# Environmental Impact Assessment

*For Children's Bay Cay*

The Exumas, The Bahamas

September 2016

Revision 1

## Table of Contents


EXECUTIVE SUMMARY 1

1.0 Introduction and Objectives 1-1

1.1 Key Issues from the Terms of Reference Meetings 1-1
1.2 Objective of the Environmental Impact Assessment 1-3
1.3 Scope of the Environmental Impact Assessment 1-3

2.0 Project Description 2-1

2.1 Conceptual Master Plan 2-1

2.1.1 Villas and Pavilions 2-2
2.1.2 Marina Area 2-7
2.1.3 Arrival Pavilion 2-10
2.1.4 Spa and Recreational Facilities 2-10
2.1.5 Bridge to Williams Cay 2-10
2.1.6 Back-of-House 2-10
2.1.7 Surface Water Features 2-11

2.2 Infrastructure and Utilities 2-11

2.2.1 Transportation 2-12
2.2.2 Potable Water 2-12
2.2.3 Wastewater 2-12
2.2.4 Electricity 2-13
2.2.5 Solid Waste 2-13
2.2.6 Stormwater Runoff 2-13

3.0 Development Area and Boundaries 3-1

3.1 Site Location 3-1
3.2 Site Boundaries 3-1
3.3 Areas of Influence 3-1

3.3.1 Adjacent Communities 3-3
3.3.2 Natural Parks, Protected Areas and Marine Reserves 3-3

3.4 Alternatives 3-4

3.4.1 No Action Alternative 3-4
3.4.2 Proposed Alternative 3-5

4.0 Baseline Description of the Development Site 4-1

4.1 Present Condition 4-1
4.2 Geography and Topography 4-1

4.2.1 Physical Geography 4-1
4.2.2 Upland Topography 4-2
4.2.3 Bathymetry 4-6

4.3 Climate and Meteorology 4-6

4.3.1 Temperature 4-7

4.3.2 Precipitation 4-7
4.3.3 Winds 4-8
4.3.4 Storms 4-10
4.4 Geology 4-11
4.4.1 Regional Geology 4-11
4.4.2 Seismology 4-12
4.4.3 Geomorphology 4-13
4.4.4 Site Geology 4-13
4.4.5 Hydrogeology and Water Resources 4-14
4.4.6 Soils 4-14
4.4.7 Caves and Blue Holes 4-14
4.4.8 Air Quality and Noise 4-15
4.5 Surface Waters 4-15
4.5.1 Water Levels and Circulation 4-16
4.5.2 Water Quality 4-17
4.6 Shoreline and Coastal Processes 4-17
4.6.1 Wave Climate 4-17
4.6.2 Shoreline Distribution 4-18
4.6.3 Existing Coastal Processes 4-19
4.7 Marine Ecology 4-20
4.7.1 Data Acquisition and Methods 4-20
4.7.2 Description of the Existing Marine Environment 4-23
4.8 Terrestrial Ecology 4-46
4.8.1 Data Acquisition and Methods 4-47
Description of the Existing Terrestrial Environment 4-48
4.8.2 Dry Broad-Leaved Evergreen Forest (DBEF) 4-48
4.8.3 Coastal Rock (CR) 4-55
4.8.4 Sand (SAND) 4-57
4.8.5 Sand Strand (DUNE) 4-60
4.8.6 Dwarf Salt-Tolerant Evergreen Shrubland (DS-TES) 4-62
4.8.7 Mangrove (M) 4-62
4.8.8 Coconut Grove (CG) 4-65
4.8.9 DBEF – impacted (DBEF-i) 4-65
4.8.10 Salt Ponds (SP) 4-65
4.8.11 Other Existing Development-Related Land Cover and Land Uses 4-67
4.8.12 Windsock Cay Terrestrial Ecology 4-76
1.1.12 BEST Commission National Invasive Species Strategy 4-81
4.9 Socioeconomic Aspects 4-82
4.9.1 Adjacent Communities 4-82
4.9.2 Economic Base and Status 4-82

4.9.3 Existing Opportunities for Employment 4-83
4.9.4 Current Land Uses 4-83
4.9.5 Existing Transportation 4-83
4.9.6 Existing Infrastructure and Public Services 4-83
Air Quality 4-83

4.10 Cultural Resources 4-83
4.10.1 Historic Overview of Children's Bay Cay and Vicinity 4-83
4.10.2 Assessment of Cultural Resources 4-84

4.11 Existing Utility Services 4-87
4.11.1 Potable Water 4-87
4.11.2 Wastewater 4-87
4.11.3 Electricity 4-87
4.11.4 Roads 4-87
4.11.5 Solid Waste 4-88

4.12 Regulatory and Legal 4-88

5.0 Environmental Impact Analyses 5-1

5.1 Impacts to Shoreline/Nearshore and Coastal Processes 5-1
5.2 Impacts to Local Circulation and Currents 5-1
5.3 Impacts to Surface Water and Ground Water Quality 5-1
5.4 Terrestrial Ecology and Land Use Impacts 5-1
5.4.1 Upland Impacts 5-1
5.4.2 Fill 5-4

5.5 Marine Ecology Impacts 5-4
5.5.1 Area Under and in the Vicinity of the Over-Water Guest Pavilions 5-5
5.5.2 Areas Adjacent to Beaches 5-7
5.5.3 Marina Channel Realignment 5-7
5.5.4 Areas Adjacent to Overhanging Coastal Rock 5-9
5.5.5 Area Adjacent to Proposed Back-of-House Marina 5-10
5.5.6 Area Adjacent to Proposed Marina Expansion 5-11
5.5.7 Summary of Potential Direct and Indirect Impacts to the Marine Environment 5-11

5.6 Air Quality Impacts 5-12
5.7 Impacts to Utilities and Local Infrastructure 5-13
5.7.1 Potable Water 5-13
5.7.2 Wastewater 5-13
5.7.3 Electricity 5-13
5.7.4 Solid Waste 5-14

5.8 Socioeconomic Impacts 5-14
5.9 Cultural Resource Impacts 5-14

6.0 Proposed Mitigation Measures 6-1

6.1 Marine Protected Area Establishment 6-1

6.2 Mangrove Replacement 6-2
6.3 Leachate Prevention 6-2

7.0 Environmental Management Plan 7-1

7.1 Summary 7-1
7.2 Environmental Management Plan - Table of Contents 7-1

7.2.1 CHILDREN'S BAY CAY EMP OUTLINE – CONSTRUCTION PHASE 7-1

7.2.2 CHILDREN'S BAY CAY EMP OUTLINE – OPERATIONS PHASE 7-5

8.0 Public Consultation 8-1

9.0 Conclusions 9-1

10.0 References 10-1

## Figures

Figure 1-1 - General Location Map 1-4
Figure 1-2 - Aerial Photograph - Children's Bay Cay 1-5
Figure 2-1 - Conceptual Master Plan - Full 2-3
Figure 2-2 - Conceptual Master Plan - Enlarged View - West 2-4
Figure 2-3 - Conceptual Master Plan - Enlarged View - Central 2-5
Figure 2-4 - Conceptual Master Plan - Enlarged View - East 2-6
Figure 2-5 - Comparison of Existing to Proposed Marina Configuration 2-7
Figure 2-6 - Conceptual Marina Plan 2-8
Figure 3-1 - Site Boundary and Marine Protected Area 3-2
Figure 3-2 - Children's Bay Cay in Relation to Barraterre 3-4
Figure 4-1 - Children's Bay Cay Location in Reference to Great Bahama Bank Formation (NOAA Chart #11013) 4-2
Figure 4-2 - Children's Bay Cay Site Topography - West 4-3
Figure 4-3 - Children's Bay Cay Site Topography - Central 4-4
Figure 4-4 - Children's Bay Cay Site Topography - East 4-5
Figure 4-5 - Regional Bathymetry 4-6
Figure 4-6 - Daily Mean Temperature (1990-1997) 4-7
Figure 4-7 - Average Monthly Rainfall (1990-1997) 4-8
Figure 4-8 - Annual Wind Rose (1990-1997) 4-9
Figure 4-9 - Wind Rose, November-May (1990-1997) 4-9
Figure 4-10 - Wind Rose, June-October (1990-1997) 4-10
Figure 4-11 - Hurricanes and Tropical Storms within 100 miles of Great Exuma (1984-2014) 4-11
Figure 4-12 - Excerpted Relative Water Surface Elevations 4-16
Figure 4-13 - Children's Bay Cay Bathymetry from British Admiralty Chart 4-19
Figure 4-14 - Marine Transects 4-22
Figure 4-15 – Shoreline Communities 4-25
Figure 4-16 – Landside Communities 4-49

Figure 4-17 - Windsock Cay 4-77
Figure 5-1 - Comparison of Existing to Proposed Marina Configuration 5-8

## Tables

Table 2-1- Major Project Components 2-1
Table 4-1 - Children's Bay Cay Vegetative Communities and Land Cover/Land Use Types 4-50
Table 4-2 - Invasive Plant Species Identified on Children's Bay Cay, April 2015 4-82
Table 5-1 - Impacts to Children's Bay Cay Vegetative Communities and Land Cover/Land Use Types 5-2

## Appendices

Appendix A Baseline Marine Species Lists
Appendix B Baseline Upland Species Lists
Appendix C The National Invasive Species Strategy for The Bahamas
Appendix D Children's Bay Cay - Marina Flushing Study
Appendix E Lee Stocking Island Literature Review

# EXECUTIVE SUMMARY

In May of 2016, the Bahamas Environment, Science and Technology (BEST) Commission approved the Terms of Reference (TOR) provided by CBC Services for the development of a comprehensive Environmental Impact Assessment (EIA) for a proposed luxury resort hotel, marina, golf course, and residential community on Children's Bay Cay and Williams Cay, Exuma, The Bahamas.

CBC Services has conducted an Environmental Impact Assessment (EIA) for a proposed resort development on Children's Bay Cay, a sparsely inhabited island near Barraterre off the northern tip of Great Exuma. The purpose of this EIA is to support the master planning of the island and identify potential environmental impacts, explore alternatives and identify mitigation opportunities to offset both short term and long term potential environmental impacts. The planned out-island resort development will consist of low density private and rental villas with amenities including a spa, beach club, water sports and marina for guests and residents. The Owner intends to maintain as much of the natural vegetation as possible, with limited clearing of uplands for construction of cart paths, villas, recreation areas, marina and staff accommodation.

The island resort construction is expected to generate several hundred temporary jobs, which will evolve into 200 to 300 permanent staff jobs once the resort becomes operational. In addition, businesses on Great Exuma will directly benefit from increased demand for local goods and services from this development. Facilities for service vessels including barges for fuel, provisions and removal of collected solid wastes, and utility runabout vessels will be provided in a back of house area cut into uplands.

Currently, the island is sparsely developed with onsite power generation and water desalinization. The new development will require power generation, a desalination plant for potable water and a wastewater treatment plant. The potable water and electrical power facilities will be constructed on an off-island site to be located near or on Barraterre and the wastewater treatment facilities will be constructed on Williams Cay. Minimal fuel storage will be required and will be located in the back of house area on Children's Bay Cay. Alternative renewable energy sources such as photovoltaic solar arrays are being considered to provide a sustainable electrical source for the project and to reduce the demand from Barraterre. These systems will be further investigated as the electrical supply system engineering moves into the design stages.

The Owner's planning and design team has given the highest level of attention to environmental quality and enhancement for the Children's Bay Cay development. The project team is committed to the development and utilization of the most comprehensive and state-of-the-art environmental technologies and management methodologies. Careful consideration has been given to the environmental impacts and sequence of development activity to minimize long-term and short-term adverse impacts to the upland and marine ecology. In support of this goal, the following project components and methodologies will be implemented.

- Clearing for all required areas will be limited to the immediate area necessary for dwelling construction and amenities. Adjacent area clearing will be restricted to thinning the underbrush and clearing areas with invasive or low resource value underbrush.
- Landscaping around villas and common areas will make extensive use of the diverse selection of native vegetation representative of the island. In addition, the project's landscape architects will emphasize planting trees listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order, including the *Guaiacum sanctum* (lignum vitae), which are known to be native to this area.
- The realignment of the marina channel and back of house berthing area will utilize state-of-the-art best management practices (BMPs) to minimize impacts. A detailed summary of BMPs to be implemented during construction and operations will be developed as part of the environmental management plan to be provided under separate cover.
- For boats using the marina, a marina management program will be established and will include a no-discharge policy and provide a pump-out facility. The marina will meet or exceed international standards for clean marinas to assure that the marina is operated under strict environmental protection guidelines.
- As part of this development, the Owner seeks to establish a marine protected area that will incorporate Windsock Cay and will exclude power boats and serve as a protected area for conch and other marine species.

- The existing beaches will be left in their natural condition with minimal impacts expected from development.
- All power, potable water and wastewater infrastructure will be constructed offsite, will be purpose built for the project and should create no impacts to adjacent community electrical, water and wastewater infrastructure. Electrical power and potable water for the project will be generated on Barraterre and wastewater will be treated on Williams Cay. Solid wastes will be removed from the island for offsite disposed in an approved landfill on Great Exuma. During construction, waste wood products will be burned and waste concrete products will be utilized as fill onsite or landfilled offsite.

In support of the EIA, the Owner has conducted a survey of the island to identify important natural and cultural resources. The studies included the following:

- An inventory and mapping of the upland plant and animal species and habitats.
- A qualitative reconnaissance survey and mapping of dominant species within the marine habitats in the areas of interest around the island with descriptions of dominant marine species and benthic communities.
- A flushing analysis of the reconfigured marina basin to assess circulation, flushing and water quality.
- Assessment of cultural and historic resources on the island.

These studies serve as the baseline to design and develop Children's Bay Cay in a manner that minimizes environmental impacts and, where possible, preserves and enhances the natural and cultural resources on and surrounding the island. These studies also provide the baseline conditions upon which positive and negative impacts have been quantified. The following summarizes the key impacts, both positive and negative, defined under this EIA.

- Approximately 26 acres of upland habitat will be impacted due to clearing for the resort development. This will likely result in the reduction of habitat for some species of nesting birds. Additional habitat will be created through enhancement of the two existing salt ponds on the island and creation of an additional pond with permanent pools to allow for more substantial invertebrate colonization and foraging opportunities for birds. All ponds will be planted with strategically interspersed fringing mangrove communities around a portion of their perimeters.

- Beach areas will be preserved and there will be minimal benthic impacts from construction of the resort. Minimal impacts to submerged aquatic vegetation (SAV) and hardbottom resources will result from up to 30,000 square feet ($ft^2$) of dredging for the realigned marina channel and construction of approximately 14,000 $ft^2$ of overwater villas and decks. The overwater villas and decks will be field located to minimize impacts. Unavoidable impacts will include shading of some sparse areas of SAV and limited intertidal and subtidal rock communities. The benthic community in the area of the proposed marina channel realignment will be surveyed prior to construction and significant resources will be relocated.
- The flushing study indicates that to meet the U.S. EPA flushing recommendation that the percent dye remaining after 4 days should be down to 10 percent, pumping will be required to augment natural flushing in the marina basin. To meet these requirements, the Owner will install and operate a 4,000 GPM flushing pump as recommended by the study.
- Elimination of unregulated anchoring and potential illicit discharges to the waters adjacent to the proposed marine protected area will have a positive impact upon water quality conditions, SAV and benthic resources within the area.
- Construction and dredging impacts to water quality in the marina channel, back of house marina area and adjacent waters of the island will be short-term and limited by using site-specific controls and turbidity reduction and containment measures.
- Impacts to existing water and wastewater infrastructure on adjacent islands will not occur since these services will be provided fully on Barraterre (potable water) and Williams Cay (wastewater treatment).
- Minimal cultural and historic resources were found to exist on the island. However, any additional resources discovered during construction will be preserved and studied in cooperation with the government.

- This EIA presents the design and planning conducted to date for the development of Children's Bay Cay and the environmental, social and cultural impacts associated with the present master plan.
- All additional planning and detailed design efforts will be conducted in accordance with the objectives of this EIA document, with additional details to be provided to the Bahamas Government as addendums to this EIA as the project develops should any additional regulatory requirements be identified.

In accordance with this EIA document and with the proper planning, application and monitoring of the Environmental Management Plan and if Best Management Practices are conscientiously planned, engineered and implemented, many of the impacts that are generated during construction and operation should be minimized or completely eliminated for the proposed project.

This document is a revised version of the original submitted in July of 2016 and reflects clarifications and additional information requested by the BEST Commission following their review.

# 1.0 Introduction and Objectives

This study presents an environmental impact assessment (EIA) for the Children's Bay Cay project proposed by CBC Services, Ltd. The general location of Children's Bay Cay in the Exuma chain of islands is shown in Figure 1-1. This EIA follows the Terms of Reference (TOR) approved by the Bahamas Environment, Science and Technology (BEST) Commission. This EIA was completed by Waypoint Consulting Ltd. (Waypoint), a Nassau based environmental consultancy, and Applied Technology & Management (ATM) in accordance with the approved TOR and best engineering and environmental practices. The EIA incorporates comments and recommendations provided by BEST. The objectives of the EIA and the scope are described in the following sections. CBC Services, Ltd., owns all of Children's Bay Cay as well as all of the adjacent Williams Cay.

## 1.1 Key Issues from the Terms of Reference Meetings

The following key issues were identified based on input from BEST during the March 2016 site visit and during a meeting with BEST on April 25, 2016. They were incorporated into the draft TOR provided to the Best Commission on May 5, 2016, which was subsequently approved later that month. Per the approved TOR, the EIA effort must include or address the following:

1. *A comprehensive EIA covering all aspects of the project including cumulative impacts will need to be completed. Two (2) EIAs will be submitted under separate cover, one for Children's Bay Cay and one for Williams Cay.*
2. *An in-depth review and analysis of back-of-house operations on Barraterre and Lee Stocking Island, Exuma will be provided as a supplemental report. The EIAs for Children's Bay Cay and Williams Cay will outline back-of-house operations as it relates to specifically the Cays. The islands will generate wastewater, garbage, grey water and other wastes that will be treated either on island or exported to other appropriate facilities for proper disposal or treatment. The EIA will address the handling of these wastes, as well as the utilities to be placed on the island or offshore on Barraterre* [and Lee Stocking Island[1]]. *The facility will require potable water, irrigation water, electrical*

[1] The original plan was to place the wastewater plant on Lee Stocking Island. Since the original TOR efforts, the proposed plant location has been changed to the central area of Williams Cay.

*power and fuel for accessory vehicles and boats. The EIA will address the storage, handling and transfer of these resources.*

3 *For Children's Bay Cay, a comparison of the existing marina and placement of the proposed marina will be presented under the project details. The EIA will note the placement of a channel and dredge requirements to allow for vessel access to the marina.*

4 *For Williams Cay, the golf course and its aspects will be specifically addressed in that EIA. Per discussion with BEST on April 25, 2016, materials sourcing and a fill balance for golf course sands/fill materials will be included in addition to terrestrial and marine impacts analysis.*

5 *Techniques to mitigate impacts identified in the EIAs will be outlined. Mitigation measures will align with best practices in The Bahamas including the removal and maintenance of invasive species, planting with native vegetation, natural beach accretion, and protection of marine habitat through a proposed marine reserve.*

6 *To note, the EIAs will reference the potential future development of Lee Stocking Island but will not contain field investigations or technological studies which will be included in a Supplemental EIA when appropriate. A review of readily available literature pertinent to Children's Bay Cay and Williams Cay from the former Perry Marine Institute and will be included in the EIA as an appendix.*

The following EIA is intended to meet all of the requirements as listed in the approved TOR for the Children's Bay Cay portion of the project. To meet all of the approval requirements for the overall project, the following additional documents will be provided under separate covers:

- Environmental Management Plan (EMP) for Children's Bay Cay
- EIA and EMP for Williams Cay
- Supplemental back of house (BOH) report for Barraterre Cay
- Lee Stocking Island Report

At the time of this EIA, complete earthwork and grading plans have not been completed and as such the cut and fill calculations have not been completed. They will be supplied to the BEST

Commission as a supplement to the EIA on completion and will address the fill questions needed to meet the requirements of the Terms of Reference.

## 1.2 Objective of the Environmental Impact Assessment

This report provides an EIA for the proposed development on Children's Bay Cay, located approximately 1.5 miles north of the northern tip of Great Exuma. Figure 1-2 is a recent aerial photograph of Children's Bay Cay and is representative of existing conditions. Low-density development is proposed throughout the approximately 183-acre Children's Bay Cay, with much of the island left undisturbed. The EIA process is necessary to ensure that potential environmental impacts from this development are identified and considered during the development planning process, as well as to assure unavoidable impacts are minimized and mitigated.

The report is formatted in general accordance with the *General Outline for an Environmental Impact Assessment of Resort Developments* provided by the BEST Commission. The owner of the island will be working with Government to establish a marine protected area on the leeward side of the island that will encompass Windsock Cay and is intending to restrict this area to non-power vessels.

## 1.3 Scope of the Environmental Impact Assessment

In general, this effort has included detailed evaluations of the project site and the plans conceived during the planning process. The report summarizes the nature, type, duration and extent of potential environmental impacts both during and after construction.

## *Figure 1-1 - General Location Map*

*Figure 1-2 - Aerial Photograph - Children's Bay Cay*

# 2.0 Project Description

## 2.1 Conceptual Master Plan

The owner has proposed to develop Children's Bay Cay, a sparsely developed island approximately 1.5 miles off the northern tip of Great Exuma, into an out-island high-end luxury boutique resort, marina and residence community. The conceptual master plan for development of Children's Bay Cay is presented in Figures 2-1. Figures 2-2 through 2-4 illustrate the same master plan split into three sections for easier viewing of the site details. Table 2-1 lists the major project components depicted on the master plan. Electrical power and potable water will be developed in Barraterre to serve the resort and residences; with underwater utility lines providing the connections between the resort on Children's Bay Cay and the utility services at Barraterre. Wastewater will be treated on Williams Cay. Limited support staff will reside permanently on the island, with the majority commuting from Barraterre via water.

***Table 2-1- Major Project Components***

| Description | Qty. |
|---|---|
| Private Villas | 8 |
| Guest Pavilions | 46 |
| Family Beach Club | 1 |
| Adult Beach Club | 1 |
| Guest Marina w/ separate Water Sports (Jet Ski) Basin | 1 |
| Marina Village (Restaurants/Shopping) | 1 |
| Marina Apartments | 8 |
| Arrival Pavilion | 1 |
| Back-of-House Area w/ Docking Facility | 1 |
| Village Guest Rooms | 8 |
| Managers' Villas | 5 |
| Gym/Recreation Complex | 1 |
| Spa | 1 |
| Constructed Ponds | 3 |
| Bridge to Williams Cay | 1 |

The development includes a marina and back-of-house (BOH) area to support the resort and residences. The following sections provide a more detailed description of these components.

