs and seagrass beds are common.

One possible location for the pipeline, that would minimize the destruction of seagrass and coral reef during installation, is in the sand channel just north of Zone B. Biologists surveyed the length of this sand channel which separates Zone B from Zone D, starting at Enighed Pond. They found that its width varies from 4-14 m. and it is fairly well defined to a depth of 18 m. They also found that this sand channel supports relatively little benthic biota.

The shoreline area around the pond inlet is fringed with a narrow section of boulders and bedrock which support small amounts of coral and algae. Numerous colonies of dead coral were noted in this area. The coral in this area was probably damaged when subjected to the turbid discharge of Enighed Pond (opened to the sea in 1950).

The shallow part of the sand channel (<9m.) has a few large Montastraea annularis heads which appear to be in poor health (partially overgrown with algae). Other biota that were found in small abundance include, drifting algae (Lobophora, Dictyota, Chaetomorpha), stony corals (Dendrogyra, Porites astreoides) and an encrusting hydrozoan (Millepora). Following the sand channel seaward, there is a patch of the pioneering seagrass

Halodule wrightii at ca. 10 m.. At a slightly deeper depth, other seagrass (Thalassia, Syringodium) algae (Udotea, Penicillus, Halimeda, Wrangelia, Dasya, encrusting blue-greens) and invertebrates (Oreaster, Strombus) were observed. Moving seaward, this area quickly thins to sand.

From depths of 12 to 18 m. the channel has relatively little benthic biota. Several patches of garden eels were observed in these sandy areas. Stringrays and lizard fish were occasionally observed feeding. Although rare, scattered clumps of reef invertebrates were also observed (tube sponges, Porites furcata, Millepora, Madracis decactis, gorgonians).

At 17 m. the number of gorgonians, algae and sponges became more abundant, making the channel less distinct. This flat plain was dominated by gorgonians and algae (Sargassum, Caulerpa racemosa, Valonia) with small amounts of stony coral (Montastraea cavernosa, Acropora cervicornis, Siderastrea siderea).

In addition to the direct destruction of the benthic biota by trenching and burying, adjacent biota could be indirectly stressed by an increase in sedimentation rates and water turbidity. Sediments containing a high percentage of fines would stay in suspension longest and could stress communities some distance from the site. Sediment samples analyzed by NRM staff showed a relatively small fine fraction (<3 % mud) in the sand channel and a slightly higher fine fraction in the seagrass area (<6 % mud) at a depth of ca. 7 m. of depth. Divers noted that sediments along the entire channel had only a very small fine fraction.

The impact from the wastewater effluent on critical habitats is also an important consideration. The outfall should extend far enough so that nearshore reefs and beaches are not affected. If the pipeline was installed along the above described route to a depth of 18 or more meters, it is doubtful that marine biota would be affected. Since the distance from the reef is so great and the current so strong, it is unlikely that domestic sewage (no industrial wastewater) would adversely impact the reefs. Current studies measuring dilution should confirm this.

## References

Olsen, D.A., Boulon, R. and G.R. McCrain. 1981. An analysis of the St. Thomas fishery with special reference to the benthic communities on the shelf south of St. Thomas, USVI. A report submitted to the Dept. of Fish and Wildlife, USVI.

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Rogers, C.S., Gilnack, M., and C.H. Fitz. 1983. Monitoring of coral reefs with linear transects: A study of storm damage. J. Exp. Mar. Biol. Ecol. 66:285-300.

APPENDIX D, (cont.)

## WATER QUALITY IN THE VICINITY OF TURNER BAY, ST. JOHN, USVI

The United States Virgin Islands Department of Conservation and Cultural Affairs Division of Natural Resources Management, DCCA/NRM, maintains a water quality monitoring station in Turner Bay (SJ 55) approximately 50 feet off of the drainage canal from Enighed Pond. Water quality data for this station including temperature (T), salinity (S), dissolved oxygen (D.O.), pH (because of the consistency of data and lack of significant pH altering inputs, this parameter is no longer measured routinely by DCCA/NRM), turbidity (T), total suspended solids (TSS), nitrate ($NO_3$), nitrite ($NO_2$), total phosphorous (P) and fecal coliforms (FC) from 1973 to the present is included on the attached data summary sheets.

The most recent routine sampling was performed on 1/23/86 and 3/18/86 at SJ 55 and at a location approximately 500 meters southwest of SJ 55 (SJ 55a). The data for SJ 55a is summarized below.

| | T(C) | S(°/₀₀) | D.O.(mg/1) | T(NTU) | TSS(mg/1) | $NO_3$ | $NO_2$ | P (mg/1) | F.C. (#/100ml) |
|---|---|---|---|---|---|---|---|---|---|
| 1/23 | 25.0 | 35.0 | 6.5 | 0.24 | 0.4 | 0.1 | 0.01 | 0.01 | 0 |
| 3/18 | 27.5 | 34.0 | 6.5 | 0.34 | 0.9 | 0.1 | 0.01 | 0.01 | 0 |

Temperature, salinity and dissolved oxygen profiles were also performed at this location. With the exception of some slight surface warming, the values were uniform from surface to bottom which is typical of the well mixed condition of nearshore waters in the USVI.

Inspite of the input from intermittently contaminated Enighed Pond, water quality in the vicinity of Turner Bay fully supports its designated use as class "B" water (see attached USVI Water Quality Standards). The vast assimilation capabilities of the clear, nutrient poor, well flushed waters of the

Caribbean, as exemplified by SJ 55 and SJ 55a, are why well designed ocean outfalls are such advantageous methods of wastewater disposal in the region.

Based on the water quality data collected to date and wastewater dilution information gained during the 301h waiver application study for St. Thomas and St. Croix, DCCA/NRM is of the opinion that the proposed Cruz Bay Region Wastewater Facility discharge (200,000 gpd of secondarily treated wastewater) will not cause violations of any USVIWQS and that the probable impact on the water quality in the vicinity of the proposed outfall will be negligible.

SUMMARY OF WATER QUALITY DATA

ST. JOHN

STATION No. 55

TURNER BAY - 50' off drain to Enighed Pond

Water Depth 3½/4½ meters

| YEAR | 1973 | | | | | 1974 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1/3 | 1/29 | 5/9 | 6/27 | 9/26 | 4/25 | 6/4 | 9/13 | 10/8 | 11/25 | 12/1 |
| Temp. °C. | 27.0 | 26.7 | 28.5 | 29.0 | 28.8 | 26.1 | 27.3 | 28.5 | 28.3 | 27.0 | 27.0 |
| Salinity ppt | 36.4 | 34.7 | 36.1 | - | 35.6 | 34.7 | 36.1 | 35.5 | 36.6 | 34.9 | 34.1 |
| Diss.Oxy. mg/1 | 6.7 | 6.3 | 6.7 | 6.7 | 6.25 | 6.6 | 6.6 | 6.0 | 5.9 | 6.7 | 6.5 |
| pH | 8.2 | 8.2 | 8.2 | 8.15 | 8.25 | 8.25 | 8.35 | 8.2 | 8.2 | 8.2 | 8.2 |
| Turbidity FTU | 0.5 | 1.2 | 014 | 0.4 | 0.2 | 012 | 0.2 | 0.3 | 0.3 | 0.2 | 0.6 |
| Secchi meters | B= Bottom | B | B | B | B | B | B | B | B | B | B |
| Fecal Col per 100ml | ½ | neg | neg | neg | 12 | 1 | 3½ | ½ | neg | 3½ | 9 |
| Sea State | mod | mod | calm | calm | mod | mod | mod | calm | calm | mod | calm |
| Wind kts. | ESE 10/20 | E 20 | E/NE 10 | <10 | ESE 10/15 | SE 10/15 | E 15/20 | ENE 15 | <10 | E 20 | E 15 |
| Clouds % | - | 25/50 | <20 | <20 | 50/80 | 70/90 | 20/50 | 20/50 | <20 | <20 | 20/30 |

| YEAR | | | 1975 | | | |
|---|---|---|---|---|---|---|
| DATE | 1/16 | 2/28 | 3/14 | 6/13 | 8/6 | 9/25 |
| Temp. °C. | 25.7 | 24.8 | 25.1 | 28.0 | 28.2 | 28.8 |
| Salinity ppt | 35.6 | 35.7 | 36.1 | 37.8 | 36.9 | 37.4 |
| Diss.Oxy. mg/1 | 6.95 | 6.65 | 6.8 | 6.5 | 6.65 | 6.85 |
| pH | 8.4 | 8.2 | 8.0 | 8.05 | 8.4 | 8.15 |
| Turbidity FTU | 1.9 | 0.3 | 0.4 | 0.3 | 0.2 | 0.1 |
| Secchi meters | B | B | B | B | B | B |
| Fecal Col per 100ml | neg | neg | neg | neg | neg | neg |
| Sea State | calm | rough | rough | calm | mod | flat |
| Wind kts. | E 20 | ESE/SE 20 | E 25 | E 10 | E 10 | SE 5 |
| Clouds % | 10/20 | <20 | 30 | 20 | 40/60 | <20 |

# SUMMARY OF WATER QUALITY DATA

ST. JOHN- STATION NO. 55

LATITUDE: $18^{o}$ 19 42.6 LONGITUDE: 064 47 49.8

TURNER BAY - 50' OFF DRAIN TO ENIGHED POND

WATER DEPTH 3½ / 4½ METERS

| YEAR | | 1976 | | | | | 1977 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 2/27 | 4/1 | 5/21 | 2/24 | 3/30 | 5/20 | 5/16 | 7/28 | 8/17 | 9/8 | 10/3 |
| Temp. °C. | 23.8 | 24.9 | 26.1 | 26.3 | 26.0 | 26.8 | 27.2 | 28.0 | 26.7 | 24.8 | 28.5 |
| Salinity ppt | 36.6 | 36.7 | 36.4 | 36.24 | 36.17 | 35.98 | 35.85 | 36.63 | 35.82 | 34.8 | 34.9 |
| Diss.Oxy. mg/l | 6.55 | 7.15 | 6.5 | 6.7 | 6.50 | 7.10 | 6.75 | | | 6.65 | 6.25 |
| pH | 8.2 | 8.2 | 8.3 | 8.45 | 8.30 | 8.30 | 7.90 | 8.27 | 8.25 | 8.30 | 8.20 |
| Turbidity FTU | 0.5 | 0.3 | 0.35 | 6.3 | .29 | .30 | .38 | .32 | .25 | .24 | .35 |
| Secchi meters | B | B | B | B | B/4 | B/3. | B/3.5 | B/.4. | B/4.2 | B/3 | B/3.0 |
| Fecal Col per 100ml | Neg | Neg | Neg | Neg | Neg | Neg | Neg | | Neg | Neg | Neg |
| Sea State | Mod | Flat | calm | | | 4/6 | 4/6 | 4/6 | 3/5 | S.E 5/7 | S.E 1/3 |
| Wind kts. | E/ENE 10/20 | N/NW 5/15 | E 5/10 | | 15/20 | 10/20 | ESE 15/20 | ESE 15/20 | ESE 5/10 | E 17/21 | E 4/6 |
| Clouds % | 40/20 | 20/30 | <10 | | Partly | 75% | Full white | 5/20 | 50/80 | 80/95 | 5/20 |
| | | | | | | | | | | | LSH |

| YEAR | | 1977 | | 1978 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 11/29 | 12/29 | | 2/24 | 4/5 | 5/16 | 6/20 | 7/18 | 8/21 | 9/18 | |
| Temp. °C. | 27.1 | 26.9 | | 26.1 | 26.5 | 28.7 | 29.0 | 28.8 | 28.2 | 29.7 | |
| Salinity ppt | 35.2 | 35.0 | | 35.6 | 35.8 | 36.0 | 36.0 | 35.5 | 35.8 | 34.9 | |
| Diss.Oxy. mg/l | 6.45 | 7.80 | | 6.55 | 6.40 | 6.30 | 6.25 | 6.20 | 6.20 | 5.90 | |
| pH | 8.20 | 8.15 | | 8.28 | 8.20 | 8.20 | 8.20 | 8.30 | 8.25 | 8.20 | |
| Turbidity FTU | 0.65 | .52 | | 1.2 | .92 | .63 | 1.0 | .34 | .42 | .27 | |
| Secchi meters | B/3 | B/4.5 | | B/4.0 | B/3.5 | B/4.5 | B/4.0 | B/3.5 | B/2.7 | B/2.6 | |
| Fecal Col per 100ml | Neg | Neg | | Neg. | 94 | 4 | Neg. | Neg. | Neg. | Neg. | |
| Sea State | S.E 5/8 | S.E 1/3 | | 3-5' | 3-5' | 3-5' | 1-3' | 3-6' | 1-3' | 1-3' | |
| Wind kts. | E 21/28 | E 6/10 | | 17-21 | N.E. 21-30 | 17-21 | SE 7-10 | S.E. 15-20 | ESE 8-10 | SE 6-10 | |
| Clouds % | 50/80 | 20/50 | | 20-50% | 80-95% | 20-50% | 20-50% | 20-40% | 80-100% | 20-50% | |

LSH

SUMMARY OF WATER QUALITY DATA

ST. JOHN- STATION NO. 55

LATITUDE: 18° 19 42.6 LONGITUDE: 064 47 49.8

TURNER BAY - 50' off drain to enighed pond

WATER DEPTH 3 1/2 - 4 1/2 meters

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 1979 | | | | | | | | | | |
| DATE | 1-10 | 2-22 | 3-19 | 5-17 | 6-19 | 8-22 | 9-26 | | | | |
| Temp. °C | 26.2 | 26.6 | 27.1 | 29.3 | 29.4 | 29.3 | 28.8 | | | | |
| Salinity ppt | 35.9 | 35.5 | 35.4 | 35.3 | 36.1 | 35.3 | 35.2 | | | | |
| Diss.Oxy. mg/l | 6.45 | 6.40 | 6.35 | 6.10 | 6.50 | 6.45 | 6.80 | | | | |
| pH | 8.20 | 8.20 | 8.25 | 8.20 | 8.10 | 8.15 | 8.10 | | | | |
| Turbidity FTU | 0.28 | 0.44 | 0.39 | 0.49 | 0.70 | 0.46 | 0.38 | | | | |
| Secchi meters | B/2.5 | B/2.4 | B/3.5 | B/4.4 | B/4.0 | B/2.7 | B/3.5 | | | | |
| Fecal Col per 100ml | Neg. | Neg. | Neg. | Neg. | Neg. | 1 | Neg. | | | | |
| Sea State | —— | 5-7' | 3-5' | 103' | 3-5' | 1-3' | 1-3' | | | | |
| Wind kts. | —— | ENE, 0-15 Kts | NE, 6-8 mph | SE, 8 mph | SEm 8 Kts | ESE, 7-Kts | SE, 8-9 Kts | | | | |
| Clouds % | —— | 50% | 40% | 60% | 40% | 40-50% | 30-40% | | | | |
| | | | | | | | LSH | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | | | | | | | | | | | |
| DATE | | | | | | | | | | | |
| Temp. °C | | | | | | | | | | | |
| Salinity ppt | | | | | | | | | | | |
| Diss.Oxy. mg/l | | | | | | | | | | | |
| pH | | | | | | | | | | | |
| Turbidity FTU | | | | | | | | | | | |
| Secchi meters | | | | | | | | | | | |
| Fecal Col per 100ml | | | | | | | | | | | |
| Sea State | | | | | | | | | | | |
| Wind kts. | | | | | | | | | | | |
| Clouds % | | | | | | | | | | | |

SUMMARY OF WATER QUALITY DATA

LATITUDE: 18° 19 42.6 LONGITUDE: 064 47 49.8

St. John STATION # 55

Turner Bay - 50' off Drain to Enighed Pond

WATER DEPTH: meters. STANDARD DEPTH: 3.5/4.5 meters.

| YEAR | 1979 | | | 1980 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 10/11 | 11/9 | 12/12 | 1/21 | 2/4 | 3/3 | 4/23 | 5/7 | 7/23 | 8/18 |
| SECCHI/BOTTOM DEPTH.meters | B/3.2 | B/3.5 | B/2.5 | B/3.0 | B/3.5 | B/3.5 | B | B | B | B |
| TEMPERATURE °C | 30.0 | 28.8 | 27.8 | 26.4 | 27.3 | 26.5 | 26.5 | 27.8 | 28.8 | 28.3 |
| DISSOLVED $O_2$ mg/l | 6.45 | 6.4 | 6.4 | 6.75 | 6.95 | 6.85 | 6.60 | 6.45 | 7.05 | 7.80 |
| SALINITY ppt | 35.4 | - | 35.5 | 35.7 | 35.7 | 35.9 | 36.5 | 36.5 | 35.8 | 35.9 |
| SUSP. SOLIDS mg/l | | | | | | | | | | |
| TURBIDITY 90°-NTU | 0.32 | 0.3 | 0.77 | 0.89 | 0.65 | 0.76 | 0.53 | 0.41 | 0.3 | 0.52 |
| pH | 8.05 | 8.10 | 8.15 | 8.20 | 8.25 | 8.20 | 7.90 | 8.00 | 8.25 | 8.10 |
| FECAL COLI per 100 ml | NeG | NEG | 1 | NEG | NEG | NEG | NEG | NEG | NEG | NEg |
| SEA STATE feet | 1-3 | - | 3-5 | 1-3 | 3-4 | 3-5 | 1-3 | 1' | 1-3 | 1-3 |
| WIND knots | SE 6-7 | - | ESE 8-12 | ENE 7-9 | ESE 10-12 | SE 10-12 | ENE 6-10 | SE 6-10 | 10-17 | SE 10-17 |
| CLOUD COVER % | 40 | - | 20 | 10 | 40 | 40 | 100 | 5-20 | 5-20 | 5-20 |
| | | | | | | | | | | LSH |

| YEAR | 1980 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 9/30 | | | | | | | | | |
| SECCHI/BOTTOM DEPTH.meters | B | | | | | | | | | |
| TEMPERATURE °C | 29.1 | | | | | | | | | |
| DISSOLVED $O_2$ mg/l | 6.8 | | | | | | | | | |
| SALINITY ppt | 34.4 | | | | | | | | | |
| SUSP.SOLIDS mg/l | --- | | | | | | | | | |
| TURBIDITY 90°-NTU | 0.98 | | | | | | | | | |
| pH | 7.95 | | | | | | | | | |
| FECAL COLI per 100 ml | 2 | | | | | | | | | |
| SEA STATE feet | <1 | | | | | | | | | |
| WIND knots | ESE 6-10 | | | | | | | | | |
| CLOUD COVER % | 20-50 | | | | | | | | | |
| | LSH | | | | | | | | | |

# MARINE WATER QUALITY DATA

Virgin Islands Department of Conservation and Cultural Affairs
Division of Natural Resources Management

Station No: 55 Location:

| ear: | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ay | | | | | | | | | | | | |
| emperature<br>eg. C | | | | | | | | | | | | |
| alinity<br>pt. | | | | | | | | | | | | |
| issolved<br>xygen mg/l | | | | | | | | | | | | |
| H | | | | | | | | | | | | |
| urbidity<br>.t.u. | | | | | | | | | | | | |
| ecchi<br>epth m. | | | | | | | | | | | | |
| ater<br>epth m. | | | | | | | | | | | | |
| . Coliform<br>er 100 ml. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

| ear: 81 | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ay | | | | | 29 | 16 | 13 | 28 | | | | |
| emperature<br>eg. C | | | | | 28.1 | 28.8 | 28.2 | 28.7 | | | | |
| alinity<br>pt. | | | | | 37.3 | 35.8 | 35.2 | 35.8 | | | | |
| issolved<br>xygen mg/l | | | | | | 6.55 | 6.65 | 6.39 | | | | |
| H | | | | | 8.3 | 8.35 | 8.25 | 8.2 | | | | |
| urbidity<br>.t.u. | | | | | 1.2 | 1.3 | 0.42 | 1.4 | | | | |
| ecchi<br>epth m. | | | | | B | B | B | B | | | | |
| ater<br>epth m. | | | | | | | | | | | | |
| . Coliform<br>r 100 ml. | | | | | <1 | 1 | <1 | 1 | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

MARINE WATER QUALITY DATA
Virgin Islands Department of Conservation and Cultural Affairs
Division of Natural Resources Management

Station No: 55 Location: ST J TURNER BAY

| ear: 82 | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ay | | | | | | | | | | | | 15 |
| emperature eg. C | | | | | | | | | | | | 26.5 |
| alinity pt. | | | | | | | | | | | | 33.8 |
| issolved xygen mg/l | | | | | | | | | | | | 6.4 |
| H | | | | | | | | | | | | 8.2 |
| urbidity .t.u. | | | | | | | | | | | | 1 |
| ecchi epth m. | | | | | | | | | | | | B |
| ater epth m. | | | | | | | | | | | | [illegible] |
| . Coliform er 100 ml. | | | | | | | | | | | | K9 |
| | | | | | | | | | K1 = LESS THAN 1 BUT NOT 0 | | | |
| | | | | | | | | | | | | |

| ear: | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ay | | | | | | | | | | | | |
| emperature eg. C | | | | | | | | | | | | |
| alinity pt. | | | | | | | | | | | | |
| issolved xygen mg/l | | | | | | | | | | | | |
| H | | | | | | | | | | | | |
| urbidity .t.u. | | | | | | | | | | | | |
| ecchi epth m. | | | | | | | | | | | | |
| ater epth m. | | | | | | | | | | | | |
| . Coliform er 100 ml. | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

MARINE WATER QUALITY DA

Virgin Islands Department of Conservation and Cultural Affairs

Division of Natural Resources Management

Station No. 55 Location:

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 84 | | | | | | | | | | | | |
| Day | | | | | | | | | | 10/31 | | |
| Temperature deg. C | | | | | | | | | | 25.0 | | |
| Salinity ppt. | | | | | | | | | | 35.0 | | |
| Dissolved Oxygen mg/l | | | | | | | | | | 6.6 | | |
| Turbidity n.t.u. | | | | | | | | | | 0.44 | | |
| Secchi Depth m | | | | | | | | | | L 4 | | |
| F. Coliform per 100 ml | | | | | | | | | | K 1 | | |
| Suspended Solids mg/l | | | | | | | | | | | | |
| Nitrate mg/l | | | | | | | | | | | | |
| Nitrite mg/l | | | | | | | | | | | | |
| Phosphorus Total mg/l | | | | | | | | | | | | |

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 85 | | | | | | | | | | | | |
| Day | | 2/22 | | | | 6/20 | | 8/20 | | | | |
| Temperature deg. C | | 25.9 | | | | 28.0 | | 28.0 | | | | |
| Salinity ppt. | | 35.3 | | | | 38.0 | | 38.5 | | | | |
| Dissolved Oxygen mg/l | | 7.2 | | | | 6.3 | | 6.4 | | | | |
| Turbidity n.t.u. | | 0.41 | | | | 0.38 | | 0.21/0.27 | | | | |
| Secchi Depth m | | L 4 | | | | L 4 | | L4 | | | | |
| F. Coliform per 100 ml | | K 1 | | | | K 1 | | K1/K1 | | | | |
| Suspended Solids mg/l | | | | | | 2.2 | | | | | | |
| Nitrate mg/l | | | | | | <0.1 | | | | | | |
| Nitrite mg/l | | | | | | <0.01 | | | | | | |
| Phosphorus Total mg/l | | | | | | 0.01 | | | | | | |

MARINE WATER QUALITY DATA

Virgin Islands Department of Conservation and Cultural Affairs

Division of Natural Resources Management

Station No. 55 Location:

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 86 | | | | | | | | | | | | |
| Day | 1/23 | | 3/18 | | | | | | | | | |
| Temperature deg. C | 25.0 | | 28.0 | | | | | | | | | |
| Salinity ppt. | 35.0 | | 34.0 | | | | | | | | | |
| Dissolved Oxygen mg/1 | 6.5 | | 6.5 | | | | | | | | | |
| Turbidity n.t.u. | - | - | 0.99/1.1 | | | | | | | | | |
| Secchi Depth m | L 4 | | L 4 | | | L = GREATER THAN | | | | | | |
| F. Coliform per 100 ml | 5 | | 2/2 | | | | | | | | | |
| Suspended Solids mg/1 | 0.6 | | 2.5 | | | | | | | | | |
| Nitrate mg/1 | K0.1 | | K0.1 | | K = LESS THAN | | | | | | | |
| Nitrite mg/1 | K0.01 | | K0.01 | | | | | | | | | |
| Phosphorus Total mg/1 | K0.01 | | K0.01 | | | | | | | | | |

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | | | | | | | | | | | | |
| Day | | | | | | | | | | | | |
| Temperature deg. C | | | | | | | | | | | | |
| Salinity ppt. | | | | | | | | | | | | |
| Dissolved Oxygen mg/1 | | | | | | | | | | | | |
| Turbidity n.t.u. | | | | | | | | | | | | |
| Secchi Depth m | | | | | | | | | | | | |
| F. Coliform per 100 ml | | | | | | | | | | | | |
| Suspended Solids mg/1 | | | | | | | | | | | | |
| Nitrate mg/1 | | | | | | | | | | | | |
| Nitrite mg/1 | | | | | | | | | | | | |
| Phosphorus Total mg/1 | | | | | | | | | | | | |

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subchapter. Any such notice may be combined with other notices required of the applicant under this subchapter or other appropriate laws.

### § 184-83. Hearing procedures

(a) At a public hearing held with regard to a permit application and tentative determination, any person shall be afforded the opportunity to present oral or written statements, arguments or data, Provided, however, that the Department shall have the discretion to fix reasonable time limits on the presentation of oral statements and when time and scheduling considerations necessitate, may require the submission of statements in writing.

(b) The hearing shall be conducted by a hearing officer [who] shall cause a record of the hearing to be made, which shall include any public comments or statements received, and shall render a report to the Commissioner setting forth the appearances and relevant facts and arguments presented at the hearing. The hearing officer is empowered to:

(1) Provide for the taking of written and oral statements, testimony under oath, and documentary evidence; and

(2) Regulate the course of the hearing, fix the time for the filing of written statements and data, provide for the scheduling and preservation of oral statements, testimony under oath and documentary evidence, and set the time and place for continued hearings.

(c) Any materials, including records and documents, in the possession of the Department of which it desires to avail itself, may be offered by the Department and made part of the record. Such materials may be relied upon by the Commissioner in making a final decision or other disposition.

(d) Cross-examination of witnesses shall be permitted and the strict procedural rules of evidence may be modified at the discretion of the hearing officer. The determination of the hearing officer shall be founded upon the record of the hearing and upon competent relevant material evidence which is substantial in view of the entire record.

## DIVISION 10. CONFLICTS OF INTEREST

SECTIONS



### § 184-91. Conflicts of interest

Pursuant to 12 V.I.C. § 196, the Commissioner or his designee responsible for issuance of TPDES permits, is prohibited from





receiving, or from having received during the previous two years, a significant portion of his income directly or indirectly from permit holders or applicants for a permit. For the purposes of this section (a) "significant portion of his income" shall mean 10 percent of gross personal income for a calendar year, except that it shall mean 50 percent of gross personal income for a calendar year if the recipient is over 60 years of age and is receiving such portion pursuant to retirement, pension, or similar arrangement; (b) "income" includes retirement benefits, consultant fees, and stock dividends, and (c) income is not received "directly or indirectly from permit holders or applicants for a permit" where it is derived from mutual-fund payments, or from other diversified investments over which the recipient does not know the identity of the primary sources of income.

## *Subchapter 186. Water Quality Standards for Coastal Waters of the Virgin Islands*

SECTIONS



### § 186-1. General water quality criteria

All surface waters shall meet generally accepted aesthetic qualifications and shall be capable of supporting diversified aquatic life. These waters shall be free of substances attributable to municipal, industrial, or other discharges or wastes as follows:

(a) Materials that will settle to form objectionable deposits.

(b) Floating debris, oil, scum, and other matter.

(c) Substances producing objectionable color, odor, taste or turbidity.

(d) Materials, including radionuclides, in concentrations or combinations which are toxic or which produce undesirable physiological responses in human, fish and other animal life, and plants.

(e) Substances and conditions or combinations thereof in concentrations which produce undesirable aquatic life.

Source. Sections 186-1 to 186-11: Rules and Regulations Relative to Water Quality Standards for Coastal Waters of the Virgin Islands were revised and issued by Commissioner of Health, dated July 20, 1973, and approved by Governor. Filed with Lieutenant Governor July 26, 1973; File No. 750.

Authority. 12 V.I.C. § 186(a).

Prior regulations—1968. Similar regulations of the Commissioner of Health, dated Oct. 4, 1968, and approved by the Governor were filed with Government Secretary Jan. 16, 1969; File No. 570.

## § 186-2. Class A

(a) **Best usage of waters:** Preservation of natural phenomena requiring special conditions, such as the Natural Barrier Reef at Buck Island, St. Croix and the Under Water Trail at Trunk Bay, St. John.

(b) **Quality criteria:** Existing natural conditions shall not be changed.

## § 186-3. Class B

(a) **Best usage of waters:** For propagation of desirable species of marine life and for primary contact recreation (swimming, water skiing, etc.).

(b) **Quality criteria:**

(1) **Dissolved oxygen:** Not less than 5.5 mg/l from other than natural conditions.

(2) **pH:** Normal range of pH must not be extended at any location by more than ± 0.1 pH unit. At no time shall the pH be less than 7.0 or greater than 8.3.

(3) **Temperature:** Not to exceed 90° F. at any time, nor as a result of waste discharge to be greater than 1.5° F. above natural. Thermal policy section 186-5 shall also apply.

(4) **Bacteria:** Shall not exceed a geometric (log) mean of 70 fecal coliforms per 100 ml. by MF or MPN count.

(5) **Dissolved gas:** Total dissolved gas pressures shall not exceed 110 percent of existing atmospheric pressure.

(6) **Phosphorus:** Phosphorus as total P shall not exceed 50 ug/l in any coastal waters.

(7) **Suspended, colloidal, or settleable solids:** None from waste water sources which will cause disposition or be deleterious for the designated uses.





(8) **Oil and floating substances:** No residue attributable to waste water nor visible oil film nor globules of grease.

(9) **Radioactivity:**

(A) **Gross beta:** 1000 picocuries per liter, in the absence of Sr 90 and alpha emitters.

(B) **Radium-226:** 3 picocuries per liter.

(C) **Strontium-90:** 10 picocuries per liter.

(10) **Taste and odor producing substances:** None in amounts that will interfere with the use for primary contact recreation, potable water supply or will render any undesirable taste or odor to edible aquatic life.

(11) **Color and turbidity:** A Secchi disc shall be visible at a minimum depth of one meter.

## § 186-4. Class C

(a) **Best usage of waters:** For the propagation of desirable species of marine life and secondary contact recreation (boating, fishing, wading, etc.).

(b) **Quality criteria:**

(1) **Dissolved oxygen:** Not less than 5.0 mg/l from other than natural conditions.

(2) **pH:** Normal range of pH must not be extended at any location by more than ± 0.1 pH unit. At no time shall the pH be less than 6.7 or greater than 8.5.

(3) **Bacteria:** Shall not exceed a geometric (log) mean of 1,000 fecal coliforms per 100 ml. by MF or MPN count.

(4) **Taste and odor producing substances:** None in amounts that will interfere with the use for potable water supply or will render any undesirable taste or odor to edible aquatic life.

(5) Other provisions for Class B waters shall apply.

## § 186-5. Thermal policy

(a) Fish and other aquatic life shall be protected from thermal blocks by providing for a minimum 75 percent stream or estuarine cross-section and/or volumetric passageway, including a minimum of one half of the surface as measured from water edge to water edge at any stage of tide.

(b) In non-passageway the surface water temperature shall not exceed 93° F.

(c) No heat may be added except in designated mixing zones which would cause temperatures to exceed 90° F., or which would cause the monthly mean of the maximum daily temperature at any site, prior to the addition of any heat, to be exceeded by more than 1.5° F.

(d) No discharge or combination of discharges shall be injurious to fish or shellfish or the culture or propagation of a balanced indigenous population thereof.

(e) Rate of temperature change outside the mixing zone shall not be more than 1° F. per hour nor to exceed 5° F. in any 24-hour period except when natural phenomena cause these limits to be exceeded.

(f) Unless specific conditions, such as spawning ground, migratory routes, or other sections of conditions from these regulations are applicable, the mixing zone should be defined by a sphere with a specified point as the center (not necessarily the outfall but limited to one point for each installation) and a radius equal to the square root of the volume of discharge (A) expressed as millions of gallons per day, times 200 feet; and in no case exceed 3/8 mile. The formula is:

$$\frac{2}{\ }\sqrt{A} \qquad 200 = \text{radius of mixing zone.}$$

—Amended Sept. 1, 1978.

Amendments—1978. Section 186.5(b) and (f) was amended by the Department of Conservation and Cultural Affairs Aug. 31, 1978, approved Sept. 1, 1978 by the Governor of the Virgin Islands. Filed with Lieutenant Governor Sept. 1, 1978; File No. 1053. Amendment became effective without prior publication by certification dated Sept. 1, 1978.

### § 186–6. *Mixing zones*

The need, location, size and depth of the mixing zones in surface waters and estuaries shall be established according to the following mixing zone criteria and boundaries.

(a) **Mixing zone criteria:**

(1) *Mixing zones shall be provided solely for mixing. Mixing* must be accomplished as quickly as possible through the use of devices which insure that the waste is mixed with the allocated dilution water in the smallest practicable area.

(2) For the protection of aquatic life resources, the mixing zones, must not be used for, or be considered as, a substitute for waste treatment facilities.





(3) At the boundary of the mixing zone the water should comply with all the water quality standards set forth for its classification. If, after complete mixing with the available dilution water, these requirements are not met, the effluent must be adequately pretreated until the standards are met.

(4) No conditions shall be permitted to exist within the mixing zone, (A) that are rapidly lethal (i.e. exceed the 96-hour median tolerance limit) to locally important and desirable indigenous aquatic life, (B) that prohibit planktonic organisms from being carried through the mixing zone. These organisms will be exposed to its conditions only for the period of time required to drift through the mixing zone and will survive without undue damage or stress while they are passing through.