### 2.1.1 Villas and Pavilions

The development will include eight approximately 10,000 square foot ($ft^2$) villa lots for private residences. The residences will be custom built, each with a private pool. Site preparation for the villa lots will be limited to 5 feet (ft) outside of the area of construction to preserve as much vegetation and habitat as possible.

Along with the villas, 46 guest pavilions for short-term rental are proposed (Figures 2-1 and 2-2 to 2-4). Each villa will have a private pool and external terraces connecting the pavilion to the pool. Six of the 46 guest pavilions will be located over water in areas of sparse seagrass coverage. Each overwater guest pavilion will be supported on pilings. Each pavilion will have a private pool and connecting terraces and walkways to the uplands.

## *Figure 2-1 - Conceptual Master Plan - Full*

## *Figure 2-2 - Conceptual Master Plan - Enlarged View - West*

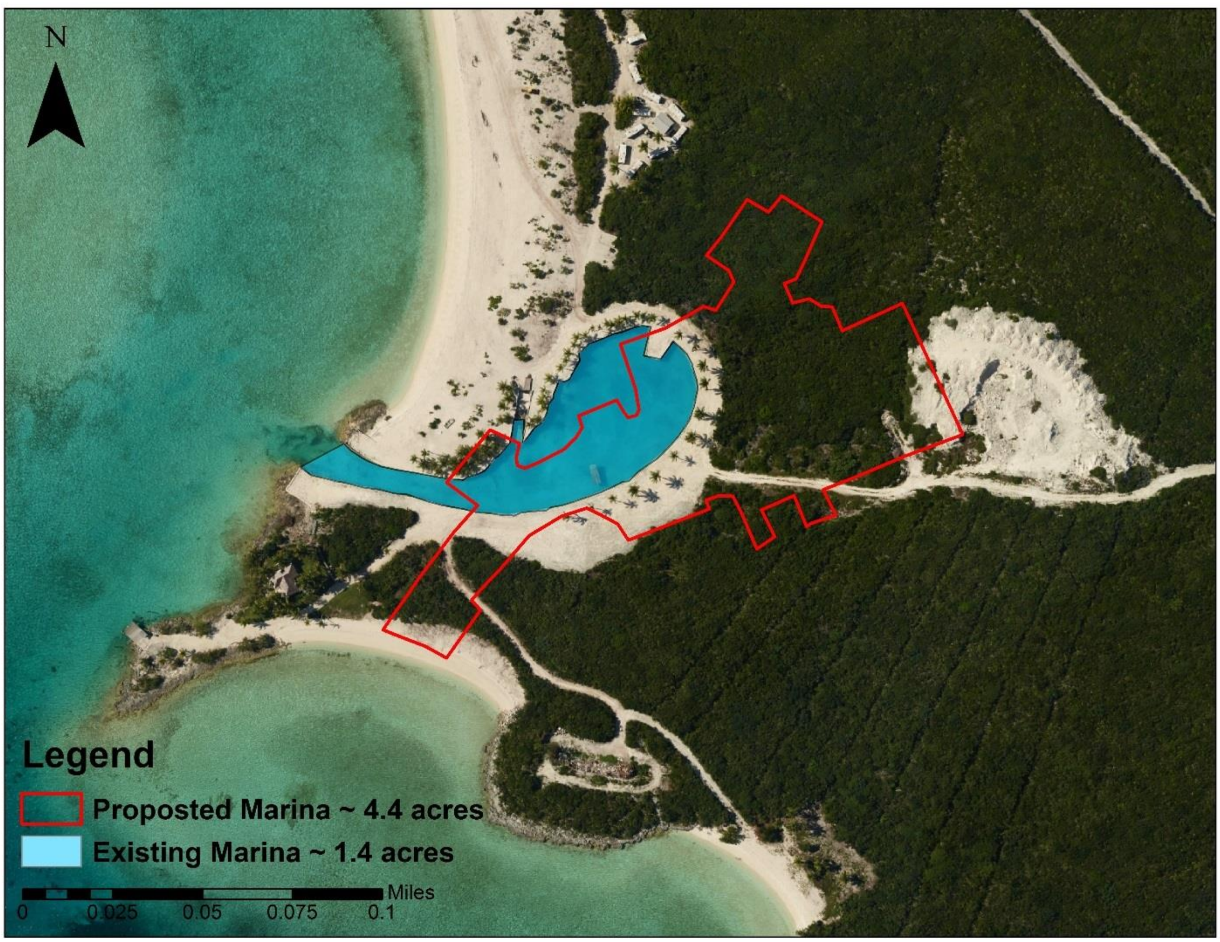
## *Figure 2-3 - Conceptual Master Plan - Enlarged View - Central*

## Figure 2-4 - Conceptual Master Plan - Enlarged View - East

### 2.1.2 Marina Area

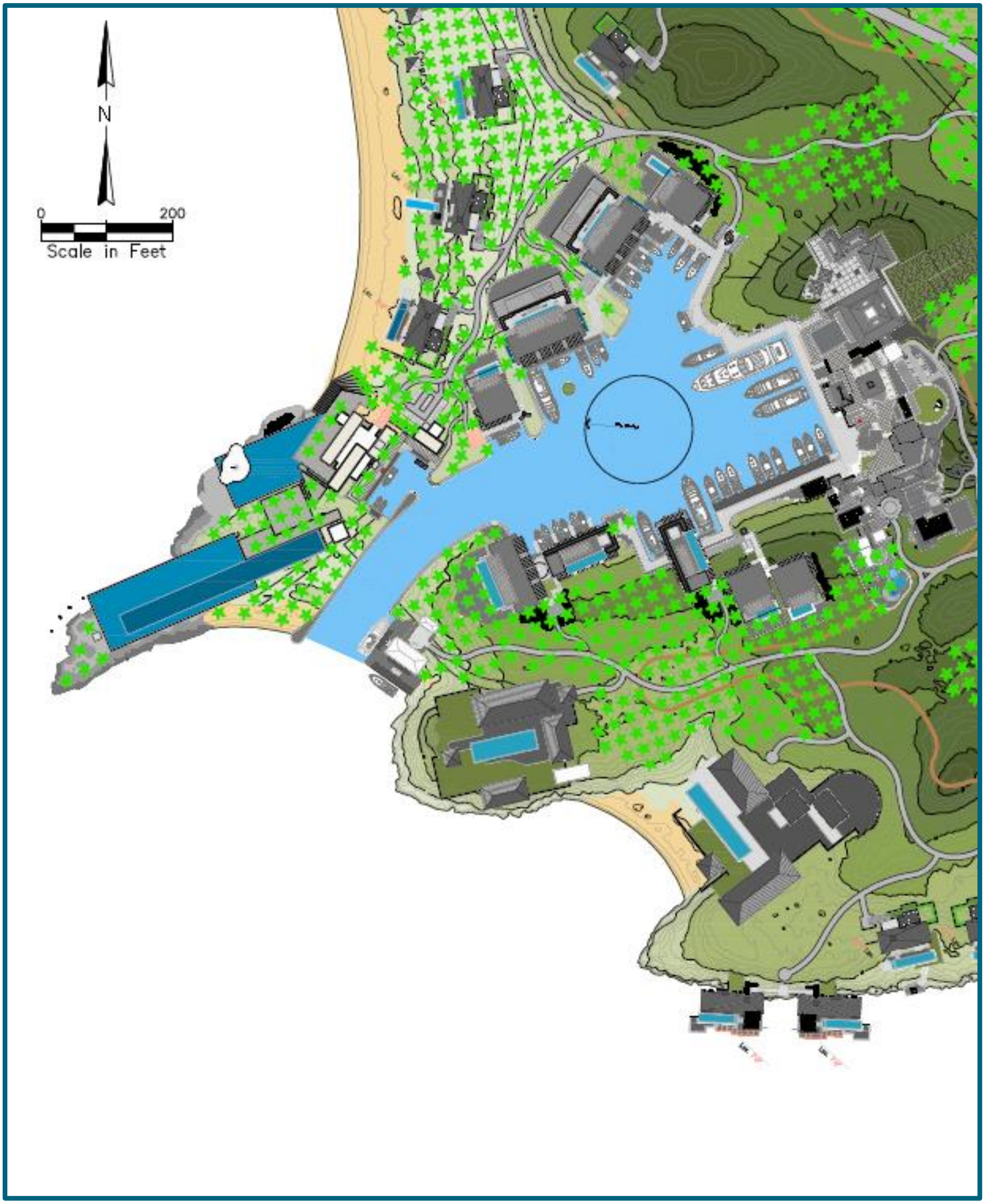
The existing upland cut marina basin at Children's Bay Cay will be enlarged to accommodate additional vessels and allow adequate room for safe maneuvering. The existing marina channel will be realigned to the south to better accommodate vessel approach from the south, which is the preferred access direction. Figure 2-5 provides a comparison of the existing marina to the proposed marina showing the new configuration and entrance location.

***Figure 2-5 - Comparison of Existing to Proposed Marina Configuration***




Channel realignment will require cutting through Saba Beach and dredging a short distance offshore to reach deep water. The existing marina channel will be filled in to accommodate construction of the adult beach club. Figure 2-6 shows the proposed marina plan.

## *Figure 2-6 - Conceptual Marina Plan*



The current configuration of the marine basin does not provide adequate room for maneuvering once slips are installed. To correct this deficiency, the marina basin will be expanded to accommodate proposed slips and side-tie docks for approximately 25 boats, with an average size of 50 to 70 ft. Boat size will be limited by the approximate eight-foot controlling depth outside the marina basin. Additional low freeboard docks will be constructed for docking and storage of small catamarans, canoes, jet skis, etc., along the northwest side of the marina basin.

Given the relatively small size of the marina, a portable pump-out cart is proposed in lieu of a fixed pump-out system. No fuel pumps or fuel storage are proposed at the Children's Bay Cay marina. Great Exuma is just a short distance away and offers full-service marinas with fuel, pump-outs, and repair facilities. However, there will be relatively small quantities of fuel stored in the back of house area for work boats, maintenance vehicles, etc.

Supporting development surrounding the marina is proposed to include offices for the food and beverage manager, front office manager, chief engineer, head housekeeper and security. Additional amenities proposed include:

- Café and bar
- Retail
- Dive center
- Marine supply shop
- Health clinic
- Environmental center
- 2,700-ft$^2$ conference/boardroom
- Customs and Immigration Office

The flushing study indicates that to meet the U.S. EPA flushing recommendation that the percent dye remaining after 4 days should be down to 10 percent, pumping will be required to augment natural flushing in the new marina basin. To meet these requirements, the Owner will install and operate a 4,000 GPM flushing pump as recommended by the study.

### 2.1.3 Arrival Pavilion

An arrival pavilion will be constructed on the east side of the mouth of the new marina entrance channel. The pavilion will be equipped with a docking facility.

### 2.1.4 Spa and Recreational Facilities

Augmenting the development will be a 21,500-ft$^2$ spa located on the east side of the island. A recreation complex will offer a lap pool, gym, tennis courts, basketball court, and an athletic field and is located near the back of house area on the southwest side of the island.

### 2.1.5 Bridge to Williams Cay

Williams Cay will eventually be an integral component to this proposed development. In accordance with the TOR, the development on Williams Cay is addressed in a separate EIA document. The channel between the two islands is approximately 70 ft wide at its narrowest point. A single-lane bridge is proposed to span this gap and provide a connection between the two islands. The bridge will be a prefabricated metal structure with concrete abutments placed above the waterline on the ironshore and elevated sufficiently to allow boat traffic that would normally be expected to use this channel. The placement of the bridge on the west side of the channel will help to protect it from extreme wind and wave conditions.

### 2.1.6 Back-of-House

Children's Bay Cay will require a BOH area to provide support to the project during both construction and operation. The BOH will require construction of a small boat dock and landing area to accommodate supply and transportation vessels. Dredging will be required to obtain a target depth of 10 ft. All loading and unloading of provisions and equipment will occur at this BOH location. The approximately 24,000-ft$^2$ BOH area will include:

- Storage
- Engineering
- Workshop
- Small boat repair and haul out
- Housekeeping and laundry
- Backup generator

- Staff cafeteria
- Recycle and refuse storage
- Wastewater pump station
- Administration offices
- Golf cart/vehicle parking
- Fuel storage
- Container storage

The utility connections for water and electricity from Barraterre and the wastewater connection to Williams Cay will also be located at the BOH area.

### 2.1.7 Surface Water Features

For aesthetics, function and fill material, three surface water features with permanently standing water will be created as part of this development. All three of these ponds will require excavation with the excavated materials used for construction and roadways on the island. The ponds will primarily utilize natural vegetation for the edge treatments with strategically interspersed planted red and black mangroves. There will be no direct connection to the surface waters surrounding the island and the ponds will serve as stormwater treatment and retention areas. The proposed pond adjacent to Horseshoe Beach is an existing ephemeral feature and will be approximately 1 acre in surface area and would utilize a liner to maintain water quality and water levels. The other two ponds are low areas interspersed with buttonwood and white mangroves and are located as shown on Figure 2-1 behind Goat Beach and southeast of Goat Beach. The areas of these two ponds will be approximately 1.3 acres and 4.5 acres.

## 2.2 Infrastructure and Utilities

Currently, potable water is produced on the island with a reverse osmosis water treatment plant. Wastewater is disposed of in soakaways, located adjacent to habitable buildings. Electricity is produced onsite by several diesel generators. This infrastructure will be abandoned with the proposed development and replaced with state-of-the-art facilities on Barraterre and Williams Cay.

### 2.2.1 Transportation

Children's Bay Cay is accessible only by boat. Staff access and egress from the island, along with construction materials, solid wastes and provisions will be primarily at the docks proposed in the BOH area (Figure 2-1). Guests will arrive by boat at the arrival pavilion.

The existing informal roadway network on Children's Bay Cay, primarily concrete pathway and native soils, will be mostly abandoned and replaced with an engineered system utilizing crushed lime rock, concrete or asphalt depending on location. Drainage and other design details necessary will be done in accordance with the standards and specifications of the Ministry of Works and Utilities and best management practices (BMPs). The proposed roadway surfaces will be crushed lime rock, concrete or asphalt depending on their location. Vehicular traffic will be limited to golf carts and other small service vehicles. Some standard-sized trucks and utility vehicles will be located on the island for use by the marina and other support facilities.

### 2.2.2 Potable Water

All proposed development on Children's Bay Cay will be served by a potable water distribution network extending throughout the island. Potable water will be delivered to the island via subsea water line extending from a reverse osmosis water treatment plant located in Barraterre. The specific locations of the reverse osmosis water treatment plant and water line have not been identified yet. When formally identified, this is information will be addressed in a separate report for Barraterre.

### 2.2.3 Wastewater

There will be no onsite treatment and disposal of wastewater on Children's Bay Cay. All wastewater will be collected throughout the island development via a gravity and/or low-pressure collection systems where gravity lines are not feasible. The wastewater collection system will terminate at a lift station in the BOH area and will be pumped to Williams Cay for treatment at a new membrane bioreactor (MBR) wastewater treatment plant to be located near the center of the island in the golf course maintenance area. Treated effluent from the MBR wastewater treatment facility will be utilized for irrigation of nursery areas and other areas as needed on Lee Stocking Island. Excess treated water would be conveyed through deep wells for disposal. There will be no surface water discharge of treated effluent.

### 2.2.4 Electricity

Children's Bay Cay will contain no electrical-generating equipment with the exception of several diesel generators used for backup power only. Electricity will be provided via a new subsea cable from Barraterre. Williams Cay is currently served via subsea cable from Barraterre. The specific location of the subsea electrical cable from Barraterre, along with the landing locations of the cable will be addressed in a report for Barraterre to be provided under separate cover. All electrical distribution wiring required for this development will be below ground in conduit.

Alternative renewable energy sources such as photovoltaic solar arrays are being considered to provide a sustainable electrical source for the project and to reduce the demand from Barraterre. These systems will be further investigated as the electrical supply system engineering moves into the design stages.

### 2.2.5 Solid Waste

No permanent solid waste disposal facilities will be constructed on Children's Bay Cay. All solid wastes generated both during and after construction will be collected, processed for volume reduction and barged to Barraterre for disposal in an appropriate manner. Landscape clippings and other organic wastes may be composted onsite for reuse as a soil amendment.

### 2.2.6 Stormwater Runoff

Stormwater runoff from the roadway network will be handled through standard accepted BMPs and will be directed to strategically placed drainage wells. Stormwater runoff from buildings will be collected for reuse where feasible. Where this is not feasible, stormwater runoff will be routed to drainage wells for disposal. Direct discharge of stormwater runoff to surface waters will not occur, and no water quality issues are anticipated.

# 3.0 Development Area and Boundaries

## 3.1 Site Location

Children's Bay Cay is located in the southern end of the Exuma chain of islands, approximately 1.5 miles off the northern tip of Great Exuma at 23°44'40"N, 76° 3'49"W, as shown in Figure 1-1. Children's Bay Cay is located directly southeast of Williams Cay and Lee Stocking Island and northwest of Rat Cay. The island has a southeast-to-northwest orientation on the eastern edge of the shallow Great Bahama Bank.

Children's Bay Cay is situated on a comparatively narrow sand bank, with the deep water of the Tongue of the Ocean being approximately 25 miles [40 kilometers (km)] to the west and deep water of Exuma Sound just over 1 mile to the east. The windward side of the island faces Exuma Sound and leeward side faces the Great Bahama Bank. The island is typical of islands in the Bahamas and made up of carbonate formations.

## 3.2 Site Boundaries

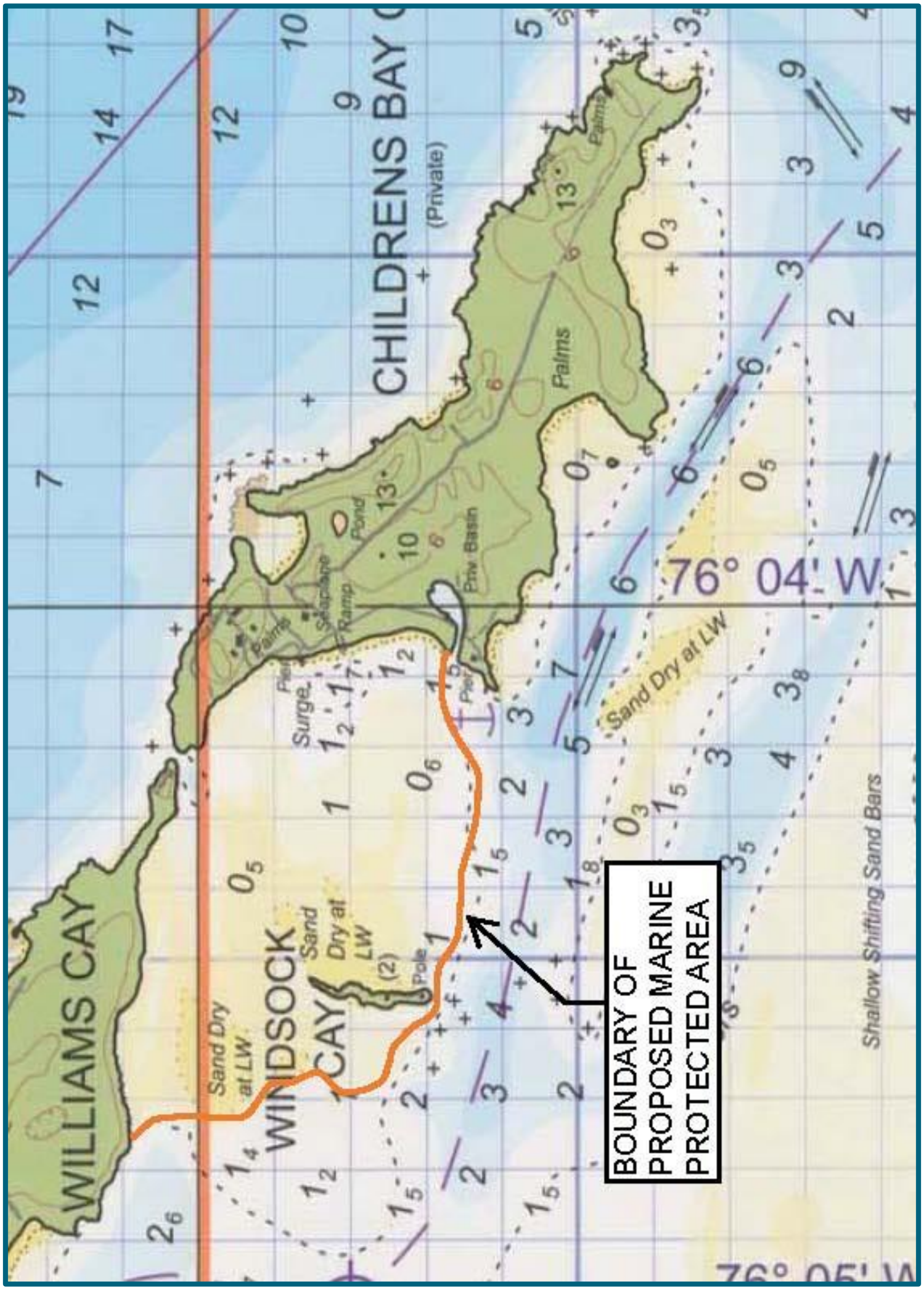
The boundaries for this project include all of Children's Bay Cay, the channel between Children's Bay Cay and Williams Cay, and the proposed marine protected area surrounding Windsock Cay (Figure 3-1).

## 3.3 Areas of Influence

This development will be primarily limited to the upland areas of Children's Bay Cay, the BOH marina, and bridge to Williams Cay. Local areas of influence due to this project include the following:

- Direct and secondary impacts to Children's Bay Cay and Windsock Cay, including impacts to the marine bottom near the pier and docking facilities.
- Direct and secondary impacts at the support facility near Barraterre, including impacts to marine bottom near the pier and docking facilities.
- Direct impacts to the submerged bottom within and adjacent to the utility crossing alignment.
- Secondary impacts to adjacent marine areas, cays, and communities.

***Figure 3-1 - Site Boundary and Marine Protected Area***



Upland onsite influences include land clearing associated with the development, roadways, island amenities, infrastructure, and docking areas. Marine influence areas include hardbottom and seagrass communities impacted by the widening of the marina entrance channel, creation of a docking area at the BOH, and the construction of five over-water bungalows. Marine influence areas also include coral reef, hardbottom, and seagrass communities impacted by the utility crossing installation. If depths are sufficient, it is anticipated the utilities (i.e., power cables and potable water lines) will be placed directly on the bottom. However, in shallower areas, trenching will be necessary to bury the cables and pipelines for security. This EIA provides an inventory of all proposed project components and details their potential environmental impacts, with the exception of the utility lines, which will be addressed in a separate report on Barraterre.

### 3.3.1 Adjacent Communities

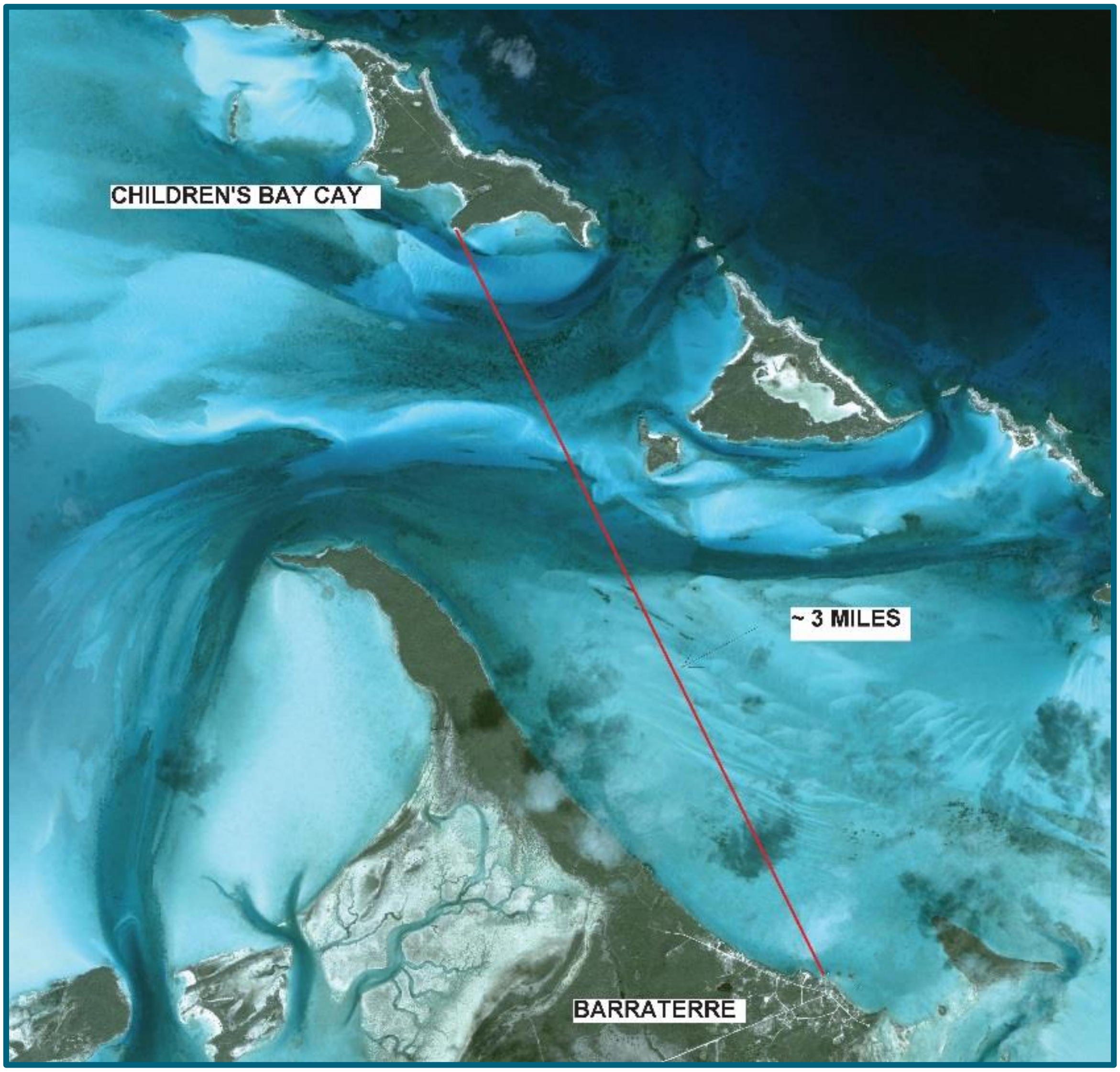
The only adjacent community to Children's Bay Cay is Barraterre, located approximately 3 miles south-southeast of the island (Figure 3-2). Children's Bay Cay is entirely privately owned and has no existing communities or settlements. Similarly, Williams Cay to the northwest is privately owned and has no communities or settlements. Rat Cay to the southeast is uninhabited.

### 3.3.2 Natural Parks, Protected Areas and Marine Reserves

There are no formally established natural parks, protected areas, or marine reserves currently located on or immediately adjacent to the project components on either Children's Bay Cay or Great Exuma. The Exumas Land and Sea Park is located farther northwest along the Exumas chain, beginning approximately 40 miles northwest of Children's Bay Cay.

While no marine reserves are currently located within the project area, the developer is proposing establishment of a marine protected area around Windsock Cay. A subsequent section provides details for this proposal.

### *Figure 3-2 - Children's Bay Cay in Relation to Barraterre*




## 3.4 Alternatives

### 3.4.1 No Action Alternative

As a component of the EIA, planning and impacts alternatives are compared to the "No Action" alternative. This is an important part of the EIA process as it sets the baseline for comparison.

No action alternatives typically fall into one of two scenarios, one where absolutely no further activities occur and the other where the property continues to be used for a similar use as it had been historically. In almost every scenario where property is not specifically purchased or otherwise obtained for the intent of restoration and preservation, the assumption is that the property would continue to be used and maintained as it has been during recent history. That is our assumption for the no action alternative.

Under this scenario, Children's Bay Cay would continue to have occasional construction of residences and smaller impacts that would not fall under a master planned program. Wastewater would continue to be disposed of via soakaways and electrical would continue to be generated by individual diesel generators. The more natural areas would likely remain in a similar condition as they are today. All economic stimulus to adjacent islands and to the Bahamas being gained through construction, increased investment, increased tourism and new jobs would be lost.

The "No Action" alternative would keep Children's Bay Cay in a similar condition as it is today and would not consider any new construction effectively eliminating the original purpose for purchasing the property.

### 3.4.2 Proposed Alternative

The proposed alternative is provided within this EIA. The island is privately owned and the development footprint has been minimized wherever possible. Along with the environmental and mitigation planning discussed herein, an Environmental Management Plan will be supplied to the BEST Commission further outlining steps to be taken to minimize or eliminate negative environmental impacts.

# 4.0 Baseline Description of the Development Site

## 4.1 Present Condition

Children's Bay Cay is a 188-acre island consisting predominately of Dry Broadleaf Evergreen habitat. Children's Bay Cay is privately owned and consists of several private residences, support buildings and a marina basin. An unimproved road spans the length of the island, with several secondary roads/paths providing access to the buildings, marina and beach areas. Two small docks and a seaplane ramp are located on the leeward side of the island.

Limited clearing has occurred in areas surrounding the existing buildings, roadways and marina basin. The windward side of the island is dominated by ironshore, with two beach formations (Horseshoe Beach and Goat Beach). Horseshoe Beach is located within an eroded ironshore cove, and Goat Beach has a much shallower indentation into the shoreline. The sand on both of these beaches is transient due to high current and wave conditions experienced on this side of the island. Given the location on Exuma Sound and prevailing easterly winds, there is little vegetative growth along the ironshore on this side of the island.

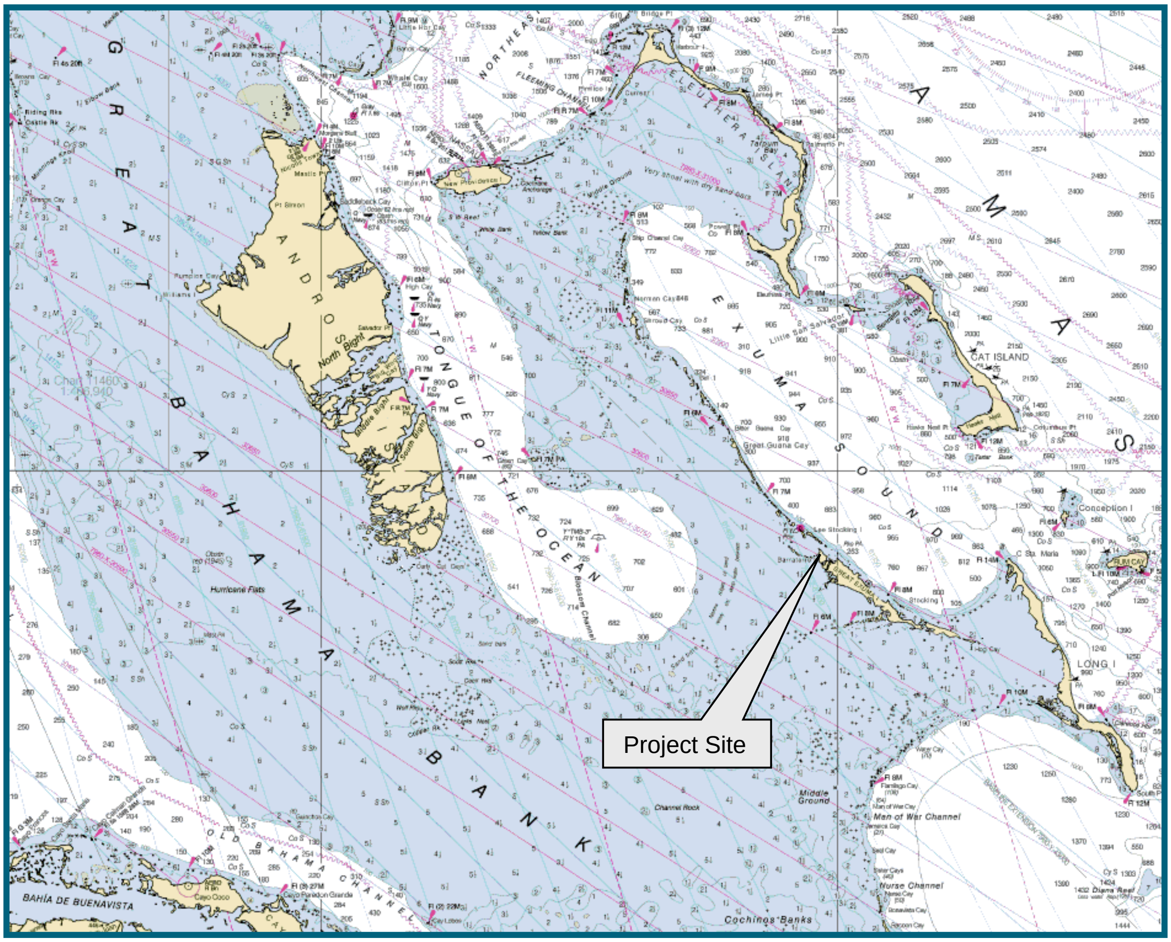
The leeward side of the island has an approximately 1,600-ft-long beach extending northwest from the marina basin. Southeast of the marina basin, the shoreline is characterized by a series of pocket beaches anchored between sections of ironshore. These beaches are much more stable than the beaches on the windward side of the island.

## 4.2 Geography and Topography

### 4.2.1 Physical Geography

The Bahamian archipelago is a system of carbonate banks and islands with a common geological origin. The archipelago stretches over almost 7 degrees in latitude (420 nautical miles or 770 km), from the tropical dry islands of the Turks and Caicos, to the subtropical island of Grand Bahama. The archipelago includes territories of three countries: The Bahamas, the Turks and Caicos Islands, and the Dominican Republic. Children's Bay Cay occupies the eastern edge of the Great Bahama Bank (Figure 4-1).

***Figure 4-1 - Children's Bay Cay Location in Reference to Great Bahama Bank Formation (NOAA Chart #11013)***

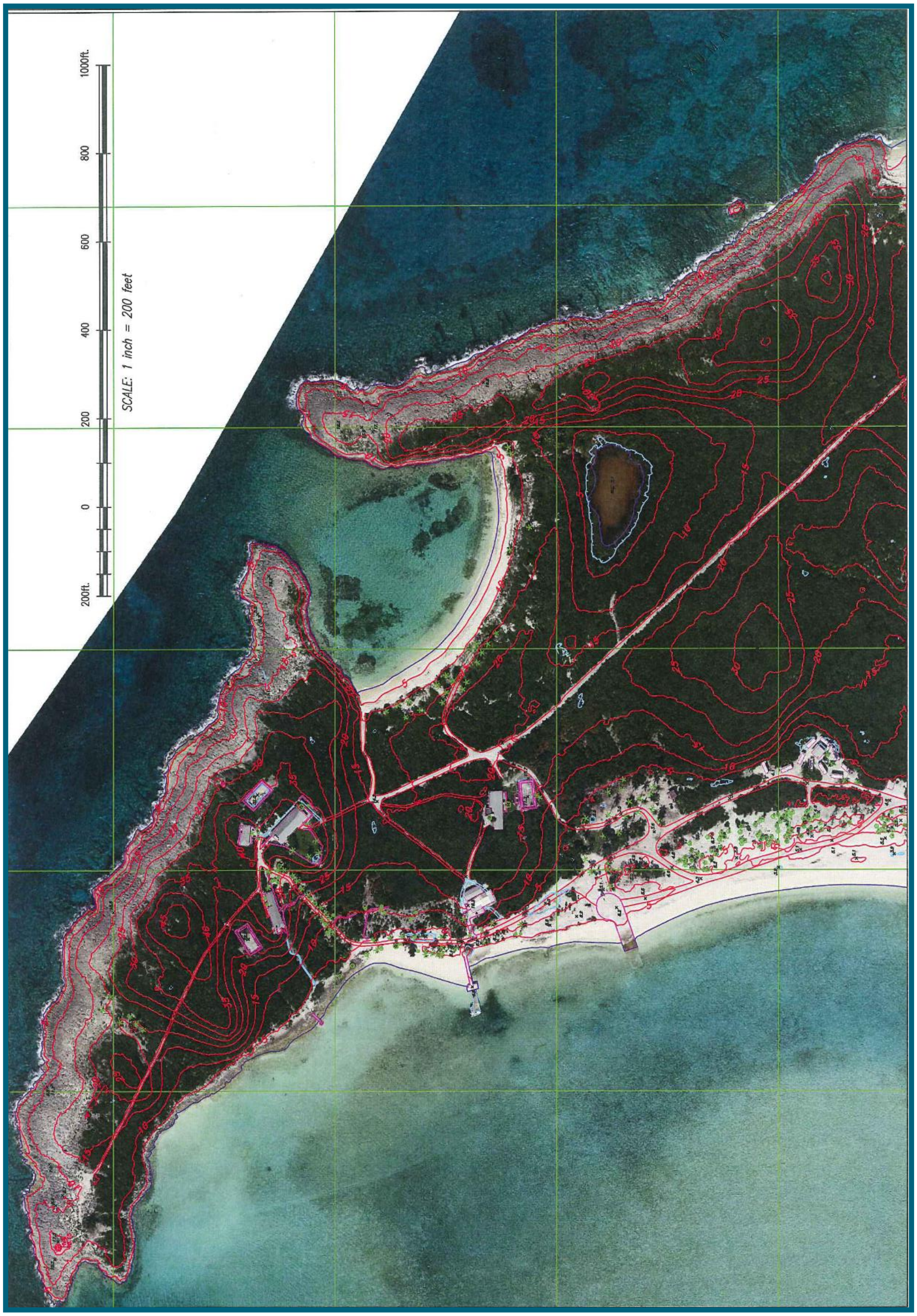



Children's Bay Cay is 188 acres and approximately 1.3 miles long and 0.4 mile wide at its widest point. The windward side of the island borders Exuma Sound and the leeward side borders the Great Bahama Bank. The island generally has a northwest-to-southwest orientation. Barraterre is the closest community, located approximately 3 miles south-southeast.

## 4.2.2 Upland Topography

Site topography (Figures 4-2 through 4-4) varies along the length of the island, with areas of higher relief along the windward (northeastern) side. The high point on the island is near the northwest end at 48.4 ft. The island ground elevations average 5 to 45 ft above mean high water (MHW). Several flood prone interior areas of the island are at or just above sea level.

## *Figure 4-2 - Children's Bay Cay Site Topography - West*



## *Figure 4-3 - Children's Bay Cay Site Topography - Central*

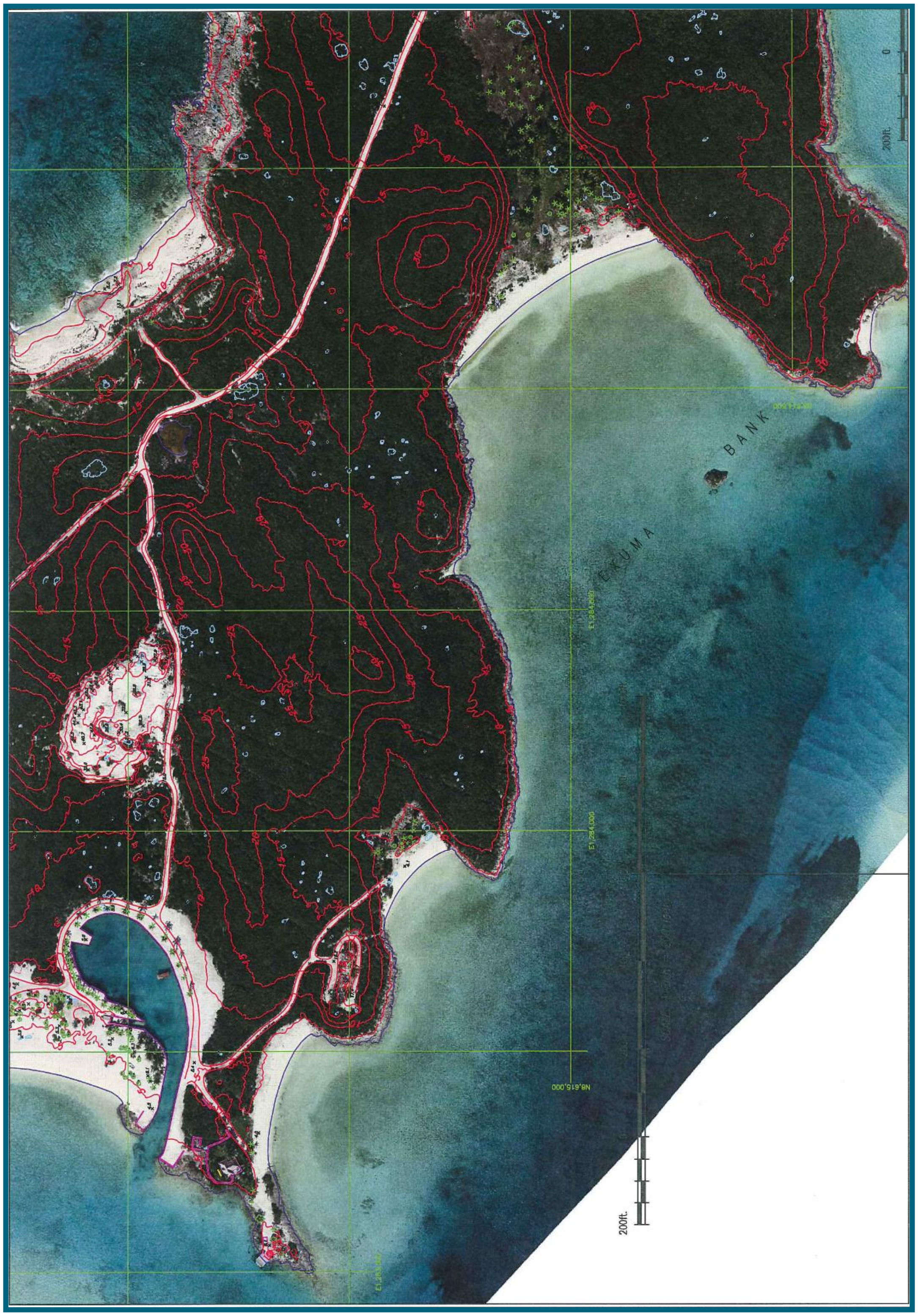
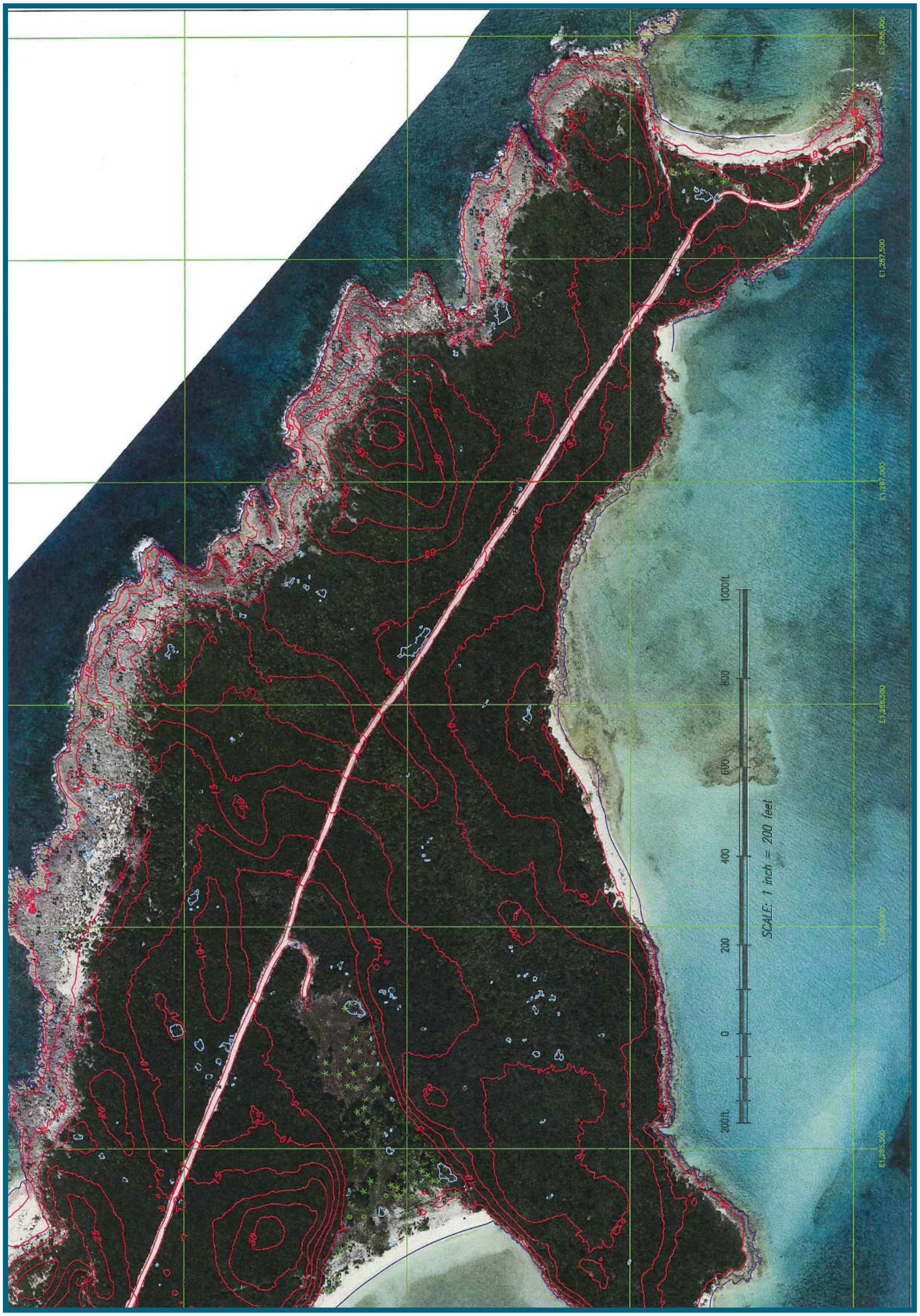