(5) Maximum vertical dispersion of waste water discharge flow shall be provided for in the mixing zone.

(6) Mixing zones shall not intersect spawning or nursery areas, migratory routes, water intake nor mouths of rivers.

(7) Suspended solids in waste waters being discharged shall not settle in measurable amounts in the mixing zones.

(b) **Mixing zone boundaries:**

(1) The mixing zone must be located in such manner as to allow at all times, passageways for the movement on drift of the biota (pelagic or invertebrate organisms). The width of the mixing zone and the volume of flow in it shall depend on and will be determined by the nature of the water current and/or the estuary. The area, depth, and volume of the flow must be sufficient to provide a usable and desirable passageway for fish and other aquatic organisms.

(2) The passageway must contain at least 75 percent of the cross sectional area and/or volume of flow of the estuary, and should extend to at least 50% of the width.

(3) A mixing zone shall not overlap with an adjacent mixing zone.

### § 186–7. Antidegradation

Waters whose existing quality is better than the established standards as of the date on which such standards become effective will be maintained at their existing high quality. These and other waters of the Virgin Islands will not be lowered in quality unless and until it has been affirmatively demonstrated to the Territory's water pollution control agency and the Environmental Protection

Agency that such change is justifiable as a result of necessary economic or social development and will not interfere with or become injurious to any assigned uses made of, or presently possible in such waters. Any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters will be required, as part of the initial project design, to provide the highest and best practicable degree of waste treatment available under existing technology, and since these are also Federal standards, these waste treatment requirements will be developed cooperatively.

**§ 186–8. Analytical procedures**

The analytical procedures used as methods of analysis to determine the chemical, bacteriological, biological, and radiological quality of waters sampled shall be in accordance with the latest edition of "Standard Methods for the Examination of Water and Waste Water" or other methods approved by the Virgin Islands Department of Conservation and Cultural Affairs and the Environmental Protection Agency.—Amended Sept. 1, 1978.

**§ 186–9. Applicability of standards**

The proceeding criteria will be applicable to all Virgin Islands Coastal Waters at all places and at all times.

**§ 186.–10. Natural waters**

Natural waters may, on occasion, have characteristics outside of the limits prescribed by these criteria. The criteria contained herein do not relate to violation of standards resulting from natural forces.

**§ 186–11. Legal limits**

(a) Class "A" (natural phenomena).

(1) Within 0.5 miles of the boundaries of Buck Island's Natural Barrier Reef, St. Croix.

(2) Trunk Bay, St. John.

(b) Class "B" (marine life and primary contact recreation).

(1) All other coastal waters not classified Class "A" or Class "C".

(c) Class "C" (marine life and secondary contact recreation).

(1) St. Thomas:

(A) St. Thomas Harbor beginning at Rupert Rock and extending to Haulover Cut.





(B) Crown Bay enclosed by a line from Hassel Island at Haulover Cut to Regis Point at West Gregeri Channel.

(C) Krum Bay.

(2) St. Croix:

(A) Christiansted Harbor from Fort Louise Augusta to Golden Rock.

(B) Frederiksted Harbor from La Grange to Fisher Street.

(C) Hess Oil Virgin Islands Harbor.

(D) Martin-Marietta Alumina Harbor.

**§ 186–12. Reissuance of this chapter**

Title 12, chapter 7, sections 186–1 through 186–11, Virgin Islands Rules and Regulations, as previously issued by the Commissioner of Health, are hereby reissued by the Commissioner of Conservation and Cultural Affairs.

**Source.** Section 186–12. Regulations to reissue this chapter issued by the Department of Conservation and Cultural Affairs Aug. 31, 1978, approved Sept. 1, 1978, by the Governor of the Virgin Islands. Filed with Lieutenant Governor Sept. 1, 1978; File No. 1053.

**Effective date.** The regulation, File No. 1053, contained a certificate dated Sept. 1, 1978, which provided such regulation shall take effect without the usual prior publications.

APPENDIX E.

CURRENT SURVEY

# FINAL REPORT

# ST. JOHN CIRCULATION STUDY

# CRUZ BAY, ST. JOHN, USVI

TO: C. E. Maguire, Inc.
1 Court Street
New Britain, CT 06051

FROM: Ocean Surveys, Inc.
91 Sheffield Street
Old Saybrook, CT 06475

22 July 1986

TABLE OF CONTENTS

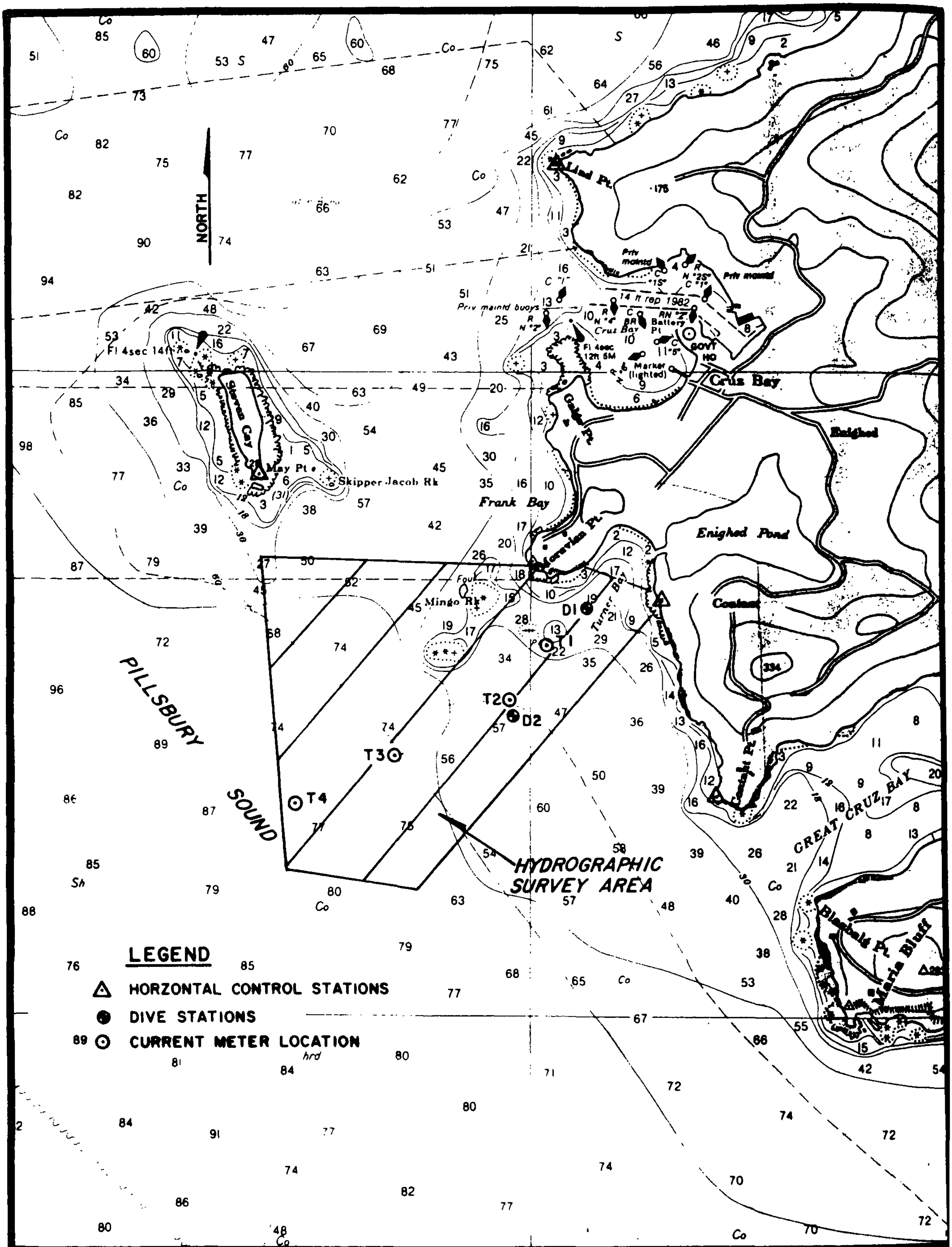
FINAL REPORT
ST. JOHN CIRCULATION STUDY
CRUZ BAY, ST. JOHN, USVI

## 1.0 PROJECT SUMMARY

During the period 23-27 February 1986 Ocean Surveys, Inc. (OSI) conducted a reconaissance level hydrographic sounding survey and Eulerian and Lagrangian current studies in the vicinity of Turner Bay on the southwest coast of St. John in the U.S. Virgin Islands. OSI returned to the site on 30 May 1986 to conduct a dye dilution investigation and to collect seasonal current data. These studies were comissioned by C. E. Maguire for the purpose of evaluating the area southeast of Moravian Point as a potential wastewater outfall site (Figure 1).

The hydrographic sounding work covered an area of approximately 0.51 square kilometer (0.20 square mile) of seafloor extending approximately 914m (3000 ft) offshore in a fan-shaped pattern from a point on the eastern shore of Turner Bay. The current studies consisted of the deployment of in situ current meters at four stations and the tracking of free-drifting drogues released at various depths along the proposed outfall alignment. The dye tracer study entailed injecting fluorescent dye into the water at a controlled rate and mapping the resulting dye plume concentrations. The dye investigation provides information concerning the potential trajectory, aerial distribution and dilution of an offshore wastewater discharge.

The Eulerian and Lagrangian current data collected during this program reveal that currents flood to the north-northwest and ebb to the south-southeast at the Turner




| FIGURE NO. | SURVEY DATE | |
|---|---|---|
| 1 | 23-27 FEB 1986 | **OCEAN SURVEYS, INC.** |
| SCALE 1" = 1250' | BY MAN | OLD SAYBROOK, CONNECTICUT |

Bay site with a strong net drift to the north. These results are in contrast with published general current data for Pillsbury Sound which indicate that currents should be expected to flood to the south and ebb to the north.

Drogues released along the proposed outfall alignment generally displayed shore-parallel trajectories. During the February drogue studies a number of drogues released at potential outfall diffuser locations became grounded on Steven Cay to the north and Bovocoap Point to the south. No drogues approached shore during the June drogue studies when released from Stations T-3 and T-4. Moderate east-southeasterly winds probably caused the surface drogues to be transported away from shore.

Dye dilution studies revealed little lateral dispersion prior to the dye plume reaching Two Brothers daymark. Eddy diffusion coefficients were between .038 and .111 $m^2$/sec (.41 and 1.19 $ft^2$/sec) and dilution ratios were on the order of 198 to 888 at distances comparable to the distance from T-3 to Steven Cay.

The data was processed by OSI and are included herein as tabulations and graphical presentations of current and drogue speed and direction for each deployment. Also presented are a 1:2400 (1"=200') plan view drawing depicting soundings collected along survey vessel tracklines and 1:15,000 (1"=1250') plan view drawings of drogue trajectories and dye concentrations.

## 2.0 EQUIPMENT AND FIELD PROCEDURES

### 2.1 Horizontal Control

After consulting with C. E. Maguire's onsite personnel, OSI's field crew established navigation and horizontal control stations at positions which provided suitable site coverage, were easily recoverable by boat and were recognizable on NOAA 1:15,000 nautical chart number 25647, "PILLSBURY SOUND". These control stations were plotted on the NOAA chart and their latitude and longitude were picked from the plotted positions. The latitude and longitude coordinates were then converted to the Puerto Rican Coordinate System, Virgin Islands Extension for use during final plotting of the hydrographic and drogue data (Table 1). The estimated accuracy of this horizontal control procedure is ±15.2m (±50 ft).

### 2.2 Navigation

The primary means of establishing vessel position during all drogue tracking activities was a Motorola "Mini Ranger" electronic positioning system [±3m (±9.9 ft) accuracy]. The Mini Ranger System (MRS) used on this project consists of four components: three transponders, which are deployed at shoreline locations, and an MRS interrogator unit which is installed aboard the survey vessel. Range measurements to the transponders are obtained by determining the elapsed time between the transmitted microwave interrogation produced by the MRS transmitter and the reply received by the MRS from each transponder. The onboard MRS interrogator unit alternately displays and updates the range measurements at a one-second rate.

TABLE 1

HORIZONTAL CONTROL STATIONS

| Station Designation | Latitude | Longitude | North* (ft) | East* (ft) | Established By |
|---|---|---|---|---|---|
| Lind | $18^{\circ}21'$ 18" | $64^{\circ}47'$ 57" | 185,970 | 1,066,681 | OSI |
| Point Beach | $18^{\circ}19'$ 39" | $64^{\circ}47'$ 47" | 181,978 | 1,067,670 | OSI |
| Contant | $18^{\circ}19'$ 20" | $64^{\circ}47'$ 42" | 180,120 | 1,068,182 | OSI |
| Steven Cay 2 | $18^{\circ}19'$ 59" | $64^{\circ}48'$ 30" | 183,992 | 1,063,530 | OSI |
| Current Rock | $18^{\circ}19'$ 00.9" | $64^{\circ}50'$ 05.8" | 178,013.96 | 1,054,378.93 | NOS |
| Steven Cay | $18^{\circ}19'$ 50.4" | $64^{\circ}48'$ 26.7" | 183,085.75 | 1,063,893.64 | NOS |

*Coordinates are in the Puerto Rican Coordinate System, Virgin Islands Extension

During hydrographic sounding survey activities vessel positions were provided employing the combination of a Path transit and one range of the MRS. Operationally, the survey vessel was controlled by the transit operator who turned predetermined angles from a known backsight to establish boresights. Using a hand-held VHF radio, he directed the vessel along each survey transect line. Distance along each line was measured using the MRS.

The MRS was calibrated on site prior to the initiation of field work by measuring the length of a known baseline. Calibration was verified each day before the commencement of survey activities by measuring the distance to a known point. A specification sheet for the Motorola Mini Ranger is provided in Appendix 1.

## 2.3 Tide Level Monitoring

Water level was monitored continuously during the project using a Stevens Type F water level recorder installed at the National Park Service pier. The relationship between OSI's temporary benchmark (TBM) and the mean low water datum was determined by taking simultaneous water measurements at OSI's TBM and at National Ocean Survey benchmark "NO. 2, 1972" located at the head of the public dock adjacent to National Park Service property in Cruz Bay.

## 2.4 In Situ Current Monitoring

Continuous measurements of current speed and direction were obtained by installing Endeco Type 105 in situ recording current meters on taut line moorings at four locations along the proposed outfall alignment specified by C. E. Maguire.

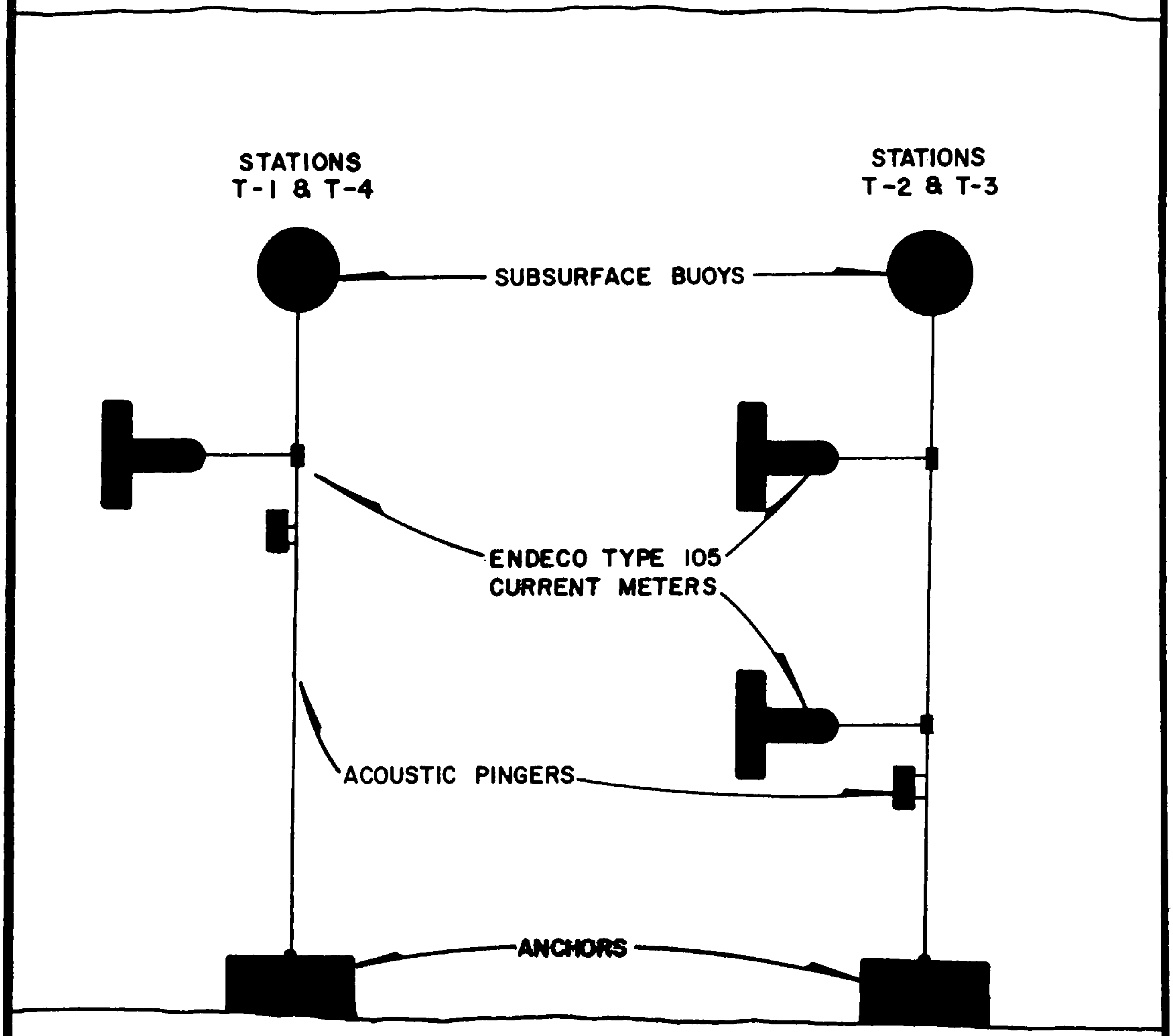
One current meter was deployed at the nearshore and furthest offshore stations (T-1 and T-4, Figure 2) and two current meters were deployed at stations T-2 and T-3 (Figure 2). Table 2 provides information concerning current meter and water depths relative to mean low water (MLW) at each station.

The design of the Endeco Type 105 current meter incorporates two features which are well suited for shallow coastal deployments: a ducted impellor, which cancels the considerable effects of wave-induced orbital velocities, and a flexible tether attachment, which decouples the instrument from mooring line motion. Specification sheets for the Endeco Type 105 current meter are presented in Appendix I.

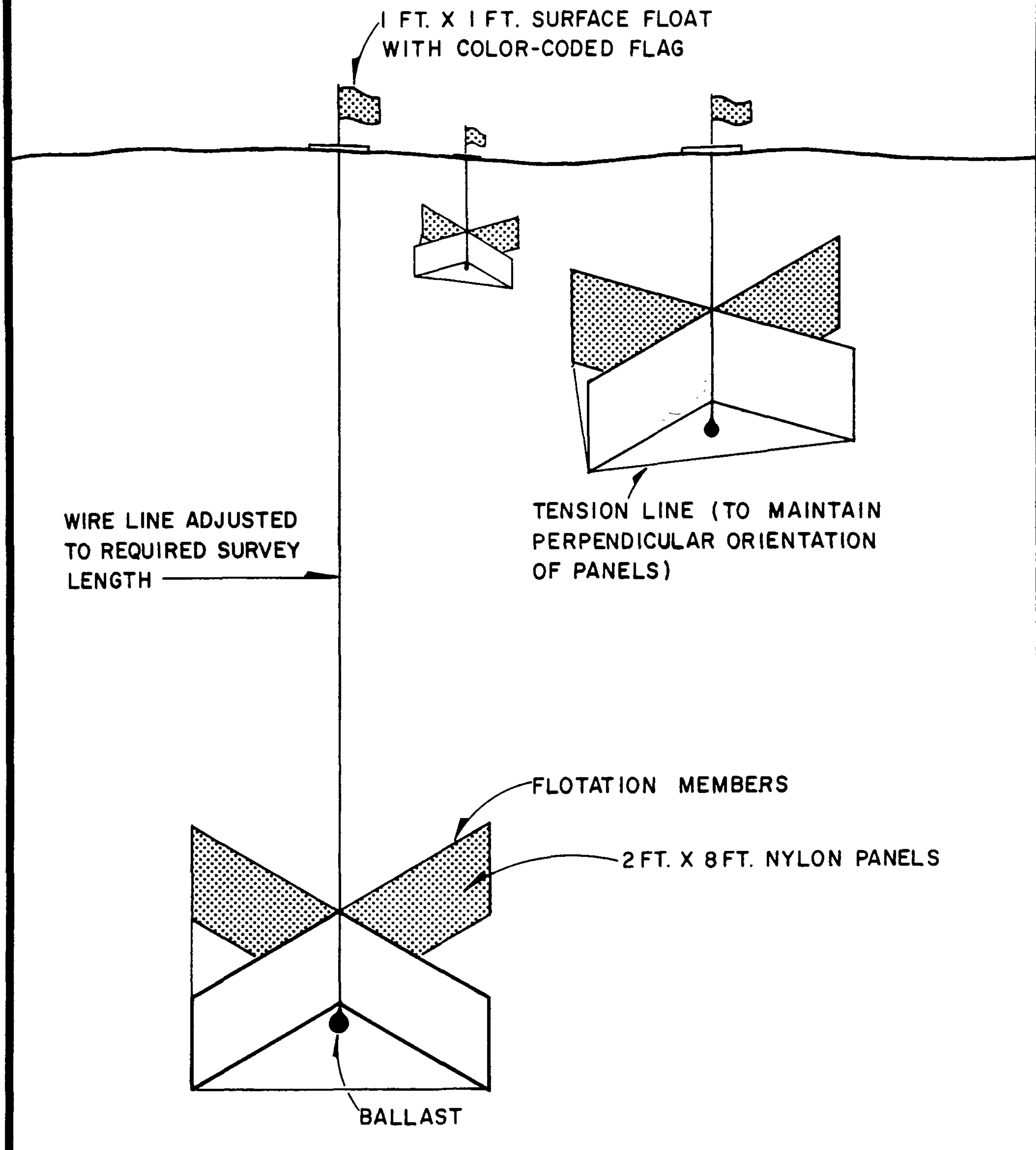
## 2.5 Drogue Tracking

Drogue tracking studies were conducted along the proposed outfall alignment at various stages of the tide in order to acquire Lagrangian current data. The drogues were designed and built by OSI and consisted of flagged surface floats connected by varying lengths of tension line to large subsurface nylon sails (Figure 3). The surface floats were designed to minimize the influence of the wind, while the 3.0 square meters (32 $ft^2$) of sail area maximizes the influence of the currents at the deployment depth.

Drogue deployments during the February study consisted of the simultaneous release of 4-5 drogues at various depths at a single location or along the outer portion of the proposed outfall alignment. During the second Lagrangian current study drogues were released in a similar fashion but the drogue sail depth was kept constant at 1 meter (3 ft). The position of the free-drifting drogues were noted at nominal 30-minute intervals using the MRS electronic positioning




| FIGURE NO. | DATE | |
|---|---|---|
| 2 | 9·APRIL·1986 | OCEAN SURVEYS, INC. |
| SCALE | BY | OLD SAYBROOK, CONNECTICUT |
| N/A | J.A. DOYLE | OSI |




OSI DROGUE DESIGN

| FIGURE NO. 3 | DATE 20·SEP·84 | OCEAN SURVEYS, INC. |
|---|---|---|
| SCALE N.T.S. | BY VAK | OLD SAYBROOK, CONNECTICUT |

TABLE 2

IN SITU CURRENT MONITORING STATION

| Station | Water Depth MLW (ft) | Water Depth MLW (m) | Meter | Meter Depth Below MLW (ft) | Meter Depth Below MLW (m) |
|---|---|---|---|---|---|
| T1 | 35 | 10.7 | TOP | 10 | 3.1 |
| T2 | 61 | 18.6 | TOP | 11 | 3.4 |
| | | | BOTTOM | 41 | 12.5 |
| T3 | 71 | 21.6 | TOP | 11 | 3.4 |
| | | | BOTTOM | 41 | 12.5 |
| T4 | 85 | 25.9 | TOP | 10 | 3.1 |

system. This was accomplished by conning the vessel to each drogue in turn. When the Mini Ranger antenna was directly beside the drogue float, a position "fix" was noted. These range readings were recorded into field survey logs, and the approximate location of each drogue was plotted onboard. This last step (preliminary plotting) was performed to monitor the movement of the drogues for relocation purposes, and to verify positioning data.

## 2.6 Hydrographic Sounding Survey

Thirteen sounding lines were run at the Turner Bay project site employing a combination of a Path transit and one range of the MRS. A continuous record of water depths along each sounding transect was obtained employing a Raytheon Model DE-719B survey grade echo sounder. The DE-719B incorporates adjustments for both tide and transducer draft, plus a calibration for local water mass sound speed.

Sound speed calibration was accomplished by performing a "bar check" at the beginning and end of the survey day. The bar check procedure consisted of lowering an acoustic target on a graduated sounding line, then adjusting the DE-719B speed of sound control such that the target reflection was printed precisely at its known depth. A specification sheet for the Raytheon DE-719B is included in Appendix I.

During hydrographic survey operations the echo sounder records were marked and the contemporaneous distance measurement from the shore responder was entered into the field logs at range intervals of nominally 50m (164 ft). This procedure permits post-survey correlation of vessel position with depth data.

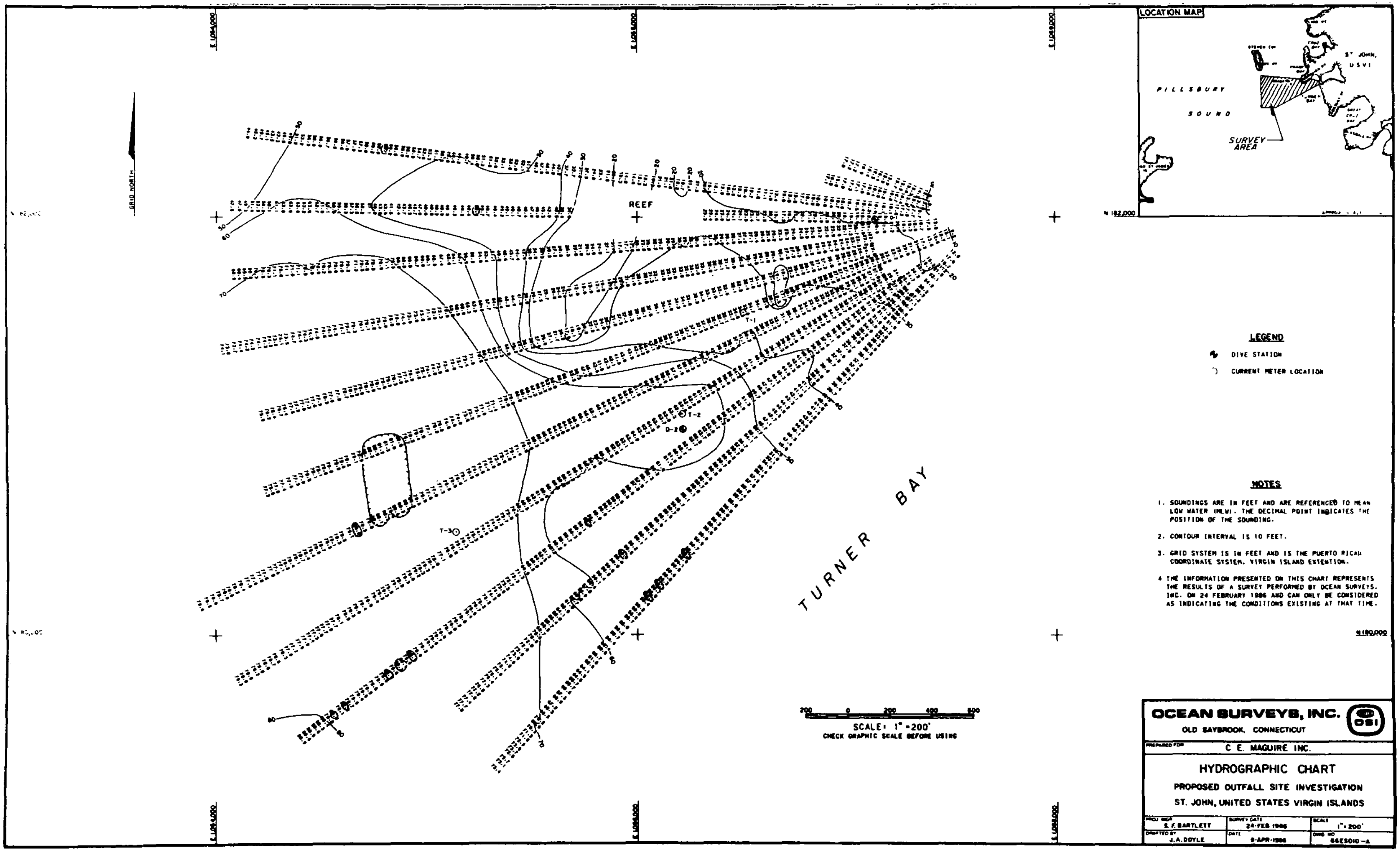

LOCATION MAP
PILLSBURY SOUND
ST JOHN, USVI
SURVEY AREA
GRID NORTH
REEF
T-1
T-2
D-2
T-3
TURNER BAY
LEGEND
DIVE STATION
CURRENT METER LOCATION
NOTES
1. SOUNDINGS ARE IN FEET AND ARE REFERENCED TO MEAN LOW WATER (MLW). THE DECIMAL POINT INDICATES THE POSITION OF THE SOUNDING.
2. CONTOUR INTERVAL IS 10 FEET.
3. GRID SYSTEM IS IN FEET AND IS THE PUERTO RICAN COORDINATE SYSTEM, VIRGIN ISLAND EXTENTION.
4 THE INFORMATION PRESENTED ON THIS CHART REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 24 FEBRUARY 1986 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME.
SCALE: 1" = 200'
CHECK GRAPHIC SCALE BEFORE USING
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT
C E. MAGUIRE INC.
HYDROGRAPHIC CHART
PROPOSED OUTFALL SITE INVESTIGATION
ST. JOHN, UNITED STATES VIRGIN ISLANDS
S. F. BARTLETT
24-FEB 1986
1" = 200'
J.A. DOYLE
9-APR-1986
86ES010-A

FIGURE NO. 4

## 2.7 Dye Tracer Study

### 2.7.1 Operational Theory

Dye dilution studies are based on the principle that the downstream dilution of a conservative substance such as Rhodamine WT dye is directly proportional to the mixing characteristics of the receiving water body.

Once downstream concentrations are corrected for temperature, instrument calibration and background fluorescence, it is possible to quantify the mixing characteristics of the receiving water body by computing dilution ratios and eddy diffusion coefficients.

### 2.7.2 Field Procedures

OSI injected 15 pounds of Rhodamine WT dye during the St. John studies. Rhodamine WT is a fluorescent, biodegradable tracer that is extremely soluable in water and detectable in very small concentrations (less than 0.05 parts per billion). The dye was supplied as a 20 percent solution by Crompton and Knowles Corporation, Gibraltar, Pennsylvania. The specific gravity of the individual lot of Rhodamine WT which OSI used at St. John was 1.126 at 66$^{o}$F.

The dye injection system, consisting of a 12 volt DC Fluid Metering, Inc. laboratory pump, was installed in a small boat moored at Station T-3. A 20 percent solution of Rhodamine WT dye was injected at the surface for approximately 6 hours at a nominal rate of 2.5 pounds per hour. Dye concentrations in the study area were measured with a calibrated Turner Designs Model 10 fluorometer mounted on board the survey vessel. Water was pumped continuously throught the instrument from an intake positioned 18 inches below the water surface.

The fluorometer provides a relative measure of the quantity of light emitted from a fluorescent solution. In principle, a lamp within the fluorometer emits light which is filtered and allowed to strike the sample as it flows continuously past the light source. Any dye present in the solution will fluoresce. The emitted spectrum is passed through a secondary filter to a sensor, and the relative quantity of light received is indicated on the fluorometer readout.

The fluorescence of dye varies with sample temperature; therefore, the water temperature in the sampling line was monitored with a Yellow Springs Instrument Company Series 700 thermistor to enable data processors to correct recorded dye concentrations for solution temperature. Both dye concentration and temperature were continuously recorded on a Soltec VC 6723-S two-pen strip chart recorder packaged with the fluorometer in a custom, splash-proof field case.

Surficial downstream dye concentrations and water temperature were monitored along 14-17 survey transects during each of three mapping sessions. These transects were oriented nominally perpendicular to the trajectory of the dye plume. Dye concentrations were also taken within 1 meter (3.3 ft) of the dye discharge point to determine initial dilution and upstream of the dye injection station to measure background fluorescence levels.

The fluorometer used at St. John (S/N 172) was calibrated prior to shipment to St. John. This pre-survey calibration was conducted using standard solutions prepared with dye drawn from the lot used for this study and with glassware which meets or exceeds National Bureau of Standards requirements.

Specification sheets for Rhodamine WT dye, Fluid Metering, Inc. laboratory pumps and the Turner Designs Model 10 Fluorometer are provided in Appendix I.

## 3.0 DATA PROCESSING AND PRESENTATION

### 3.1 Introduction

Prior to data processing the field team reviewed all log sheets and prepared a detailed summary of daily activities and relevant site conditions. Data acquired in the field were processed by OSI at its Connecticut data processing facility on a Digital Equipment Corporation PDP 11/44 computer. All the hydrographic and oceanographic data are presented in engineering units and, where applicable, reflect post-calibration corrections.

### 3.2 Vessel Position and Survey Trackline Reconstruction

Drogue positions and hydrographic survey tracklines were reconstructed from transit angles and/or MRS range measurements logged at each position "fix". These values, together with the Puerto Rican grid coordinates of the horizontal control stations, were input into the computer system where calculations were made for the X and Y coordinates of each recorded position. During calculation of vessel and/or drogue position geometric consideration for transponder elevations, interrogator antenna height, X and Y corrections for sensor layback and offset (relative to the MRS antenna) and range calibration data were also input to yield the most precise computations possible.

### 3.3 Tide Level Data

Continuous tide level chart recordings made during the program were digitized, referenced to the mean low water datum and listed at 15-minute intervals.

### 3.4 In Situ Current Data

Endeco Type 105 current meters record current run and a compass reading onto 16mm film as a fraction of a calibrated full scale value. At OSI's computer facility, the films are projected onto a translucent plate, and digitized using a Talos Model 6221 tablet digitizer interfaced with the DEC computer.

The current data are presented by station as 30-minute tabulations of average current speed and direction. The data are also presented statistically, as frequency distributions and graphically as progressive vector, current rose and time series plots. These are attached in Appendix II and III.

OSI calibrates all its Endeco meters at an in-house test facility and computer processes the film records. The post-calibration accuracy of reported current data is within the $\pm 3\%/\pm 6^{\circ}$ accuracies specified by the manufacturer; that is, the specified accuracies reflect measurement as well as data processing (digitizing) accuracies. Equipment accuracies are based on tests made by the manufacturer or by independent test facilities.

### 3.5 Drogue Tracking Data

Recorded drogue fix times were combined with MRS range information to reconstruct drogue tracks and to compute average drogue speed and direction between fixes. This information is presented as tabulations of time interval, drogue speed and drogue direction, and as plan view drawings at a scale of 1:15,000 (1"=1250') in Appendix II and III.

The accuracy of Lagrangian data acquired in tracking free drifting drogues is limited by the accuracies inherent in vessel positioning, ground control and the timing of position fixes. Reasonable estimates of the accuracies associated with the reported drogue data are 5 percent for relative speed and 2 to 4 degrees for relative direction, depending in part on the distance travelled by the drogues between position fixes.

### 3.6 Hydrographic Data

Processing and presentation of the hydrographic data was accomplished in three steps:

- Transit and MRS range data were converted into X-Y positions referenced to the Puerto Rican coordinate system. This information was then used to reconstruct survey vessel tracklines.

- Continuous analog echo sounder records were digitized using a Summagraphics tablet digitizer. The digital depth data were then adjusted for the draft of the survey vessel and water surface elevation (referenced to MLW employing NOAA predicted tides).

- After the X-Y data were combined with the sounding data, the MLW water depths were computer plotted onto a plan view basemap at a scale of 1:2,400 (1"=200'); Drawing 86ES010-A.

## 3.7 Dye Concentration Data

Survey vessel tracklines were reconstructed by computer plotting the "Mini Ranger" range-range data which were logged during the study. Dye concentration data which were recorded on strip charts were corrected for a 3.0 second dye measurement response time (pumping time), digitized, corrected as discussed below, then plotted along vessel tracklines.

Fluorometer data were reduced in three steps as follows:

° Step 1: Correct water temperature data according to results of pre-survey thermistor system calibrations.

° Step 2: Correct fluorometer outputs for temperature according to the equation:

$$CONC_{TRUE} = CONC_{REC} \times e^{0.015(T_R - T_S)}$$

where, $CONC_{TRUE}$ = dye concentration corrected for sample temperature

$CONC_{REC}$ = recorded fluorometer output

$T_R$ = corrected sample temperature (from Step 1)

$T_S$ = standard (reference) temperature; in this case, $T_S = 68^{o}F$

° Step 3: Using pre-survey calibration data for the Turner Designs Model 10 fluorometer (S/N 172) and the specific gravity of the dye lot used in St. John, the "equivalent" dye concentrations were calculated in parts per billion (ppb) by weight.

Eddy diffusion coefficients were calculated using the approach taken by Brooks (1959), whereby the eddy diffsuion coefficient is related to the variance of the concentration profile perpendicular to the current. By assuming a normal dye concentration distribution perpendicular to the current, by employing Brook's definition of field width ($C_z$=24), and by using current speed data collected at T-3 TOP, it was possible to calculate the eddy diffusion coefficient (E) using:

$$^{*}E = \frac{W_B^{\,2} - W_A^{\,2}}{C^z(t_B - t_A)}$$

where, $W_B$-$W_A$ is the difference in plume widths at two stations

and $t_B$-$t_A$ is the time required for the current to transport a particle of dye from Station A to Station B.

Dilution ratios are calculated employing the formula:

$$\text{Dilution} = (C_I/C_D)-1$$

where $C_I$ = Initial concentration = 320 ppb and
$C_D$ = Downstream concentration

---

*Brooks, N. H. (1959): "Diffusion of Sewage Effluent in an Ocean Current," in Waste Disposal in the Marine Environment, edited by E. A. Pearson, pp. 246-267, Pergamon Press, New York.

## 4.0 DISCUSSION OF DATA

### 4.1 Tide Level Data

The mean tide range observed in Cruz Bay during the June study was 24.2 cm (0.79 ft) with a maximum tide range of 49.4 cm (1.62 ft). Mean low water was 2.4 cm (.08 ft) below the datum of mean low water and the mean tide level was 9.68 cm (.32 ft).

Small scale perturbations superimposed on the analog tide records were recorded on OSI's in situ gauge. These perturbations had periods ranging from 7-30 minutes and are often observed in tide records from the Carribean.

Recorded times of high and low tides compared very favorably with predicted times, but were variable relative to predicted tide height (±.12m = ±.4 ft). Low slack tide observed onsite precedes low tide by approximately 1.5-2 hours, while high slack corresponds closely with the time of high tide.

### 4.2 Current Speed and Direction Data

#### 4.2.1 Historical Data

A 13 cm/s (.25 KT) ocean current varying from northwestward to westward prevails among the Virgin Islands throughout the year. Tidal currents typically flood to the southeast and ebb to the northwest, with a net drift to the southeast during the summer months (mid June to mid August) and a northwest net drift during September, November, March and April*.

*U.S. NAVAL OCEANOGRAPHIC OFFICE: SAILING DIRECTIONS FOR THE WEST INDIES, VOLUME II, H.O. PUBLICATION 22, U.S. GOVT. PRINTING OFFICE, WASHINGTON, 1963.

A phenomenon of particular interest is the "St. John's Tide" which reportedly occurs near the beginning of the summer months (mid June). During this period tidal currents set continually to the southeastward with "unusual force".

Within Pillsbury Sound tidal currents reportedly flood southward and ebb northward at rates of approximately 102 cm/s (2 Kts). Tidal current speeds as great as 204 cm/s (4 Kts) have been reported near Dog Island, and Leeward, Middle and Windward Passages.

### 4.2.2 In Situ Current Speed and Direction

Table 3 summarizes the in situ current speed and direction data and shows that there was a strong northerly net drift at all stations during both deployment periods, with a range of 5.4 to 39.4 percent of the current recordings exhibiting a southerly component and 57.4 to 71.7 percent having a northerly component.

The current data collected during these studies indicate that the tidal currents predominantely flood to the north-northwest and ebb to the south-southwest. This information is supported by the drogue data and is in direct contrast with the more general historical tidal current information for Pillsbury Sound presented in Section 4.1.1. The north-northwest - south-southeastern tidal flow pattern is most strongly developed at the furthest offshore Stations T-3 and T-4) and less pronounced, with a slightly greater onshore-offshore (northeast-southwest) component, toward the nearshore Station T-1.

TABLE 3

SUMMARY OF IN SITU CURRENT DATA

DEPLOYMENT #1

| Station Designation | Meter Position | % Occurrence of Current Directions: Southerly | Northerly | % Exceedence (speed categories in cm/s): 20.0 | 40.0 | 60.0 | 80.0 |
|---|---|---|---|---|---|---|---|
| T-1 | TOP | 28.2 | 59.9 | 35.6 | 0.0 | 0.0 | 0.0 |
| T-2 | TOP | 23.3 | 65.6 | 63.2 | 14.4 | 0.6 | 0.0 |
| | BOTTOM | 23.9 | 65.0 | 61.8 | 2.3 | 0.0 | 0.0 |
| T-3 | TOP | 37.6 | 60.7 | 81.0 | 56.8 | 20.9 | 2.9 |
| | BOTTOM | 39.4 | 57.4 | 79.2 | 52.3 | 15.2 | 1.7 |

DEPLOYMENT #2

| Station Designation | Meter Position | % Occurrence of Current Directions: Southerly | Northerly | % Exceedence (speed categories in cm/s): 20.0 | 40.0 | 60.0 | 80.0 |
|---|---|---|---|---|---|---|---|
| T-2 | TOP | 22.9 | 61.1 | 42.5 | 4.6 | 0.0 | 0.0 |
| | BOTTOM | 5.4 | 71.7 | 37.9 | 0.0 | 0.0 | 0.0 |
| T-3 | TOP | 34.4 | 58.1 | 75.5 | 47.5 | 16.0 | 0.4 |
| | BOTTOM | 35.7 | 61.0 | 68.0 | 31.1 | 2.5 | 0.0 |
| T-4 | TOP | 34.6 | 60.1 | 69.4 | 33.0 | 8.5 | 0.0 |

The time series plots of current speed and direction show that all stations demonstrated tidal current reversals, but that southerly ebb tidal currents were brief (0-3.5 hrs) and weak during high to higher-low ebb tides.

Current speed data presented in Table 3 for Stations T-2 and T-3 show that the currents recorded within this region of Turner Bay were substantially stronger at both depths during the February deployment. Table 3 also shows that the surface currents at Station T-3 substantially exceeded those recorded at Station T-4.

4.2.3 Drogue Data

Figures 19-22 and 33-37 graphically display the drogue trajectories and the accompanying tabulations present the corresponding drogue velocity data. The time series insets on Figures 19-22 for tide are from the NOAA predicted tide tables and the time series plots of current speed and direction are from Station T-3 top. Time series insets on Figures 33-37 for tide are from tide level data collected from a gauge located at the National Park Service Facility in Cruz Bay.

The Lagrangian current data collected during the four days of drogue releases support the conclusion that tidal currents flood north-northwestward and ebb south-southeastward in this region of Pillsbury Sound. Figures 33 and 36 demonstrate the brievity of the southerly ebb tidal currents, while Figures 20, 21 and 36 display the nature of the ebb-to-flood tidal reversal within Turner Bay.

Drogue movements display predominantely shore-parallel trajectories with onshore movements occurring on Steven Cay and Bovocoap Point during the February studies. Total travel time from the proposed outfall alignment to the two grounding locations was approximately 65 minutes to Steven Cay and 4 hours to Bovocoap Point (Figures 21 and 22).

Discussions with an experienced local boat captain indicate that sea and meteorological conditions which existed onsite during the second set of studies were more typical of the Carribean than those encountered in February. During the first study winds were light and did not appear to influence drogue trajectories. During the latter study, winds reported onsite by OSI's field crew were typically east-southeast at 14-20 KPH (8-11 knots). These wind conditions acted to keep drogues released from Station T-3 well offshore of Steven Cay.

## 4.3 Hydrographic Sounding Data

Water depths ranged from 2.8 m (9.1 ft) at the nearshore end of the hydrographic survey area to 24.7 m (81.2 ft) at the outer-central portion of the site. The reef located in the north-central portion of the site is steep-sided with the surface of the main body being awash at low tide.

## 4.4 Dye Dilution Data

Figures 38-40 and Table 4 present the results of the dye dilution investigations. Figure 38 depicts the developing dye plume approximately 60 minutes after the initiation of dye injection at Station T-3. Winds were light and current speeds recorded during the period were on the order of 24 cm/s (.45 Kt). Eddy diffusion coefficients ranged from .038 to .088 $m^2$/sec (.41 to .95 $ft^2$/sec) during this mapping session, which is manifested by the lack of dispersion normal to the axis of the plume. Assuming an initial concentration of 320 ppb at a distance of 1 meter (3.3 ft) from the

TABLE 4

EDDY DIFFUSION COEFFICIENTS

| Plume Designation | Plume Widths Station A (Meters) | Plume Widths Station B (Meters) | Distance (Station B-Station A) (Meters) | Downstream Dilution Ratio | Current Speed (m/sec) | Eddy Diffusion Coefficients ($m^2$/sec) | Eddy Diffusion Coefficients ($ft^2$/sec) |
|---|---|---|---|---|---|---|---|
| #1 | .1 | 91.4 | 1,267 | 3,199:1 | .24 | .066 | .71 |
| | .1 | 57.2 | 857 | 198 | .24 | .038 | .41 |
| | .1 | 38.1 | 165 | 69 | .24 | .088 | .95 |
| | 38.1 | 91.4 | 1,102 | | .24 | .046 | .49 |
| #2 | .1 | 952.5 | 2,155 | 5,078 | .37 | 6.49 | 69.8 |
| | .1 | 205.7 | 1,885 | 3,264 | .37 | .342 | 3.68 |
| | .1 | 80.[illegible] | 857 | 888 | .37 | .111 | 1.19 |
| | .1 | 72.4 | 461 | 347 | .37 | .177 | 1.90 |
| | .1 | 26.7 | 62 | 30 | .37 | .177 | 1.90 |
| | 26.7 | 205.7 | 1,496 | | .37 | .353 | 3.80 |
| #3 | .1 | 845.8 | 2,700 | 5,613 | .37 | 4.09 | 44.0 |
| | .1 | 228.6 | 2,060 | 3,367 | .37 | .390 | 4.20 |
| | .1 | 137.2 | 960 | 1,599 | .37 | .111 | 1.19 |
| | .1 | 53.3 | 363 | 404 | .37 | .177 | 1.90 |
| | .1 | 41.9 | 104 | 30 | .37 | .260 | 2.80 |
| | 41.9 | 228.6 | 1,956 | | .37 | .399 | 4.29 |

discharge (measured), dilution ratios varied from 69 at a point 165 meters (541 ft) downstream to 3,199 at the tip of the dye plume 1267 meters (4,157 ft) downstream.

Figures 39 and 40 display the characteristics of a fully-developed flood tidal dye plume. Similar to Figure 38, there is little lateral dispersion of the dye plume except in the vicinity of Two Brothers. As shown in Table 4, the maximum downstream dilution ratio measured was 5,613 at a distance of 2,700 meters (8,858 ft) with typical nearfield ratios equalling 30 at distances of 62 and 104 meters (203 and 341 ft). Eddy diffusion coefficients increased slightly once the flood tidal currents approached a maximum speed and the dye plumes became fully developed. These coefficients varied between .111 in the nearfield and 6.49 $m^2$/sec (1.19 and 69.8 ft2/sec) at the downstream end of the plume.

The dilution data suggests that a conservative substance released at Station T-3 undergoes little lateral dispersion (E=.038 to .111$m^2$/sec = .41 to 1.19 $ft^2$/sec) and is diluted on the order of 198 to 888 times, depending on the mixing characteristics of Turner Bay, at a distance approximately equal to the distance form T-3 to Steven Cay.

## 5.0 CONCLUSIONS

The oceanographic data collected during the February and June circulation studies in Turner Bay suggest that effluent released at T-3 under typical meteorological conditions (moderate SE to ESE winds) would probably be transported offshore of Steven Cay. The water mass is then transported toward Two Brothers where it is distributed into Windward, Middle and probably Leeward Passages.

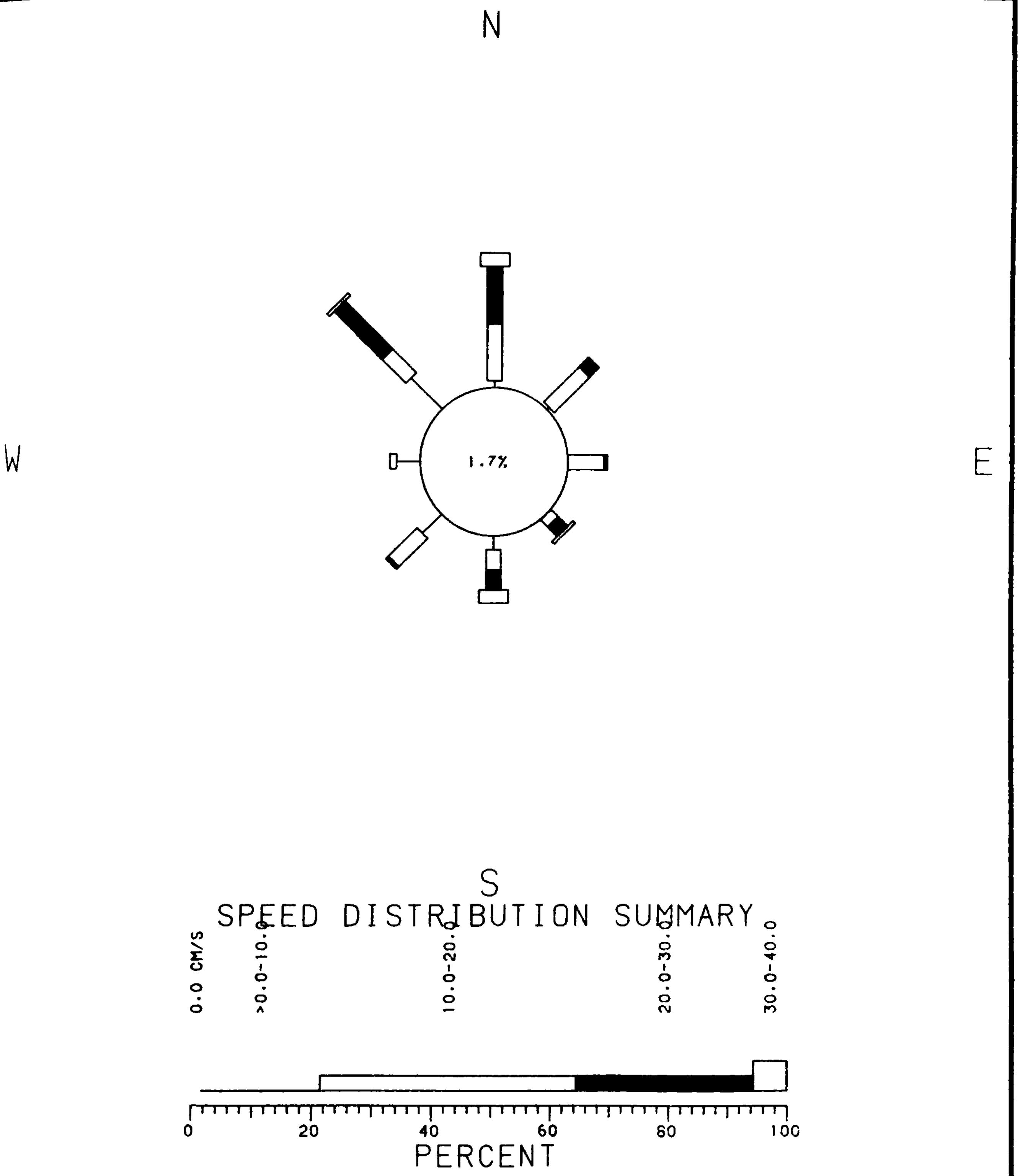
Under meteorological conditions where wind speeds are light and/or when the wind has a westerly component, Steven Cay would probably be impacted by effluent discharged at T-3 or T-4. These conditions coupled with short residence times, minimal lateral dispersion and low dilution could potentially have a negative impact on Steven Cay. Flow rates, diffuser characteristics and initial mixing, however, must be considered before a complete assessment of the potential effects of an outfall in Turner Bay can be made.

# APPENDIX E.1

## CURRENT SPEED AND DIRECTION DATA

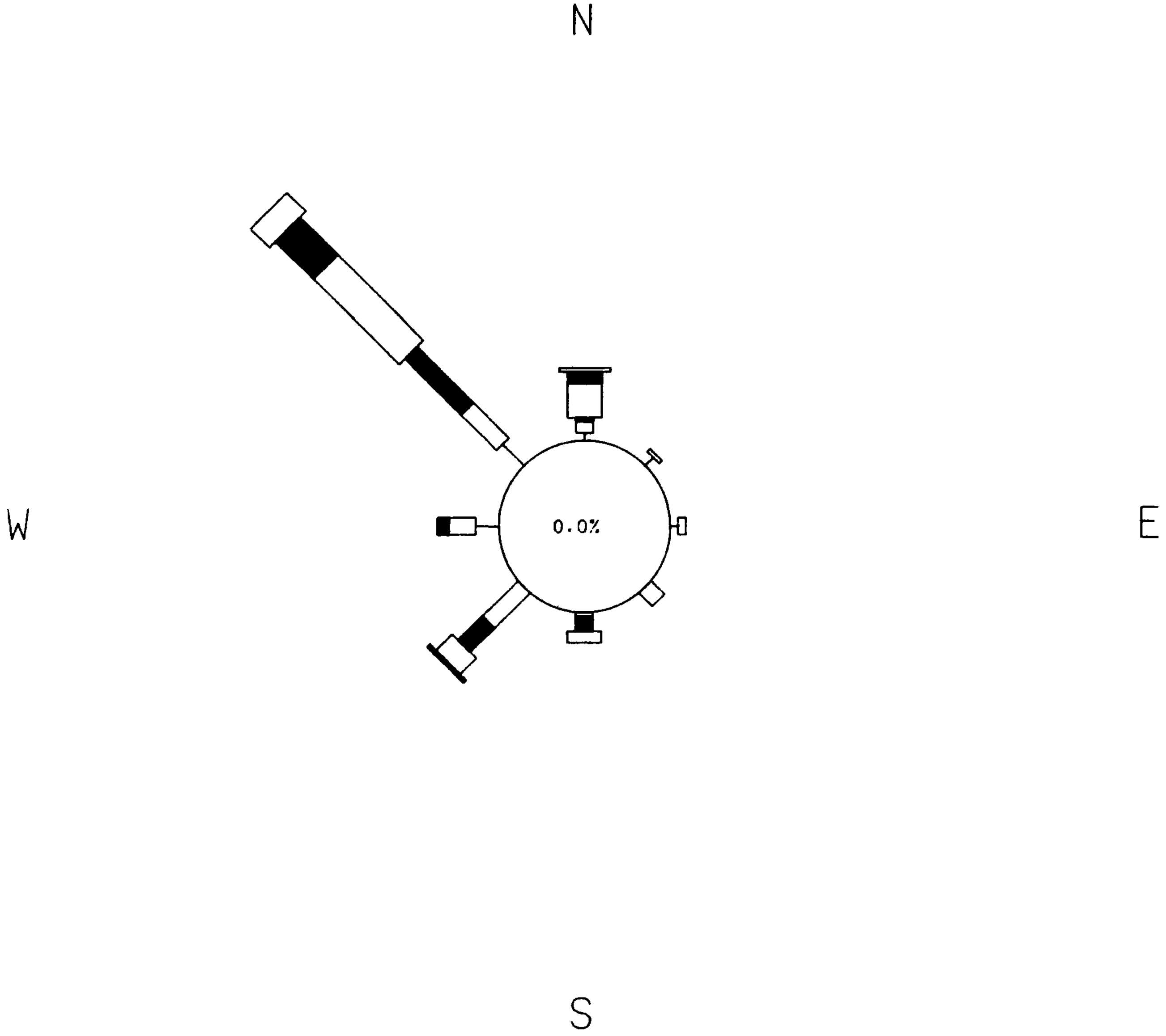
## FEBRUARY STUDIES

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION
# CRUZ BAY, ST. JOHN, VI

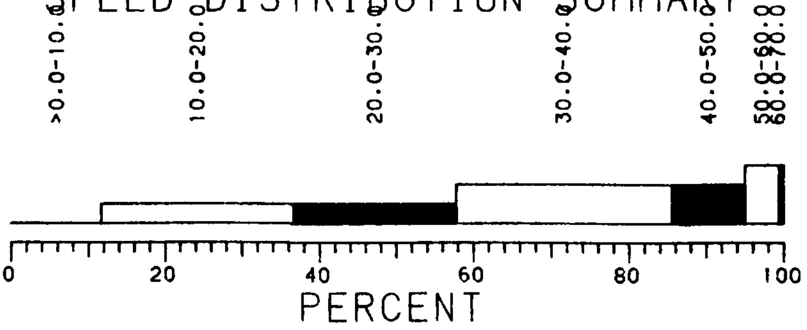



| OCEAN SURVEYS, INC. | DATA PERIOD 23 FEB 86 -27 FEB 86 | SCALE 1"=25% | DATE 7 APR 86 |
|---|---|---|---|
| | LOCATION STATION T-1 | BY CRR | FIGURE 9 |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION
# CRUZ BAY, ST. JOHN, VI

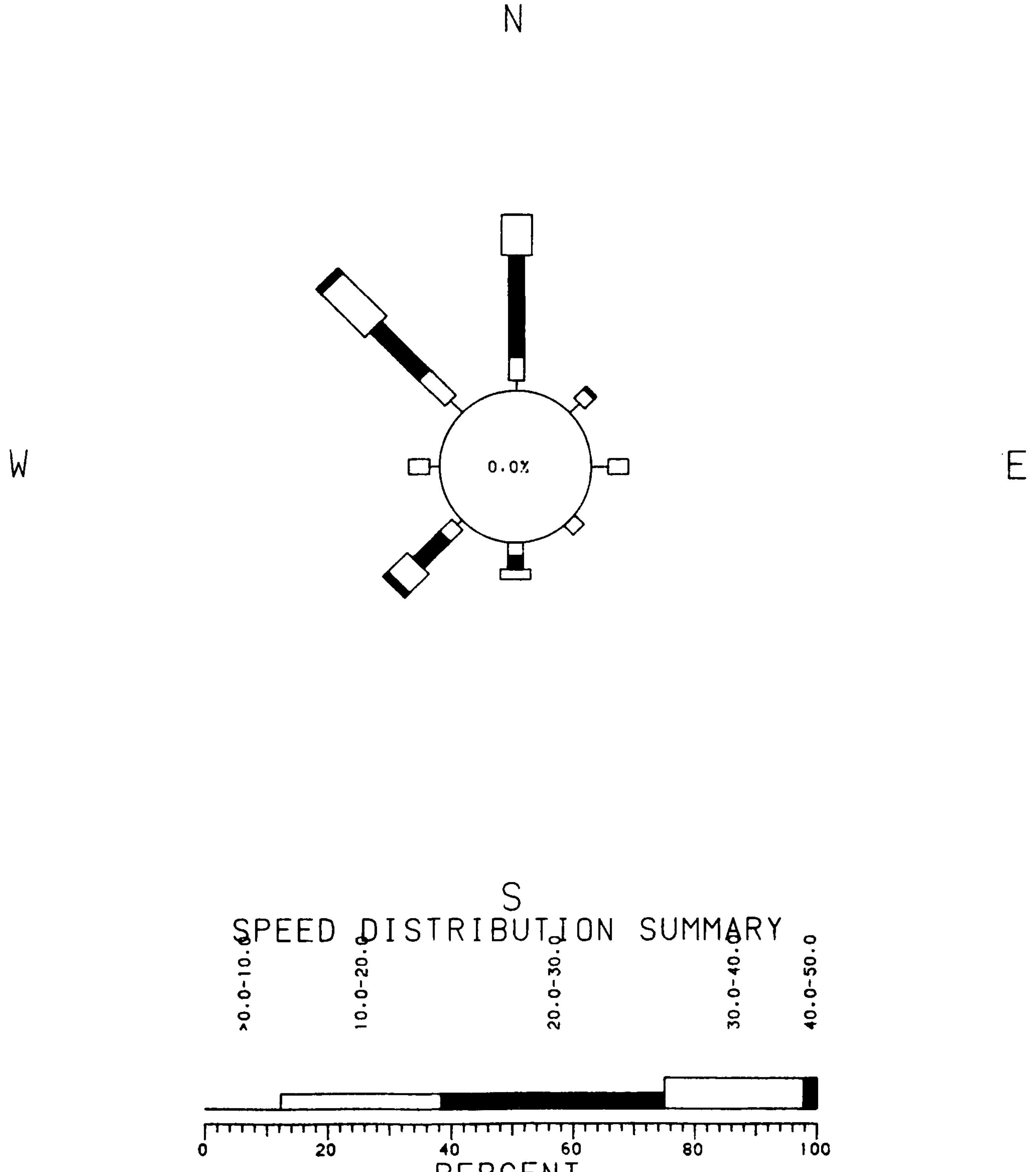



SPEED DISTRIBUTION SUMMARY



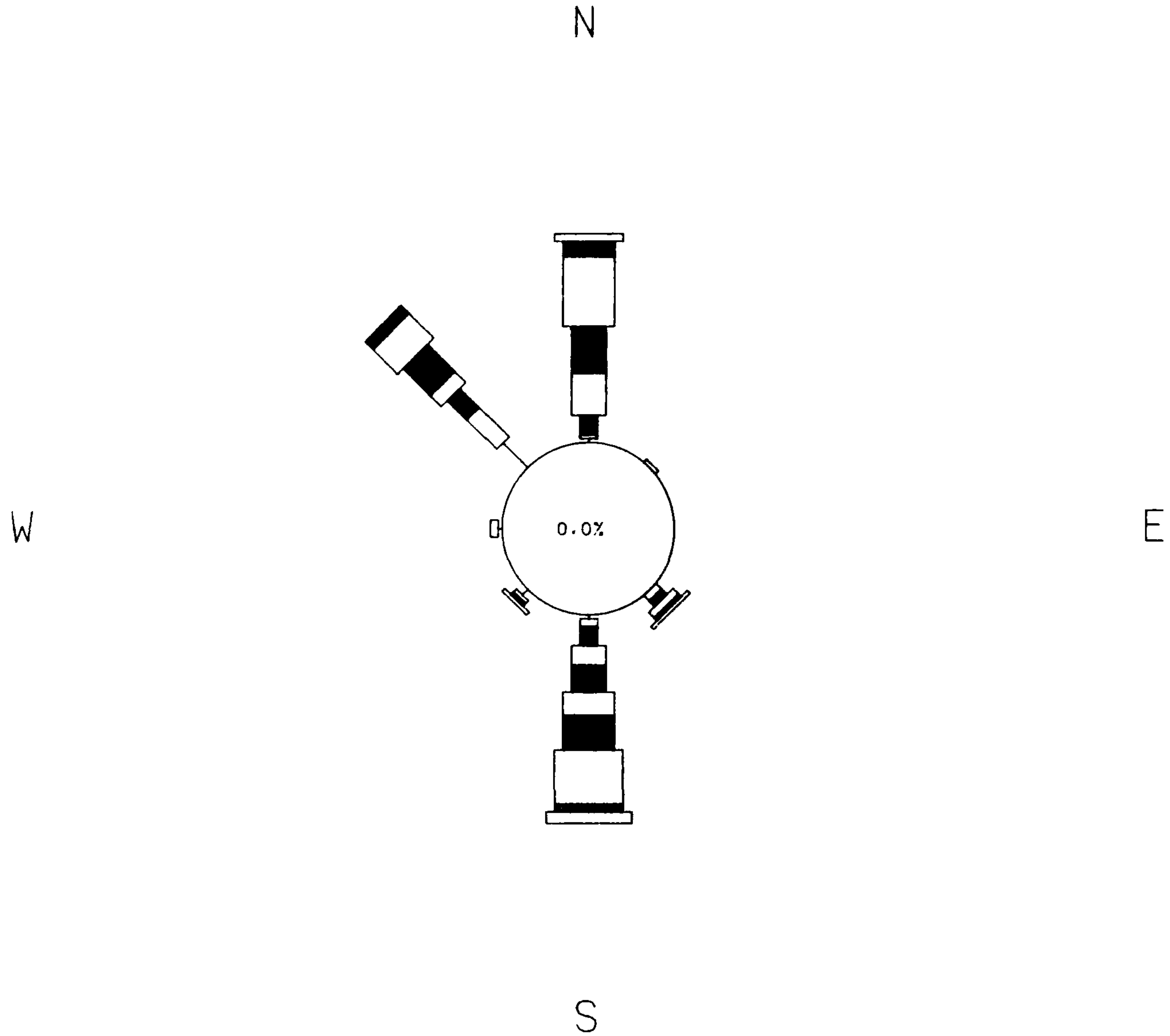

| OCEAN SURVEYS, INC. | DATA PERIOD 23 FEB 86 -27 FEB 86 | SCALE 1"=25% | DATE 7 APR 86 |
|---|---|---|---|
| | LOCATION STATION T-2 TOP | BY CRR | FIGURE 10 |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION
# CRUZ BAY, ST. JOHN, VI

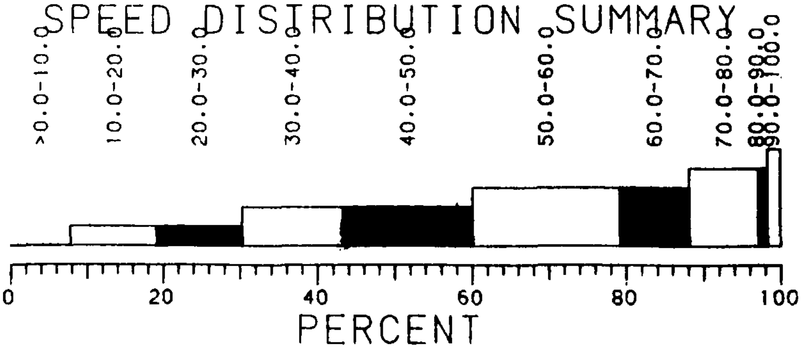



| OCEAN SURVEYS, INC. | DATA PERIOD 23 FEB 86 -27 FEB 86 | SCALE 1"=25% | DATE 7 APR 86 |
|---|---|---|---|
| | LOCATION STATION T-2 BOT | BY CRR | FIGURE 11 |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION
# CRUZ BAY, ST. JOHN, VI