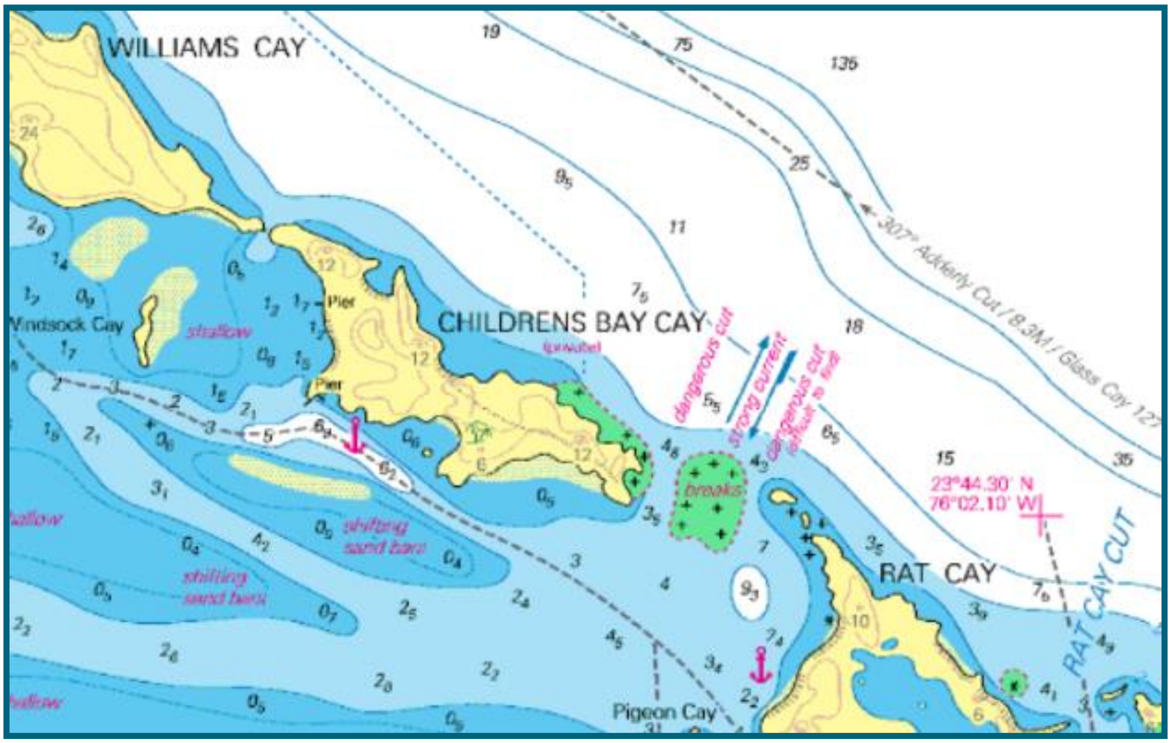
***Figure 4-4 - Children's Bay Cay Site Topography - East***



### 4.2.3 Bathymetry

Offshore water depths vary dramatically, with Exuma Sound to the east and the Great Bahama Bank to the west. Exuma Sound exceeds 3,000 ft [914 meters (m)] deep, while the Great Bahama Bank is very shallow, with depths typically less than 20 ft (6 m). The Great Bahama Bank also contains many shallow reefs and navigational hazards. Depths near Children's Bay Cay provide relatively safe navigation for most recreational vessels, including yachts. Regional bathymetry is presented in Figure 4-5.

***Figure 4-5 - Regional Bathymetry***



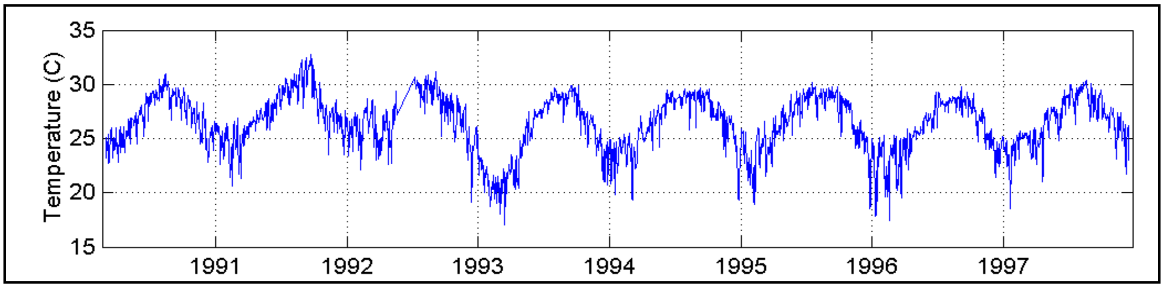

## 4.3 Climate and Meteorology

Like the other islands of the Bahamas, Children's Bay Cay enjoys a subtropical climate characterized by relatively warm, wet summers and drier, cooler winters. In summer, persistent easterly trade winds predominate, bringing warm, humid air to the island. In winter, the influence of high-pressure cells over the North Atlantic and North America produce periodic influxes of drier continental air, marked by the passage of cold fronts that sometimes bring rain but do not subject the island to freezing temperatures.

### 4.3.1 Temperature

The climate of Children's Bay Cay is subtropical, with a mean temperature of 23 degrees Celsius (°C) [73 degrees Fahrenheit (°F)] in January to 29°C (84°F) in August. The island is characterized by generally warm moist summers and drier cooler winters. Figure 4-6 presents daily temperature data from the Perry Institute for Marine Science (PIMS). The data reflect the temperate climate of the Bahamas, with a low degree of fluctuation in air temperature

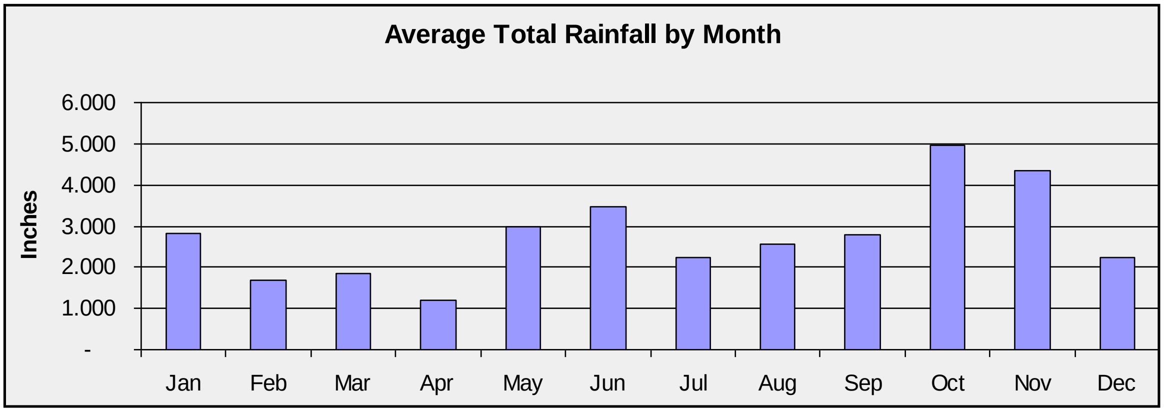
***Figure 4-6 - Daily Mean Temperature (1990-1997)***




### 4.3.2 Precipitation

Meteorological data from PIMS on Lee Stocking Island, approximately 3 miles northeast of the project site, were used for the meteorological analyses. The primary source of data extends from 1990 to 1997, while other sources of data include the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) and Georgetown airport [30 miles (48 km) southeast of site]. Annual rainfall averages between 30 and 35 inches per year (Figure 4-7). Precipitation is generally higher during the hurricane season (June to November).

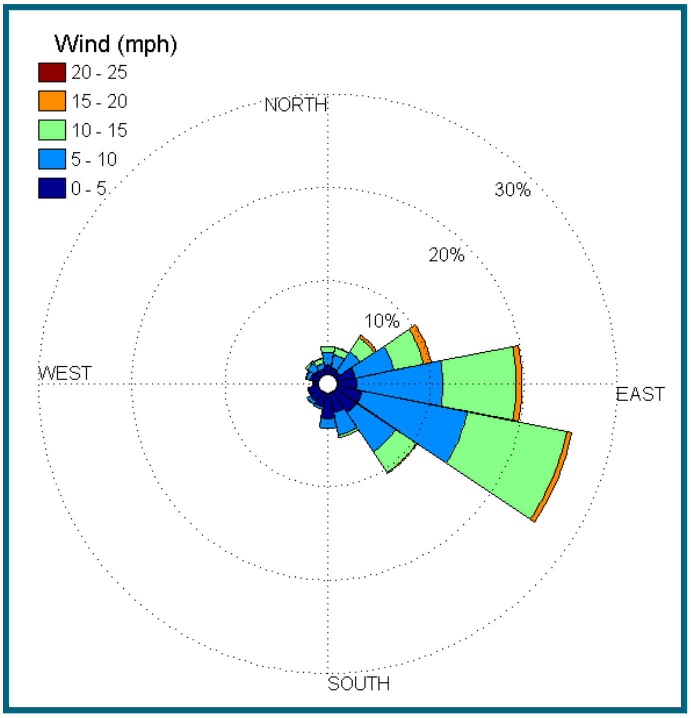
### *Figure 4-7 - Average Monthly Rainfall (1990-1997)*



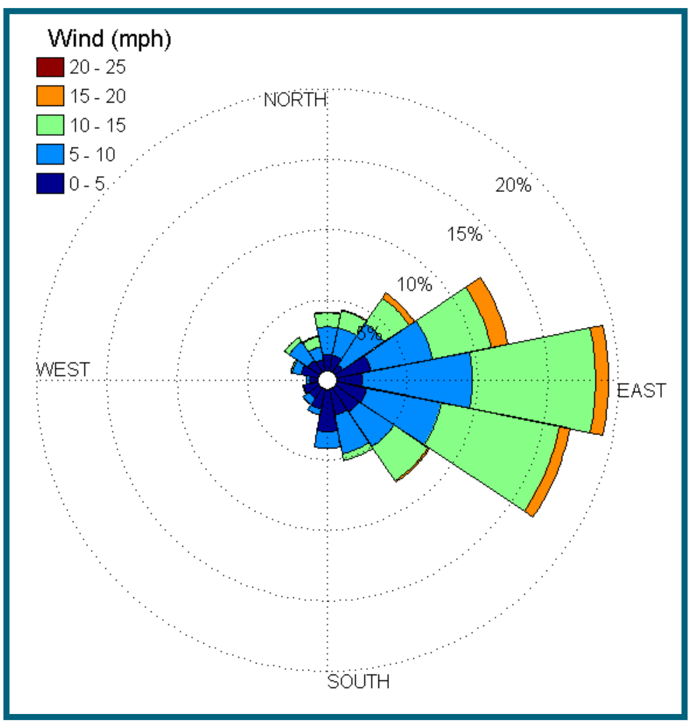

## 4.3.3 Winds

The prevailing winds at the site are primarily influenced by the easterly trade winds, although variations in wind patterns associated with tropical storms and/or frontal systems occur sporadically throughout the year. Average annual wind speed is approximately 8 miles per hour (mph) [3.6 meters per second (m/s)] over the data period. Average wind speeds are generally stronger in the winter (Figures 4-8 through 4-10) while extreme wind speeds generally occur during tropical storms (refer to Section 4.3.4 for more information).

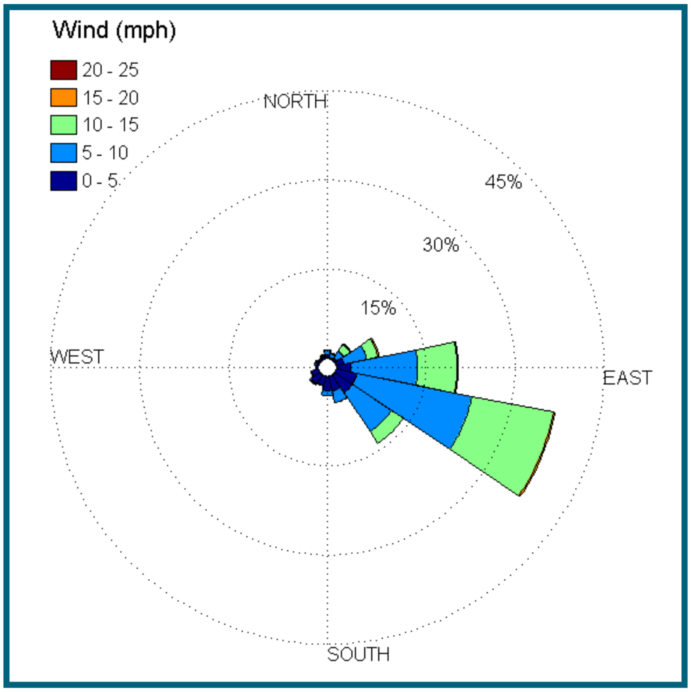
### *Figure 4-8 - Annual Wind Rose (1990-1997)*




### *Figure 4-9 - Wind Rose, November-May (1990-1997)*



### *Figure 4-10 - Wind Rose, June-October (1990-1997)*

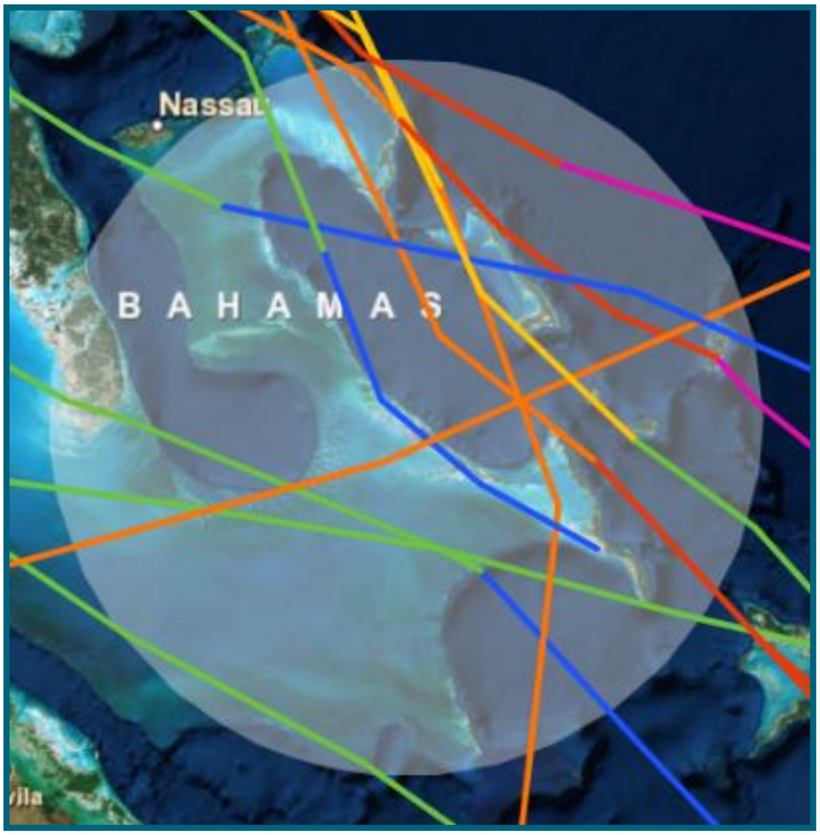



## 4.3.4 Storms

Children's Bay Cay is located within the Atlantic Tropical Cyclone basin. This basin includes much of the North Atlantic, Caribbean Sea and the Gulf of Mexico. On the average, six to eight tropical storms per year form within this basin. The formation of these storms, and possible intensification into mature hurricanes, occurs over warm tropical and subtropical waters. Eventual dissipation or modification, averaging 7 to 8 days later, typically occurs over the colder waters of the North Atlantic, or when the storms move over land and away from the sustaining marine environment.

Due to the destructive nature of these storms, landfall can result in significant damage to upland development and facilities from storm surge, waves and wind. Eleven tropical storms and hurricanes have passed within 100 miles of the project area over the past 30 seasons (from 1984 through 2014), as reported by the NOAA Coastal Services Center (Figure 4-11).

***Figure 4-11 - Hurricanes and Tropical Storms within 100 miles of Great Exuma (1984-2014)***




A recent storm of record is Hurricane Lili in 1996. This storm passed over Great Exuma as a Category 2 storm with 85-knot winds near the project site. This storm resulted in an estimated storm surge of 15 ft on parts of Great Exuma. In 2011, Hurricane Irene passed to the east of the project area as a Category 2 storm with sustained winds of up to 95 knots as it passed Great Exuma. This storm caused extensive damage throughout the Bahamas.

## 4.4 Geology

### 4.4.1 Regional Geology

As is the case of islands throughout the Bahamas, Children's Bay Cay is the result of shallow water deposited carbonate sediments building on the stable, but aseismically subsiding Great Bahama Bank. The shallow strata at Children's Bay Cay are anticipated to correlate with the Pliocene/Pleistocene age Lucayan Formation, that is comprised of a laterally discontinuous sequence of fossil coral and carbonate deposits (Ewbank Preece Limited, 1996). The carbonate/evaporitic sequences of the Bahamas are geologically young and have generally not been deformed, folded or faulted through regional tectonic forces. However, relatively small scale growth faults are commonly present in outcrop exposures such as the sea cliffs at Clifton, New Providence.

### 4.4.2 Seismology

Inasmuch as the Great Bahama Bank is located on the North American Plate and over 700 miles from the North American-Caribbean Plate boundary, it is usually thought of as being aseismic. The closest potential large-scale seismic source is most likely the North Hispaniola fault, located offshore of northern Dominican Republic, some 750 miles southeast of New Providence (Dixon et al., 1998) and the Septentrional fault, which is exposed within the Cordillera Septentrional of Hispaniola (Prentice et al., 1997). The Septentrional fault zone (SFZ) continues to the west of Hispaniola as a transform boundary comprised of a complex of left-lateral faults extending across the Caribbean Sea and into Central America. To the east of Hispaniola, the plate boundary is located within a transition zone between a subduction zone and a transform zone. The primary geologic structures associated with the transform zone to the east of Hispaniola and offshore of northern Puerto Rico are the North and South Puerto Rico Slope faults (Prentice et al., 1997).

Paleoseismology studies conducted by the U.S. Geological Survey (USGS) and cooperating universities indicated that the most recent earthquake that ruptured ground surface along the SFZ in the northern Dominican Republic occurred about 800 years ago. These studies were based on identifying and analyzing paleoliquefaction structures in shallow Holocene age alluvial deposits in the western and eastern Cibao Valley. In general, an earthquake of magnitude 5.5 to 6.0 is considered to be the threshold at which soils will undergo liquefaction. Under soil liquefaction conditions, soils become quick and lose their load-bearing capacity.

Analysis of global positioning system (GPS) measurements collected during 1986, 1994, and 1995 at various stations in the Dominican Republic, Puerto Rico, Cuba and Grand Turk Island provided an estimate of the velocity of the Caribbean Plate relative to the North American Plate. The data analyses indicated a relative motion of the Caribbean Plate toward the east at 21 ± 1 millimeter per year (mm/yr). The data were combined with elastic strain models to provide estimates of slip rates for major left lateral strike-slip faults on Hispaniola and environs. Slip along the North Hispaniola fault (offshore of the north coast of Hispaniola) was calculated to be 4 ± 3 mm/yr and 8 ± 3 mm/yr for the Septentrional fault, located onshore in northern Dominican Republic (Dixon et al., 1998). The authors concluded that the relatively high plate motion and the slip rates on the major left lateral strike-slip faults, strain accumulation, and historical seismicity may indicate an increased risk of moderate or larger earthquake occurrence in the northern Caribbean basin than prior estimates had predicted (Dixon et al., 1998). These data notwithstanding, seismic concerns relative to the Bahama Archipelago in general, and the project site specifically, are minimal.

### 4.4.3 Geomorphology

Children's Bay Cay is located proximal to a major submarine canyon (Exuma Sound). The dropoff or wall of the bank is situated several miles northeast of the project site. The average water depth within the Exuma Sound is approximately 6,500 ft.

The dominant geomorphology of Children's Bay Cay is karst landscape, typified by solutional features such as erosional vugs, caves and shafts, sink holes and dolines and solutionally enlarged joints and fractures within the surface and subsurface limestone country rock. The stability of the shoreline is and will continue to be a function of eustatic sea level rise, carbonate sediment supply and asymmetrical subsidence of the larger carbonate platform.

Children's Bay Cay and the surrounding cays are the emergent portion of the larger Great Bahama Bank carbonate platform. The interior of the larger carbonate platform is shallow and dissected by fringe reef, patch reef, intertidal shoals, and emergent island landforms. The emergent landform known as Children's Bay Cay is a cay composed of carbonate sand and a series of weathered limestone ridges. These topographic high, ridge features were formed by the solidification and partial solidification of carbonate sand dunes during the Pleistocene geologic time period of lower sea level. The carbonate sand was provided by the original and persistent carbonate reef system that has developed into the Great Bahama Bank carbonate platform.

### 4.4.4 Site Geology

The geology of Children's Bay Cay is all dominated by high topographic relief limestone that is partially overlain by a thin soil veneer. Exposed limerock (i.e., ironshore) is visible throughout much of the site, particularly in shoreline areas of exposed coastal rock. Sand beaches exist intermittently along the shoreline and significant soil exists in low areas. With the exception of areas mapped as sand strand community, the majority of the site has a notable absence of soil cover or, at most, a thin veneer. Organic topsoil occasionally accumulates within forested areas or seasonal wetland depressions, but the limestone typically lies just below the surface soil layer.

### 4.4.5 Hydrogeology and Water Resources

Hydrogeologic resources are not estimated to be significant on Children's Bay Cay, although the presence of several abandoned wells noted on the island suggests that a small freshwater lens may exist. It is likely that the salinity of waters in these wells varies considerably during different times of the year. As described more fully in the Section 4.8, observations of open-water and/or wetland vegetation at various landside areas on Children's Bay indicate the intermittent presence of surface water features of varying size and location.

For purposes of the proposed development, it is unlikely that freshwater resources are of a magnitude and degree of reliability that they could be adequate to serve the proposed development. Therefore, potable will be supplied to the project area through an offsite reverse osmosis water treatment plant.

### 4.4.6 Soils

Soils on Children's Bay Cay are dominantly composed of windblown and hydraulically deposited calcareous sand, silt and clay. These soils range from lagoonal, inter-tidal, supra-tidal and upland deposits, with moderate to low organic content. The upland soil, where it exists, is a very thin veneer over the underlying calcareous limestone. The upland soil has undergone only minor soil genesis and generally is not considered as significant. The humus content of the upland soil is minimal, and the shallow soil horizons lack significant trace elements and basic nutritional compounds (nitrogen, phosphorus and potassium) that would sustain traditional agriculture without considerable anthropogenic assistance.

### 4.4.7 Caves and Blue Holes

Several minor solution features were noted on Children's Bay Cay. No caves, blue holes or solution shafts of notable size were observed during the landside assessment.

### 4.4.8 Air Quality and Noise

No specific testing of air quality or noise was conducted. However, the island is currently undeveloped, with the exception of a single private residence and several temporary housing units powered by small diesel generators. No significant source of air pollution is known in the vicinity of the project site. Existing site management activities (e.g., diesel generators and solid waste management practices that involve occasional burning of combustible materials in a burn pit located near the marina basin) make minor contributions to degradation of existing air quality. The only sources of noise pollution on the island are the generators and reverse osmosis water treatment plant. The overall noise levels are likely low and commensurate with remote cays with established single-family residences.

## 4.5 Surface Waters

Children's Bay Cay is surrounded by the Exuma Sound on the northeastern side of the island and the shallower Grand Bahama Bank on the southwest side. Nearshore, on the Grand Bahama Bank side of the island, surface waters are generally shallow, with areas of exposed flats at low tide. These waters are fairly protected, and navigable waters generally range from 4 to 12 ft in the deeper waters outside of the flats. Adequate depths are available without dredging to accommodate smaller boat sizes. Currents are tidally driven and increase at both ends of the island, where the Grand Bahama Bank connects with Exuma Sound.

The Exuma Sound side of the island is marked by higher wave and stronger current conditions because it is on the windward side of the island and adjacent to the deep waters of Exuma Sound. The nearshore depths along the ironshore shoreline generally range from 3 to 10 ft. The depth gradually increases to more than several 1,000 ft within several miles of the shoreline.

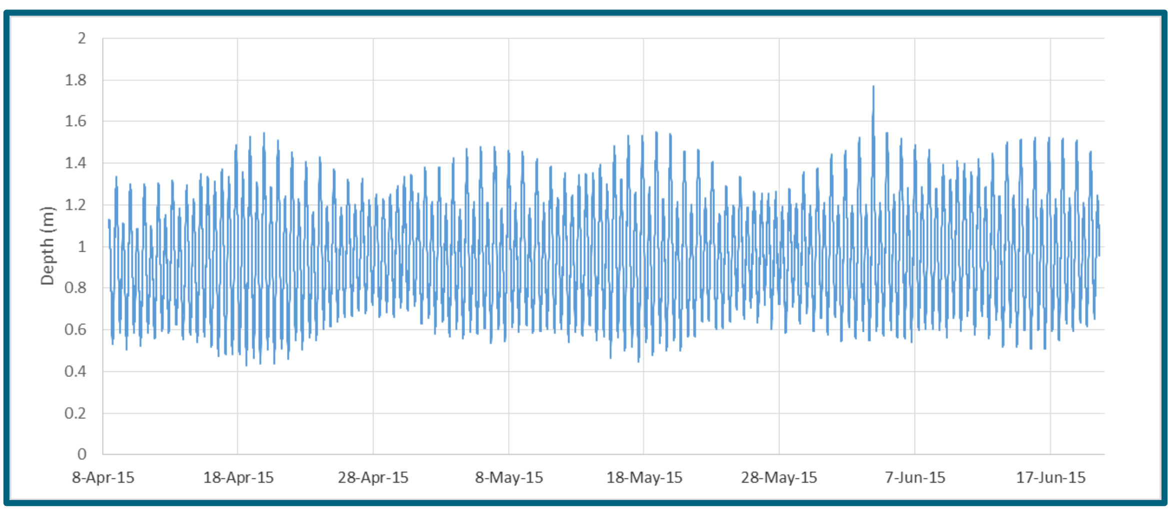
There are three isolated areas of surface water on the island, all of which are ephemeral, depending on tidal conditions and rainfall. The largest depressional area containing surface water on the island is the ephemeral pond located south of the Horseshoe Beach on the northeastern side of the island. This area is approximately 100 ft wide by 180 ft long and described in more detail in Section 4.8.11. Southwest of Goat Beach along the main access road is a depressional area measuring approximately 50 ft wide by 80 ft long. This area appears ephemeral as well and is described in more detail in Section 4.8.11. The third surface water feature on the island is the low area located inland of Party Camp Beach and extending across the main road. White and black mangroves dominate this area, with several strands of isolated red mangroves. There is no direct connection to area surface waters from any of these three features.

### 4.5.1 Water Levels and Circulation

The tides at Children's Bay Cay are semi-diurnal (12.42-hour period). A tide gauge was deployed at the project site at the main dock for more than 60 days. The resulting data are presented in Figure 4-12. Omitting an outlier on June 3, likely due to a storm event, the largest observed tide range was 3.6 ft. The smallest observed range recorded was 1.7 ft.

The currents around Children's Bay Cay vary widely and are predominantly wind driven in the coastal area, with additional influence from the tide range and the local geometry (i.e., depths and shoreline features). Near Children's Bay Cay, the tidally driven flood currents nominally move from Exuma Sound through the cut between Children's Bay Cay and Williams Cay and around the southwest tip of Children's Bay Cay. The surface currents also respond to the local wind forcing and can dominate the tidal currents at times. The predominant direction produced by the wind forcing is from the southeast in the summer months, reversing periodically to come from the northeast during the winter months.

***Figure 4-12 - Excerpted Relative Water Surface Elevations***



### 4.5.2 Water Quality

This area of the Bahamas is known for its extremely clear, nutrient-deficient, oligotrophic water. Overall water quality conditions in the waters surrounding Children's Bay Cay are very good, with no areas showing any significant degradation. Upland impacts to water quality are also minimal due to the Island's undeveloped nature as well as the undeveloped nature of adjacent islands. It is not anticipated that upland sources will contribute to water quality degradation within the area due to runoff or other sources.

## 4.6 Shoreline and Coastal Processes

### 4.6.1 Wave Climate

The prevailing wave conditions near Children's Bay Cay are representative of the prevailing wind direction and magnitude. The project area can also be impacted by waves resulting from tropical storms, hurricanes, frontal systems and other weather events with elevated wind conditions. As described in Section 4.3.3, the prevailing winds are from the east, and are influenced by the trade winds. Generally, the trade winds vary seasonably from the east-northeast to southeast directions, resulting in the southwest (leeward) side of the island being well protected from waves.

Children's Bay Cay is relatively well protected from distant storm swells due to sheltering effects from nearby islands including Andros, Eleuthera, Cat Island, Great Exuma, and Cuba. In addition to these larger islands, smaller nearby islands and cays also provide sheltering from wave events to varying degrees. Nonetheless, all shorelines are susceptible to wave energy, and any undesirable erosion will be mitigated in the future on a site-specific basis.

Figure 4-13 presents a British Admiralty Chart of Children's Bay Cay and adjacent islands. The northeastern shoreline is the most exposed to waves, as predominant easterly winds create consistent small to moderate wave energy conditions. The southwestern shoreline also has some exposure to wind waves, with approximately 6 miles (11 km) of open-water fetch extending to the Brigantine Cays. Note that wind conditions from the south are relatively infrequent; therefore, the southwestern leeward shoreline is exposed to a relatively low-energy wave climate, although susceptible to episodic storm conditions.

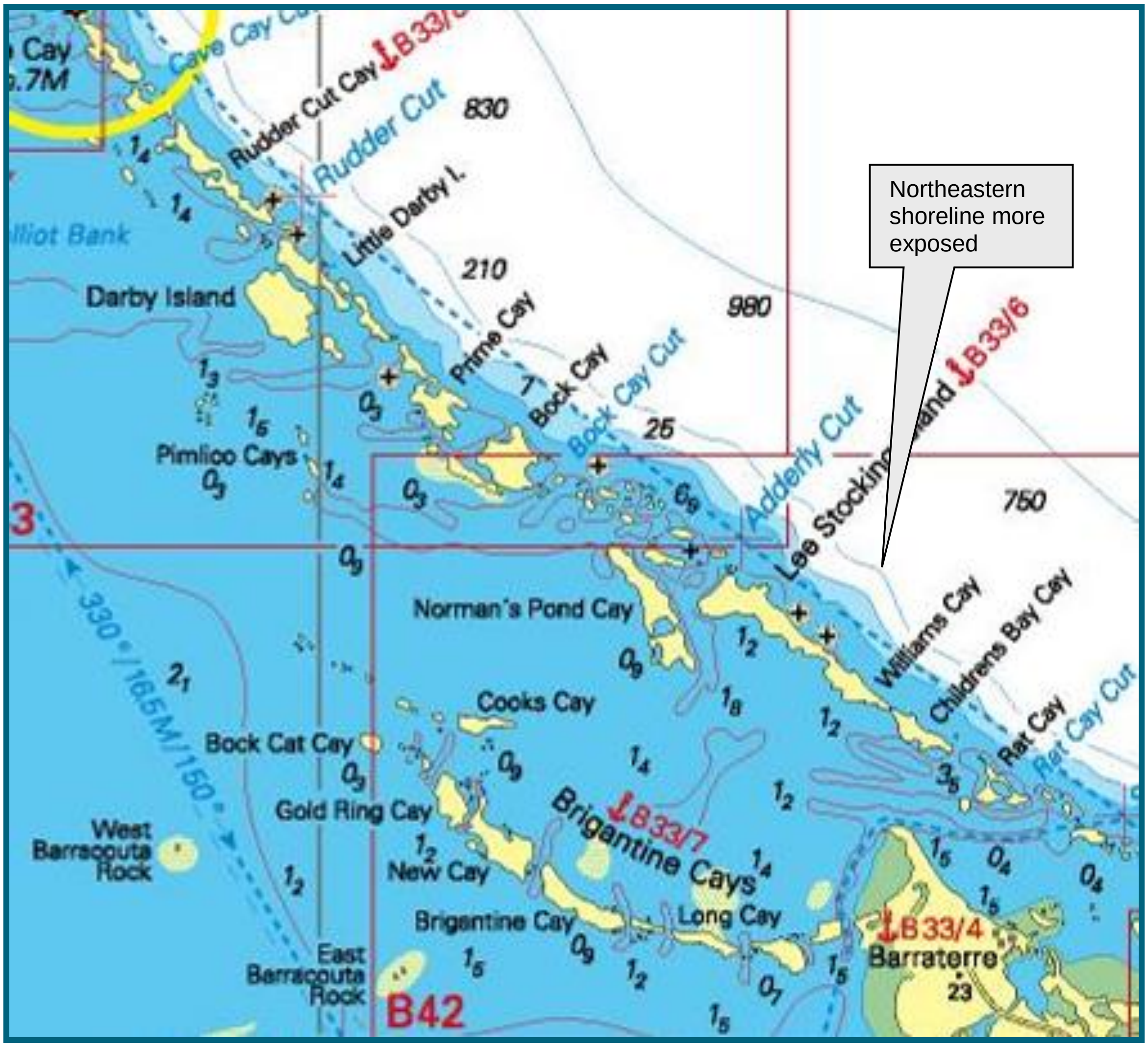
### 4.6.2 Shoreline Distribution

The shoreline features of Children's Bay Cay are dominated by ironshore rock, but also include isolated sandy beaches. The rocky portions of the shoreline generally have approximately 4 to 6 ft of relief above the mean high water (MHW) on the windward side of the island and 2 to 4 ft of relief on the leeward side of the island, although it is quite variable. Areas of mixed sand, rock and coral, with seagrasses, occur in the waters adjacent to the shoreline surrounding Children's Bay Cay, as well on the leeward side of the island.

The windward side of the island is dominated by ironshore, with two beach formations (Horseshoe Beach and Goat Beach). Horseshoe Beach is located within an eroded ironshore cove, while Goat Beach has a much shallower indentation into the shoreline. Given the location on Exuma Sound and prevailing easterly winds, there is little vegetative growth along the ironshore on this side of the island.

The leeward side of the island has an approximately 1,600-ft-long beach extending northwest from the marina basin. Southeast of the marina basin, the shoreline is characterized by a series of pocket beaches anchored between sections of ironshore. These beaches are generally in areas where a cove-like feature in the shoreline occurs.

### *Figure 4-13 - Children's Bay Cay Bathymetry from British Admiralty Chart*




## 4.6.3 Existing Coastal Processes

There is limited knowledge of the coastal processes at Children's Bay Cay. The shoreline is predominantly ironshore, with limited areas of significant deposits of sand, so conclusions cannot be drawn on island-wide coastal processes. However, a review of historical aerial photographs indicates that along the 1,600-ft-long beach on the leeward side of the island, there is generally a northwest-to-southwest component to the transport of sand. This is likely due to tidal currents emanating from the cut at Williams Cay.

Sand on both of the windward beaches is reported to be transient due to high current and wave conditions experienced on this side of the island. The beaches on the leeward side of the island are much more stable than the beaches on the windward side of the island.

## 4.7 Marine Ecology

Children's Bay Cay is a small, relatively undeveloped island, set in an Exumas location with high current flows and surrounded by a high-quality, highly biodiverse marine ecosystem. Without any intensive human development anywhere in the proximity and surrounded by Exuma Sound to the east and the Exuma Bank to the west, the nearshore area around Children's Bay Cay consists of extensive beds of submerged aquatic vegetation (SAV), sandy bottoms and coral reefs intermixed with hardbottom. Several aspects of proposed development activities have the potential to adversely affect the surrounding marine environment. These include both direct and indirect impacts from modifications of the existing marina, construction of over-water bungalows and construction of the BOH docking area. Less direct impacts, but equally important issues, are those impacts derived from land-based activities that can filter into the marine environment. These impacts may occur during the short-term construction phase or the longer-term operation of the island.

The first step in impact assessment is creation of a benthic habitat map that identifies and characterizes the benthic communities within the areas of potential project-related influence. This process allows for development of a site plan that can be based on avoidance and minimization of impacts to irreplaceable marine resources.

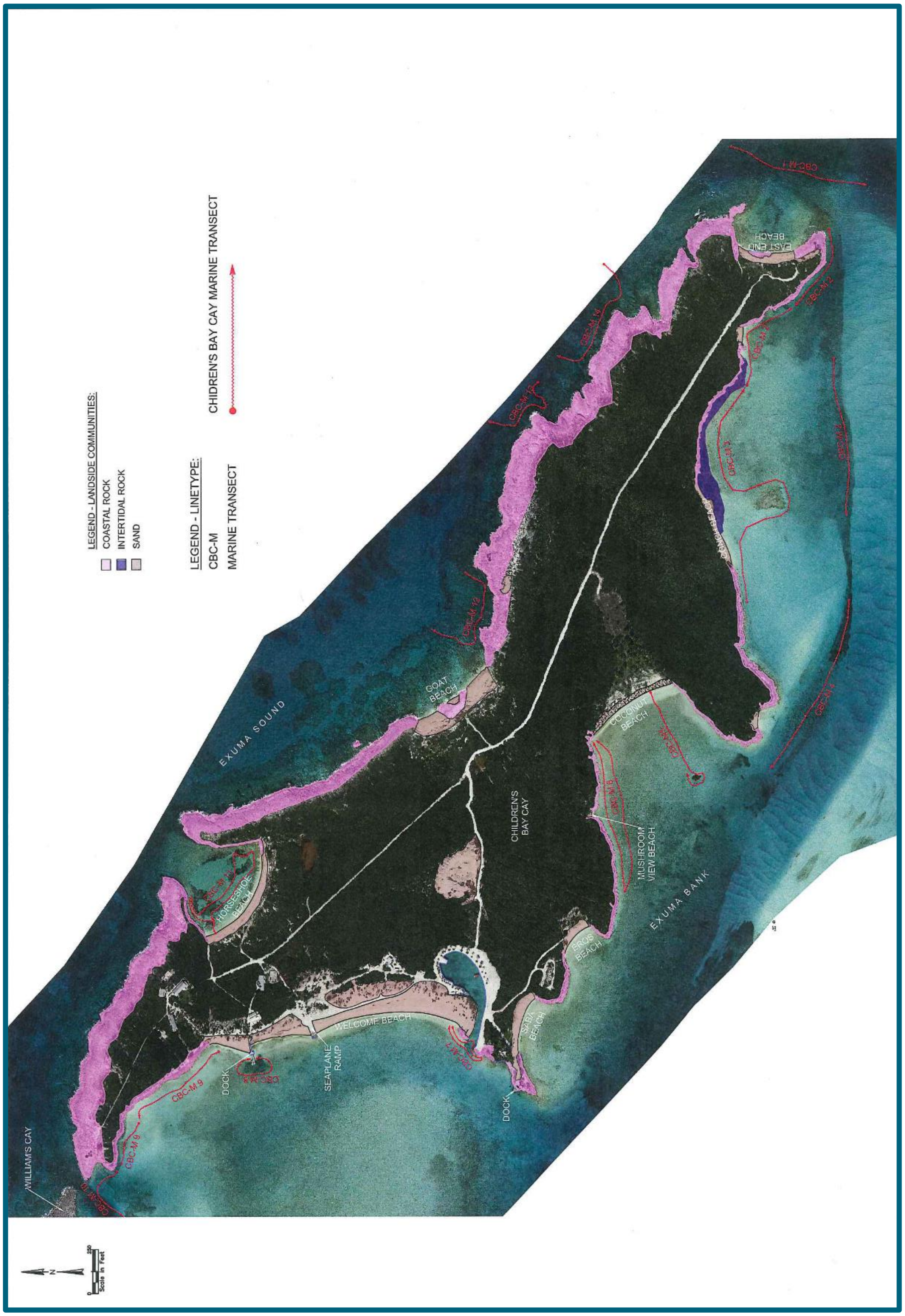
### 4.7.1 Data Acquisition and Methods

Prior to conducting field investigations, scientists from ATM acquired and performed a desktop analysis of recent (2014) aerial imagery of Children's Bay Cay. This analysis suggested the presence of a highly variable benthic ecosystem that would likely include: a) extensive areas of SAV on the west (Exuma Bank) side of the island; b) a mosaic of coral, hardbottom and sandy sea floor on the east (Exuma Sound) side of the island, and; c) unknown areas in the shoreline intertidal and subtidal zone.

Overlaying the conceptual plan for landside development onto the aerial photograph showing marine habitats indicated the need to assess conditions in 14 different areas to be able to determine potential future impacts. The location of these 14 marine investigation transects (numbered in consecutive order in a clockwise direction beginning at the southeast tip of the island) (Figure 4-14) include the following:

- CBC M-1 (i.e., Children's Bay Cay Marine-1): A shore-parallel transect at the southeast end of the island;
- CBC M-2: A shore-parallel transect that began in the intertidal rock community near the southeastern tip of the island and continued westward adjacent to Mouse Beach;
- CBC M-3: A shore-parallel transect that included apparent hardbottom areas and the intertidal rock community adjacent to Conch Beach;
- CBC M-4: Benthic habitats extending offshore from the proposed new marina area where a new navigation channel would be dredged;
- CBC M-5: A shore-perpendicular transect extending from Coconut Beach to Mushroom Rock;
- CBC M-6: A shore-parallel transect that included intertidal rock and benthic communities adjacent to Infant Beach and adjacent proposed villas;
- CBC M- 7: Benthic habitats in the vicinity of the existing marina, where an expansion of the marina could have an effect;
- CBC M-8: A shore-parallel transect in the vicinity of the existing dock along Welcome Beach;
- CBC M-9: A shore-parallel transect that included intertidal rock and nearshore benthic communities adjacent to proposed overwater villas;
- CBC M-10: Benthic habitats near the pass between Children's Bay Cay and Williams Cay;
- CBC M-11: Benthic habitats in Horseshoe Bay adjacent to proposed beachfront villas;
- CBC M-12: Nearshore benthic habitats adjacent to proposed development on Goat Beach;
- CBC M-13: Nearshore benthic habitats adjacent to the proposed development on the wide, heavily pounded coastal rock communities with a northeasterly exposure; and
- A circumnavigation of marine conditions around Windsock Cay.

## *Figure 4-14 - Marine Transects*



A three-person team consisting of two ATM scientists experienced in underwater assessments and the Children's Bay Cay island manager conducted reconnaissance mapping investigations of marine habitats surrounding Children's Bay Cay on several days during the week of April 6 to 10, 2015. The underwater investigations were conducted by snorkeling along current-swept drift transects through the 14 survey areas. Digital photographs of representative and/or notable conditions were taken using an Olympus Stylus 770 SW with a marine housing.

Approximate habitat boundaries were sketched on aerial photographs. Benthic habitats were described by assigning general habitat classifications, identifying dominant SAV, coral reef and hardbottom biota, and noting the general locations of dominant and ecologically significant coral reef species within the survey areas. Additional descriptive data included general rugosity and relief features of hardbottom and reef habitats and visual assessment of the health and condition of coral reef biota. Representative photographs were taken along each of the survey areas. Marine scientists reviewed these data and documentation to develop a marine benthic habitat classification system and identify marine flora and fauna.

Figure 4-15 shows marine benthic conditions extrapolated from the results of the 14 survey areas. In general, the lines separating benthic habitats should not be interpreted as discrete boundaries. In most areas, there were transition zones (e.g., seagrass grew amid hardbottom, macroalgae was present on coral outcrops, barren patches existed within beds of SAV etc.).