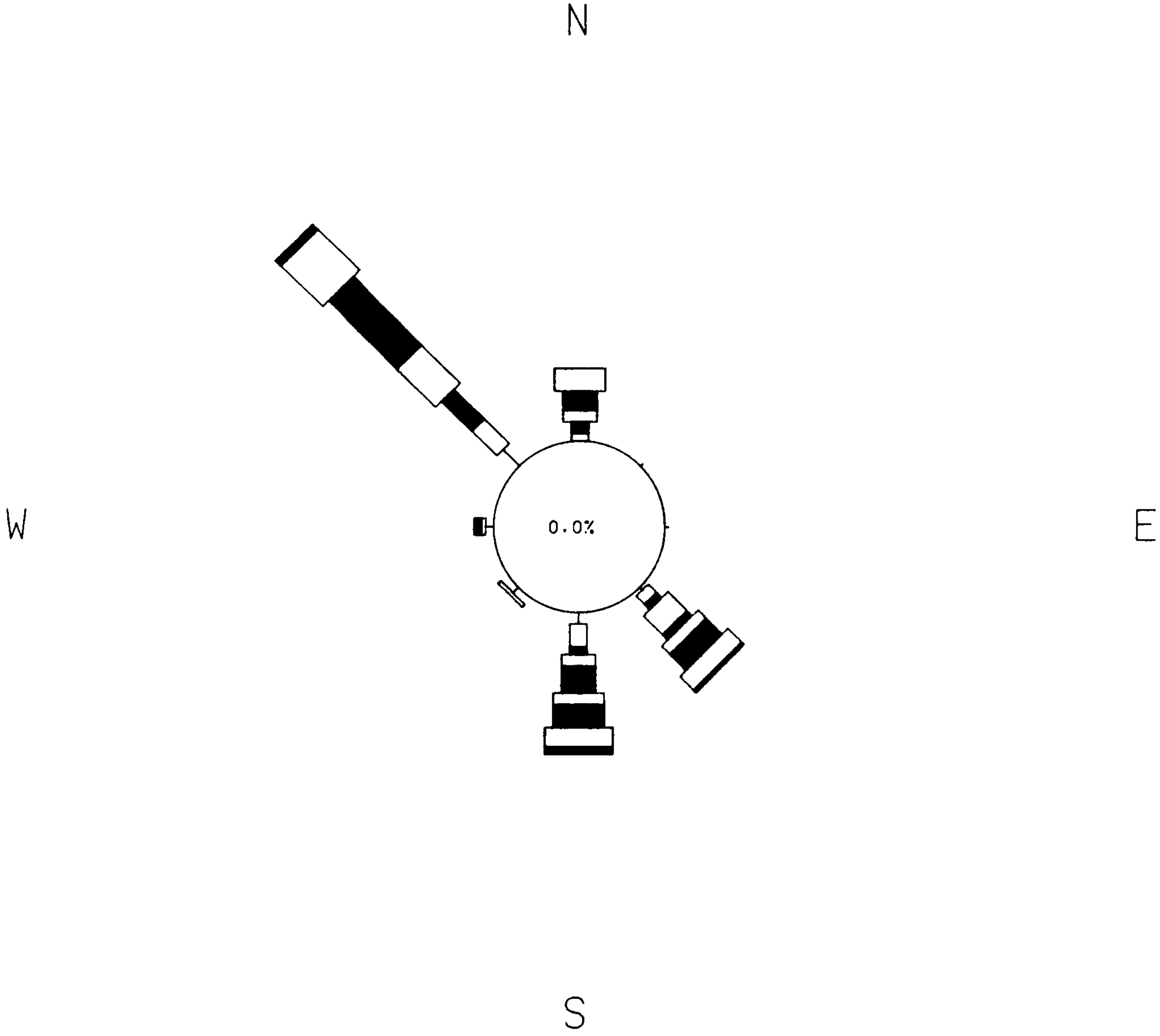



SPEED DISTRIBUTION SUMMARY

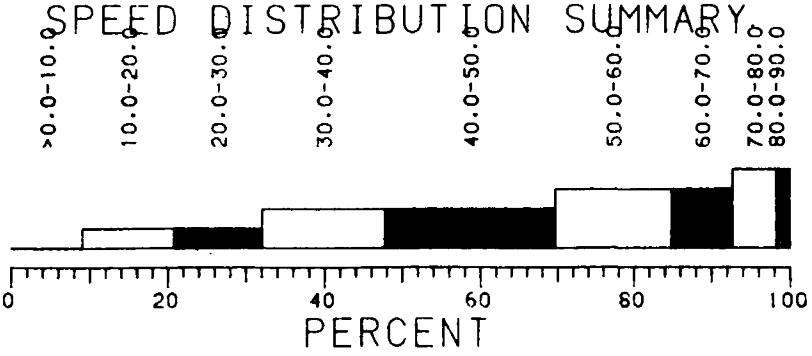



| OCEAN SURVEYS, INC. | DATA PERIOD 23 FEB 86 -27 FEB 86 | SCALE 1"=25% | DATE 7 APR 86 |
|---|---|---|---|
| | LOCATION STATION T-3 TOP | BY CRR | FIGURE 12 |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION
# CRUZ BAY, ST. JOHN, VI




SPEED DISTRIBUTION SUMMARY




| OCEAN SURVEYS, INC. | DATA PERIOD 23 FEB 86 -27 FEB 86 | SCALE 1"=25% | DATE 7 APR 86 |
|---|---|---|---|
| | LOCATION STATION T-3 BOT | BY CRR | FIGURE 13 |

# DROGUE VELOCITY DATA

## OUTFALL SITE INVESTIGATION
## CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ■ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0910 | - | 0941 | 33.8 | 0.66 | 141 |
| 2 | 0941 | - | 1009 | 44.0 | 0.85 | 128 |
| 3 | 1009 | - | 1036 | 46.7 | 0.91 | 119 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ● DATE: 25 FEB 1985

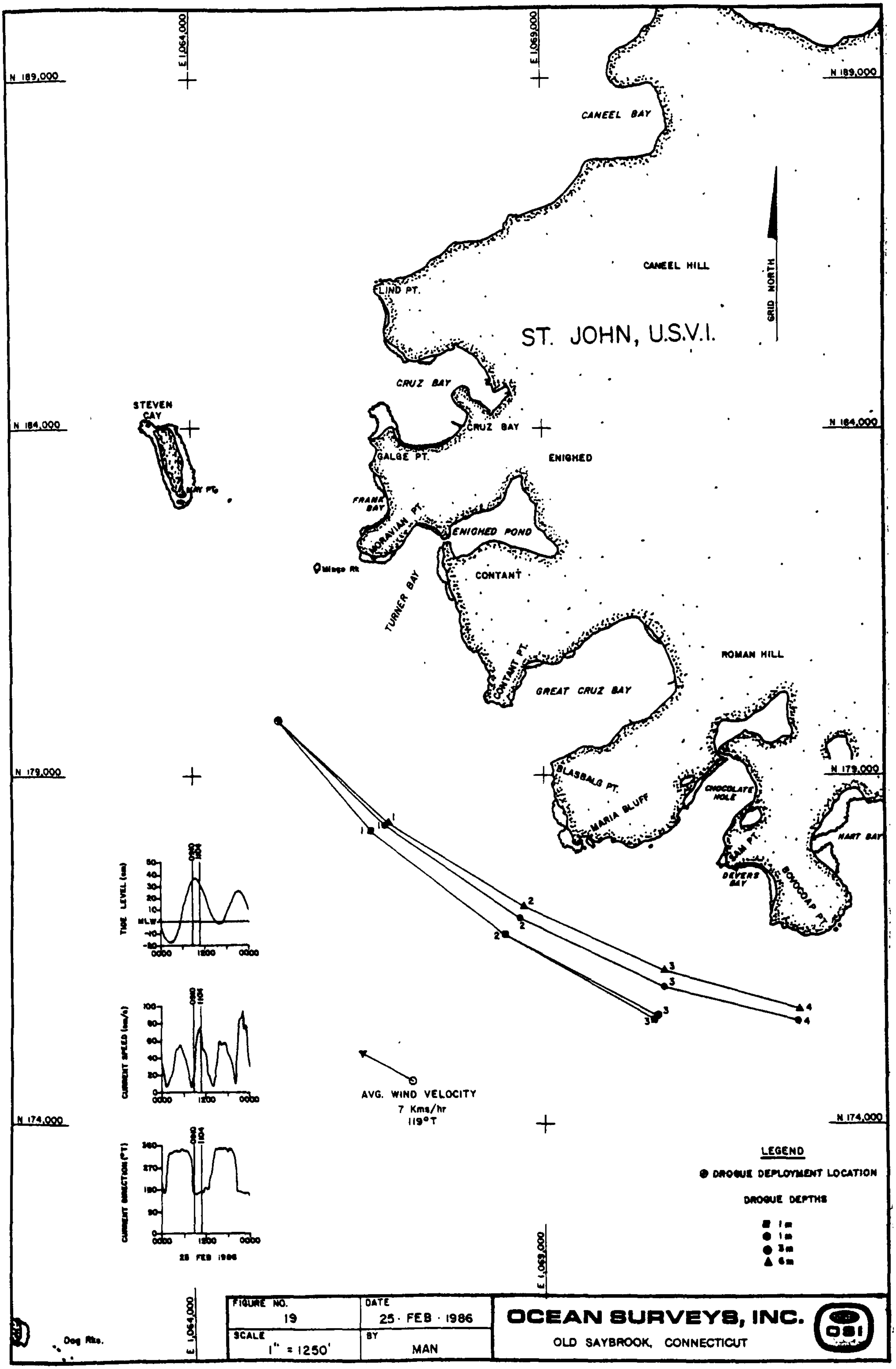
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0910 | - | 0941 | 33.9 | 0.66 | 140 |
| 2 | 0941 | - | 1009 | 43.7 | 0.85 | 129 |
| 3 | 1009 | - | 1036 | 46.4 | 0.90 | 120 |

DROGUE DESIGNATION:
DROGUE DEPTH: 3 METER(S) ● DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0910 | - | 0943 | 33.0 | 0.64 | 135 |
| 2 | 0943 | - | 1010 | 43.9 | 0.85 | 125 |
| 3 | 1010 | - | 1037 | 43.2 | 0.84 | 116 |
| 4 | 1037 | - | 1102 | 40.2 | 0.78 | 104 |

DROGUE DESIGNATION:
DROGUE DEPTH: 6 METER(S) ▲ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0910 | - | 0943 | 33.2 | 0.65 | 134 |
| 2 | 0943 | - | 1011 | 41.0 | 0.80 | 122 |
| 3 | 1011 | - | 1038 | 41.5 | 0.81 | 115 |
| 4 | 1038 | - | 1104 | 39.5 | 0.77 | 106 |



N 189,000
E 1,064,000
E 1,069,000
CANEEL BAY
CANEEL HILL
GRID NORTH
LIND PT.
ST. JOHN, U.S.V.I.
CRUZ BAY
STEVEN CAY
N 184,000
CRUZ BAY
GALGE PT.
ENIGHED
FRANK BAY
MORAVIAN PT.
ENIGHED POND
CONTANT
TURNER BAY
CONTANT PT.
GREAT CRUZ BAY
ROMAN HILL
N 179,000
BLASBALG PT.
MARIA BLUFF
CHOCOLATE HOLE
HART BAY
DEVERS BAY
BOVOCOAP PT.
TIDE LEVEL (cm)
MLW
CURRENT SPEED (cm/s)
CURRENT DIRECTION (°T)
0000
1200
25 FEB 1986
AVG. WIND VELOCITY
7 Kms/hr
119°T
N 174,000
E 1,069,000
LEGEND
DROGUE DEPLOYMENT LOCATION
DROGUE DEPTHS
1m
1m
3m
6m
Dog Rks.
FIGURE NO. 19
DATE 25 · FEB · 1986
SCALE 1" = 1250'
BY MAN
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT
OSI

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION
CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ■ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1136 | - | 1207 | 43.6 | 0.85 | 148 |
| 2 | 1207 | - | 1245 | 28.2 | 0.55 | 124 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ⬢ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1136 | - | 1207 | 46.6 | 0.91 | 151 |
| 2 | 1207 | - | 1237 | 37.2 | 0.72 | 129 |

DROGUE DESIGNATION:
DROGUE DEPTH: 3 METER(S) ● DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1137 | - | 1206 | 49.1 | 0.95 | 148 |
| 2 | 1206 | - | 1241 | 34.1 | 0.66 | 129 |

DROGUE DESIGNATION:
DROGUE DEPTH: 6 METER(S) ▲ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1138 | - | 1208 | 36.3 | 0.71 | 141 |
| 2 | 1208 | - | 1248 | 19.8 | 0.39 | 128 |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION
CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) □ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1257 | - | 1335 | 13.8 | 0.27 | 185 |
| 2 | 1335 | - | 1404 | 9.9 | 0.19 | 180 |
| 3 | 1404 | - | 1431 | 11.6 | 0.23 | 170 |
| 4 | 1431 | - | 1505 | 6.3 | 0.12 | 231 |
| 5 | 1505 | - | 1539 | 23.9 | 0.46 | 323 |
| 6 | 1539 | - | 1605 | 48.6 | 0.94 | 331 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ⬡ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1259 | - | 1333 | 15.9 | 0.31 | 193 |
| 2 | 1333 | - | 1405 | 14.6 | 0.28 | 158 |
| 3 | 1405 | - | 1432 | 11.5 | 0.22 | 169 |
| 4 | 1432 | - | 1505 | 6.4 | 0.12 | 236 |
| 5 | 1505 | - | 1536 | 21.6 | 0.42 | 323 |
| 6 | 1536 | - | 1600 | 44.5 | 0.86 | 331 |

DROGUE DESIGNATION:
DROGUE DEPTH: 3 METER(S) ○ DATE: 25 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1258 | - | 1334 | 13.2 | 0.26 | 190 |
| 2 | 1334 | - | 1405 | 14.5 | 0.28 | 165 |
| 3 | 1405 | - | 1433 | 12.7 | 0.25 | 163 |
| 4 | 1433 | - | 1506 | 4.5 | 0.09 | 224 |
| 5 | 1506 | - | 1538 | 24.6 | 0.48 | 328 |
| 6 | 1538 | - | 1608 | 53.4 | 1.04 | 329 |

DROGUE VELOCITY DATA

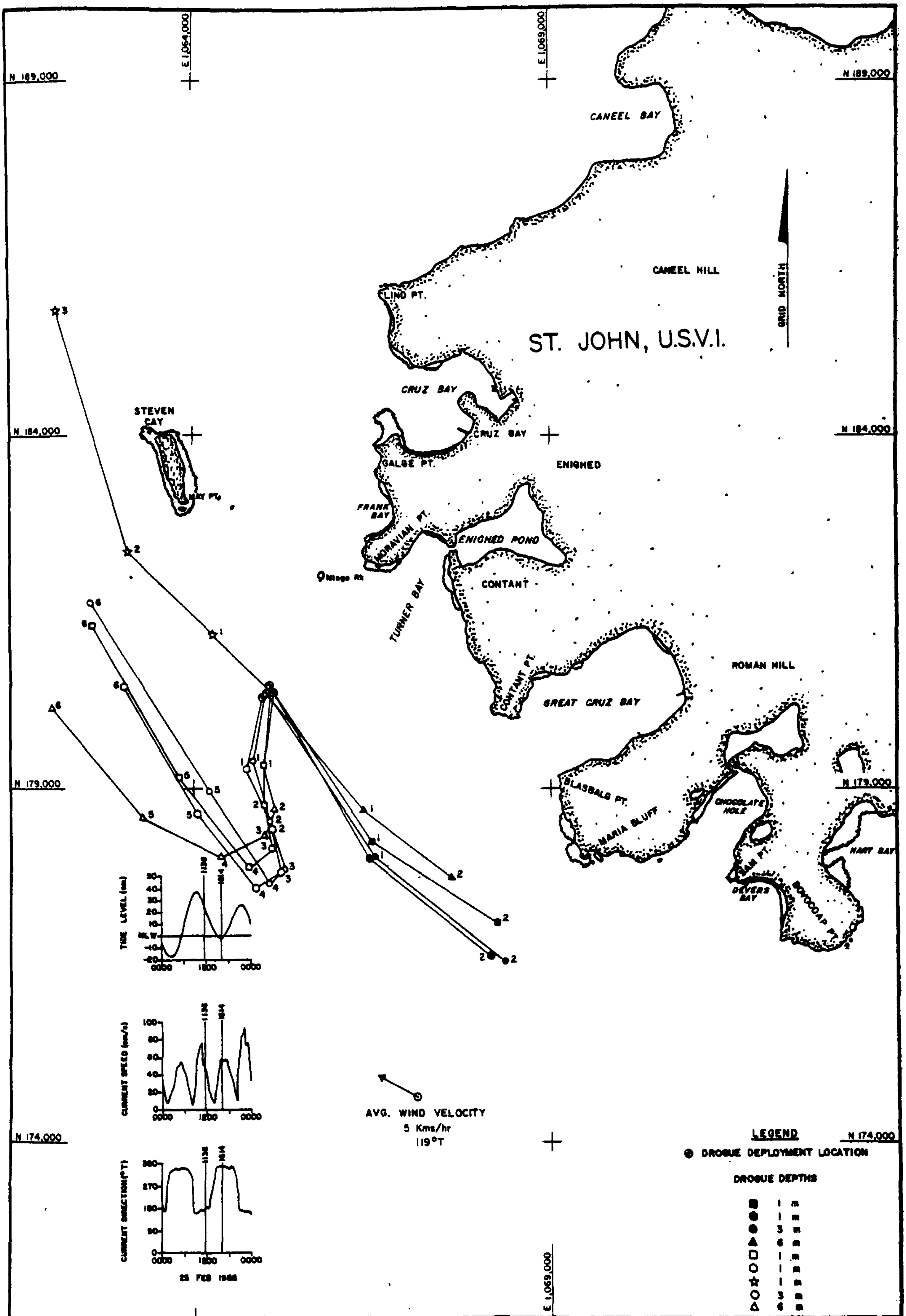
OUTFALL SITE INVESTIGATION
CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 6 METER(S) △ DATE: 25 FEB 1985

| TIME INTERVAL | | | | SPEED | | DIRECTION |
|---|---|---|---|---|---|---|
| (NO.) | (HR:MIN) | | (HR:MIN) | (CM/SEC) | (KTS) | (DEG MAG) |
| 1 | 1257 | - | 1335 | 14.1 | 0.27 | 188 |
| 2 | 1335 | - | 1407 | 10.3 | 0.20 | 167 |
| 3 | 1407 | - | 1430 | 8.7 | 0.17 | 202 |
| 4 | 1430 | - | 1503 | 10.5 | 0.20 | 245 |
| 5 | 1503 | - | 1525 | 28.1 | 0.55 | 298 |
| 6 | 1525 | - | 1603 | 27.2 | 0.53 | 321 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ☆ DATE: 25 FEB 1985

| TIME INTERVAL | | | | SPEED | | DIRECTION |
|---|---|---|---|---|---|---|
| (NO.) | (HR:MIN) | | (HR:MIN) | (CM/SEC) | (KTS) | (DEG MAG) |
| 1 | 1515 | - | 1530 | 42.4 | 0.82 | 318 |
| 2 | 1530 | - | 1544 | 60.3 | 1.17 | 315 |
| 3 | 1544 | - | 1614 | 60.7 | 1.18 | 344 |




| FIGURE NO. | DATE |
|---|---|
| 20 | 25 · FEB · 1986 |
| SCALE | BY |
| 1" = 1250' | MAN |

**OCEAN SURVEYS, INC.**

OLD SAYBROOK, CONNECTICUT

# DROGUE VELOCITY DATA

## OUTFALL SITE INVESTIGATION
## CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ■ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0754 | - | 0809 | 37.4 | 0.73 | 325 |
| 2 | 0809 | - | 0837 | 21.5 | 0.42 | 336 |
| 3 | 0837 | - | 0908 | 5.6 | 0.11 | 10 |
| 4 | 0908 | - | 0937 | 5.6 | 0.11 | 145 |
| 5 | 0937 | - | 1009 | 36.5 | 0.71 | 167 |
| 6 | 1009 | - | 1040 | 74.3 | 1.44 | 139 |
| 7 | 1040 | - | 1109 | 52.2 | 1.01 | 117 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ⬢ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0753 | - | 0808 | 38.9 | 0.76 | 319 |
| 2 | 0808 | - | 0835 | 28.7 | 0.56 | 315 |
| 3 | 0835 | - | 0905 | 14.0 | 0.27 | 281 |
| 4 | 0905 | - | 0933 | 7.7 | 0.15 | 246 |
| 5 | 0933 | - | 1005 | 29.9 | 0.58 | 136 |
| 6 | 1005 | - | 1034 | 39.4 | 0.77 | 152 |
| 7 | 1034 | - | 1102 | 46.4 | 0.90 | 142 |
| 8 | 1102 | - | 1134 | 50.9 | 0.99 | 130 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ● DATE: 26 FEB 1985

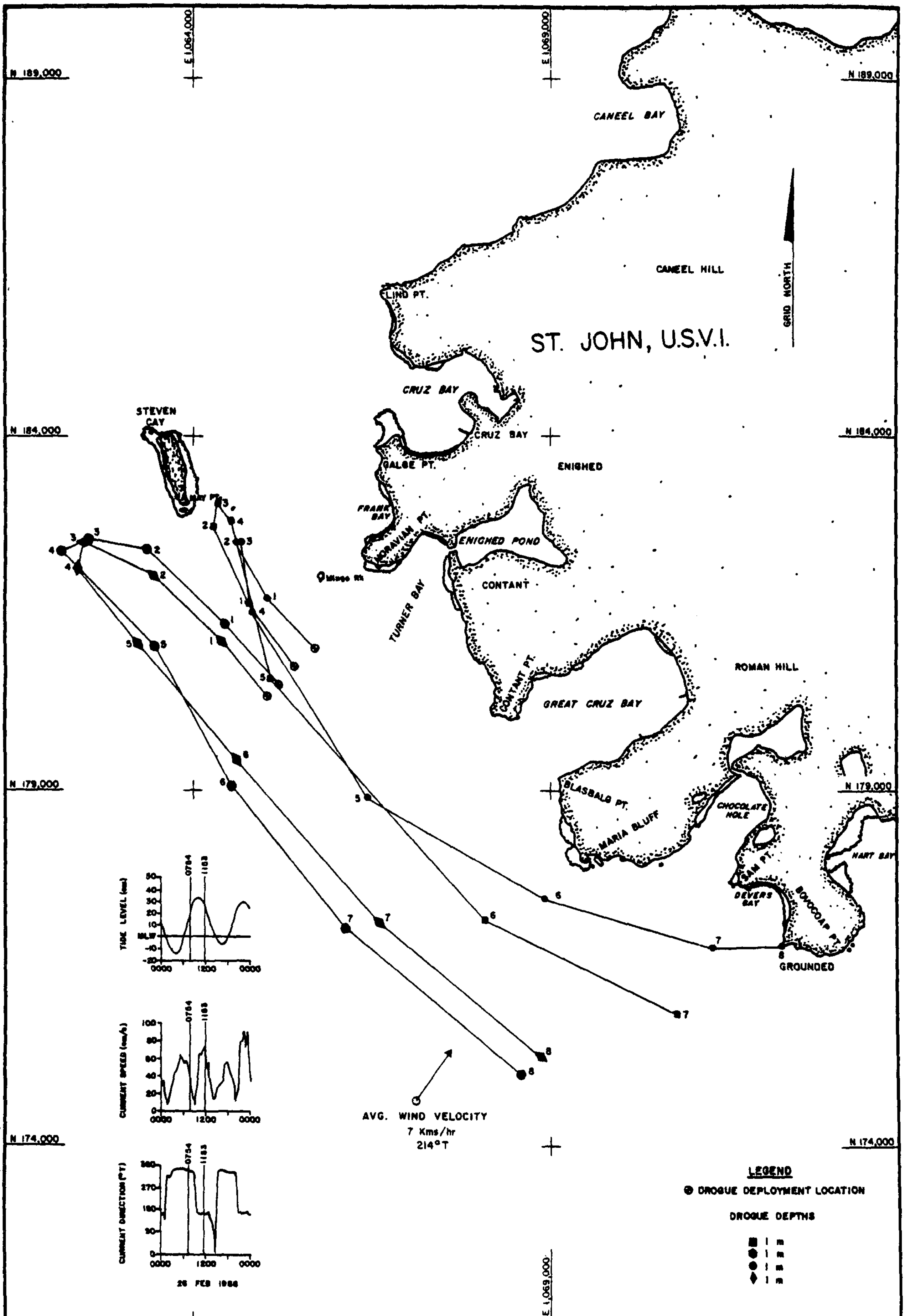
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 0755 | - | 0810 | 32.2 | 0.63 | 317 |
| 2 | 0810 | - | 0838 | 16.6 | 0.32 | 331 |
| 3 | 0838 | - | 0909 | 1.3 | 0.03 | 76 |
| 4 | 0909 | - | 0939 | 17.2 | 0.33 | 172 |
| 5 | 0939 | - | 1012 | 47.6 | 0.92 | 149 |
| 6 | 1012 | - | 1042 | 48.4 | 0.94 | 120 |
| 7 | 1042 | - | 1112 | 40.9 | 0.79 | 107 |
| 8 | 1112 | - | 1153 | 12.5 | 0.24 | 89 |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION
CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ⧫ DATE: 26 FEB 1985

| TIME INTERVAL | | | | SPEED | | DIRECTION |
|---|---|---|---|---|---|---|
| (NO.) | (HR:MIN) | | (HR:MIN) | (CM/SEC) | (KTS) | (DEG MAG) |
| 1 | 0751 | - | 0808 | 30.2 | 0.59 | 322 |
| 2 | 0808 | - | 0834 | 26.1 | 0.51 | 315 |
| 3 | 0834 | - | 0904 | 18.5 | 0.36 | 296 |
| 4 | 0904 | - | 0934 | 6.7 | 0.13 | 194 |
| 5 | 0934 | - | 1004 | 23.0 | 0.45 | 142 |
| 6 | 1004 | - | 1033 | 37.8 | 0.73 | 140 |
| 7 | 1033 | - | 1103 | 51.4 | 1.00 | 139 |
| 8 | 1103 | - | 1132 | 51.5 | 1.00 | 130 |




| FIGURE NO. | DATE |
|---|---|
| 21 | 26 · FEB · 1986 |
| SCALE 1" = 1250' | BY MAN |

**OCEAN SURVEYS, INC.**

OLD SAYBROOK, CONNECTICUT

## DROGUE VELOCITY DATA

### OUTFALL SITE INVESTIGATION
### CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ■ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1227 | - | 1247 | 14.3 | 0.28 | 206 |
| 2 | 1247 | - | 1308 | 39.9 | 0.78 | 158 |
| 3 | 1308 | - | 1335 | 27.4 | 0.53 | 113 |
| 4 | 1335 | - | 1407 | 10.0 | 0.19 | 126 |
| 5 | 1407 | - | 1445 | 12.5 | 0.24 | 144 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ⬢ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1228 | - | 1246 | 16.9 | 0.33 | 209 |
| 2 | 1246 | - | 1309 | 39.4 | 0.77 | 144 |
| 3 | 1309 | - | 1336 | 20.2 | 0.39 | 130 |
| 4 | 1336 | - | 1404 | 25.4 | 0.49 | 143 |
| 5 | 1404 | - | 1436 | 28.5 | 0.55 | 148 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ● DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1224 | - | 1250 | 26.3 | 0.51 | 166 |
| 2 | 1250 | - | 1311 | 10.0 | 0.19 | 147 |
| 3 | 1311 | - | 1337 | 14.9 | 0.29 | 155 |
| 4 | 1337 | - | 1408 | 21.7 | 0.42 | 148 |
| 5 | 1408 | - | 1442 | 27.4 | 0.53 | 144 |

# DROGUE VELOCITY DATA

## OUTFALL SITE INVESTIGATION
## CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ♦ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1229 | - | 1248 | 21.6 | 0.42 | 146 |
| 2 | 1248 | - | 1307 | 24.1 | 0.47 | 162 |
| 3 | 1307 | - | 1334 | 34.6 | 0.67 | 136 |
| 4 | 1334 | - | 1405 | 17.1 | 0.33 | 143 |
| 5 | 1405 | - | 1436 | 28.1 | 0.55 | 152 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) □ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1454 | - | 1510 | 18.8 | 0.37 | 351 |
| 2 | 1510 | - | 1524 | 30.3 | 0.59 | 337 |
| 3 | 1524 | - | 1545 | 28.0 | 0.54 | 355 |
| 4 | 1545 | - | 1628 | 2.3 | 0.04 | 325 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ○ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1459 | - | 1514 | 45.0 | 0.87 | 320 |
| 2 | 1514 | - | 1529 | 50.3 | 0.98 | 8 |
| 3 | 1529 | - | 1550 | 67.2 | 1.31 | 359 |
| 4 | 1550 | - | 1617 | 51.9 | 1.01 | 348 |

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ○ DATE: 26 FEB 1985

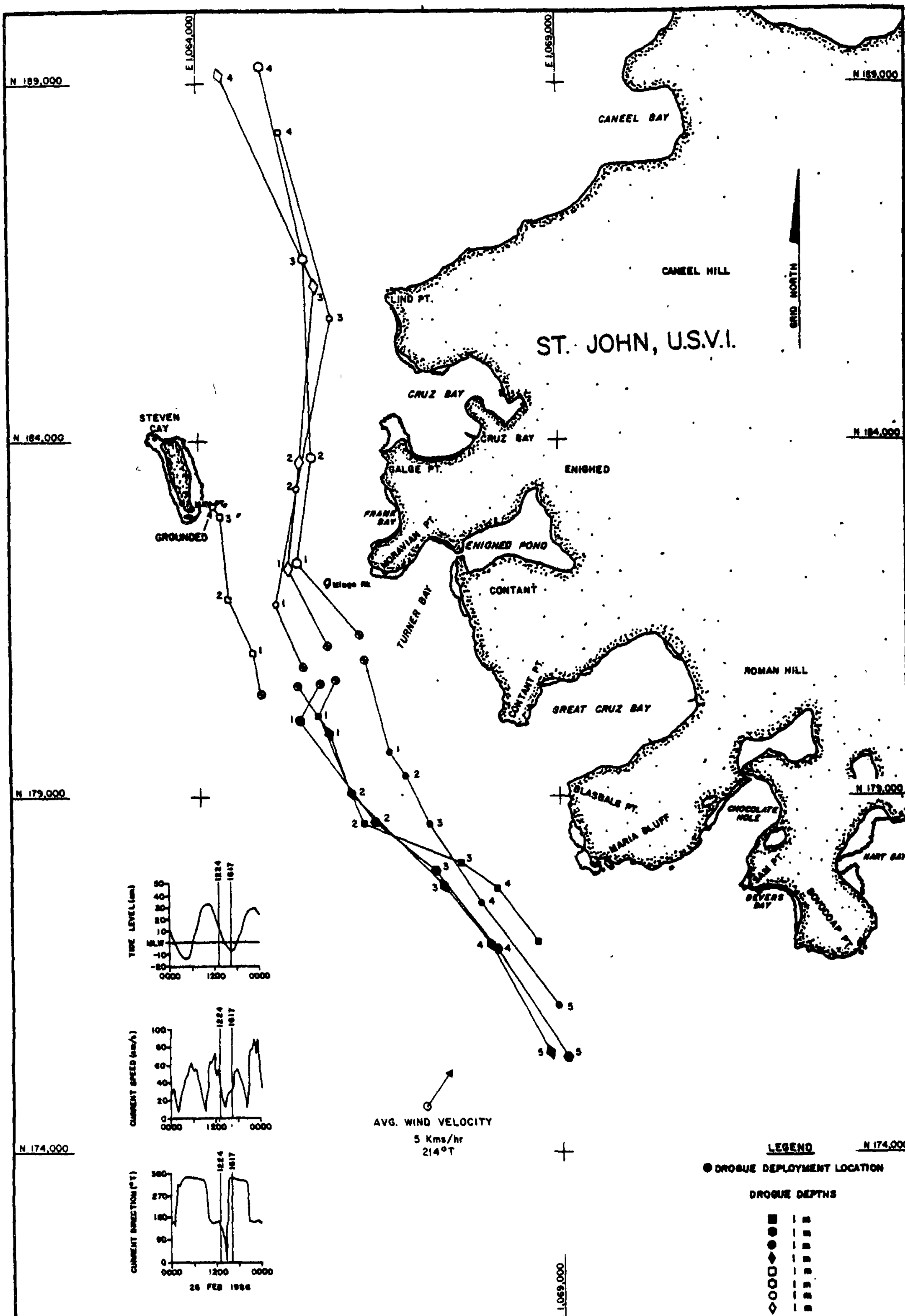
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1456 | - | 1511 | 32.1 | 0.62 | 337 |
| 2 | 1511 | - | 1527 | 52.8 | 1.03 | 11 |
| 3 | 1527 | - | 1548 | 58.9 | 1.14 | 12 |
| 4 | 1548 | - | 1613 | 55.5 | 1.08 | 345 |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION
CRUZ BAY, ST. JOHN, VI