A list of the dominant stony corals, octocorals, SAV, fishes and other marine life observed within the 14 survey areas is included in Appendix A. This marine species list is not comprehensive of all marine benthic and fish species in these habitats, as survey methods did not include collection of quantitative data.

### 4.7.2 Description of the Existing Marine Environment

The following sections provide descriptions of the benthic habitats encountered within the 14 assessment areas around Children's Bay Cay. Due to the similarities encountered in some of the transects, the habitats are separated into five generalized categories:

1. Mixed hardbottom, corals and sandy bottoms on the island's east (Exuma Sound) side;
2. SAV and sandy bottoms on the island's west (Exuma Bank) side;

3. Soft coral garden;
4. Shoreline rock, and
5. Brown-algae dominated hardbottom.

The following subsections include descriptions of dominant floral and faunal species and the results of quantitative evaluations of each habitat.

#### 4.7.2.1 Mixed Hardbottom, Corals and Sandy Bottoms on the East (Exuma Sound) Side of the Island

The nearshore benthic community along most of the northeast facing shoreline of Children's Bay Cay consisted of a highly variable mosaic of coral-dominated hardbottom and algae-dominated hardbottom, with intermixed patches of sand. A more or less shore-parallel corridor of sandy patches intermixed with low-relief hardbottom was present approximately 300 to 500 ft offshore in water depths of 20 to 30 ft (Photo 4-1). Intermittent sea rods, reaching heights of 2 to 4 ft extended from low-relief hardbottom (Photo 4-2). Coral- and algae-dominated boulders occasionally extended upward in 3- to 5-ft outcrops (Photo 4-3).

## *Figure 4-15 – Shoreline Communities*

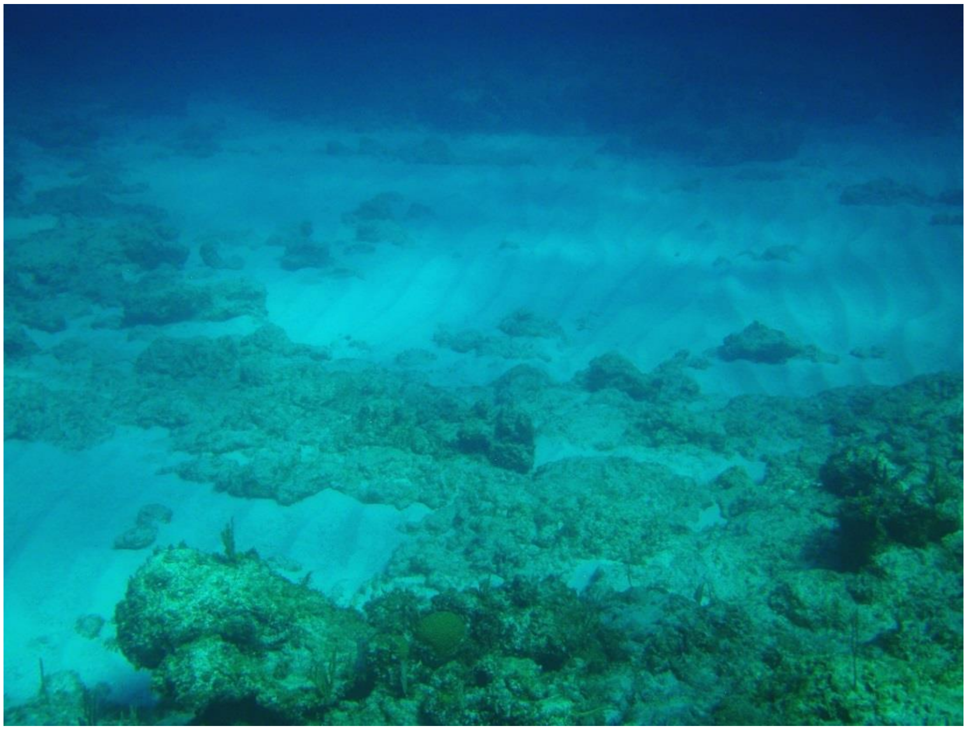


***Photo 4-1. Shore-Parallel Corridor of Sandy Patches and Low-Relief Hardbottom***

***Photo 4-2. Sea Rods on the Low-Relief Hardbottom***

***Photo 4-3. Coral- and Algae-Dominated Boulder***

As water depths decreased closer to shore, hardbottom became increasingly rugose, with sandy-bottom trenches occurring in a shore-perpendicular alignment between rising hardbottom in a spur-and-groove formation (Photo 4-4). Low-growing hard corals (e.g., brain corals, *Diploria* spp.) became increasingly common as proximity to shore increased, while soft corals, such as sea rods and sea fans, grew primarily in or adjacent to channels between the rocks (Photo 4-5).

Small pockets of loose rubble (Photo 4-6), likely deposited during rough sea conditions associated with tropical storms, hurricanes or large ground swells, were interspersed in the hardbottom, providing habitat for various juvenile reef fishes, including wrasses, squirrelfish, blue tangs and others.

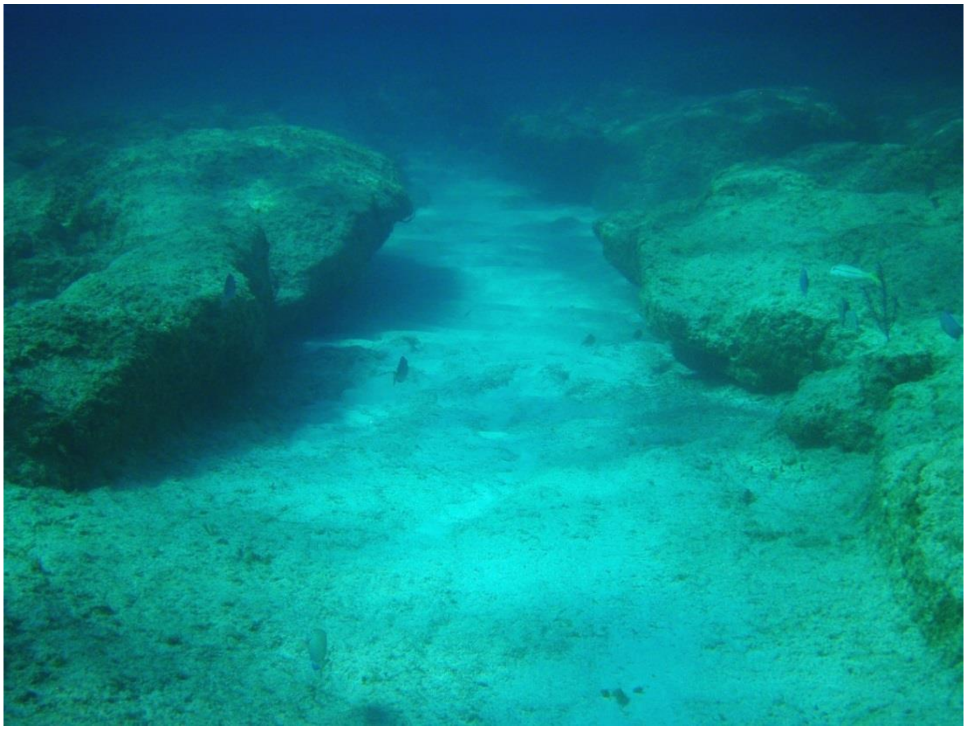


***Photo 4-4. Sandy-Bottom Trench between Rising Hardbottom***

***Photo 4-5. Soft Corals Growing In and Near Channel between the Rocks***

***Photo 4-6. Small Pocket of Loose Rubble***

Closer to shore, generally in water depths of 5 to 15 ft, hard corals, including blade fire coral (*Millepora complenata*) and sea fans (*Gorgonia ventalina*), became abundant (Photo 4-7). Most of the corals appeared to be in excellent condition, with no major signs of natural or human-influenced coral bleaching or disease.

Macroalgae were generally present in healthy abundances, but had colonized and become over-abundant in widely spaced areas where large brain corals (Photo 4-8) or sea fans (Photo 4-9) had likely been damaged by some previous trauma or impact.

One particularly notable assemblage was the benthic community within the somewhat-protected cove immediately offshore of Horseshoe Beach. Dense, healthy beds of turtle grass (*Thalassia testudinum*) were present in the comparatively well-protected shoreline areas (Photo 4-10). Fire corals (*Millepora alcicornis* – Photo 4-11), large brain corals (Photo 4-12), mustard hill coral (*Porites astreoides*) and others were fairly common in the reef areas that were protected from heavy sea swells.

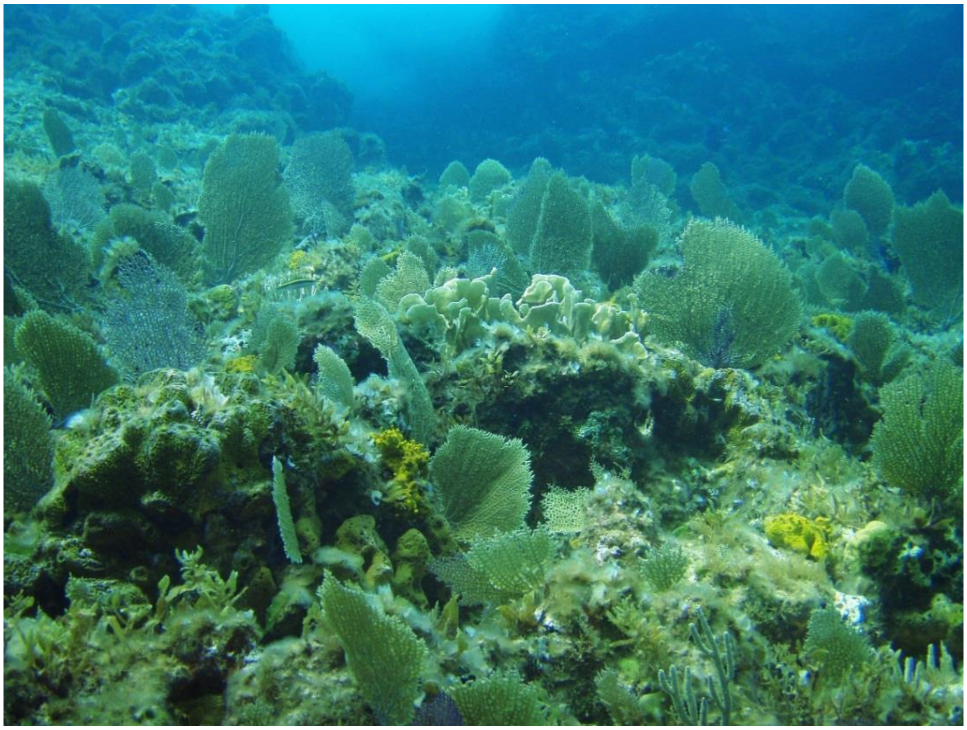


***Photo 4-7. Abundant Display of Hard Corals***

***Photo 4-8. Macroalgae Colonized on Damaged Area of Large Brain Coral***

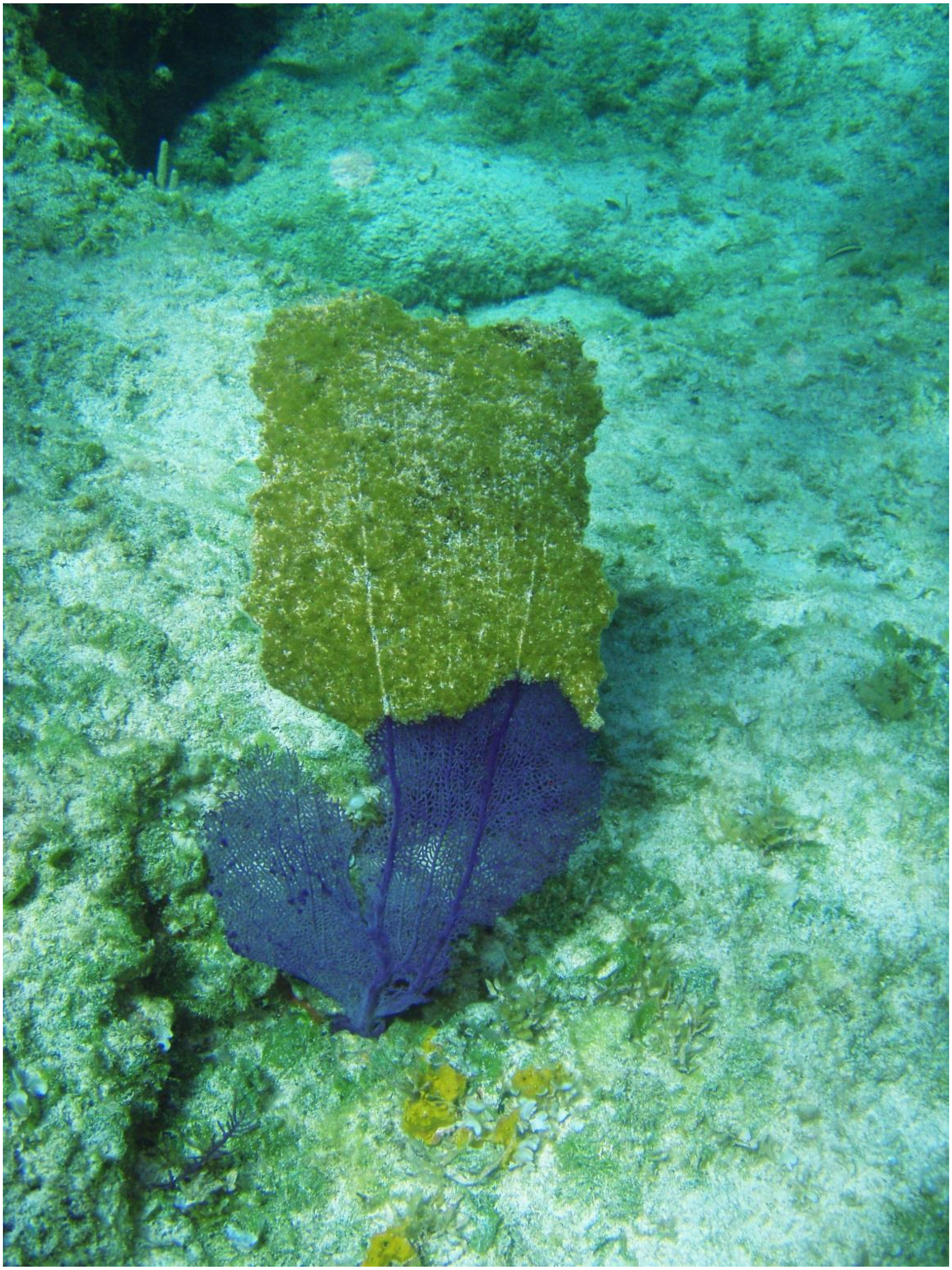


***Photo 4-9. Macroalgae Colonized on Damaged Area of Sea Fan***

***Photo 4-10. Dense, Healthy Turtle Grass Bed***

***Photo 4-11. Fire Coral***

**Photo 4-12. Large Brain Coral**

This was also the only location where the team observed elkhorn coral (*Acropora palmata*), a species that is designated by the International Union for the Conservation of Nature (IUCN) as endangered. Healthy Acropora colonies up to 2 ft in length (Photo 4-13) appeared to be re-establishing amid areas where skeletons of former elkhorn colonies were present.

Closer to shore on both flanks of the Horseshoe Beach reef were extensive colonies of finger coral (*Porites porites*) and calcareous red algae (e.g., *Neogoniolithon spectabile*) (Photo 4-14).

***Qualitative Condition***

Overall, the quality of this mosaic of benthic habitats was excellent. The reefs and hardbottom communities appeared healthy and consisted of floral and faunal populations typical of healthy reef fringes. No human-related debris (e.g., abandoned fishing nets) was observed, and the area did not appear to be adversely affected by any degradation of water quality. The occasional presence of damaged corals appeared to be related to intermittent rough sea conditions. The landward edge of the dense bed of turtle grass near Horseshoe Beach appeared to have been eroded by strong currents, creating a narrow band of exposed rhizomes.

***Photo 4-13. Acropora Colony***

***Photo 4-14. Finger Coral and Calcareous Red Algae***

#### 4.7.2.2 SAV-Dominated Sandy Bottoms on the West (Exuma Bank) Side of the Island

The majority of the benthic community along the western side of Children's Bay Cay was found to consist of SAV. Turtle grass was by far the most abundant species, covering extensive areas of sandy bottom in densities often more than 80 percent cover in lush grassbeds (Photo 4-15). Manatee grass (*Syringodium filiforme*) was intermittently present, sometimes in association with turtle grass, other times in monotypic, but less dense grassbeds (Photo 4-16). Juvenile and mature cushion sea stars (Photo 4-17), milk conch, queen conch (Photo 4-18), sea pens (*Pinna carnea*) and sting rays (*Dasyatis americana* (Photo 4-19) and *Urolophus jamaicensis*) of varying sizes were frequently seen in the beds of seagrass-dominated SAV. Green macroalgae, including *Halimeda incrassata*, *Rhipocepalus phoenix*, and various species of *Caulerpa* and *Udotea* were frequently intermixed with the dominant seagrasses. Areas where the cover of seagrasses was extremely high are specifically identified on Figure 4-15; in other areas of SAV, seagrass density varied from approximately 5 percent to 75 percent cover.

***Photo 4-15. Extensive Turtle Grass***

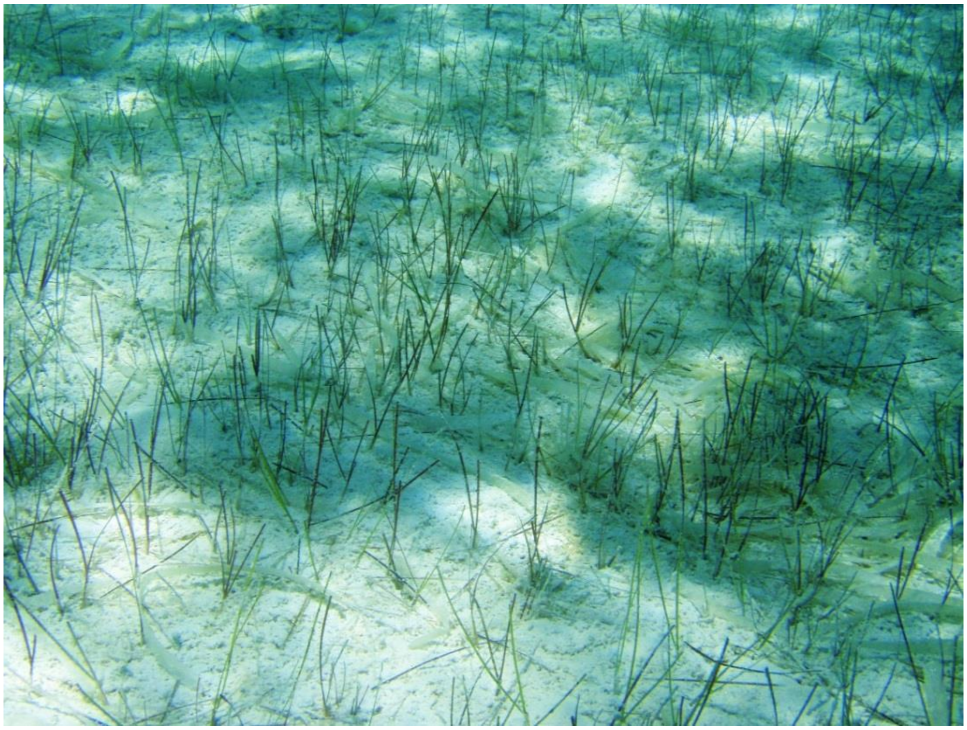


***Photo 4-16. Manatee grass***

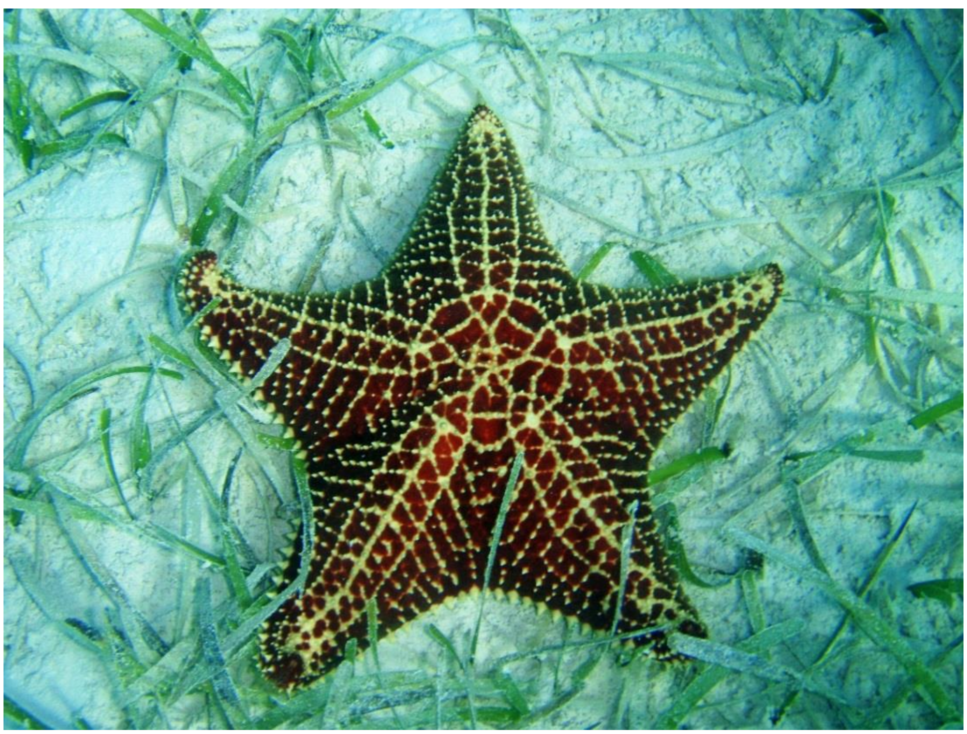


***Photo 4-17. Cushion Sea Star***

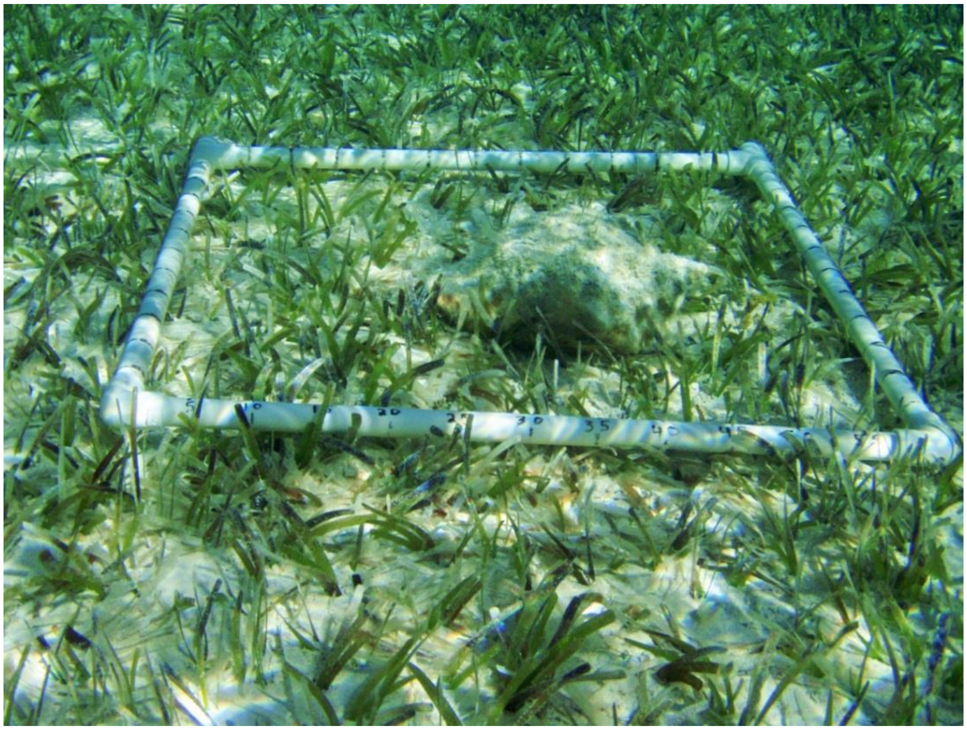


***Photo 4-18. Queen Conch***

***Photo 4-19. Sting Ray***

Seagrasses are an important food source for green sea turtles and provide critical habitat for many commercially and recreational important fishery species, such as conch and lobster. The beds of SAV along the south and west sides of Children's Bay Cay appear to provides valuable foraging habitat and refuge for fishes, queen conch and other marine life.

In areas designated as SAV where the thickness of the sand substrate was thinner or nearly non-existent, hardbottom was covered by macroalgae. Various brown algae (Phaeophyta) were common, occasionally reaching densities in excess of 75 percent cover (Photos 4-20 and 4-21). Occasionally, low-profile hard corals (e.g., finger coral – Photo 4-22), young rose corals (*Manicina areolata* - Photo 4-23) and black-ball sponges (*Ircinia strobilina*) were present amid the seagrasses and/or macroalgae. Often these small corals were present in areas near more extensive coral colonies, suggesting that they may have broken off from larger assemblages during storm events but were able to survive in less-than-ideal conditions.

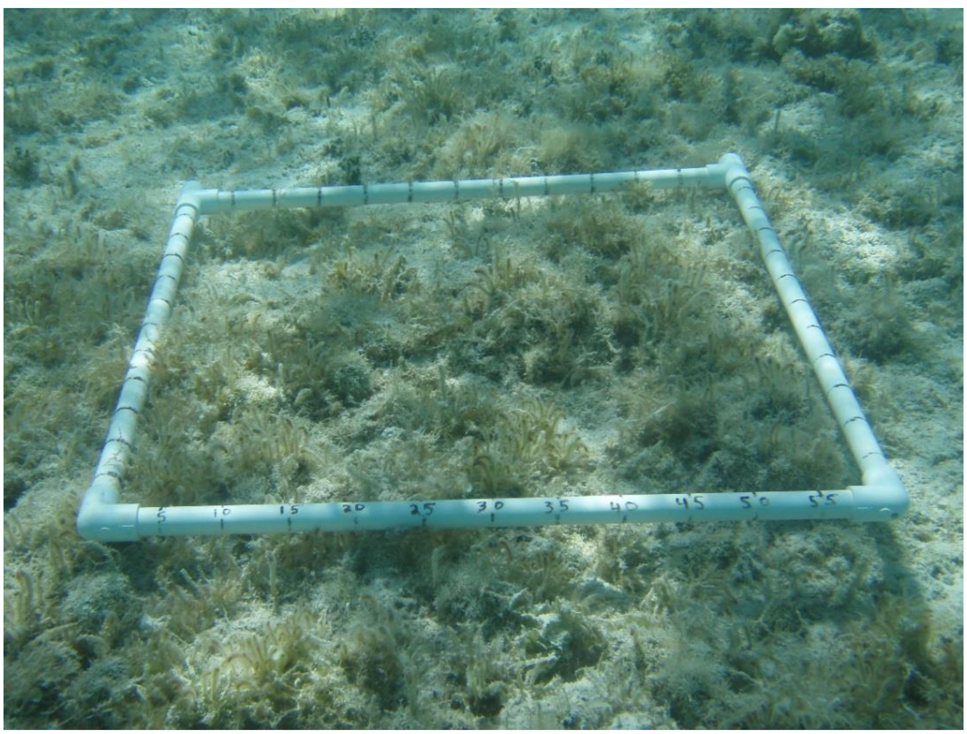



***Photo 4-20. Dense Bed of Brown Algae***

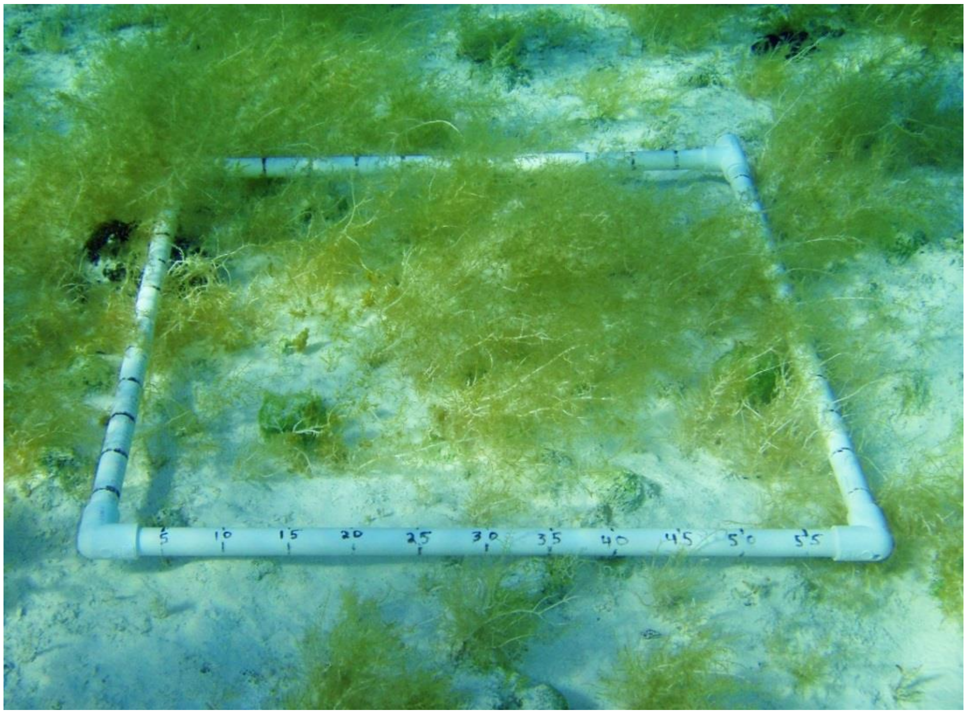


***Photo 4-21. Brown Algae Bed***

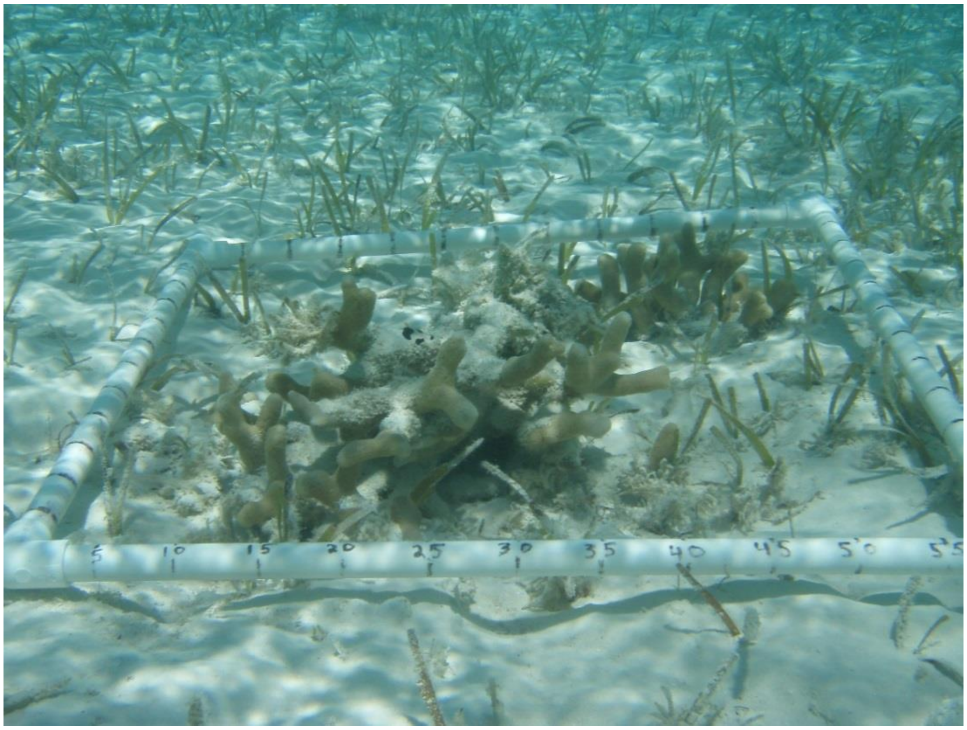


***Photo 4-22. Low-Profile Finger Coral***

***Photo 4-23. Young Rose Coral***

Juvenile reef-fish, including wrasses, rays and barracudas, were common in the grassbeds. Conical mounds indicating the presence of interstitial marine invertebrates (e.g., southern lugworms – *Arenicola cristata*) were present in areas where the SAV beds were the least dense and the currents least strong.

**Qualitative Condition**

Overall, the quality of these SAV beds was excellent. They appeared healthy and consisted of floral and faunal populations typical of healthy grassbeds. No human-related impacts (e.g., abandoned fishing nets, debris, propeller scars) were observed, and the area did not appear to be adversely affected by any degradation of water quality. The occasional presence of damaged corals along the edges of the SAV beds appeared to be related to intermittent rough sea conditions.

#### 4.7.2.3 Soft Coral Garden

One notable feature amid the grassbed-dominated southwest side of the island was a soft coral garden (See Figure 4-15). Bounded by dense seagrass areas to the east and west, sparse SAV to the north, and mostly barren sand to the south, this approximately 2.3-acre area was composed of a variety of soft corals, like sea rods (e.g., *Plexaura flexuosa*, *P. homomalia*) and sea plumes (*Pseudopterogorgia* sp.), many of which were 4 to 5 ft in height. Along the edges, coral colonies were somewhat sparse (e.g., Photo 4-24), but density and biodiversity increased substantially in interior areas (Photo 4-25). Water depths in this area were similar to adjacent areas (i.e., 15 to 20 ft), and no explanation was apparent for the presence of this atypical feature, which was not observed anywhere else during the marine investigation.

***Photo 4-24. Edge of Soft Coral Garden Displaying Lower Colony Density and Biodiversity***

***Photo 4-25. Density and Biodiversity in Interior Area of Soft Coral Garden***

**Qualitative Condition**

The quality of this one soft coral garden was excellent. It appeared healthy and consisted of floral and faunal populations typical of this habitat. No human-related impacts (e.g., abandoned fish traps, debris, and propeller wash holes) were observed, and the area did not appear to be adversely affected by any degradation of water quality. The water in this area was deep enough and the location was sheltered enough that it showed no effects of intermittent rough sea conditions that were evident in other marine investigation areas.

#### 4.7.2.4 Shoreline Rock

In a narrow band located under the over-hanging coastal rock all along the western shoreline, intertidal and subtidal rock provided habitat for a variety of corals, anemones, sea urchins and other marine life that require a hard substrate. The band of this habitat is too narrow (typically less than 6 to 8 ft) to be visible on the marine habitat map Figure 4-15.

Above or near the water line, bleeding tooth nerites (*Nerita peloronta*), chitons (*Acanthopleura granulata*), and beaded periwinkles (*Tectarius muricatus*) were common. Brown algae (e.g., *Turbinaria turbinata* and *Dictyota* spp.) and sponges (Demospongiae – Photo 4-26) were often observed attached to the rock substrate. The abundance of these organisms attracted various grazing invertebrates, including rock boring urchins (*Echinometra lucunter*), West Indian sea egg urchins (*Tripneustes ventricosus*), long-spined urchins (*Diadema antillarum* - Photo 4-27) and variegated urchins (*Lytechinus variegatus*) (Photo 4-28). The areas that had the highest water flows (e.g., at the southeastern and northwestern tips of Children's Bay Cay and around Windsock Cay) appeared to have the highest densities of corals and marine life. Areas where flow was less had reduced coral, sponge and marine life densities.

**Qualitative Condition**

The quality of this shoreline rock community was excellent. It appeared healthy and consisted of floral and faunal populations typical of this habitat and likely serves as a nursery area for juvenile reef fishes and lobster. No human-related impacts (e.g., abandoned fishing nets, debris) were observed and the area did not appear to be adversely affected by any degradation of water quality.

***Photo 4-26. Sponges Attached to the Rock Substrate near the Water Line***

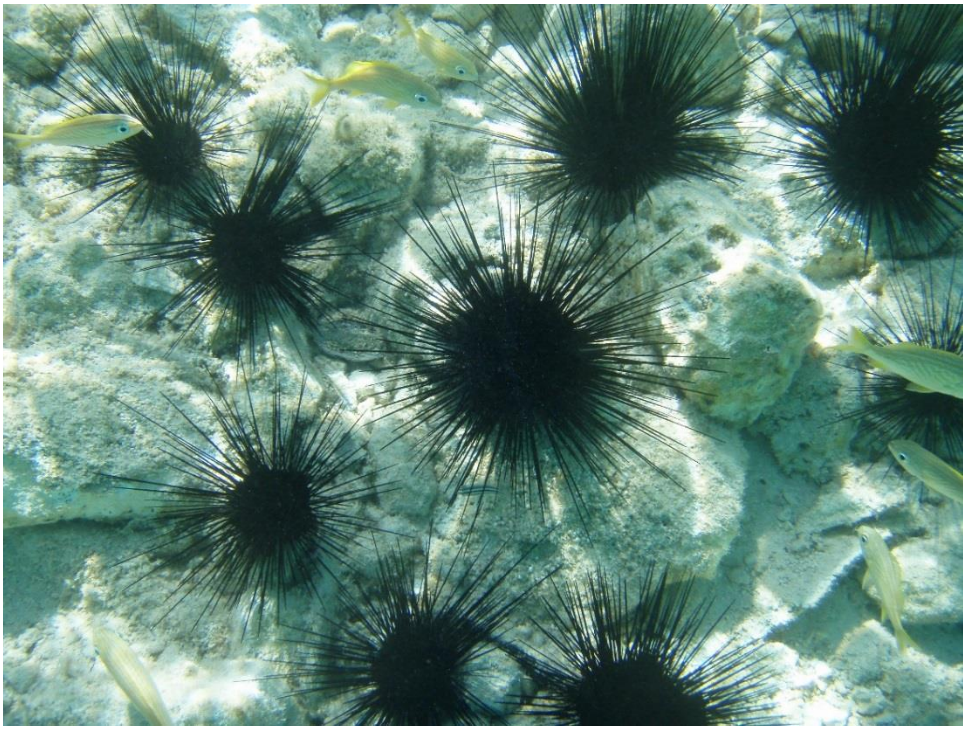


***Photo 4-27.  Long-Spined Urchins near the Water Line***

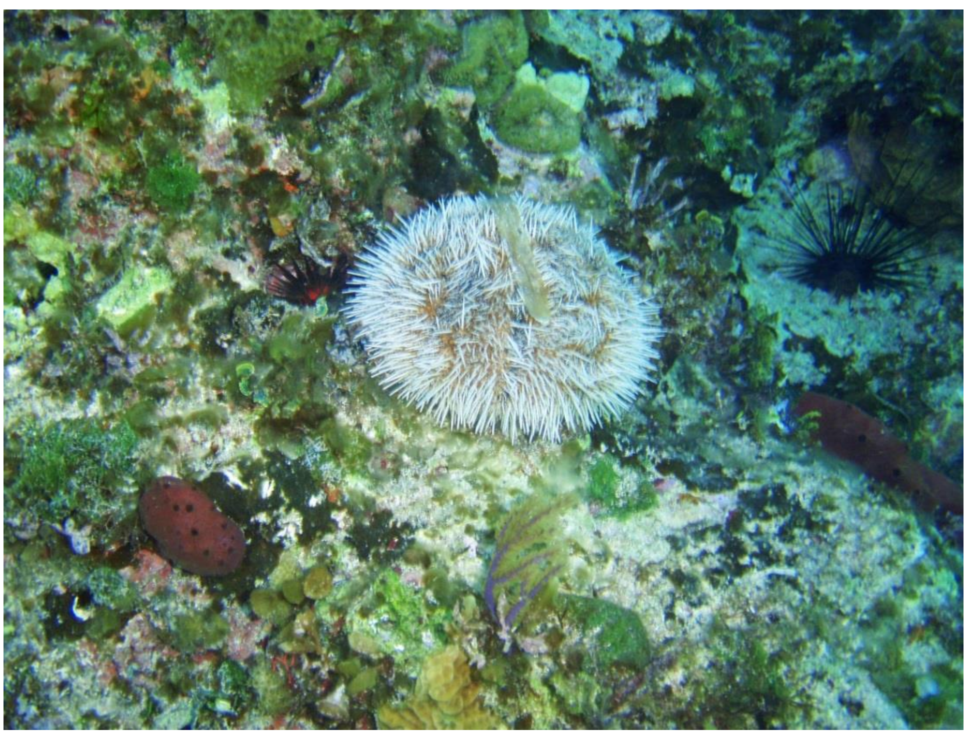


***Photo 4-28.  Variegated Urchin near the Water Line***

Occasionally, large pieces of the previously overhanging rock had broken off and fallen to the sea floor, likely as the direct result of rough sea and wave conditions. The variation in habitat and relief in these areas provided edge-effect habitat benefits, and were often a nucleus of fish density and marine life (Photo 4-29).

***Photo 4-29. Habitat for Marine Life Where Overhanging Rock Has Fallen to the Sea Floor***

### 4.7.2.5 Brown-Algae Dominated Hardbottom

Although sea conditions were too rough for a nearshore investigation to be safely conducted at the southeastern tip of Children's Bay Cay, the offshore location of CBC M-1 revealed the substrate to be covered by a dense growth of *Sargassum*. A strong southerly flowing current laid over the long growths of *Sargassum*, making it appear as an underwater lawn (Photo 4-30). Although *Sargassum* was present in other areas, on both the eastern and western sides of Children's Bay Cay, this area was notable in both its density of *Sargassum* and expansive monoculture, which is likely the result of a variety of criteria, including water depths, current and substrate.

***Photo 4-30. Strong Southerly Flowing Current in Long Growths of Sargassum***

**Qualitative Condition**

The quality of this *Sargassum*-dominated community was excellent. It appeared healthy and consisted of floral and faunal populations typical of this habitat and may serve to hold shifting sandy sediments and as a nursery area for juvenile reef fishes. No human-related impacts (e.g., abandoned fish traps, propeller scars) were observed, and the area did not appear to be adversely affected by any degradation of water quality.

## 4.8 Terrestrial Ecology

Children's Bay Cay is a typical example of a small, almost undeveloped, island in the Exumas chain; having relatively low topographic relief and being densely vegetated with the dry broad-leaved evergreen coppice that is so common throughout the Bahamas archipelago. Like similar islands lying alongside the western edge of the Exuma Sound and exposed to the trade winds blowing from the east, Children's Bay Cay has both a distinct windward side, with a rocky, high-energy shoreline and wind and salt-spray pruned vegetation, as well as a leeward side with intermittent, wide, gently sloping pocket beaches. Two intermittently flooded salt ponds are the only surface waterbodies.

Privately owned for many decades and generally used as a residential retreat, the island's several owners have collectively cleared or developed only a small fraction of the island. Existing development is limited and includes some scattered buildings (some still in use and some abandoned), several long-abandoned concrete-lined water storage tanks, two small docks, a marina basin, and a single unpaved roadway running much of the length of the island. Accordingly, much of the dense coppice vegetation remains undisturbed.

The proposed resort will require selective clearing for additional roadways, building footprints, and utility installation; however, most of the coppice vegetation will remain. Potential construction-related impacts, most notably stormwater management for erosion and turbidity control, will require consideration, especially since these can cause runoff to the marine environment. Post-construction secondary impacts from waste disposal may also affect the marine environment and are included in the impact analyses.

The first step for the terrestrial habitat assessment is creation of a vegetative cover and land cover-land use map that identifies and characterizes the island's terrestrial features. This map can guide the site planning process to avoid and minimize impacts to sensitive areas.

### 4.8.1 Data Acquisition and Methods

ATM conducted field surveys to characterize Children's Bay Cay terrestrial flora and fauna during April 2015. Plant community types, as well as other land cover and land uses, were characterized, and observations were made about the presence of birds and other animal species. While the late spring season was not optimal for conducting breeding bird surveys, the potential for protected plants and animal species to occur on Children's Bay Cay, particularly birds during migration, was addressed.

Vegetative assessments were conducted April 6 through 11, 2015. The field methodology consisted of inspections around the perimeter of the island and along roads and footpaths. The field reconnaissance was guided by high-resolution color aerial photography dated June 2014. Areas discerned on the aerial photographs as discrete signatures were located in the field and inspected. Based on these field inspections, boundaries for each cover type were delineated to produce a comprehensive land cover map for Children's Bay Cay (Figure 4-16). Observations were recorded of plant and animal species encountered, and, where necessary, GPS coordinates were recorded at edges of transition zones and/or at other notable locations. In addition, the entire island shoreline was inspected either on foot or from a boat.

Vegetation was identified to species whenever possible. Approximately 142 vascular plant species were recorded within the various plant communities on Children's Bay Cay. A list of the plant species observed is included as Appendix B. Vegetative community classification follows *A Guide to Caribbean Vegetation Types: Preliminary Classification Systems and Descriptions* (Areces-Mallea, et al., 1999) and Flora of the Bahama Archipelago (Correll and Correll, 1982). Vegetative communities and other land cover and land uses are inventoried and quantified in Table 4-1, which also provides the areal extent for each.