DROGUE DESIGNATION:
DROGUE DEPTH: 1 METER(S) ◊ DATE: 26 FEB 1985

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG MAG) |
|---|---|---|---|---|---|---|
| 1 | 1457 | - | 1513 | 38.9 | 0.76 | 334 |
| 2 | 1513 | - | 1528 | 50.3 | 0.98 | 7 |
| 3 | 1528 | - | 1549 | 60.2 | 1.17 | 6 |
| 4 | 1549 | - | 1615 | 63.1 | 1.23 | 336 |




| FIGURE NO. | DATE |
|---|---|
| 22 | 26 FEB 1986 |
| SCALE | BY |
| 1" = 1250' | MAN |

**OCEAN SURVEYS, INC.**

OLD SAYBROOK, CONNECTICUT

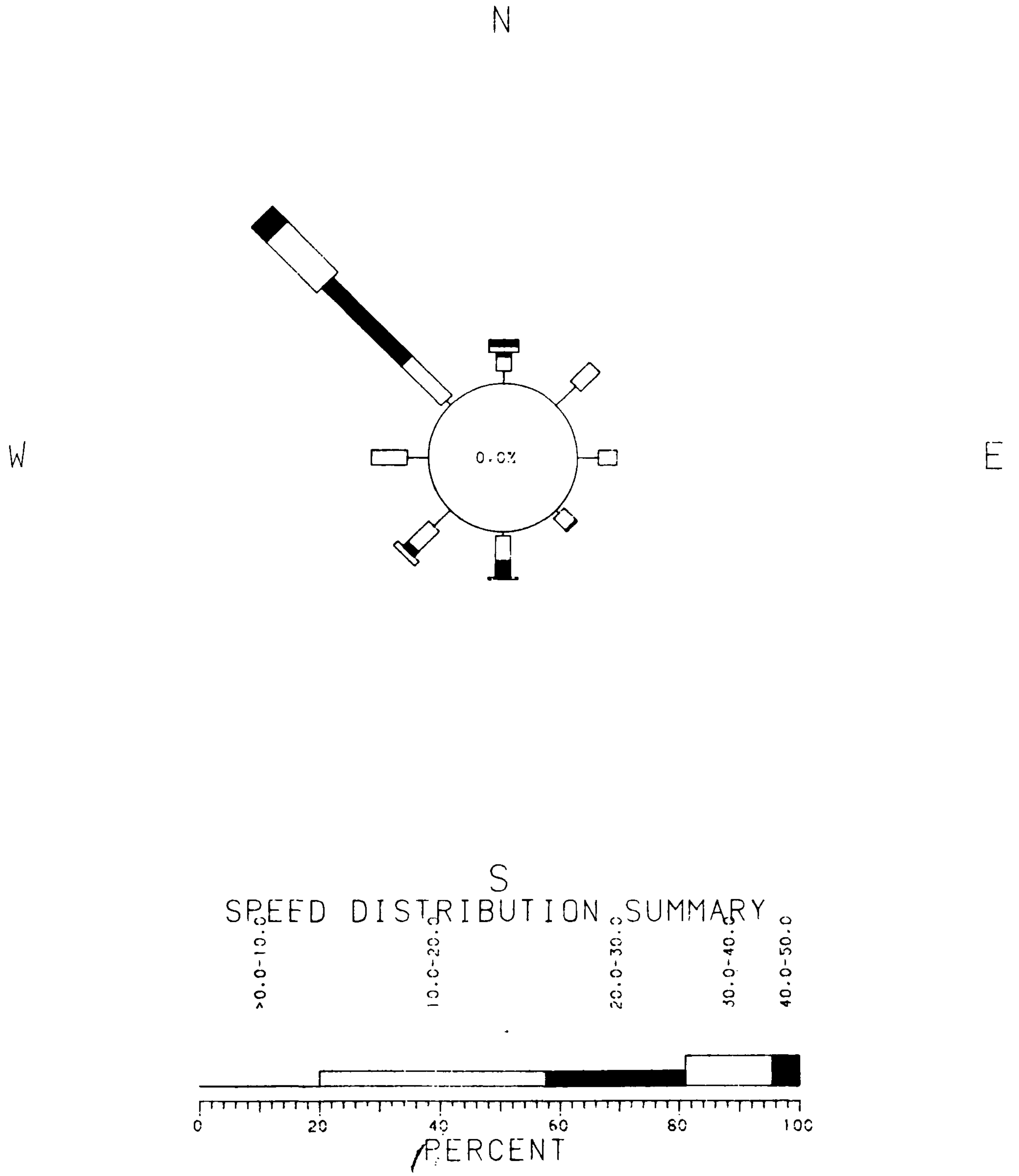
OSI

# APPENDIX E.2

# CURRENT SPEED AND DIRECTION DATA

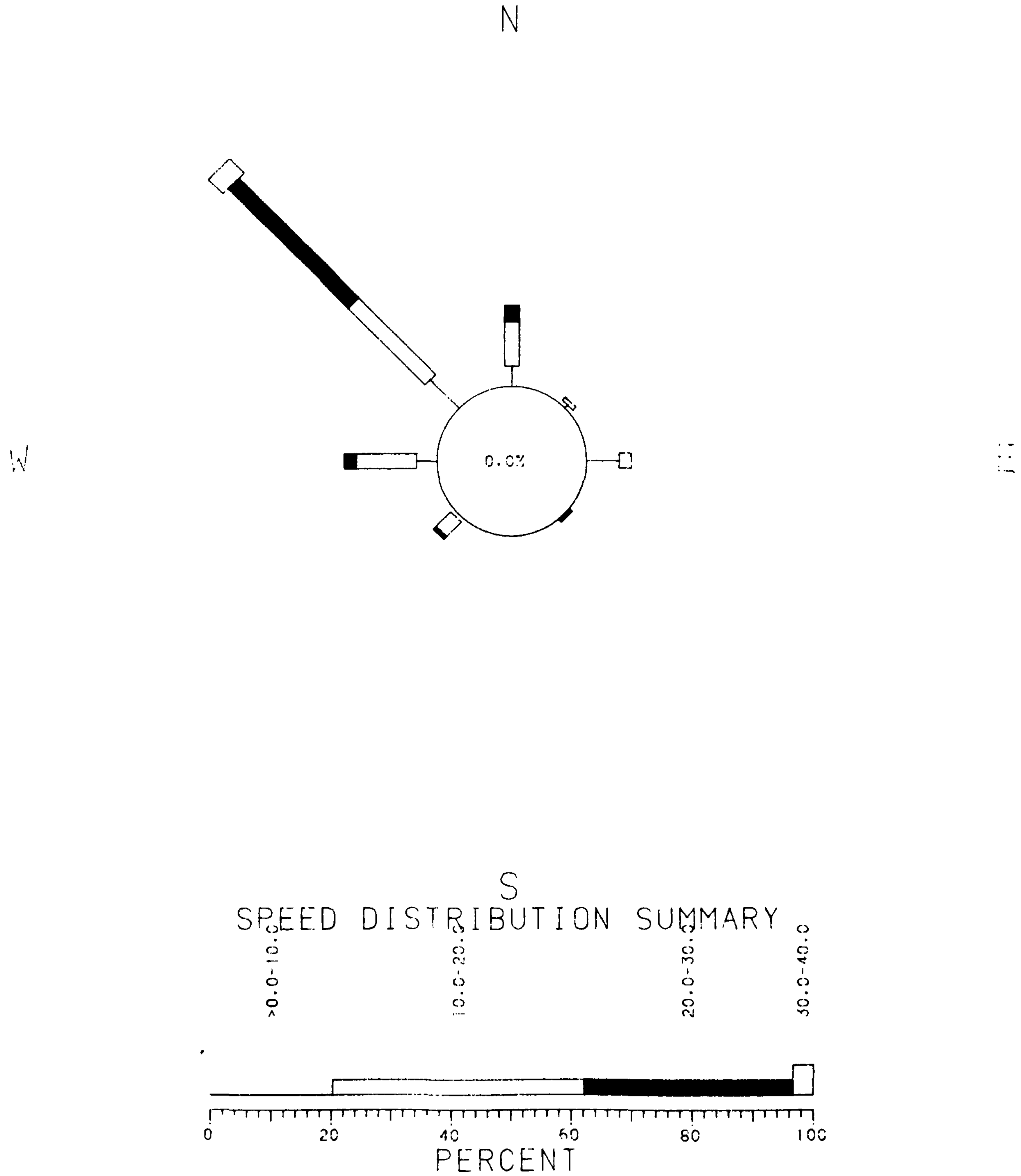
# JUNE STUDIES

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION #2
# CRUZ BAY, ST. JOHN, USVI



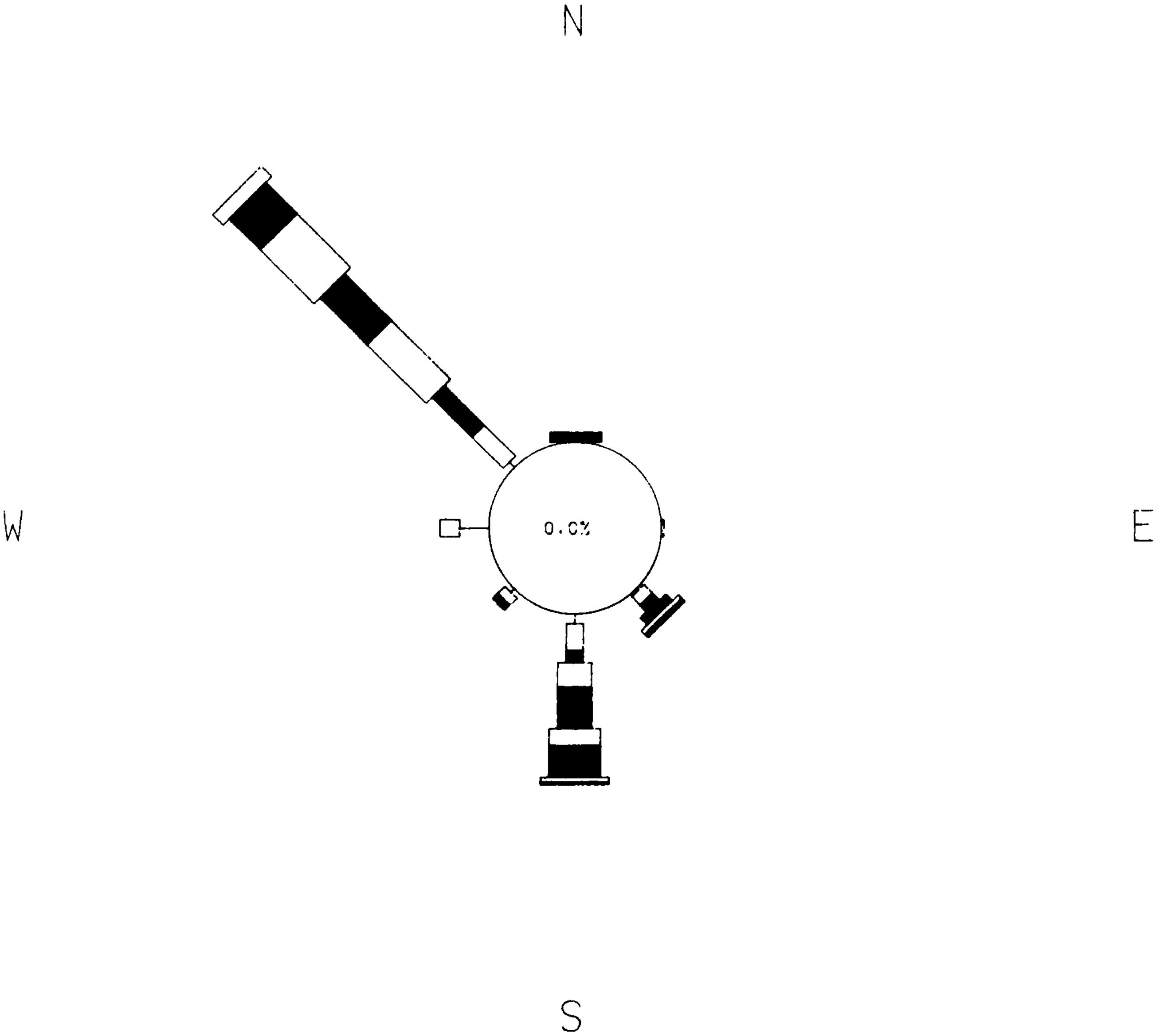

| OCEAN SURVEYS, INC. | DATA PERIOD<br>31 MAY 86 -05 JUN 86 | SCALE<br>1"=25% | DATE<br>09 JUL 86 |
|---|---|---|---|
| | LOCATION<br>STATION T-2 TOP | BY<br>BJB | FIGURE<br>**28** |

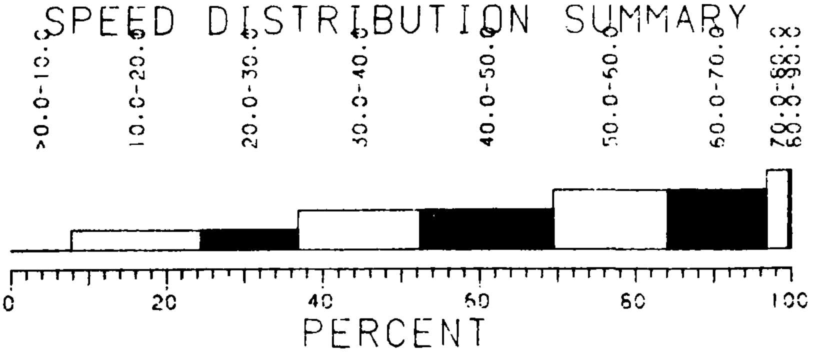
# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION #2
# CRUZ BAY, ST. JOHN, USVI




| | | | |
|---|---|---|---|
| OCEAN SURVEYS, INC. | DATA PERIOD<br>31 MAY 86 -05 MAY 86 | SCALE<br>1"=25% | DATE<br>09 JUL 86 |
| | LOCATION<br>STATION T-2 BOT | BY<br>BJB | FIGURE<br>29 |

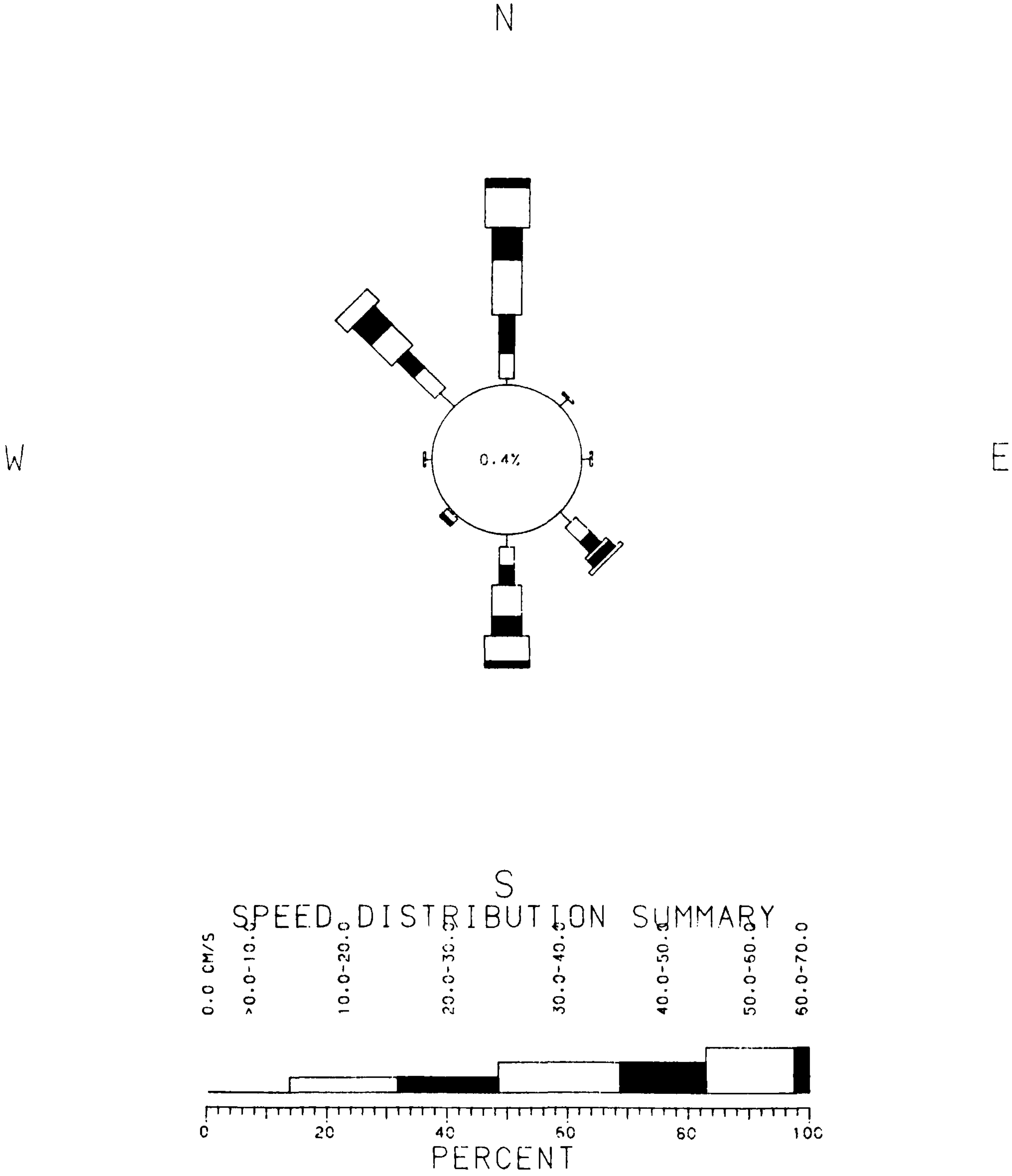
# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION #2
# CRUZ BAY, ST. JOHN, USVI



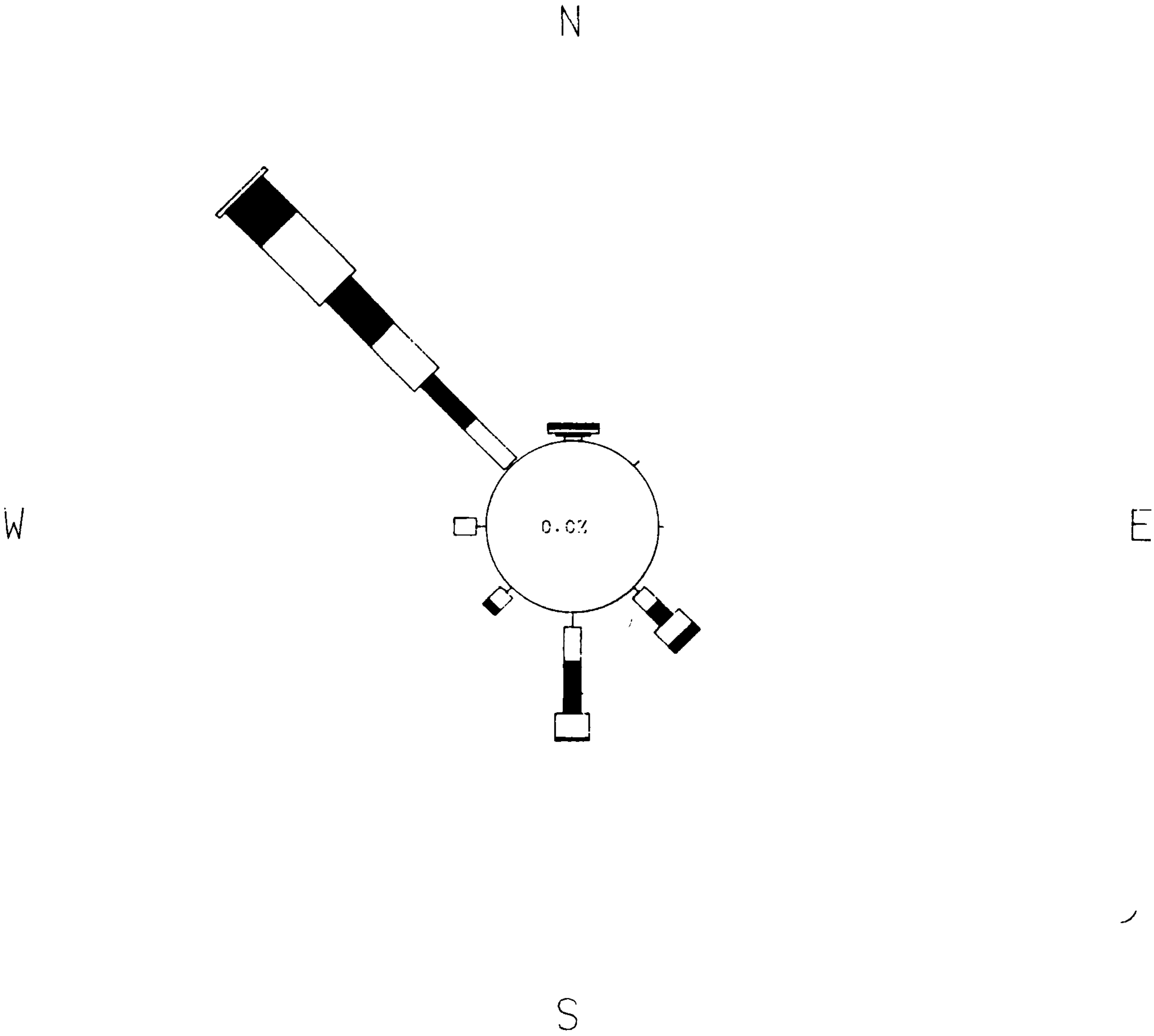

| OCEAN SURVEYS, INC. | DATA PERIOD<br>31 MAY 86 -06 JUN 86 | SCALE<br>1"=25% | DATE<br>09 JUL 86 |
|---|---|---|---|
| | LOCATION<br>STATION T-3 TOP | BY<br>SJB | FIGURE<br>**30** |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION #2
# CRUZ BAY, ST. JOHN, USVI

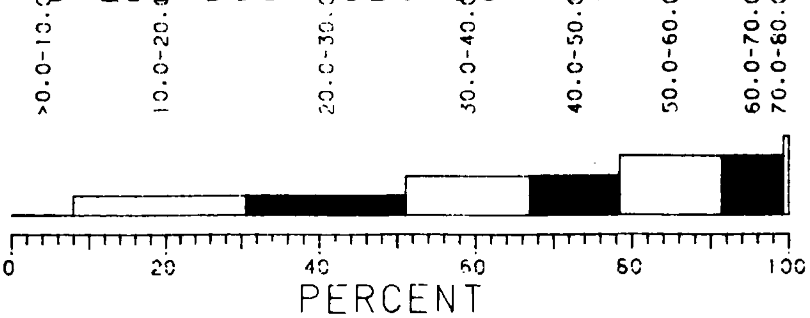



| OCEAN SURVEYS, INC. | DATA PERIOD 31 MAY 86 -06 JUN 86 | SCALE 1"=25% | DATE 09 JUL 86 |
|---|---|---|---|
| | LOCATION STATION T-3 BOT | BY BJB | FIGURE 31 |

# CURRENT VELOCITY ROSE
# OUTFALL SITE INVESTIGATION #2
# CRUZ BAY, ST. JOHN, USVI




SPEED DISTRIBUTION SUMMARY




| OCEAN SURVEYS, INC. | DATA PERIOD<br>31 MAY 86 -06 JUN 86 | SCALE<br>1"=25% | DATE<br>0? JUL 86 |
|---|---|---|---|
| | LOCATION<br>STATION T-4 TOP | BY<br>BJB | FIGURE<br>32 |

# DROGUE VELOCITY DATA

## OUTFALL SITE INVESTIGATION #2
## DEPLOYMENT #1

DROGUE DESIGNATION: ■

DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 0951 | - | 1018 | 58.5 | 1.14 | 316 |
| 2 | 1018 | - | 1036 | 83.8 | 1.63 | 335 |
| 3 | 1036 | - | 1108 | 67.0 | 1.30 | 15 |

DROGUE DESIGNATION: ●

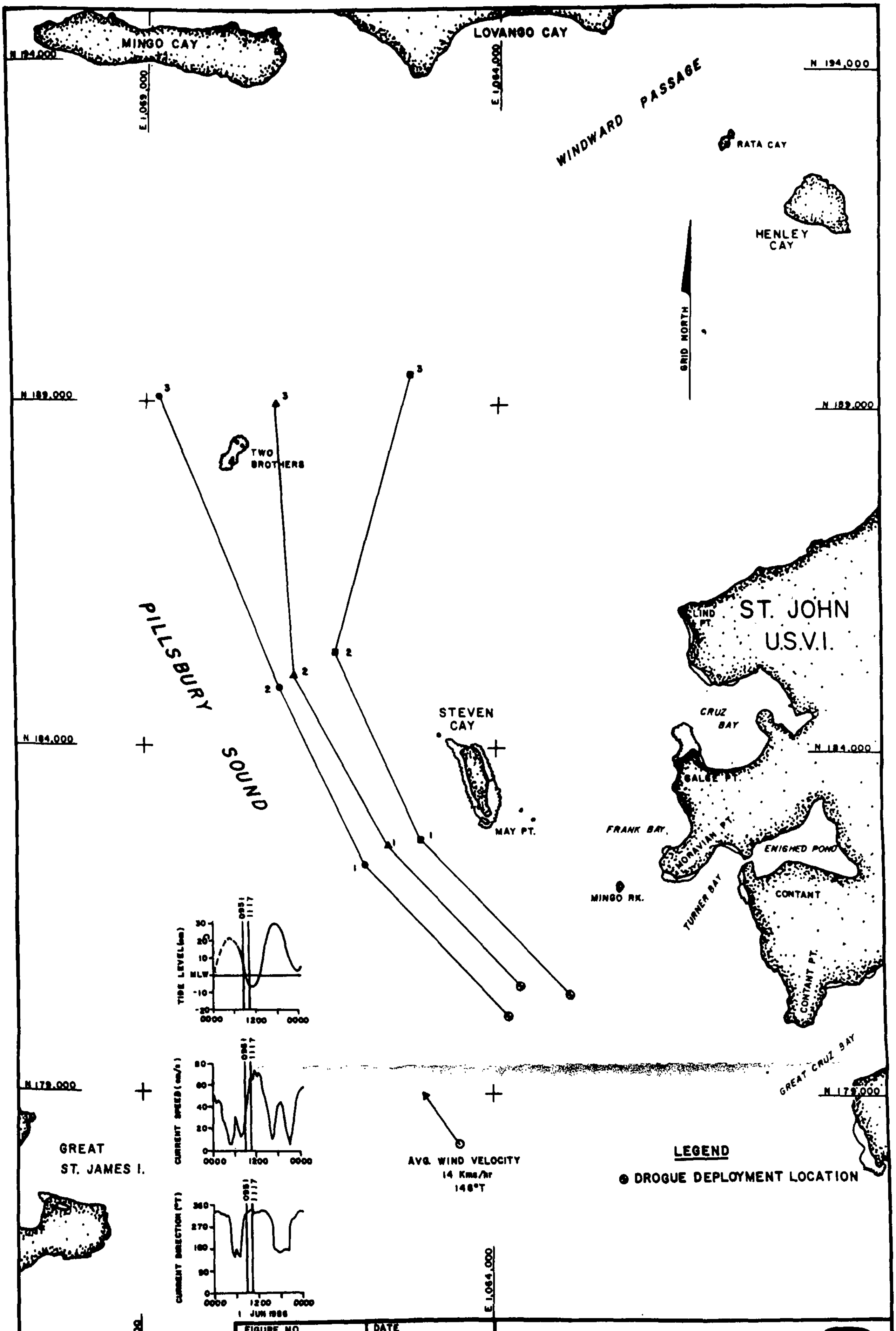
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 0958 | - | 1020 | 69.4 | 1.35 | 316 |
| 2 | 1020 | - | 1038 | 80.3 | 1.56 | 334 |
| 3 | 1038 | - | 1117 | 59.6 | 1.16 | 338 |

DROGUE DESIGNATION: ▲

DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1002 | - | 1022 | 70.6 | 1.37 | 317 |
| 2 | 1022 | - | 1039 | 84.3 | 1.64 | 331 |
| 3 | 1039 | - | 1113 | 59.3 | 1.15 | 356 |




| FIGURE NO. 33 | DATE 1-JUNE-1986 | OCEAN SURVEYS, INC. OLD SAYBROOK, CONNECTICUT |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #2

DROGUE DESIGNATION: ▲
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1137 | - | 1200 | 71.7 | 1.39 | 317 |
| 2 | 1200 | - | 1230 | 77.0 | 1.50 | 334 |
| 3 | 1230 | - | 1308 | 57.5 | 1.12 | 342 |

DROGUE DESIGNATION: ◆
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

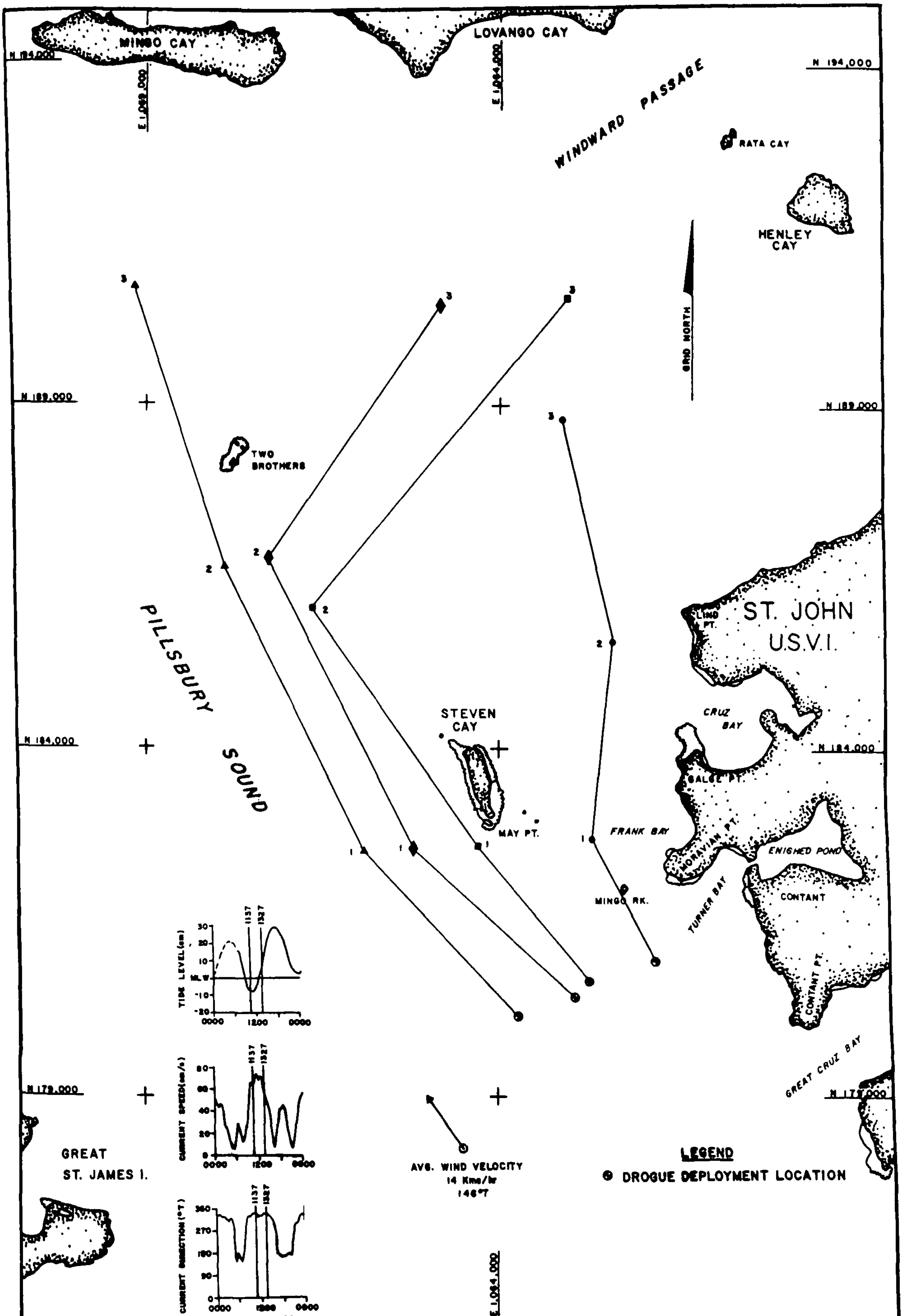
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1140 | - | 1202 | 73.2 | 1.42 | 313 |
| 2 | 1202 | - | 1231 | 81.7 | 1.59 | 334 |
| 3 | 1231 | - | 1322 | 44.5 | 0.86 | 34 |

DROGUE DESIGNATION: ●
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1144 | - | 1208 | 42.0 | 0.82 | 333 |
| 2 | 1208 | - | 1244 | 40.5 | 0.79 | 6 |
| 3 | 1244 | - | 1327 | 39.3 | 0.76 | 347 |

DROGUE DESIGNATION: ■
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1146 | - | 1204 | 70.8 | 1.37 | 320 |
| 2 | 1204 | - | 1233 | 73.2 | 1.42 | 325 |
| 3 | 1233 | - | 1319 | 64.4 | 1.25 | 39 |




| FIGURE NO. 34 | DATE 1-JUNE-1986 | OCEAN SURVEYS, INC. OLD SAYBROOK, CONNECTICUT |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #3

DROGUE DESIGNATION: ▲
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1346 | - | 1417 | 23.2 | 0.45 | 297 |
| 2 | 1417 | - | 1447 | 32.3 | 0.63 | 309 |
| 3 | 1447 | - | 1522 | 27.0 | 0.52 | 300 |
| 4 | 1522 | - | 1540 | 25.6 | 0.50 | 308 |
| 5 | 1540 | - | 1609 | 29.3 | 0.57 | 302 |

DROGUE DESIGNATION: ◆
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1349 | - | 1421 | 56.8 | 1.10 | 313 |
| 2 | 1421 | - | 1453 | 56.8 | 1.10 | 323 |
| 3 | 1453 | - | 1508 | 44.2 | 0.86 | 337 |
| 4 | 1508 | - | 1547 | 29.9 | 0.58 | 329 |
| 5 | 1547 | - | 1602 | 28.4 | 0.55 | 333 |

DROGUE DESIGNATION: ⬢
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1350 | - | 1423 | 56.6 | 1.10 | 315 |
| 2 | 1423 | - | 1454 | 47.9 | 0.93 | 327 |
| 3 | 1454 | - | 1514 | 40.7 | 0.79 | 331 |
| 4 | 1514 | - | 1546 | 34.1 | 0.66 | 330 |
| 5 | 1546 | - | 1558 | 27.9 | 0.54 | 325 |

DROGUE DESIGNATION: ■
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

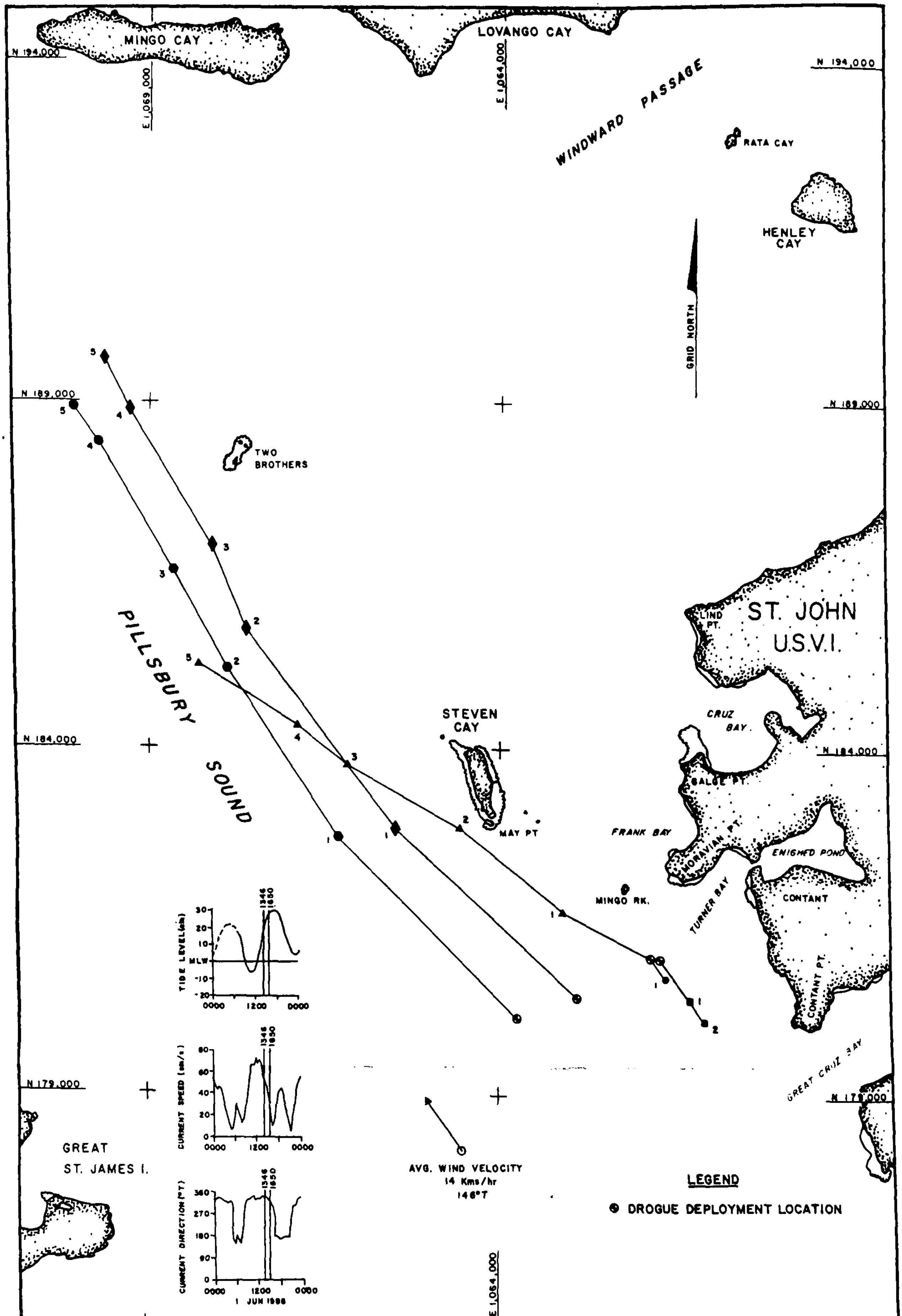
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1532 | - | 1627 | 6.6 | 0.13 | 144 |
| 2 | 1627 | - | 1640 | 14.8 | 0.29 | 145 |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #3

DROGUE DESIGNATION: ●
DROGUE DEPTH: 1 METER(S) DATE: 1 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1629 | - | 1650 | 8.6 | 0.17 | 144 |




| FIGURE NO. 35 | DATE 1-JUNE-1986 | OCEAN SURVEYS, INC. |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | OLD SAYBROOK, CONNECTICUT |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #4

DROGUE DESIGNATION: ●
DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 0800 | - | 0810 | 21.9 | 0.43 | 199 |
| 2 | 0810 | - | 0832 | 12.1 | 0.23 | 168 |
| 3 | 0832 | - | 0847 | 8.7 | 0.17 | 152 |
| 4 | 0847 | - | 0918 | 0.9 | 0.02 | 206 |
| 5 | 0918 | - | 0945 | 3.7 | 0.07 | 183 |
| 6 | 0945 | - | 1011 | 4.4 | 0.09 | 345 |
| 7 | 1011 | - | 1038 | 15.6 | 0.30 | 323 |
| 8 | 1038 | - | 1054 | 31.8 | 0.62 | 314 |
| 9 | 1054 | - | 1155 | 20.4 | 0.40 | 351 |
| 10 | 1155 | - | 1240 | 5.4 | 0.11 | 12 |
| 11 | 1240 | - | 1312 | 5.1 | 0.10 | 228 |
| 12 | 1312 | - | 1348 | 1.4 | 0.03 | 265 |
| 13 | 1348 | - | 1359 | 12.5 | 0.24 | 342 |

DROGUE DESIGNATION: ★
DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1025 | - | 1056 | 15.7 | 0.31 | 301 |
| 2 | 1056 | - | 1135 | 31.3 | 0.61 | 319 |
| 3 | 1135 | - | 1211 | 50.9 | 0.99 | 345 |

DROGUE DESIGNATION: ♦
DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1203 | - | 1318 | 56.1 | 1.09 | 330 |

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #4

DROGUE DESIGNATION: ■

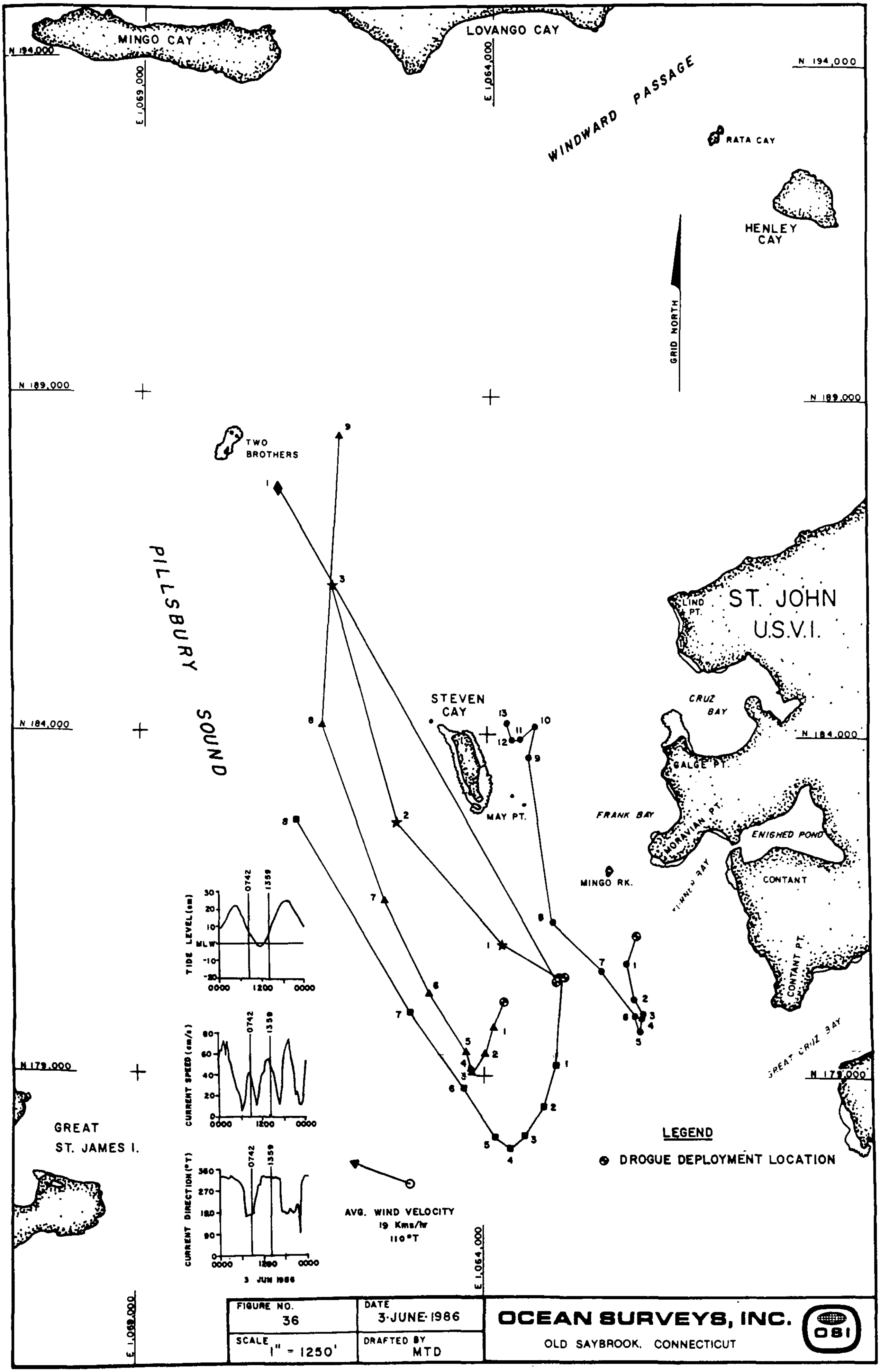
DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 0742 | - | 0804 | 30.0 | 0.58 | 184 |
| 2 | 0804 | - | 0825 | 15.1 | 0.29 | 196 |
| 3 | 0825 | - | 0851 | 9.7 | 0.19 | 210 |
| 4 | 0851 | - | 0922 | 4.7 | 0.09 | 229 |
| 5 | 0922 | - | 0950 | 5.0 | 0.10 | 306 |
| 6 | 0950 | - | 1029 | 11.0 | 0.21 | 327 |
| 7 | 1029 | - | 1059 | 23.2 | 0.45 | 325 |
| 8 | 1059 | - | 1141 | 39.6 | 0.77 | 329 |

DROGUE DESIGNATION: ▲

DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 0745 | - | 0807 | 9.3 | 0.18 | 203 |
| 2 | 0807 | - | 0828 | 9.6 | 0.19 | 197 |
| 3 | 0828 | - | 0854 | 7.0 | 0.14 | 211 |
| 4 | 0854 | - | 0925 | 1.4 | 0.03 | 357 |
| 5 | 0925 | - | 0953 | 4.8 | 0.09 | 341 |
| 6 | 0953 | - | 1032 | 13.2 | 0.26 | 328 |
| 7 | 1032 | - | 1102 | 25.3 | 0.49 | 334 |
| 8 | 1102 | - | 1138 | 38.7 | 0.75 | 340 |
| 9 | 1138 | - | 1220 | 51.6 | 1.00 | 3 |


MINGO CAY
LOVANGO CAY
N 194,000
E 1,059,000
E 1,064,000
WINDWARD PASSAGE
RATA CAY
HENLEY CAY
GRID NORTH
N 189,000
TWO BROTHERS
PILLSBURY SOUND
ST. JOHN U.S.V.I.
LIND PT.
CRUZ BAY
STEVEN CAY
N 184,000
MAY PT.
FRANK BAY
GALGE PT.
MORAVIAN PT.
ENIGHED POND
MINGO RK.
CONTANT
CONTANT PT.
GREAT CRUZ BAY
N 179,000
GREAT ST. JAMES I.
TIDE LEVEL (cm)
MLW
CURRENT SPEED (cm/s)
CURRENT DIRECTION (°T)
0742
1359
0000
1200
3 JUN 1986
AVG. WIND VELOCITY
19 Kms/hr
110°T
LEGEND
DROGUE DEPLOYMENT LOCATION
FIGURE NO.
36
DATE
3-JUNE-1986
SCALE
1" = 1250'
DRAFTED BY
MTD
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT
OSI

DROGUE VELOCITY DATA

OUTFALL SITE INVESTIGATION #2
DEPLOYMENT #5

DROGUE DESIGNATION: ▲

DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1303 | - | 1330 | 59.7 | 1.16 | 315 |
| 2 | 1330 | - | 1353 | 65.4 | 1.27 | 330 |
| 3 | 1353 | - | 1444 | 45.5 | 0.88 | 11 |
| 4 | 1444 | - | 1533 | 23.8 | 0.46 | 37 |

DROGUE DESIGNATION: ■

DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1307 | - | 1336 | 56.5 | 1.10 | 315 |
| 2 | 1336 | - | 1403 | 64.3 | 1.25 | 325 |
| 3 | 1403 | - | 1441 | 46.9 | 0.91 | 353 |
| 4 | 1441 | - | 1530 | 30.8 | 0.60 | 35 |

DROGUE DESIGNATION: ⬢

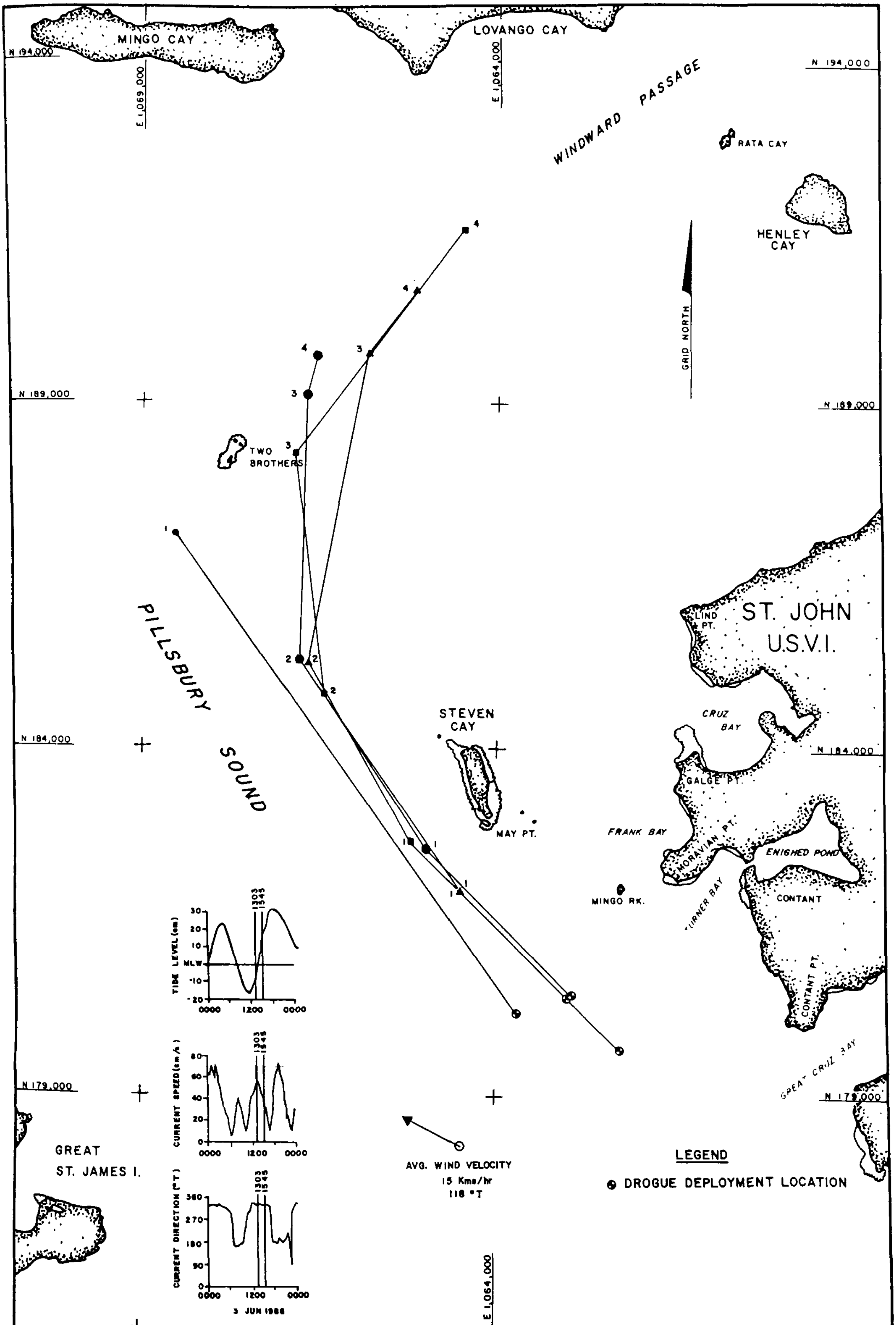
DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1344 | - | 1410 | 58.0 | 1.13 | 315 |
| 2 | 1410 | - | 1437 | 61.4 | 1.19 | 326 |
| 3 | 1437 | - | 1526 | 39.8 | 0.77 | 1 |
| 4 | 1526 | - | 1538 | 24.2 | 0.47 | 14 |

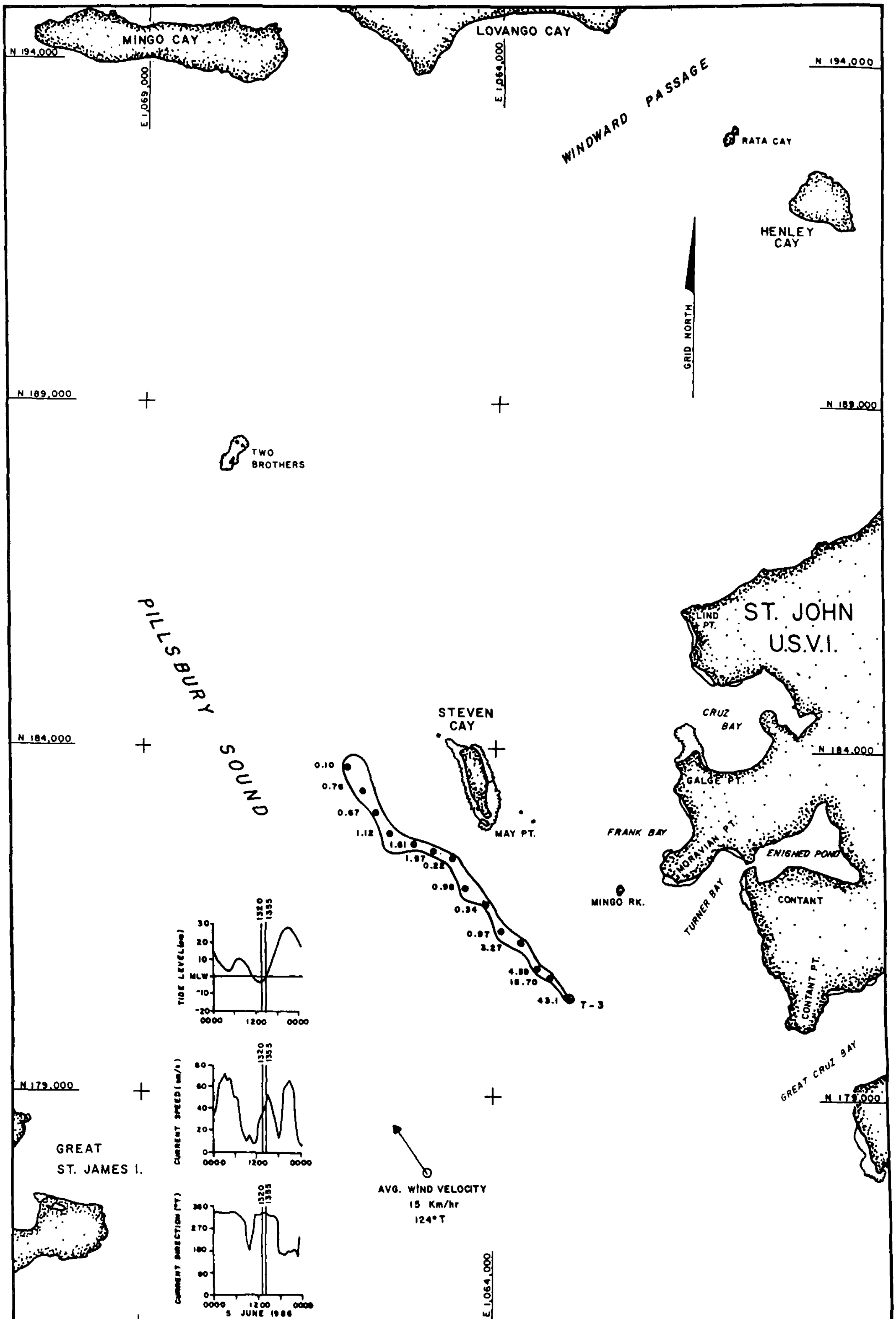
DROGUE DESIGNATION: ●

DROGUE DEPTH: 1 METER(S) DATE: 3 JUN 1986

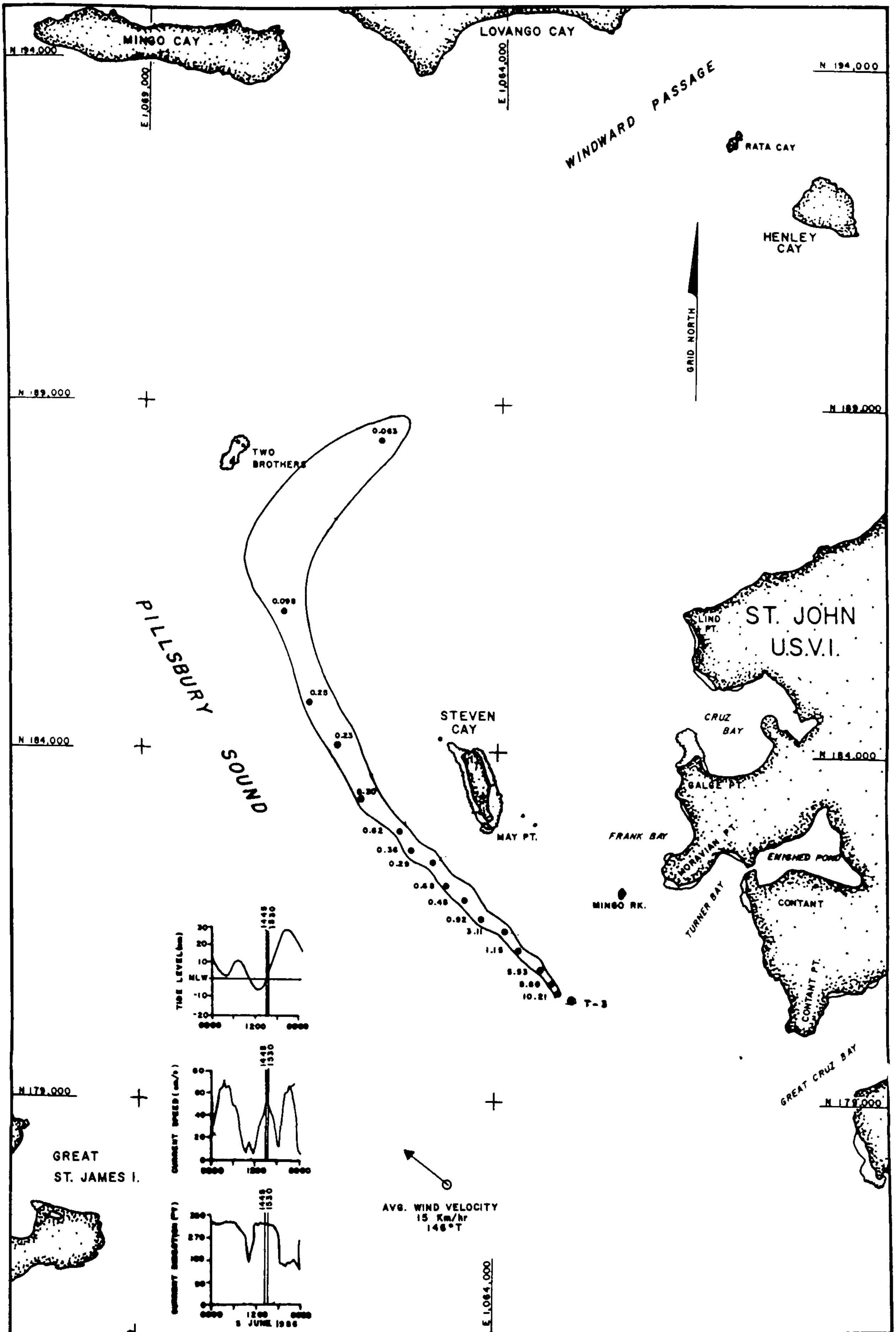
| TIME INTERVAL (NO.) | (HR:MIN) | | (HR:MIN) | SPEED (CM/SEC) | (KTS) | DIRECTION (DEG TRUE) |
|---|---|---|---|---|---|---|
| 1 | 1418 | - | 1545 | 49.4 | 0.96 | 325 |



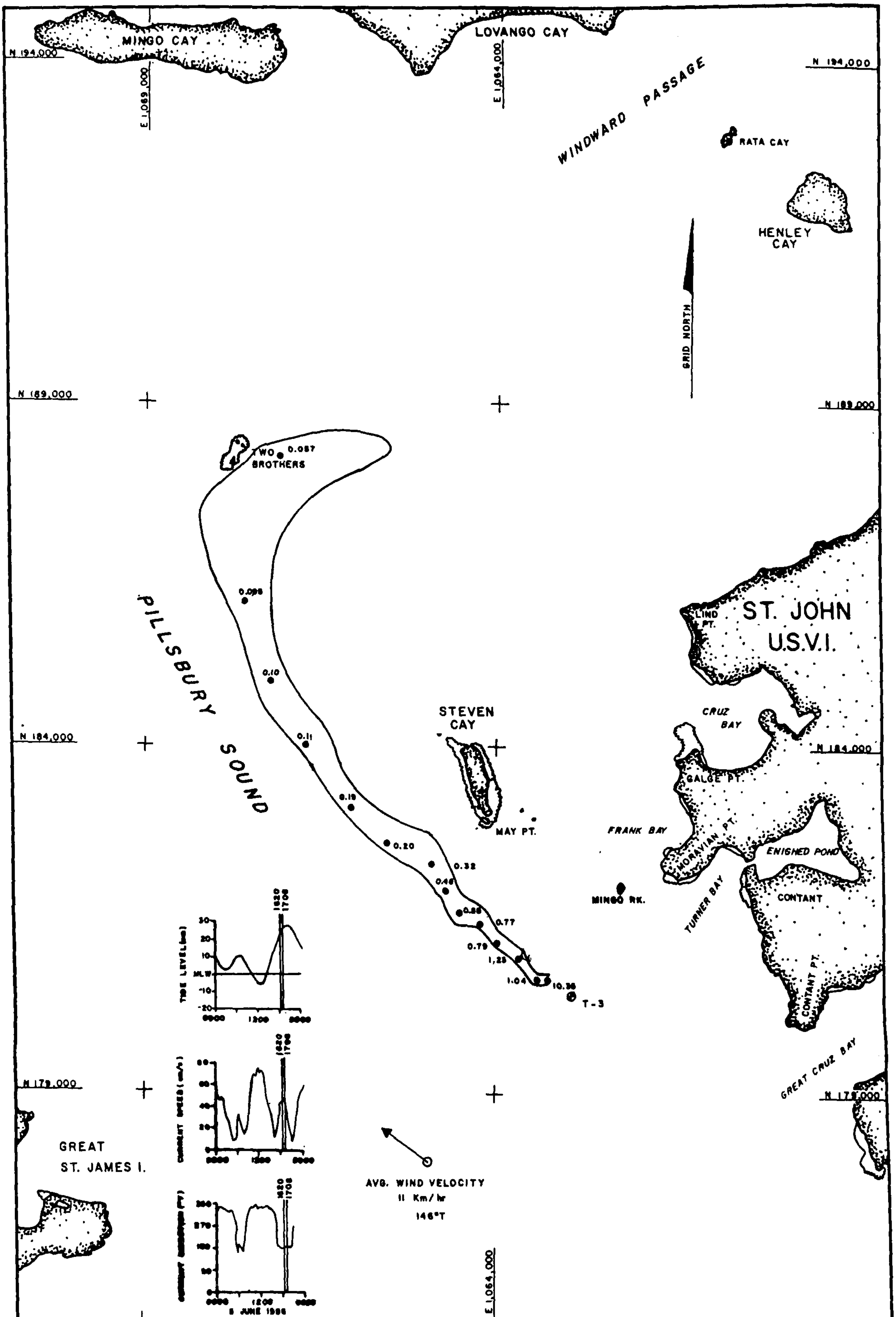

| FIGURE NO. 37 | DATE 3-JUNE-1986 | OCEAN SURVEYS, INC. |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | OLD SAYBROOK, CONNECTICUT |




| FIGURE NO. 38 | DATE 5·JUNE·1986 | OCEAN SURVEYS, INC. |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | OLD SAYBROOK, CONNECTICUT |




| FIGURE NO. 39 | DATE 5-JUNE-1986 | **OCEAN SURVEYS, INC.** |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | OLD SAYBROOK, CONNECTICUT |




| FIGURE NO. 40 | DATE 5-JUNE-1986 | OCEAN SURVEYS, INC. |
|---|---|---|
| SCALE 1" = 1250' | DRAFTED BY MTD | OLD SAYBROOK, CONNECTICUT |

# APPENDIX F

## IMPORTANT FLORA AND FAUNA PRESENT IN THE CRUZ BAY STUDY AREA, ST. JOHN, US VIRGIN ISLANDS

## APPENDIX F

### IMPORTANT FLORA AND FAUNA PRESENT IN THE CRUZ BAY STUDY AREA, ST. JOHN, US VIRGIN ISLANDS

Note: This Appendix lists species mentioned in the text, as well as any special status species (if applicable) and related pertinent comments.

### PLANT SPECIES

| Common Name | Genus and Species | Designation and Comments (if applicable) |
|---|---|---|
| Algae (Marine) (Various Species) | Caulerpa spp.<br>Halicystis osterhontii<br>Padina spp | |
| Bermuda Grass | Cynodon dactylon | |
| Guinea Grass | Panicum maximum | |
| Slender Manatee Grass | Cymodocea manatorum | |
| Turtle Grass | Thallasia testidinum | |
| Sea Grape | Coccoloba uvifera | Common along shoreline |
| | Opolonia spinosa | Shrub |
| | Tragia volubilis | Vine |
| | Talinum triangulare | Herb |
| Fustic | Pictetia aculeata | Scrub |
| Cactus | Pilocereous royenii | |
| Pricklypear | Opuntia (Consolea) rubescens | Cactus |
| Prickly Ash | Zanthoxylum thomasianum | Territory Endangered |
| | Tillandsia lineatispica | Territory Endangered |
| Machette | Erythrina eggersii | Proposed Category 3* |

*Category 3 species should be recognized as threatened, but more study is required to determine their actual population status.

PLANT SPECIES

| Common Name | Genus and Species | Designation and Comments (if applicable) |
| --- | --- | --- |
| Maricao | Byrsonima spp. | Limited distribution |
| Common Guava | Psidium spp. | Limited distribution |
| Coconut Palm | Cocos nucifera | |
| Croton | Codiaeum sp. | |
| Acacia | Acacia sp. | |
| Red Mangrove | Rhizophora mangle | |
| Black Mangrove | Avidennia germinans | |
| White Mangrove | Languncularia racemosa | |
| Button Mangrove | Conocarpus erectus | |

ANIMAL SPECIES

| | | |
| --- | --- | --- |
| | Coelenterates | |
| Brain Coral | Daploria scrigosi | |
| Elk Horn Coral | Acropora palmata | |
| Finger Coral | Porites porites furcata | |
| Fire Coral | Millepora alcicrovis | |
| Sea Fans | Gorgonia spp. | |
| Soft Corals | Alcyonacea sp. | |
| | Echinoderms | |
| Starfish | Oreastra reticulatus | |
| Sea Cucumber (various species) | Holothuria mexicana<br>Holothuria glaberrina | |
| Sea Urchin (various species( | Echinometra lucunter<br>Tripnuestes esculentes<br>Lytechinus variegatus | |
| | Molluscs | |
| Queen Conch | Strombus gigas | |

ANIMAL SPECIES

| Common Name | Genus and Species | Designation and Comments (if applicable) |
|---|---|---|
| Helmet Shell | *Cassas tuberosa* | |
| Stocky Cerith | *Cerithium litteratum* | |
| | **Arthropods** | |
| Blue Crab | *Callinectes danae* | |
| Land Crab | *Cardisoma guanhami* | |
| Mangrove Tree Crab | *Aratus pisonii* | |
| | **Reptiles** | |
| Common Iguana | *Iguana iguana* | Territory Endangered |
| Gecko | *Spaerodactylus macrolepis* | Territory Endangered, Federal Endangered. |
| American Green Turtle | *Chelonia mydas* | Territory Endangered, Federal Endangered |
| Leatherback Turtle | *Demochelys coriacea* | Territory Endangered, Federal Endangered. |
| | **Birds** | |
| Brown Pelican | *Pelecanus occidentalis* | Territory Endangered, Federal Endangered. |
| White Cheeked Pintail | *Anas bahamensis* | |
| White Crowned Pigeon | *Columba leucocephala* | Territory Endangered, found on east side of Fish Bay. |
| Puerto Rican (solid) Flycatcher | *Myiarchus stolidus* | Territory Endangered may be found near Fish Bay. |
| Puerto Rican Screech Owl | *Otus nupides* | Territory Endangered, may be found in upper parts of Fish Bay and Battery Guts. |

## ANIMAL SPECIES

| Common Name | Genus and Species | Designation and Comments (if applicable) |
|---|---|---|
| Antillean Night hawk | (*Chordeiles gundilachii*) | Territory Endangered, may be found in the study area. |
| Peregrine Falcon | (*Falco peregrinus*) | Territory Endangered, may be found in the study area. |
| Mammals | | |
| West Indian Manatee | *Trichechus manatus* | Territory Endangered, Federal Endangered, |
| Humpback Whale | *Megaptera novaegliae* | Territory Endangered, Federal Endangered, has been observed offshore of St. John in the winter and spring. |
| Indian Mongoose | *Herpestes auropunctatus* | Introduced species |

# APPENDIX G

# GOVERNMENT AGENCIES AND OFFICIALS

APPENDIX G

## GOVERNMENT AGENCIES AND OFFICIALS

An important issue which has been identified through the public participation program is that many residents of Cruz Bay have little knowledge of, or access to those government agencies and officials which have responsibility for water quality and wastewater facilities. The following discussion presents a brief and simple explanation of this structure. This discussion is intended to serve as a guide to inform residents about which government departments or offices are responsible for various issues included in the wastewater facilities planning project. All citizens of the Virgin Islands have the right to seek and gain information from these offices. Current telephone numbers and addresses for territorial and local government offices are listed in the Virgin Islands Telephone Company (VITELCO) Telephone Directory.

### FEDERAL GOVERNMENT

- U.S. Environmental Protection Agency (EPA) - EPA is the lead agency for this project, and may participate in funding a major share of the project's eligible construction cost. In addition, EPA oversees the Territory's implementation of the Territorial Pollution Discharge Elimination System (TPDES) program. EPA is also responsible for complying with the regulations of the National Environmental Policy Act (NEPA) and for implementing the provisions of the Federal Water Pollution Control Act (Clean Water Act).

  Preparation of this Environmental Impact Statement (EIS) is the responsibility of EPA. More information on this project is available from:

  Mr. William Lawler, P.E., Project Officer
  US Environmental Protection Agency - Region II
  Environmental Impacts Branch
  26 Federal Plaza, New York, NY 10278
  (212) 264-8556

- U.S. Department of the Interior, National Park Service (NPS) - NPS is responsible for the administration and maintenance of the Virgin Island National Park. Local NPS offices are located in Cruz Bay, St. John and in Redhook, St. Thomas.

- U.S. Representative - The Virgin Islands is represented by one non-voting member of the US Congress. The Representatives office is in the Federal Building in Charlotte Amalie.

U.S. VIRGIN ISLAND (TERRITORIAL) GOVERNMENT

- Department of Public Works (DPW) - DPW is responsible for planning, financing, constructing, operating, and maintaining public wastewater facilities in accordance with the requirements of its TPDES permit, and the public water supply in the study area.

  It is expected that DPW will apply for the EPA wastewater facilities construction grant for this project and thus become the project "grantee". The grantee will be responsible for funding the portion of the overall project that is not funded by EPA, as well as for operation and maintenance of wastewater conveyance and treatment facilities once they are built. DPW has a local office on St. John in Adrian.

- Department of Conservation and Cultural Affairs (DCCA) - DCCA has primary responsibility for general environmental issues in the Virgin Islands. Three distinct divisions of DCCA are relevant to this project: The Division of Natural Resource Management, the Division of Fish and Wildlife, and the Office of Coastal Zone Management.

  - Division of Natural Resource Management (NRM) - NRM is responsible for monitoring and enforcing compliance with Territorial Discharge Elimination System (TPDES) permits. This Division has primary authority over protection of water quality and other Natural Resources in the territory.

  - Division of Fish and Wildlife (FWS) - FWS is responsible for the study and protection of fish and wildlife, particularly endangered or threatened species, in the territory.

  - Office of Coastal Zone Management (CZM) - CZM is responsible for defining and administering coastal zones and Areas of Particular Concern which are protected under the Coastal Zone Management Act. A CZM permit is required for construction of wastewater facilities (or other structures) in coastal zones.

Other departments with authority over peripheral issues of this project include:

The VI Planning Office,
The VI Port Authority, and
The VI Department of Health.

- Virgin Island Territorial Representative

  St. John is represented by one member in the territorial Congress. The Representative's local office is the Boulon Center in Cruz Bay.

ST. JOHN (LOCAL) GOVERNMENT

Administrator - Each of the three main Virgin Islands has an administrator who reports to the Governor. The office of St. John's Administrator is located at the Battery in Cruz Bay.

# APPENDIX H

## PUBLIC PARTICIPATION PROGRAM

APPENDIX H

## PUBLIC PARTICIPATION PROGRAM

A full scale public participation program has been conducted for this project. This ongoing program is an integral part of the EIS process as it encourages public awareness and involvement, thus facilitating the acceptance and implementation of the project's recommendations.

A mailing list of approximately 200 addresses, radio announcements, and posted notices have been used to inform citizens, agencies, and other involved parties of the project's developments and status. A 19 member Citizens Advisory Committee (CAC) was formed in order to review project reports and make recommendations regarding wastewater treatment alternatives. A series of CAC and public meetings have been held in Cruz Bay to facilitate public participation and allow concerned individuals the opportunity to comment and ask questions regarding the project.

Major events of this program are summarized as follows:

| Event | Date | Primary Activity |
|---|---|---|
| Scoping Meeting | December 17, 1985 | Introduced project and identified major issues |
| CAC solicitation and formation | December and January, 1985/86 | Announcements and screening of applicants. |
| Needs Survey | January 13-17, 1986 | Door to door survey |
| 1st CAC Meeting | January 16, 1986 | Presented needs and constraints analyses and identified major issues. |
| 2nd CAC meeting | February 27, 1986 | Selected CAC chairman, presented preliminary alternatives |
| 3rd CAC meeting | March 20, 1986 | Presented water use projections and alternatives. |
| Project Newsletter | April 30, 1986 | Distributed approximately 200 copies |
| 4th CAC Meeting | April 30, 1986 | Discussed feasible alternatives |
| Public Meeting | May 1,1986 | Presented alternatives and identified major issues |

Responsiveness summaries of the meetings listed above were prepared and distributed to the project mailing list following each meeting. These summaries and the Project Newsletter comprise the remainder of this Appendix.

ENVIRONMENTAL IMPACT STATEMENT FOR THE
CRUZ BAY WASTEWATER FACILITIES PLAN

PROJECT SCOPING MEETING

RESPONSIVENESS SUMMARY

Date: 7:30 PM, Thursday
December 17, 1985

Place: Territorial Court Building
Boulon Center
Cruz Bay, St. John, US Virgin Islands

## Introduction:

The scoping meeting for the Cruz Bay Wastewater Facilities Plan Environmental Impact Statement (EIS) was a public meeting held by representatives of the US Environmental Protection Agency (EPA) - Region II and its consultant, CE Maguire, Inc. The purpose of the meeting was to introduce the project to interested public officials, citizens, and other individuals; to present major issues involved in this project; and to offer attendees the opportunity to comment and ask questions on the project.

Approximately thirty (30) persons attended the meeting. (See attachment A for a list of attendees)

Each attendee was given a "scoping meeting handout", which included a description of the project's purpose and need, a preliminary EIS outline, and a preliminary project schedule.

The following is a summary of the evening's proceedings.

## Presentation:

Mr. Cecil George, Commissioner of the Virgin Islands Department of Public Works, opened the meeting by welcoming attendees and introducing Mr. William Lawler, EPA project officer. Mr. Lawler introduced the representatives of EPA and its consultant who were present, briefly addressed the purpose and need of the project, and discussed the purpose of the scoping meeting. The purpose of the meeting was stated as (1) to bring forth issues involved in the project, and (2) to welcome comments and questions on the project.

Mr. Clinton Webb, project manager for CE Maguire, Inc., then presented a more in-depth discussion of the project's purpose and need. Mr. Webb explained that EPA was required by the National Environmental Policy Act to prepare an EIS for Cruz Bay wastewater facilities plan, and that the project would be conducted under an aggressive schedule in order to permit a fiscal year 1986 EPA design/construction grant. Finally, Mr. Dean Slocum, project Planner for CE Maguire, Inc., briefly described the importance of the project's public participation program and Citizens Advisory Committee. Mr. Slocum also notified attendees that CE Maguire will be conducting a door to door survey of wastewater treatment needs in Cruz Bay during the week of January 12-18, 1986.

Comments/Responses:

After the presentations by EPA and CE Maguire, Inc., Mr. Lawler invited attendees to comment or ask questions on the project. The comments and questions raised and the responses to these are summarized as follows:

Question: Will EPA funding be available to pay for operation and maintenance of wastewater facilities?

Response: No, the EPA grant may be used for design and construction of facilities only.

Comment: The Virgin Islands Public Works Department (PWD) must reactivate and enforce the sewer-use fee. These funds may be used to pay for operation and maintenance of facilities.

Question: Will residents who are currently using septic tanks be required to connect to the proposed system?

Response: PWD will encourage these residents to connect to this system.

Comment: PWD has extended its study of wastewater needs to areas beyond the boundary of the area which is eligible for EPA wastewater facility funding.

Question: If new, bigger wastewater treatment facilities are implemented but not properly operated/maintained, won't this just increase the problems?

Response: The point is well taken. EPA will carefully consider this point in weighing alternatives, and will implement a relatively simple system with low operation and maintenance requirements.

Comment: The population of St. John is divided on whether or not more growth should occur. The proposed wastewater facilities may have a positive effect on growth by influencing higher density zoning.

Comment: The technical aspects of the Comprehensive Plan for the Sewage Needs of Cruz Bay are not understandable to the layman and ordinary citizen of St. John. EPA should explain the technical aspects of alternatives in simple terms.

Comment: It is good that an Environmental Impact Statement (EIS) is being prepared for this project, but an EIS is not good if it only produces more words and more time spent planning. The document must yield a sound and implementable plan of action.

Comment: It is difficult to establish a Citizens Advisory Committee that will have real power to influence decisions, because Cruz Bay is such a small community. Political decisions are typically made on St. Thomas, with little input from the people on St. John.

Comment: Environmental issues (particularly those associated with a potential ocean outfall) should be addressed more thoroughly in the EIS than in the Comprehensive Plan for Sewage Needs for Cruz Bay.

Question: What did EPA find deficient in the Comprehensive Plan for Sewage Needs of Cruz Bay report? Was this report a waste of time and money?

Response: This report was not a waste of resources. It was the first step in the planning process for the overall Cruz Bay wastewater facilities project. In reviewing this report, EPA found that the project involves issues that must be addressed in more detail, and therefore required the preparation of an EIS.

Question: Is Cruz Bay's existing wastewater treatment plant functioning properly?

Response: No, the plant is not operating in compliance with EPA design criteria.

Question: When will EPA funding be granted for design and construction of the proposed facilities? Isn't EPA cutting back on funding wastewater facilities?

Response: EPA expects to issue a design/construction grant for this project before October 1, 1986. Although the Clean Water Act has not yet been reauthorized by Congress, EPA allocates (under provisions of this Act) approximately one million dollars each year to the Virgin Islands government for design and construction of wastewater facilities. The exact amount of the grant for this project has not yet been determined.

Question: What happens to the money that EPA collects from the Virgin Islands government as a fine for not complying with wastewater treatment criteria?

Response: This money is put into a fund for the territorial government to use for operation and maintenance of its wastewater treatment plants.

Question: Is EPA satisfied with the Virgin Islands government's effort to bring its plants into compliance with EPA criteria?

Response: As of tonight, yes. However, it is important to continue this effort and push to get the plans implemented.

Comment: Citizens need to know the chain of command of the Virgin Islands government so that they know with whom to speak about specific issues. It is unclear who is responsible for issues such as wastewater facilities, for instance.

Comment: It is good that EPA is working on this project. Please finish it as soon as possible so that the problems can be solved.

Comment: The project study area includes only areas where condominiums and other development will occur. Needy areas are not included.

Question: Do citizens have access to documents and other resources in the Virgin Islands Public Works Department's (PWD) office, so that they may learn more about wastewater facilities?

Response: Yes, all of these resources are public information. Citizens are welcome to go to the PWD office and review this material.

Question: Will EPA be considering any other treatment plant sites than that which was proposed in the Comprehensive Plan for the Sewage Needs of Cruz Bay?

Response: Yes, EPA will determine if there are other feasible sites by conducting on site fieldwork and by analyzing maps and other pertinent resources.

The meeting was adjourned at approximately 9:30 PM, with an understanding that anyone interested in serving on the Citizens Advisory Committee would notify EPA immediately.

Please Note: EPA consultants will be conducting a door to door survey of wastewater treatment needs in Cruz Bay during the week of January 12-18.

ENVIRONMENTAL IMPACT STATEMENT FOR THE
CRUZ BAY WASTEWATER FACILITIES PLAN

CITIZENS ADVISORY COMMITTEE MEETING

## RESPONSIVENESS SUMMARY

DATE: 8:00 PM, THURSDAY
JANUARY 16, 1986

PLACES: TERRITORIAL COURT BUILDING
BOULON CENTER
CRUZ BAY, ST. JOHN, US VIRGIN ISLANDS

## INTRODUCTION:

The purpose of the first Citizens Advisory Committee (CAC) meeting was to create the CAC as required by law and to introduce prospective CAC members to the project. The meeting included a presentation of the major issues and provided an opportunity to comment and ask questions relating to the project.

Approximately thirty (30) people attended the meeting. (See Attachment A for a list of attendees.)

The following is a summary of the evening's proceeding:

## PRESENTATION:

Mr. Clinton L. Webb, project manager of CE Maguire, Inc., opened the meeting by welcoming the attendees. He briefly addressed the purpose and need of the project and discussed the purpose of the CAC meeting. The purpose of the meeting was stated as follows:

(1) The opportunity for admission to the CAC by the public as well as individuals representing local/territorial agencies, the appointment of CAC chairman and;

(2) The opportunity to comment and ask questions relating to the the project.

Mr. Webb then described the need for EIS preparation for Cruz Bay as required by the National Environmental Policy Act and that the plan would be conducted under an aggressive schedule in order to permit a fiscal year 1986 EPA design/construction grant. Finally Mr. Webb mentioned the door to door survey of wastewater treatment needs in Cruz Bay that was currently underway during the week of January 12, 1986.

COMMENT/RESPONSES:

After the presentation by CE Maguire, Inc., Mr. Webb invited attendees to comment or ask questions on the project. The comments and questions raised and the responses to these are summarized as follows:

Question: There was a previous CAC chairman (Rudolph Thomas). Will this new CAC change or keep him?

Response: The previous chairman had been invited to the 1/16/86 CAC meeting. He will be contacted again to see if he wants to be chairman of the Cruz Bay Wastewater Facilities Plan EIS.

Comment: CEM is requested to take into account that seasonal homes have an impact on the water usage flow.

Comment: The original study area has been expanded to possibly include poor sewage discharge areas not in the Cruz Bay drainage basin. If cost-effective (or necessary) these areas may also have access to the new wastewater facility.

Question: Why hasn't this committee met before?

Response: Each individual EPA project is required by law to establish a new CAC committee and the purpose of this meeting is to establish the new CAC.

Question: Had attendance to this meeting been restricted?

Response: No, this meeting was set to provide an opportunity for anyone (public or private) to participate on the CAC.

Comment: All the original CAC members were invited to join this project CAC. Not all have accepted. (A list of the previous members was passed among the attendees)

Comment: The previous meeting had agreed on the upgrading of the existing sewage treatment plant.

Question: Does the Department of Public Works (DPW) have new plans for plant improvement?

Response: No, not yet.

Question: Were the ex-committee members not invited or interested?

Response: Those members were invited.

Comment: It is mandated by law that a new CAC be formed for each project.

Comment: This meeting will reflect strongly on who will be chosen for the committee by EPA.

Comment: The planning office (VIPO) wants to be represented on the committee but not as chairman. The VIPO also wants a good cross-section of the population on the CAC.

Comment: Chairmanship should be served by a private citizen, and the purpose of the CAC is to "fill the gaps" that may have occurred in the original investigations.

Comment: The public document should be pallitable to the average citizen.

Question: Where do the Virgin Islands stand in EPA's priority?

Response: The Virgin Islands are not in any ranking systems for funding. When the study and final designs are complete, then the funding process starts. This study will get St. John on the "stream" of the process to get funding.

Comment: (To the attendees from a private citizen) I have a copy of a Washington, DC Committee Report that recognizes the severe situation in Cruz Bay and says that the funding process has already begun.

Question: Can the project be speeded up? We cannot understand why it takes so long.

Response: The project is already on an aggressive schedule and the due process of funding must be followed.

Comment: The money is available for the project and the reality of its (facility) construction is closer.

Mr. Webb then asked (from the list of attendees) who would want to be on the CAC. He then informed attendees that letters would be sent to CAC members for further meeting dates and project updates. Fifteen (15) members volunteered for CAC duty.

The meeting adjourned at 9:15 P.M. with a 45 minute personal question/answer period.

CRUZ BAY WASTEWATER FACILITIES PLAN EIS

1st CAC Meeting - January 16, 1986 - Boulon Center, Cruz Bay, VI

MEETING LIST

| NAME | ORGANIZATION | ADDRESS/PHONE # |
|---|---|---|
| *Ralf H. Boulon, Jr. | DCCA-Div.Fish & Wildlife | 101 East Nazareth, St.T. 5-6762 |
| *Robert L. Norton | DCCA/DFW | 101 Estate Nazareth,St.T. " |
| *Brian Turnbull | V.I.P.O. | P.O.Box 2606, St.Thomas,VI 4-1730 |
| Cecil A. George | DPW | P.O.Box 83, St.John,VI 6-6766 |
| Lillian Smith | Merchant | |
| Roy L. Sewer | Resident | P.O.Box 181 - St. John |
| *Gabriel St. Surin | DPW | P.O.Box 4400 - St. Thomas |
| *Kurt Van Gelder | DCCA/NRM | |
| Morris Nicholson | deJongh Assoc. | P.O.Box 6155, St.Thomas,VI 00801 |
| *Deborah Charles for Sen. Maynard | Legislature | P.O.Box 66, St. John, VI 00830 776-6233 |
| *Ken Damon | Resident | 6-3-103 Est.Carolina 6-6610 |
| *Ralph Jones | PWD | Coki Point #9 5-4230 |
| *Alline Thurlow | Resident | East End, St. John 6-6920 |
| *Victor Johansson | Resident | Rendezvous Bay 6-6354 |
| Marc Pacifico | DCCA/Natural Resources | 1600 Grapetree Bay, St. Croix 3-9353 |
| Marcia Gilnack | DCCA/NRM 3-9310 | West Indies Lab., Teague Bay,Ctsd,St. Croix |
| *Haynes Small | Resident | Cruz Bay, St. John Box 6-6390 |
| *Frederica Payne | Resident | P.O.Box 312 - St. John 6-6484 |
| *Neal Sprauve | Resident, PWD | *Box 353, St. John 6-7556 |
| *Leopold Chinnery | Resident, PWD | Cruz Bay, St.John 6-7556 |
| *Geraldine Brown | Resident, PWD | Cruz Bay, St. John |
| *Glen Speer | Resident | *P.O.Box 111, St. John 6-6920 |
| *Warren A. Sewer | Resident, PWD | P.O.Box 4653, St. Thomas 6-7556 |
| Clint Webb | CE Maguire,Inc. | 1 Court St., New Britain,CT 06051 (203) 224-9141 |
| Andrew Kuchta | CE Maguire, Inc. | 1 Court St., New Britain, CT 06051 (203) 224-9141 |
| Dean Slocum | CE Maguire, Inc. | 1 Court St., New Britain, CT 06051 (203) 224-9141 |

* Interested in being a CAC member

ENVIRONMENTAL IMPACT STATEMENT
FOR THE
CRUZ BAY WASTEWATER FACILITIES PLAN

SECOND CITIZENS ADVISORY COMMITTEE MEETING

## RESPONSIVENESS SUMMARY

DATE: 8:00 P.M. THURSDAY
FEBRUARY 27, 1986

PLACE: OFFICE OF VICTOR JOHANSSON, ARCHITECT
CRUZ BAY, ST. JOHN, USVI

### INTRODUCTION:

The purpose of the second Citizens Advisory Committee (CAC) meeting was to solidify the formation of the CAC and present recent project developments for the CAC's consideration. Three members of the CE Maguire, Inc. project team and ten interested citizens or officials attended the meeting, as shown on the attached list.

### PRESENTATION:

Clinton Webb, CE Maguire project manager, opened the meeting by reminding attendees of the CAC's purpose and scope. The CAC is to serve as a group which represents community interests, reviews EPA's findings and proposals regarding this project, and advises EPA on these findings and proposals. Formation of a CAC for a project such as this is a federal requirement. The CAC should select a chairperson and secretary, and should determine the minimum number of members required to constitute a quorum for voting on issues.

The CAC elected Victor Johansson as acting chairperson and Alline Thurlow as acting secretary. Richard Berlandy, project engineer, then presented the findings of the recent survey of local sewage needs and Jared Wibberley, project ecologist/environmental planner, presented the findings of an analysis of environmental constraints to growth in the study area. Mr. Berlandy also presented the collection, treatment, effluent disposal, and sludge disposal alternatives being considered for this project. All of this information will be formally presented in the public meeting and the Draft Environmental Impact Statement, both scheduled for May, 1986.

### COMMENTS AND QUESTIONS:

Mr. Webb invited the attendees to comment and ask questions on the project. These comments and questions, along with responses to the questions, are summarized below.

Question: Why were service and infrastructure constraints (such as the limited public water supply) not quantified in area or percentage of study area in the constraints analysis?

Response: These constraints cannot be mapped or measured like physical constraints (such as steep slopes or National Park Service (NPS) land, though they may be equally or more influential.

Question: Why does the sum of percentages of total study area covered by the quantitative constraints equal more than 100 percent?

Response: These constraints are not mutually excessive, one may overlap another.

Question: Are areas with multiple constraints strictly prohibited from future development?

Response: Not necessarily, it depends on the actual influence of each particular constraint.

Question: Why are NPS land and VI Coastal Zone Management (CZM) Program land shown together on a map?

Response: Mainly in order to consolidate information. Although both are legal constraints to development, it is recognized that development is prohibited in NPS land, while development may be permitted under special conditions in CZM land.

The meeting was adjourned at approximately 8:45 PM.

ATTENDANCE LIST

| | |
|---|---|
| *Ken Damon | Resident, St. John |
| Marcia Gilnack | DCCA -DNRM, St. John |
| *Rafe Boulon | DCCA - DFW, St. Thomas |
| Marc Pacifico | DCCA - DNRM, St/ Croix |
| *Alline Thurlow | Resident, St. John |
| *Geraldine Brown | PWD, St. John |
| *Haynes Small | Resident, St. John |
| *Elroy Henley | Assistant Administrator, St. John |
| *Victor Johansson | Resident, St. John |
| *Kurt VanGelder | DCCA - DNRM, St. Thomas |
| Richard Berlandy | Project Engineer, CE Maguire, Inc. |
| Clint Webb | Project Manager, CE Maguire, Inc. |
| Jared Wibberley | Project Ecologist, CE Maguire, Inc. |

*CAC Member

ENVIRONMENTAL IMPACT STATEMENT
FOR THE
CRUZ BAY WASTEWATER FACILITIES PLAN

THIRD CITIZENS ADVISORY COMMITTEE MEETING

RESPONSIVENESS SUMMARY

DATE: 7:50 P.M. THURSDAY
MARCH 20, 1986

PLACE: TERRITORIAL COURT ROOM, BOULON CENTER
CRUZ BAY, ST. JOHN, USVI

INTRODUCTION:

The purpose of the third Citizens Advisory Committee (CAC) meeting was to present recent project developments and issues to the CAC for consideration and discussion. Three members of the CE Maguire, Inc. project team, a representative of the U.S. Environmental Protection Agency - Region II, and nine residents or officials attended the meeting (see attached attendance list). The following is a summary of the proceedings.

PRESENTATION:

Victor Johansson, CAC chairperson, opened the meeting by requesting a vote to confirm his status as chairperson. This was confirmed by a majority note of present CAC members. Mr. Johansson then introduced Mr. Clinton Webb, Maguire Project Manager.

Mr. Webb told attendees that the project team would present summarized findings of population and water use projections and the alternatives analysis. Dean Slocum, Project Planner, informed the meeting that the following increases are protected to occur in the core study area:

- an increase in population from 1892 (existing pop.) to 2555 in the design year 2010,
- an increase in per capita water use from 25 gallons per capita per day (gpcd) go 50 gpcd, and
- an increase in overall water use (including commercial and other use) from 92,150 gallons per day (gpd) to 192,290 gpd.

Richard Berlandy, Project Engineer, discussed the proposed wastewater collection system and identified two alternative treatment plant sites: (1) on the east bank of Enighed Pond, adjacent to the existing pump station, and (2) at the site of the existing treatment plant(in the spit between Enighed Pond and Turner Bay).

Mr. Webb and Mr. Johansson invited comments and questions from the audience. These are summarized (with responses to the questions raised) below.

COMMENTS AND QUESTIONS

Question: Are flood elevations being considered in treatment plant siting and preliminary design?

Response: Yes. A plant should be sited above the 100 year flood elevation (6 feet above mean high tide) and should be protected to the 500 year flood level (approximately 10 feet above msl).

Question: Are there any VI government regulations concerning required hook-ups to a wastewater treatment system and the collection of a system user fee?

Response: There are such regulations and DPW is currently preparing to implement a program for collecting user fees.

Comment: It is imperative that user fees be collected and used to assure proper operation and maintenance of wastewater facilities. The EIS for this project should address this issue.

Question/ Comment: The existing and projected average water use flow figures (25 gpcd and 50 gpcd respectively) seem too high. Is this really accurate?

Response: While average water use per se may not actually be this high, it is important to account for the excess loadings in the wastewater due to heavy solids content. While water use in the study area is much lower than in other areas of the United States, the amount of solids in the wastewater is generally the same.

Question: Have any other treatment plant sites (besides the two identified earlier) been considered? Has private land or National Park Service (NPS) land been considered?

Response: Siting on private land has not been deeply pursued based on the assumed high property values. Sites on NPS land were pursued further, but NPS expressed reservation about allowing such siting due to legal and political complications.

Comment: EPA should consider three additional plant sites on private land and one on NPS land. The CAC will pursue the issue of using NPS land with NPS officials and will inform EPA of the outcome in two weeks.

Comment: The area on the east bank of Enighed Pond (one of the proposed plant sites) is very valuable to the community for purposes other than the location of a treatment plant.

Comment: NPS, Caneel Bay Foundation, and Allen Williams (developers for the new Virgin Grand Hotel) should be more involved in this project because of their impact on the community and their resources. Representatives of these organizations should attend the next meeting.

Question: Will an ocean outfall be recommended for effluent disposal?

Response: Both the ocean outfall and land application methods of wastewater effluent disposal are being considered. (The Caneel Bay Foundation has expressed an interest in using the effluent to irrigate its lawns.)

CONCLUSION:

A public meeting date was set for Thursday, May 1 (at 6:30 p.m. in the Territorial Court Room). It was decided that the CAC should meet on the night before this (April 30th). The meeting was adjourned at approximately 10:00 p.m.

ATTENDANCE LIST

| NAME | AFFILIATION | ADDRESS/PHONE |
|---|---|---|
| Clint Webb | CE Maguire, Project Manager | 1 Court St., New Britain, CT<br>(203) 224-9141 |
| Dean Slocum | CE Maguire, Inc., Planner | " |
| Richard Berlandy | CE Maguire, Inc., Engineer | " |
| William Lawler | USEPA - Project Officer | 26 Federal Plaza, New York |
| Alline Turlow | Resident | St. John |
| Glen Speer | " | St. John |
| Robert E. Rutherford | " | Monte Bay |
| Morley Rutherford | " | " |
| Haynes Small | " | St. John |
| Geraldine Brown | " | St. John |
| Warren Sewer | " | St. John |
| Gabriel St. Surin | VI Public Works Department | St. Thomas |
| Victor Johansson | Resident, CAC Chairman | St. John |

ENVIRONMENTAL IMPACT STATEMENT FOR THE
CRUZ BAY WASTEWATER FACILITIES PLAN

FOURTH CITIZENS ADVISORY COMMITTEE MEETING

RESPONSIVENESS SUMMARY

DATE: 7:30 P.M., Wednesday
April 30, 1986

PLACE: Territorial Court Room
Boulon Center
Cruz Bay, St. John, U.S. Virgin Islands

INTRODUCTION: The purpose of the fourth Citizens Advisory Committee (CAC) meeting was to present detailed information on the project alternatives to CAC members. Representatives of the U.S. Environmental Protection Agency (EPA) and its consultant firm, CE Maguire, Inc.,attended the meeting to make the presentation. Ten CAC members also attended. (See attached list).

PRESENTATION:

Mr. Victor Johanssen, CAC chairperson, opened the meeting, reporting that he had spoken with the superintendent of the VI National Park and that the use of Park land for a treatment plant does not look promising. Mr. Johanssen then turned the meeting over to the CE Maguire project team for the presentation of alternatives.

Mr. Clinton Webb, Project Manager, presented a brief overview of the process by which the project alternatives have been developed, evaluated, and selected.

Mr. Richard Berlandy, Project Engineer, then discussed the alternatives in more detail. His presentation is summarized by the following major points:

- The proposed collection system would cost approximately $3 million, and is very similar to that proposed in the 1985 Facilities Plan.

- The size of the proposed treatment facilities is based primarily on the wastewater solids loading, which is expected to increase by approximately 30% between 1990 and design year 2010.

- Five treatment plant technologies were considered, ranging in cost from $2.5 million (aerated lagoon) to $7 million (recirculating sand filter). The rotating biological contactor, oxidation ditch, and tricking filter technologies were also considered.

- Three treatment plant sites were considered. One of these may not be a feasible alternative because it is located on National Park Service land.

- The use of ultraviolet light (rather than chlorination) is recommended for wastewater effluent disinfection.
- Alternative effluent disposal methods considered are ocean outfall, land application, and supplementary irrigation of lawns at the Caneel Bay Resort.
- The cost of the complete wastewater treatment system alternatives range in cost from approximately $7 million to $11 million.

COMMENTS, QUESTIONS, AND RESPONSES

Following this presentation, attendees were invited to comment or ask questions. The comments and questions raised and the responses to these are summarized as follows:

Comment: Outfall construction could be less expensive if light equipment is used.

Comment: It seems that land application would be more environmentally sound than ocean outfall.

Response: This may be so, although land application could cause significant adverse impacts if wastewater is not properly treated.

Question: Is there any way to use land application but to temporarily discontinue this process in the event of a treatment system failure?

Response: Yes, a requirement may be made in a sewer use ordinance that effluent must be of an acceptable quality to be land applied. However, this requirement would have to be enforced.

Question: Why are the costs of the proposed system higher than those presented in the 1985 Facilities Plan while the proposed collection system is essentially the same?

Response: The population projections are higher than those used for the Facilities Plan. Also, EPA projects higher flows from non-residential sources of wastewater (excluding those with their own treatment systems).

Question: Has the National Park Service (NPS) been contacted about the possible use of their land for a treatment plant?

Response: Yes, both project team members and CAC members have spoken with the VI National Park Superintendent. The superintendent's general feeling is that it would be very difficult to implement such use. EPA will send a copy of the Draft Environmental Impact Statement (EIS) to NPS for review and official comment.

Question: Is the CAC responsible for making a recommendation regarding the alternatives presented by EPA at this point?

Response: The CAC may make a recommendation immediately or after the Draft EIS is distributed (in late May).

Comment: Land application at Caneel Bay seems to be the best effluent disposal alternative, if it is implementable. The Draft EIS should indicate this.

Comment: Implementation of the proposed wastewater facilities may induce growth in the study area.

Question: Have the needs of the extended study area (including Monte, Gift Hill, Fish Bay, etc.) been considered by EPA?

Response: Yes. The needs of this area were identified through a needs survey. This survey indicated that the wastewater treatment needs of this area would best be served through the use of on-site (septic) systems. An exception is the Power Boyd's Plantation area, which is recommended for connection to the centralized treatment facilities.

Question: Has there been any communication with residents living near the alternative treatment plant sites.

Response: This will occur at the public meeting (on May 1 - the following night) and the public hearing (on June 26).

CONCLUSION

Mr. William Lawler, EPA Project Officer, discussed the upcoming project events. These are:

- distribution of the Draft EIS to the public in late May,
- 45 day comment period after this distribution,
- public hearing on June 26 (near the end of the comment period),
- distribution of Final EIS in late July/early August, and
- possible EPA record of decision (to award a project grant) by early September.

The meeting was adjourned at approximately 10:00 P.M.

ATTENDANCE LIST

4th CAC Meeting - April 30, 1986

| Name | Organization | |
|---|---|---|
| Bill Lawler | U.S. EPA - Region II | New York, N.Y. |
| Clinton Webb | CE Maguire, Inc. | New Britain, CT |
| Rich Berlandy | CE Maguire, Inc. | New Britain, CT |
| Dean Slocum | CE Maguire, Inc. | New Britain, CT |
| Rafe Boulon | DCCA, Div.Fish and Wildlife | St. Thomas, VI |
| Caroline Rogers | National Park Service | St. Thomas, VI |
| Kurt VanGelder | DCCA, Div. Natural Resource Mgmt. | St. Thomas, VI |
| Brian Turnbull | VI Planning Office | St. Thomas, VI |
| Haynes Small | Resident | St. John, VI |
| Geraldine Brown | Resident | St. John, VI |
| Warren Sewer | Department of Public Works | St. John, VI |
| Glen Speer | Resident | St. John, VI |
| Elroy Henley | Administrator's Office | St. John, VI |
| Victor Johannsen | Resident | St. John, VI |

ENVIRONMENTAL IMPACT STATEMENT FOR THE

CRUZ BAY WASTEWATER FACILITIES PLAN

PUBLIC MEETING

RESPONSIVENESS SUMMARY

DATE: 6:30 P.M., Thursday
May 1, 1986

PLACE: Territorial Court Room
Boulon Center
Cruz Bay, St. John, U.S. Virgin Islands

INTRODUCTION:

The purpose of the public meeting was to present information on the wastewater treatment system alternatives being considered for Cruz Bay and on the overall progress of this project. Approximately thirty (30) persons attended this meeting, including representatives of the U.S. Environmental Protection Agency (EPA), Region II and its consultant, CE Maguire, Inc. (See attached list)

PRESENTATION

Mr. William Lawler, EPA, Project Officer, opened the meeting by explaining that this project is being conducted in order to determine the most cost-effective, environmentally sound, and implementable solution to wastewater treatment needs in Cruz Bay.

Mr. Richard Berlandy, Project Engineer, then described the alternatives being considered as he had during the Citizens Advisory Committee (CAC) meeting on the previous night (see Responsiveness Summary for the fourth CAC meeting).

COMMENTS, QUESTIONS, AND RESPONSES:

At the end of this presentation, attendees were invited to comment or ask questions. The comments and questions raised and the responses to these are summarized as follows:

Question: Has EPA received a favorable response from the National Park Service (NPS) regarding the use of treatment plant site #3?

Answer: No. Members of the project team and the CAC have spoken with local NPS officials, whose response has been that it is extremely unlikely that NPS land could be used for this purpose, due to a variety of legal and political problems.

Comment: One benefit of site #3 is that treatment facilities would be further away from residences than at the other sites.

Question: Were any sites considered in the extended study area (outside of the Cruz Bay drainage basin)?

Response: Yes. Two sites in the extended study area were initially considered but dropped due to their distance from wastewater service areas and disposal sites.

Question: Has EPA considered serving the extended study (in addition to the "core" study area) area with centralized facilities?

Response: Yes, but based on the findings of the needs survey, on-site treatment systems were determined to be a more appropriate solution to the extended study area's needs.

Question: Would there be a problem in acquiring the land for site #1 from the VI Port Authority?

Response: DPW feels that it should be able to obtain this land without much problem.

Question: When will the proposed wastewater facilities be operational?

Response: It is difficult to say, because this depends on the availability of funding. Generally, facility design takes 1 - 2 years and construction takes another 1 - 2 years.

Question: What are the chances that the proposed system will not be built?

Response: The chances are very low that none of the proposed facilities will be built.

Question: Will the Draft EIS be available to the public?

Response: Yes. This document will be available for public review at the St. John Administrator's office, Cruz Bay Public Library, Enid M. Baa Public Library in St. Thomas, and Department of Public Works office in St. Thomas. In addition, copies will be sent to CAC members. The Draft EIS will be available in late May - early June.

Question: Are there any measures available to improve wastewater treatment in the interim period before the proposed facilities are operational?

Response: DPW must address this issue. For instance, the Department may develop an interim wastewater facilities plan.

Summary:

Attendees were reminded that the Draft EIS will be available for public review in late May - early June and that the next project meeting, which is the formal public hearing, will be held on June 26 in the same meeting place. The public meeting was adjourned at approximately 8:30 p.m.

ATTENDANCE LIST

5/1/86 - Public Meeting

| NAME | | |
|---|---|---|
| Clint Webb | CE Maguire, Inc. | New Britain, CT |
| Richard Berlandy | " | " |
| Dean Slocum | " | " |
| Bill Lawler | EPA - Region II | New York, NY |
| Caroline Rogers | VINP | St. John |
| Sylvia Kudirka | Resident | " |
| Dot & Doug Schouler | " | " |
| Warren A. Sewer | " | " |
| Deborah Charles/Sen. Maynard's Office | " | " |
| Robert L. Norton | Tradewinds Newspaper | " |
| Alline W. Thurlow | Resident | " |
| Glen Speer | " | " |
| Gabriel St. Surin | DPW | STT/St. John |
| Brian Turnbull | V.I.P.O. | STT/St. John |
| Noble B. Samuel | Adm. Office | St. John |
| Emily Stone | Resident | " |
| WAS | " | " |
| Roy Sewer | Retired Admin. | " |
| Austin Dalmida | DPW | " |
| Calvert Marsh | Asst. Appraiser | " |
| Ralph Jones | DPW | St. Thomas |
| Egbert Hendricks | Supv. - PWD | St. John |
| Irma Pickering | Resident | " |
| Ira Fleming | Sen. Hodge's Office | " |
| Llewellyn A. Sewer | Director Veterans Affairs | " |
| Jessie L. Richards, Sr. | Resident | " |
| Haynes Small | " | " |
| Geraldine Brown | " | " |

# APPENDIX I

## GLOSSARY

APPENDIX I

# GLOSSARY

## I-1 AGENCIES:

| | |
|---|---|
| DCCA | (VI) Department of Conservation and Cultural Affairs |
| DPW | (VI) Department of Public Works |
| EPA | (United States) Environmental Protection Agency |
| FWS | (United States) Fish and Wildlife Service |
| FEMA | Federal Emergency Management Agency |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| SCS | (United States) Soil Conservation Service |
| USGS | United States Geological Survey |
| VIPA | Virgin Islands Port Authority |
| VIPO | Virgin Islands Planning Office |
| WAPA | (VI) Water and Power Authority |

## I-2 ABBREVIATIONS:

| | |
|---|---|
| ac | acre |
| C | Centigrade |
| CAC | Citizens Advisory Committee |
| cm | centimeters |
| EIS | Environmental Impact Statement |
| F | Fahrenheit |
| ft | feet |
| gal | gallons |
| gpcd | gallons per capita per day |
| gpd | gallons per day |
| ha | hectares |
| in | inch |
| km | kilometers |

ABBREVIATIONS (Cont'd)

| | |
|---|---|
| kph | kilometers per hour |
| lat | latitude |
| long | longitude |
| l | liter |
| m | meter |
| mi | mile |
| mph | miles per hour |
| mg | miligrams |
| mgd | million gallons per day |
| N | North |
| O&M | operation and maintenance |
| ppm | parts per million |
| t | U.S. ton |
| TPDES | Territorial Pollution Discharge Elimination System (permit) |
| W | West |
| yd | yard |

## I-3 DEFINITIONS:

Alluvium: Sand, silt, or similar loose material deposited by flowing water.

Aquifer: A subsurface geologic formation made up of permeable rock, sand, or gravel that is water-bearing.

Benthic: Pertaining to the sea floor or deep water.

Contamination: Any introduction into water and/or soil of micro-organisms, chemicals, wastes or wastewater in a concentration that makes the water unfit for its desired use.

DEFINITIONS (Cont'd)

Design Life: The useful period for which the elements of a sewage disposal facility are designed. The design life will vary according to the nature of the facility and the relative ease of increasing capacity.

Ecosystem: An interrelated community of plants, animals, bacteria, and other physical and chemical features in an environment.

Effluent: Wastewater flowing out of a sewage treatment plant, after being treated.

Evapotranspiration: The process by which moisture is returned to the atmosphere by evaporation and transpiration.

Force Mains: Pipelines that convey wastewater from one elevation to a higher elevation under pressure.

Gray Water: Water reused for nonpotable purposes.

Grinder Pump: A unit used to lift wastewater from homes below street level to the lateral or interceptor sewer.

Gut: A local expression for a watercourse.

House Connections: The service sewer constructed from outside of the house foundation to the common sewer located in the street.

Impervious: Impenetrable; water cannot pass through.

DEFINITIONS (Cont'd)

| | |
|---|---|
| Industrial Wastes: | The liquid wastes from industrial manufacturing processes, trade or business, as distinct from domestic sewage. |
| Infiltration: | Seepage of ground water into sewers through pipe joints, broken pipes, cracks or openings in manholes, house connections or other defects. |
| Influent: | Wastewater flowing into a sewage treatment plant. |
| Interceptor Sewer: | A trunk or major sewer into which the sewage from one or more main sewers is discharged, intercepting the sewage which would otherwise discharge to surface drainage courses. |
| Lateral Sewer: | A common sewer serving buildings and homes on one or two streets. |
| Main Sewer: | A sewer that is receiving waste from two or more lateral sewers. |
| One hundred (100) year Flood: | A flood of the magnitude which is expected to occur with a frequency of once in 100 years. |
| Orinthologist: | A bird specialist |
| Orographic: | A type of meterological effect in which mountains form a barrier to air currents, causing moist air to be lifted to higher elevations and resulting in precipitation. |

DEFINITIONS (Cont'd)

Permeability: The ability of rock, soil, sediment or other material to allow movement of water through it without damage to the structure of the material.

Pollution: A condition created by the presence of harmful or objectionable material in water.

Sewage: A combination of the water-carried wastes from residences, business buildings, institutions, and industrial establishments, together with such ground, surface, and storm waters as may be present.

Sewerage Systems: All facilities for collecting, pumping, and transporting sewage.

Tectonic: Pertaining to movement or deformation of earth's crust.

Trunk Sewer: A major sewer collecting flow from several main sewers.

Tuff: Rock formed of compacted volcanic fragments.

Watercourse: A channel in which a flow of water occurs, either continuously or intermittently.

METRIC-CONVERSION TABLE

| | | |
|---|---|---|
| 1 | kilometer (km) | 0.6 miles |
| 1 | hectare (ha) | 2.5 acres |
| 1 | meter (m) | 3.3 feet (ft) |
| 1 | centimeter (cm) | 0.4 inches (in) |
| 1 | kilometer per hour (kph) | 0.6 miles per hour (mph) |
| 1 | cubic meter ($m^3$) | 264 gallons (gal) |
| 1 | litre (1) | 0.26 gallons (gal) |
| 1 | metric ton (mt) | 1.1 U.S. tons (t) |
| | parts per million (ppm) | |

# APPENDIX J

## CULTURAL RESOURCES

# APPENDIX J

## CULTURAL RESOURCES

This appendix contains the summaries from the Stage 1A and Stage 1B Cultural Resource Surveys conducted for the study area. A Stage 1A survey is a preliminary investigation of existing records that is undertaken in order to identify the potential for cultural resources in an area. These surveys were prepared by MAAR Associates, Inc., under contract to deJongh Associates, as part of the Comprehensive Plan for the Sewage Needs of Cruz Bay, St. John, V.I. The Stage 1A survey for the core study area was completed in September, 1985, and the Stage 1A survey for the extended study area was completed in April, 1986.

Based on the findings of the Stage 1A Surveys, a Stage 1B Survey was performed by MAAR in July, 1986 in order to investigate more closely the potential project impacts on cultural resources. The following pages are reproduced directly from these studies.

## SUMMARY AND RECOMMENDATIONS

### Summary of Investigations

This Stage IA Cultural Resources Investigation of a proposed Wastewater Treatment System at Cruz Bay, U.S. Virgin Islands was conducted under the auspices of deJongh Associates, Inc. as an integral part of the Environmental Impact Statement preparation. The investigation was undertaken by MAAR Associates, Inc., acting as a consultant to deJongh, in June and July 1985. The work involved conducting a background study, a brief reconnaissance of the project area watershed, and the analysis of available information to develop a statement as to the potential of the proposed project to impact significant cultural resources.

The background study involved gathering information about known and potential aboriginal occupation within the watershed and the documented and possible undocumented history of the Cruz Bay area. This was accomplished by reviewing the available published and unpublished documents as well as maps and land records. Reference sources at the University of Delaware's Morris Library, the Library of Congress, the Danish Archives in Copenhagen, the Enid Ba Library and National Park Service libraries on St. Thomas, and the library at Enighed, Cruz Bay were used to obtain this information.

Informant interviews and field reconnaissance were conducted by a MAAR Associates, Inc. research team on St. John. During this phase of the study, an attempt was made to contact all individuals with knowledge of and/or interest in the aboriginal and historic periods of St. John. Contacts were made with professional archaeologists and historians on St. John and St. Thomas and with avocational historians and archaeologists in the community of Cruz Bay.

The two day reconnaissance involved a pedestrian survey of the Cruz Bay area and a vehicle survey of reported historic and prehistoric sites within the limits of the proposed watershed project area. A large number of both aboriginal and historic archaeological resources have been identified through previous surveys and record searches (Figure III-1). The following paragraphs summarize the results of the background research, the informant interviews, and the field reconnaissance. They also discuss the recommendations made for further investigation within the impact area of the proposed wastewater treatment system.

### Prehistoric Site Sensitivity

Despite the several archaeological survey and excavation projects conducted in this part of the Antilles (Hatt 1924, Bullen 1962, Figueredo and Bradstreet 1973, Johnston 1981 in the Virgin Islands, Carbone 1980 in Puerto Rico, Vescelius n.d. and Figueredo 1976 in Vieques), attention has only recently been given to the development of predictive settlement and subsistence models for prehistoric cultures. In other parts of the world, models which attempt to predict the locations and types of settlements within a given cultural framework and temporal period have proven useful as tools for archaeological survey as well as for conservation planning efforts.

Indians in this part of the Antilles depended on, mainly root crops, did not require highly fertile soils. Therefore, soil fertility is probably not a good predictor of prehistoric site location.

Topography on this mountainous island imposes a particularly serious constraint for prehistoric settlement distribution. Fully 86 percent of the island has grades of 20 percent or more. Therefore, habitation sites would be limited to those few areas of level or gently sloping terrain. Second, to minimize soil loss, aboriginal horticulturalists would probably have preferred to farm level or gently sloping terrain. Level or gently sloping terrain, therefore, should be a fairly good predictor of settlement location.

The grounds around historic plantations are known to be likely locations for prehistoric settlements. It cannot now be gainsaid that all of them are disturbed beyond profitable salvage. These are locations which must be considered to have moderate to high potential for aboriginal sites.

Based on the foregoing considerations, the background research into aboriginal settlement patterns in nearby St. Thomas, Vieques and Puerto Rico, and on information previously available or obtained during the Phase IA research on St. John itself, the potential for archaeological resources to exist within the limits of the proposed wastewater treatment system is very high. Figure II-1 identifies a relatively large number of areas of high potential for aboriginal resource zones including beaches and salt ponds in the Calcareous Lowland Unit and the level or gently sloping terrain with adequate soils in the Flat Ridgetops and Flat-Topped Headlands Unit. There is a moderate potential in the Volcanic Mountain Slopes Unit for farming and resource procurement encampments. Consequently, there is a definite impact potential within the watershed.

Historic Archaeological Resource Sensitivity

The discussion of historic resources reported in the Historic Overview and Data Base sections of this report demonstrate the obvious significance of Danish, English and U.S. historical resources within the Cruz Bay watershed. The potential for adverse impact to historic archaeological and architectural resources is easily seen. In addition, ephemeral, but nonetheless historically significant sites such as slave villages, are almost certainly located in the project area. Pulsipher (1985) has proposed the use of documentary data and ethnographic analogy as tools in researching possible patterns of Caribbean slave multi-dwelling units. Such sites can occupy as little as one-quarter acre and leave little in the way of surface remains, although the observation of remnant stands of economic plants and altered landforms may serve as surface indicators. Subsurface testing in proximity to such indicators may reveal artifacts and patterns of archaeological features, i.e., soil stains where wooden, structural house parts, open hearths, trash pits, etc. were once located.

Among the types of archaeological resources that have been demonstrated to be of scientific and historical significance are plantation sites, Caribbean town or urban sites, and those sites that relate to the Afro-Caribbean peoples of the slave and post-emancipation

Three factors are involved in the construction of settlement pattern models: 1) the identification and distribution of necessary or valued natural resources in the prehistoric past; 2) the degree of disturbance, and, therefore, the recognizability of aboriginal sites; and 3) the existence of a representative sample of known sites.

Most models begin with the definition of the natural resources exploited by a given population. As has been discussed, primary prehistoric resources on St. John are freshwater and marine protein sources (i.e., beach, mangrove swamp, salt pond habitats, etc.), more or less level terrain with at least moderately fertile soils, and/or forests that have a high variety of edible or otherwise useful plant species (i.e., hardwoods for tools and sugar and starch components of the diet), and cryptocrystalline rocks for the manufacture of lithic tools. These resource zones were, no doubt, differentially emphasized in different prehistoric economies. It should also be noted that St. John is small enough that the various resource zones would always be in reasonable proximity to each other and to prehistoric encampments throughout the island. Trade between various communities could have decreased the importance of the proximity to favored resources.

The most severe constraint to settlement during all cultural periods would appear to be the availability of potable water due to the current scarcity of freshwater springs and perennial rivers. Prehistoric water availability would also appear to have precluded settlements in some areas where other valuable natural resources might otherwise have been attractive. Fresh water availability, therefore, should be the best predictor of settlement location. Unfortunately, the distribution of accessible fresh water cannot be determined in the absence of paleo-environmental investigations. The present distribution is not a reliable guide. The hydrology of the entire island has been altered due to historic period deforestation and its effects on relative humidity, bedrock absorption capacity, soil moisture retention, and runoff. As the forest is allowed to regenerate in the Virgin Islands National Park area, perhaps some of the ancient aquifers will be reactivated.

Accessibility to cryptocrystalline rocks for tool manufacture probably presented few constraints to settlement, particularly in the project area. St. John is well endowed with stone tool manufacturing materials in the Louisenhoj andesites found predominantly in the northwestern section of the island. Although it is not as good a medium for controlled chipping, basalts from the Water Island formation would also have been adequate. It should also be noted that most tropical peoples tend to utilize a wood/bone/shell tool kit, stone being used to make other tools and stone tool technologies usually being underdeveloped. Therefore, access to lithic materials is probably not a good predictor of site location on St. John.

A serious consideration for horticulturalists is access to fertile soils. The degree of fertility required, however, is largely a function of population density. insofar as dense populations tend to concentrate use of the same soils subjecting them increasingly to nutrient depletion, invasion of troublesome second growth, and erosion. There are no indications so far of prehistoric population densities having reached this magnitude. Moreover, the kind of staple crops that the prehistoric periods. As has been shown, the cultural resource potential of the Cruz Bay Watershed study area is high and should contain examples of most of the above resource types. A number of plantation sites have been documented; many of these were owned and/or operated by persons within a range of ethnic and socio-economic status positions. The presence of documented Afro-Caribbean sites of the slave period and the post-emancipation period may allow for studies of transition, adaptation by blacks to new economic and social parameters, and ethnic remnants in historic society.

In general, the research potential and historic resource conservation and education opportunities within the study area of the island of St. John are such that any impact to the available resource base must be further evaluated. Specifically, those areas noted in Figures I-4 and II-2 should not be approached without concern for possible impact to potentially significant cultural resources.

Recommendations

MAAR Associates, Inc. recommends that a Stage IB Cultural Resource Survey be conducted within the expanded portion of the proposed Cruz Bay Wastewater Treatment System on the island of St. John. Survey effort should focus on those areas identified as high and moderate potential for cultural resources (Figure II-1). However, even areas of relatively steep slope, i.e., 20 to 40 percent grades, will likely contain evidence of historic plantation activity and cannot be excluded from Stage IB investigations.

It is recommended that this survey be initiated after the development of a final and/or alternate plan(s). Stage IB surveys should be conducted at all treatment plant, pump station, and effluent spray sites proposed so that the results of the survey can be considered in the final selection process. In addition, it cannot be assumed, because the proposed collection system will be located beneath or alongside existing roadways, i.e., in already disturbed areas, that the existing disturbance has obliterated significant cultural resources. Moreover, in the absence of historical documentation on the placement of current roadways, it cannot be assumed that the current roadways have actually destroyed earlier historic and/or prehistoric resources. For example, were roadbeds cut or simply laid over historic roadways? Therefore, it must be recommended that general collector pipe areas be surveyed by means of frequent subsurface testing in adjacent house lots and other adjoining areas in the town of Cruz Bay and outside of it.

The recommended Stage IB surveys should include additional background research to assure that all pertinent Caribbean settlement data, including slave settlements, is considered. Informant interviews should be conducted over a sufficiently long period of time to allow for the natural reluctance of Cruz Bay residents to divulge information about aboriginal and historic resources of which they have knowledge. Field investigations should include surface surveys. Intensive subsurface testing and frequent shovel tests combined with limited test pitting. An evaluation of resource significance and assessment of potential impact should be made in a research report. A shortened version, or popular report, should be distributed to all involved agencies and made available to the general public on St. John and abroad.

## SUMMARY AND RECOMMENDATIONS

### Summary of Investigations

This Stage IA Cultural Resource Investigation of an expansion area of the proposed Wastewater Treatment System at Cruz Bay, U.S. Virgin Islands was conducted on behalf of deJongh Associates, Inc. as an integral part of an Environmental Impact Assessment. The investigation was undertaken by MAAR Associates, Inc., acting as a consultant to deJongh, in November 1985. The work involved conducting a background study, a brief reconnaissance of the project area watershed, and the analysis of available information to develop a statement as to the potential of the proposed project's to impact on significant cultural resources.

The background study involved gathering information about known and potential aboriginal occupation within the watershed and the documented history of the Cruz Bay area. This was accomplished by reviewing available published and unpublished documents as well as maps and land records. Reference sources at various locations were used to obtain this information.

Informant interviews and field reconnaissance were conducted by a MAAR Associates, Inc. research team on St. John. During this phase of the study, contact was made with individuals who have a knowledge of and/or interest in the aboriginal and historic occupations of St. John. Contacts were made with professional archaeologists and historians on St. John and St. Thomas and with avocational historians and archaeologists on the island of St. John.

The reconnaissance involved a vehicular survey of the expanded Cruz Bay watershed area and of reported historic and prehistoric sites within the limits of the proposed watershed project area. A small number of aboriginal and historic archaeological resources have been identified through previous surveys and record searches (Figures I-4 and II-2). The following paragraphs summarize the results of the background research, the informant interviews, and the field reconnaissance. They also discuss the recommendations made for further investigation within the expanded impact area of the proposed wastewater treatment system.

### Prehistoric Site Sensitivity

Despite the several archaeological surveys and excavation projects conducted in this part of the Antilles (Hatt 1924; Bullen 1962; Figueredo and Bradstreet 1973; Johnston 1981), in Puerto Rico, (Carbone 1980), and in Vieques, (Figueredo 1976 and Vescielius 1979), only recently has attention been given to the development of predictive settlement and subsistence models for prehistoric cultures. In other parts of the world, models which attempt to predict the locations and types of settlements within a given cultural framework and temporal period have proven useful as tools for archaeological survey as well as for preservation planning efforts.

Three factors are involved in the precision of settlement pattern models: 1) The identification and distribution of necessary or valued natural resources in the prehistoric past, 2) the degree of disturbance, and, therefore, the recognizability of aboriginal sites, and 3) the existence of a representative sample of known sites.

Most models begin with the definition of the natural resources exploited by a given population. As has been discussed, primary prehistoric resources on St. John are access to fresh water and marine protein sources (i.e., beach, mangrove swamp, salt pond habitats, etc.), more or less level terrain with at least moderately fertile soils and/or forests that have a high variety of edible or otherwise useful plant species (i.e., hardwoods for tools and sugar and starch components of the dietary), and cryptocrystalline rocks for the manufacture of lithic tools. These resource zones were no doubt differentially emphasized in different prehistoric period economies. It should also be noted that St. John is small enough that the various resource zones would always be in reasonable proximity to each other and to prehistoric encampments throughout the island. Trade between various communities could have mitigated long distances to favored resources.

The most severe constraint to settlement during all cultural periods would appear to be the availability of potable water, due to the current scarcity of fresh water springs and perennial rivers. Prehistoric water availabilities would also appear to have precluded settlements in some areas where other valuable natural resources might otherwise have been propitious. Freshwater availability, therefore, should be the best predictor of settlement location. Unfortunately, the distribution of accessible freshwater cannot be determined in the absence of paleo-environmental investigations. The present distribution is absolutely no guide, as the hydrology of the entire island has been altered due to historic period deforestation and its effects on relative humidity, bedrock absorption capacity, soil moisture retention, and runoff. As the forest is allowed to regenerate in the Virgin Islands National Park area, perhaps some of the ancient aquifers will be activated again.

Accessibility to cryptocrystalline rocks for tool manufacture probably presented few constraints to settlement, particularly in the project area. St. John is well endowed with stone tool manufacturing materials in the Louisenhoj andesites found predominantly in the northwestern section of the island. Although it is not as good a medium for controlled chipping, basalts in the Water Island formation would have been adequate. It should also be noted that most tropical peoples tend to utilize a wood/bone/shell tool kit, stone being used to make other tools and stone tool technologies usually being underdeveloped. Therefore, access to lithic materials is not a good predictor of site location on St. John.

A serious consideration for horticulturalists is access to fertile soils. The degree of the fertility required, however, is largely a function of population density, insofar as dense populations tend to concentrate use of the same soils, subjecting them increasingly to nutrient depletion, invasion of troublesome second growth, and erosion. There are no indications so far of prehistoric population densities having reached this magnitude. Moreover, the kind of staple crops that the prehistoric Indians of this part of the Antilles depended on, mainly root crops, did not require highly fertile soils. Therefore, soil fertility is probably not a good predictor of prehistoric site location.

Topography on this mountainous island imposes a particularly serious constraint for prehistoric settlement distribution. Fully 86 percent of the island has grades of 20 percent or more. Therefore, habitation sites would be limited to those few areas of level or gently sloping terrain. Second, to minimize soil loss, aboriginal horticulturalists would probably have preferred to farm level or gently sloping terrain. Level or gently sloping terrain, therefore, should be a fairly good predictor of settlement location.

While construction in the town of Cruz Bay has, no doubt, disturbed much of the prehistoric site materials, the existence of aboriginal sites, such as those only recently destroyed during construction of the modern ball field, allows us to conclude that prehistoric resources can be contained therein. Similarly, the grounds around historic plantations are known to be likely locations for prehistoric settlements. It cannot now be gainsaid that all of them are disturbed beyond profitable salvage. These are locations that must be considered as having moderate to high potentials for aboriginal sites.

Based on the foregoing considerations, the background research into aboriginal settlement patterns in nearby St. Thomas, Vieques and Puerto Rico, and on information previously available or obtained during the Phase IA research on St. John itself, the potential for archaeological resources to exist within the limits of the proposed wastewater treatment system is very high. Figure III-2 locates a relatively large number of areas of high potential for aboriginal resource zones, including beaches and salt ponds in the Calcareous Lowland Unit and the level or gently sloping terrain with adequate soils in the Flat Ridgetops and Flat-Topped Headlands Unit. There is a moderate potential in the Volcanic Mountain Slopes Unit for farming and resource procurement encampments. Consequently, there is a definite impact potential within the watershed.

Historic Archaeological Resource Sensitivity

The discussion of historic resources reported in the Historic Overview and Data Base sections of this report demonstrate the obvious significance of Danish, English and U.S. historical resources within the Cruz Bay sewershed. The potential for adverse impact to historic archaeological and architectural resources is easily seen. In addition, ephemeral but, nonetheless, historically important sites, such as slave villages, are almost certainly contained in the project area. Pulsipher (1985) has proposed the use of documentary data and ethnographic analogy as tools in researching possible patterns of Caribbean slave multi-dwelling units. Such sites can occupy as little as one-quarter acre and leave little in the way of surface remains, although the observation of remnant stands of economic plants and altered landforms may serve as surface indicators. Subsurface testing in proximity to such indicators may reveal artifacts and patterns of archaeological features, i.e., soil stains where wooden, structural house parts, open hearths, trash pits, etc. were once located.

Among the types of archaeological resources that have been demonstrated to be of scientific and historical significance are plantation sites, Caribbean town or urban sites, and those sites that relate to the Afro-Caribbean peoples of the slave and post-emancipation periods. As has been shown, the cultural resource potential of the Cruz Bay study area is high and should contain examples of all of the above resource types. A number of plantation sites have been documented, many of these were owned and/or operated by persons within a range of ethnic and socio-economic status positions. The town of Cruz Bay was a mid-19th century settlement that has rarely been studied within the Caribbean and may prove to contain cultural resources of extreme importance. Finally. the presence of documented Afro-Caribbean sites of the slave period and the post-emancipation period may allow for studies of transition, adaption by blacks to new economic and social parameters, and ethnic remnants in historic society.

In general, the research potential and historic resource conservation and education opportunities within the study area of the island of St. John are such that any impact to the available resource base must be further evaluated. Specifically, those areas noted in Figure III-1 should not be approached without concern for possible impacts on significant cultural resources.

Recommendations

MAAR Associates, Inc. recommends that a Stage IB Cultural Resource Survey be conducted within the major portion of the proposed Cruz Bay Wastewater Treatment System on the island of St. John. Areas that may be excluded are those where deep modern disturbance can be demonstrated (see below). Even areas of relatively steep slope, i.e., 20 to 40 percent grades, will likely contain evidence of historic plantation activity and cannot be excluded from Stage IB investigations.

It is recommended that this survey be initiated after the development of a final and/or alternate plan(s). Stage IB surveys should be conducted at all treatment plant, pump station, and effluent spray sites proposed, so that the results of the survey might be considered in the final selection process. In addition, it cannot be assumed, because the proposed collection system will be located beneath or alongside existing roadways, i.e., in already disturbed areas, that the depths of the existing disturbances have obliterated significant cultural resources. Moreover, in the absence of historical documentation of the placement of current roadways, it cannot be assumed that the current roadways have actually destroyed earlier historical and/or prehistoric resources. For example, were roadbeds cut or simply laid over potentially historic roadways ? Therefore, it must be recommended that general collector pipe areas be surveyed by means of frequent subsurface testing in adjacent house lots and other adjoining areas in the town of Cruz Bay and outside of it.

The recommended Stage IB surveys should include additional background research to assure that all pertinent Caribbean settlement data, including slave settlements, is considered. Informant interviews should be conducted over a sufficiently long period of time to allow for the natural reluctance of Cruz Bay residents to divulge information about aboriginal and historic resources of which they have knowledge. Field investigations should include surface surveys. Intense subsurface testing and frequent shovel tests combined with limited test pitting should be emphasized. An evaluation of resource significance and assessment of potential impact should be made in a research report. A shortened version, or popular report, should be distributed to all involved agencies and made available to the general public on St. John and abroad.

## STAGE 1B CULTURAL RESOURCE SURVEY
### SUMMARY

Summary of Investigations

In addition to a pedestrian survey, shovel testing was carried out at three locations within the project area; 1) the Sewage Treatment Plant and the flat area just south of it, 2) the land between Turner and Frank Bays, and 3) Route L (an unpaved road east of Southside road and Enighed Hill). Three backhoe cuts within the proposed sewage treatment plant site, adjacent to Route 104, revealed fill deposits. Cultural material recovered was recent, with the exception of a late 18th or early 19th century glass bottle fragment screened from material removed below the water table in Cut 2. Map study and informant interviews confirmed that the area of the proposed Sewage Treatment Plant Site was formerly marshy and has been covered with fill for about 20-30 years. The area continues to be used for dumping of soil, construction debris and other refuse such as cars.

Because it is located on Jaucas soils, thought to have high potential for aboriginal sites, the land between Turner and Frank Bays was shovel tested. The only historic materials recovered there were two bottle fragments (probably late 18th or early 19th century) recovered near the surface of two shovel tests. The artifacts could have been there due to erosion of the headland which is located near the active beach at Turner Bay. No evidence of aboriginal occupation was found.

Testing on the road east of Southside road (Route L) produced a flake of prehistoric derivation mixed in with modern materials confirming that the right of way has been filled and/or disturbed.

Discussion of Results

Dahlin (Dahlin, Tyson & Thomas 1985) had defined fresh water and marine protein sources (beach, mangrove swamp, salt pond habitats, etc.),more or less level terrain with at least moderately fertile soils, forests that would have a high variety of edible or otherwise useful plant species (i.e. hardwoods for tools and sugar and starch components of the diet), and crypto-crystalline rocks for the manufacture of lithic tools as resources that would have been exploited. He points out St. John's small size would have made resources accessible and trade could have mitigated long distances to favored resources. Although no aboriginal sites were located during this study the degree of disturbance and the limitations of the survey to areas lying within proposed construction rights-of-way did not allow a valid test of the settlement model proposed by Dahlin.

Despite the high probability for and historic remains within the project area, no in situ structural remains or significant cultural resources deposits were located during the survey. Findings were based upon examination of the project area using a combination of pedestrian survey, shovel testing, trenching, and screening. Historic materials recovered are thought to come from recent fill deposits, both at the plant site and on the road east of Southside road. The bottle fragments from the headland at the northwest corner of Turner Bay were probably washed in or may represent isolated artifacts as no other cultural materials were recovered in the shovel tests excavated there. The plant site is to be located on fill and no in situ remains were encountered in the backhoe cuts there.

The results of the Stage IB study do not constitute a valid test of the potential of the entire Cruz Bay area. Sewage lines are scheduled to be placed, for the most part, within existing road beds which have been cut, or cut and filled, The treatment plant site is to be located on recent fill. Although no historical remains from the colonial plantations, which once covered the island, were recovered within the project area, this may be due to the extensive disturance documented or because the project area does not include the major areas of plantation building in and around the town of Cruz Bay.

The 20th century development of the town of Cruz Bay has covered and or destroyed most areas within the project area with some potential for archaeological remains. As a consequence, it is unlikely that the proposed construction operations will impact any significant cultural resources. Therefore, no further investigatons are recommended.

# MANAGEMENT SUMMARY


The need to determine the potential for culturally significant sites within the project area of a proposed Cruz Bay Wastewater Treatment System on St. John, U.S. Virgin Islands, led to a Stage IB site recognition survey of potential impact areas within the watershed. This Stage IB study was conducted in June of 1986 by MAAR Associates, Inc., a cultural resources firm headquartered in Newark, Delaware. The work was contracted by the A & E firm of CE Maguire of New Britain, Connecticut.

Prehistoric cultural resources have previously been identified at two locations within the Cruz Bay area. A prehistoric village site was discovered in Cruz Bay in the 1920's but subsequently destroyed by construction activities. Another site has recently been located near the ferry dock. Several historic plantations were once located near Cruz Bay as well. Therefore, the potential was considered high that cultural resources would be found within the project area.

Field investigations, consisting of vehicular and pedestrian survey, and both shovel testing and backhoe trenching , determined that alteration of the landscape had been extensive within the project area, including cutting, trenching, and filling associated with road and residential area construction. No structural remains or artifact deposits of prehistoric or historic significance was found.

Since no evidence of <u>in situ</u> cultural resources was identified, further (Stage II) investigations of the Cruz Bay project area are not recommended.

# APPENDIX K

## REFERENCES

# APPENDIX K

## REFERENCES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