During the vegetation survey and habitat mapping, observations of terrestrial animals were also recorded. Most often these observations were of birds, including passerines and shorebirds, but also included four kinds of crabs, several snails, and several reptiles and amphibians. A list of animals observed and identified on Children's Bay Cay is included as Appendix B.

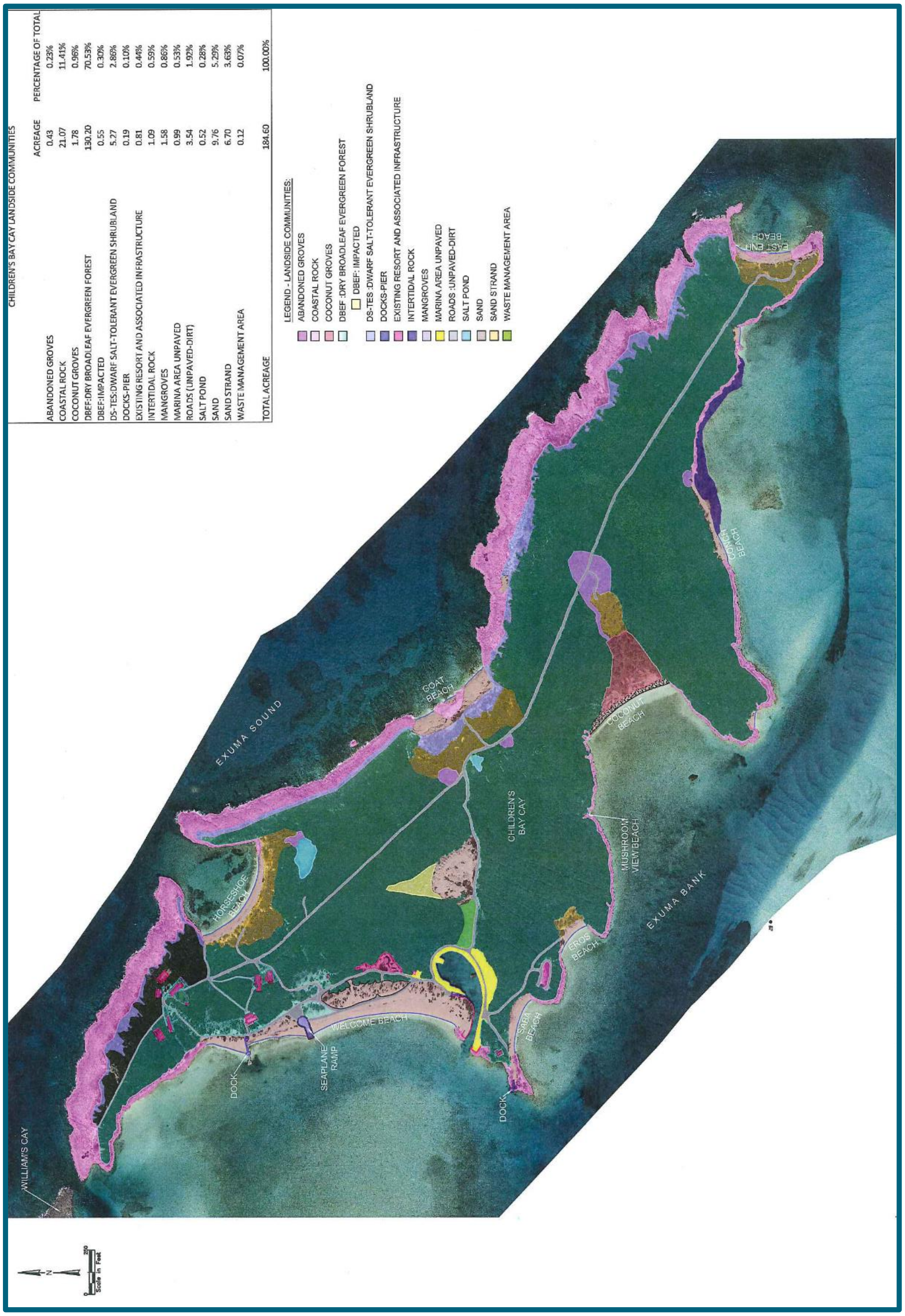
### Description of the Existing Terrestrial Environment

The following sections provide descriptions of the terrestrial vegetative habitats, land cover, and land uses identified on Children's Bay Cay. Figure 4-16 provides the vegetation and land cover map developed for Children's Bay Cay. Mapping units are keyed to the various cover types listed in Table 4-1. The following sections provide descriptions for each land cover and land use type.

### 4.8.2 Dry Broad-Leaved Evergreen Forest (DBEF)

Dry Broad-Leaved Evergreen Forest (DBEF) dominated the Children's Bay Cay vegetative cover, covering more than 70 percent of the island. DBEF consisted of dense forest canopy with a diverse tree assemblage. Except in areas where it abutted disturbed areas, the DBEF community typically began at the landward edge of the Coastal Rock, Dwarf Salt-Tolerant Evergreen Shrubland, or Sand Strand (all described in the following sections) and continued upslope to the height of the land, dominating most interior areas protected from wind and salt spray.

## *Figure 4-16 – Landside Communities*




CHILDREN'S BAY CAY LANDSIDE COMMUNITIES

| | ACREAGE | PERCENTAGE OF TOTAL |
|---|---|---|
| ABANDONED GROVES | 0.43 | 0.23% |
| COASTAL ROCK | 21.07 | 11.41% |
| COCONUT GROVES | 1.78 | 0.96% |
| DBEF:DRY BROADLEAF EVERGREEN FOREST | 130.20 | 70.53% |
| DBEF:IMPACTED | 0.55 | 0.30% |
| DS-TES:DWARF SALT-TOLERANT EVERGREEN SHRUBLAND | 5.27 | 2.86% |
| DOCKS-PIER | 0.19 | 0.10% |
| EXISTING RESORT AND ASSOCIATED INFRASTRUCTURE | 0.81 | 0.44% |
| INTERTIDAL ROCK | 1.09 | 0.59% |
| MANGROVES | 1.58 | 0.86% |
| MARINA AREA UNPAVED | 0.99 | 0.53% |
| ROADS (UNPAVED-DIRT) | 3.54 | 1.92% |
| SALT POND | 0.52 | 0.28% |
| SAND | 9.76 | 5.29% |
| SAND STRAND | 6.70 | 3.63% |
| WASTE MANAGEMENT AREA | 0.12 | 0.07% |
| TOTAL ACREAGE | 184.60 | 100.00% |

**Table 4-1 - Children's Bay Cay Vegetative Communities and Land Cover/Land Use Types**

| Vegetative Community or Land Cover/Land Use Type | Code | Areal Extent | |
|---|---|---|---|
| | | **Acres** | **Percent Total** |
| **Vegetative Community or Natural Land Cover** | | | |
| Dry Broad-Leaved Evergreen Forest | DBEF | 130.82 | 71.30 |
| Coastal Rock | CR | 21.73 | 11.84 |
| Sand (Beach) | SAND | 9.76 | 5.32 |
| Sand Strand (Dune) | SS | 6.65 | 3.62 |
| Dwarf Salt-Tolerant Evergreen Shrubland | DS-TES | 4.59 | 2.50 |
| Mangrove | M | 1.52 | 0.83 |
| Coconut Grove | CG | 1.26 | 0.69 |
| DBEF - Impacted | DBEF-i | 0.55 | 0.30 |
| Salt Pond | SP | 0.52 | 0.28 |
| | Subtotal | 177.40 ac | 96.69 |
| **Existing Development-Related Land Cover and Land Uses** | | | |
| Roads (unpaved/dirt) | | 3.54 | 1.93 |
| Marina Area Unpaved | | 0.99 | 0.54 |
| Existing Buildings and Associated Infrastructure | | 0.81 | 0.44 |
| Abandoned Groves | | 0.43 | 0.23 |
| Docks/Piers | | 0.19 | 0.10 |
| Waste Management Area | | 0.12 | 0.07 |
| | Subtotal | 6.08 ac | 3.31 |
| | **Total** | **183.48 ac** | **100.00** |

Tree diameters were generally small [less than 4 inches diameter at breast height (dbh)], but of substantial density and many trees have multiple trunks. Although tree stature was generally short (10 to 15 ft tall) the trees grew in such high density that their crowns coalesced into a dense canopy that generally limited the understory. Despite the limited understory, the high density of tree trunks and interlocking branches generally made the DBEF impassible to casual walking. A view of typical DBEF canopy on Children's Bay Cay is shown on Photo 4-31.

Common tree and shrub species within the DBEF included cinnecord (*Acacia choriophylla*), numerous poisonwood (*Metopium toxiferum*), pigeon-plum (*Coccoloba diversifolia*), sea grape (*Coccoloba uvifera*), Yellow-wood (*Zanthoxylum flavum*), abundant seven-year apple (*Casasia clusiifolia*), wild dilly (*Manilkara bahamensis*), black bead (*Pithecellobium keyense*), and silver thatch palm (*Coccothrinax argentata*). Gum elemi (also known as Gumbo limbo) (*Bursera simaruba*) and Century plants (*Agave* sp.) were also occasionally present.

***Photo 4-31. Overlooking Typical DBEF Canopy on Children's Bay Cay***

Lignum vitae (*Guaiacum sanctum*) (Photo 4-32) and narrow-leaved blolly (*Guapira discolor*) were also occasionally present within the DBEF on Children's Bay Cay. These two tree species are protected by law under the *Conservation & Protection of the Physical Landscape of The Bahamas Act.* No other protected tree species were found.

Tree trunks and branches within the DBEF occasionally hosted specimens of the air plant swollen wild pine (*Tillandsia utriculata*) (Photo 4-33) and orchids (*Encyclia* sp. – possibly *rufa*) (Photo 4-34). Very occasionally, queen of the night cactus (*Cereus* sp.) were observed within the DBEF draped across tree branches and trailing vine-like across the ground (Photo 4-35). Other cactus occasionally found were prickly pear (*Opuntia* sp.) and old man cactus (*Cephalocereus millspaughii*).

Soils within the DBEF were poorly developed and typically included a thin peat layer over the underlying limestone. The DBEF was consistent with the Blackland community type classification of Correll and Correll (1982).

***Photo 4-32. Lignum vitae on Children's Bay Cay***

***Photo 4-33. Tillandsia utriculata within DBEF***

***Photo 4-34. Encyclia sp. – possibly rufa within DBEF***

***Photo 4-35. Queen of the Night Cactus (Cereus sp.) within DBEF***

The bananaquit (*Coerba flaveola*) (Photo 4-36) and the thick-billed vireo (*Vireo crassirostris*) were the most common bird species observed within the DBEF community. Other birds occasionally observed were the Bahama mockingbird (*Mimus gundlachii*), prairie warbler (*Dendroica discolor*) and Greater Antillean bullfinch (*Loxigilla violacea violacea*) (Photo 4-37). The Bahamas woodstar hummingbird (*Calliphlox evelynae*) and white-crowned pigeon (*Columba leucocephala*) were also noted. The white-crowned pigeon was said to nest on the smaller cays offshore from Children's Bay Cay, but visited Children's Bay Cay to forage on berries from poisonwood and/or gum elemi trees.

Other animal species noted within the DBEF community included the peanut snail (*Cerion* sp.), the curly-tailed lizard (*Leiocephalus carinatus oryi*), and, as evidenced by a shed skin, the Bahama boa (*Epicrates striatus strigulatus*).

Overall, the DBEF community on Children's Bay Cay appeared to be very good quality, with human impacts restricted to the very limited development areas. Although densely growing, the overall tree size, in terms of both trunk diameters and overall height, was limited by the thin soil veneer over the limestone substrate, conditions that limit both soil fertility and water retention.

***Photo 4-36. Bananaquit (Coerba flaveola) within DBEF***

***Photo 4-37. Greater Antillean Bullfinch (Loxigilla violacea violacea) within DBEF***

### 4.8.3 Coastal Rock (CR)

Nearly the entire perimeter of Children's Bay Cay consisted of a coastal rock environment, also known as ironshore, composed of bare, exposed limestone. Photo 4-38 provides a photo of a typical coastal rock shoreline on the windward (northeast) side of the island. Photo 4-39 shows undercut rock shoreline typical for much of the quieter leeward side of Children's Bay Cay. In general, the coastal rock was steep on the east side of the island and less steep on the west side. Steep rock cliffs, with some faces approaching 30 ft in height, were common along the east shoreline that fronts Exuma Sound and receives the main force of the east wind. With occasional interruptions by stretches of sandy beach, the coastal rock began near the water line along most of the shoreline and continued upslope for varying distances of 5 to 15 m (16 to 49 ft), based on the slope and degree of wind and salt spray exposure. The coastal rock shoreline covered 21.73 acres, or 11.84 percent, of Children's Bay Cay.

Antillean nighthawks (*Chordieles gundlachii*) are well known for nesting in non-vegetated areas, where eggs are laid on open rock or shallow scrapes in the sand. Particular attention was given to identifying nighthawk nests along all sections of the coastal rock shoreline, however, no nest or egg was found.  An American oystercatcher (*Haematopus palliatus*) was observed on the coastal rock adjacent to Horseshoe Beach.

***Photo 4-38.  Coastal Rock Shoreline on the Windward Side of Children's Bay Cay***

***Photo 4-39. Coastal Rock Shoreline on the Leeward Side of Children's Bay Cay***

### 4.8.4 Sand (SAND)

Sand beaches of various lengths intermittently interrupt the coastal rock shoreline (Photo 4-40). There are nine sand beaches at various locations around the island's perimeter, covering 9.76 acres, or 5.32 percent, of Children's Bay Cay. Three beaches, Horseshoe, Goat, and East End, are located along the high-energy northeast-facing shoreline fronting Exuma Sound. These beaches are fully exposed to the trade winds and wind-driven waves. Conch, Coconut, Mushroom, Eros, Saba, and Welcome Beaches are located on the opposite side of the island, i.e., the southwest-facing shoreline, which is a more sheltered, comparatively low-energy shoreline. A relatively small, isolated sand patch, not associated with a beach, was identified just east of Goat Beach, positioned at the landward edge of the coastal rock shoreline.

***Photo 4-40. Typical Sandy Beach on Children's Bay Cay***

Bird species observed on the sandy beaches included Wilson's plovers (*Charadrius wilsonia*) (Photo 4-41), laughing gull (*Larus atricilla*) (Photo 4-42), least tern (*Sterna antiallarum*), and black bellied plover (*Pluvialis squatorola*). The most notable bird species observed on the sandy beach was a piping plover (*Charadrius melodus*) (Photo 4-43), which is designated as an endangered species by the U.S. Fish and Wildlife Service. The Atlantic population of piping plovers is estimated to be approximately 2,000 pairs, which generally breed in the northeast and winter in the southeast and the Bahamas (http://www.fws.gov/northeast/pipingplover/overview.html).

***Photo 4-41. Wilson's Plovers (Charadrius wilsonia) on Goat Beach at Children's Bay Cay, April 2015***

***Photo 4-42. Laughing Gulls (Larus atricilla) on Coconut Beach, Children's Bay Cay, April 2015***

***Photo 4-43. Piping Plover (Charadrius melodus), Children's Bay Cay, April 2015***

### 4.8.5 Sand Strand (DUNE)

Sand Strand (SS) totaling 6.65 acres in extent, or 3.62 percent of Children's Bay Cay, was identified at five locations; typically, adjacent to the landward side of a sandy beach (i.e., Horseshoe, East End, and Eros), or set back from the beach just a short distance (i.e., at Goat and Coconut Beaches). Photo 4-44 shows typical sand strand vegetation, as found on the dunes at East End Beach. Typical sand strand vegetation consisted of a mix of grasses, such as sea oats (*Uniola paniculata*), sand spur (*Cenchrus* sp.), and seashore rushgrass (*Sporobolus virginicus*); trailing vines such as morning glory (*Ipomoea pes-caprae*); shrubs such as inkberry (*Scaevola plumieri*) and bay cedar (*Suriana maritima*); and small trees such as seagrape (*Coccoloba uvifera*), which grew in dense stands. Coconut trees (*Cocos nucifera*) were also common, and buccaneer palms (*Pseudophoenix sargentii*) were observed. A few trees of the invasive non-native Australian pine (C*asuarina equisetifolia)* were occasionally present within the sand strand (Photo 4-45), however, the current Children's Bay Cay owners had an instituted an ongoing program to remove Australian pines and very few remained.

***Photo 4-44. Typical Sand Strand Vegetation Covering Dune Landward of East End Beach, Children's Bay Cay***

***Photo 4-45. Australian Pine (Casuarina equisetifolia) Present within the Sand Strand Just East of Goat Beach, Children's Bay Cay, April 2015***

### 4.8.6 Dwarf Salt-Tolerant Evergreen Shrubland (DS-TES)

Dwarf Salt-Tolerant Evergreen Shrubland occurred on the windward (northeast) side of Children's Bay Cay and was characterized by low-growing evergreen shrubs growing directly from slight fractures and solution holes in the weathered limestone rock on the landward extents of the otherwise barren coastal rock shoreline (Photo 4-46). This is an extremely harsh environment, almost constantly subjected to wind pruning and salt spray. Vegetation within the DS-TES was very limited, consisting of primarily sandfly bush (*Rhachicallis americana*), rosemary (*Strumpfia maritima*), bay cedar (*Suriana maritima*), and button bush (*Conocarpus erectus*), with the sandfly bush and rosemary being most abundant and commonly occurring together.

***Photo 4-46. Dwarf Salt-Tolerant Evergreen Shrubland Growing on Otherwise Barren Rock Just East of Goat Beach, Children's Bay Cay, April 2015***

### 4.8.7 Mangrove (M)

Mangroves were found at several locations on Children's Bay Cay. The largest stand was a non-tidally connected mangrove-dominated wetland located adjacent to Coconut Beach and the coconut grove area (Figure 4-16). This wetland included a mix of both black mangrove (*Avicennia germinans*) and red mangrove (*Rhizophora mangle*). The main east-west roadway (more precisely southeast to northwest) that runs to the island's eastern end provided an observation point for these mangroves at the point this road passed the coconut grove area. Black mangroves, growing to 20 ft and having maximum trunk diameters of 8 to 10 inches, were present on both the north and south sides of the road. Numerous pencil-like black mangrove pneumatophores were also present, extending upward from the mud around the bases of the tree trunks (Photo 4-47). The main east-west roadway crossed the eastern extent of this mangrove wetland (Figure 4-16), but the wetland extended westward as a narrow strip, averaging about 30 ft wide, along the north side of the open, grassy coconut grove area, which has a slightly higher topographic elevation than the adjacent mangrove stand.

Composed completely of black mangroves at its eastern end, the mangrove stand was a mix of black and red mangroves towards its western end, with substantial numbers of red mangrove prop roots mixed with black mangrove trunks and pneumatophores (Photo 4-48). The mangrove stand terminated abruptly at its southwestern end as the ground elevation sloped upward to form a small hill that prevented any tidal connection to the open waters adjacent to Coconut Beach. There was no standing water in the wetland on the day of the field reconnaissance (April 7, 2015), but hydrologic indicators suggest that surface water is likely present during the rainy season. All the black and red mangroves in this stand appeared healthy and robust.

Two other mangrove stands were located along the main east-west roadway, on either side of the side road to Goat Beach. Both of these mangrove stands were dense, monotypic stands of buttonwood (*Conocarpus erectus*), with heights of 10 to 15 ft.

The north end of the salt pond adjacent to Horseshoe Beach also supported a small stand of buttonwoods.

White mangrove (*Laguncularia racemosa*) trees were uncommon on Children's Bay Cay, observed only along Conch Beach.

***Photo 4-47. Black Mangrove (Avicennia germinans) Trunks and Pneumatophores near Coconut Grove on Children's Bay Cay***

***Photo 4-48. Mixed Red Mangrove (Rhizophora mangle) and Black Mangrove (Avicennia germinans) near Coconut Grove on Children's Bay Cay***

### 4.8.8 Coconut Grove (CG)

A 1.26-acre stand of coconut trees (*Cocos nucifera*) was present adjacent to Coconut Beach (Photo 4-49). Although coconut trees were present at various locations along the island shoreline, most often along the beaches, the location next to Coconut Beach is the only one that qualified as a grove. The understory was generally open and vegetated with grasses, including *Sporobolus* and sand spur. Reportedly, the coconut grove was the location of a previous homestead, although no remnant foundations or other such structures were observed.

***Photo 4-49. Coconut Grove on Children's Bay Cay***

### 4.8.9 DBEF – impacted (DBEF-i)

The DBEF – impacted (DBEF-i) cover type is limited to one location, the north side of the sand pile created by the marina excavation. This area has typical DBEF vegetation; with a robust accumulation of boulders and rock rubble, presumably from the marina excavation, covering 0.55 acre. It did appear that DBEF trees and shrubs are rapidly growing through up through the rubble and should overgrow it again in the near future.

### 4.8.10 Salt Ponds (SP)

Children's Bay Cay has two salt ponds that total 0.52 acre. The larger of the two (0.43 acre) is adjacent to Horseshoe Beach (Photo 4-50), the smaller (0.09 acre) lies adjacent to the main road, near the side road to Goat Beach (Photo 4-51). During the April 2015 field reconnaissance, the larger pond near Horseshoe Beach had no surface water and consisted of an open mud flat with a vegetated fringe.

***Photo 4-50. Larger Salt Pond near Horseshoe Beach on Children's Bay Cay, April 2015 (View from South End of Pond Facing North)***

***Photo 4-51. Smaller Salt Pond on Children's Bay Cay, April 2015 (Facing South from Main East-West Road)***

The smaller salt pond was nearly dry but did have a small puddle of shallow surface water, approximately 12 inches deep at its deepest point. The salinity of this surface water was 70 parts per thousand (ppt), as measured with a refractometer. The vegetative fringe around the pond indicated that, at high water, the smaller pond was approximately 2 ft deep. The pond perimeter was vegetated with a narrow fringe of buttonwood. Some trunks and bare limbs of dead buttonwoods were present, but there was no indication of what may have caused their demise. Other fringing vegetation included *Sporobolus* and sea oxeye (*Borrichia* sp.). There were no bird footprints in the mud that might indicate the pond was used for foraging; however, with the exception of some unidentified water bugs, there did not appear to be much to forage on, such as small crabs.

### 4.8.11 Other Existing Development-Related Land Cover and Land Uses

As noted, Children's Bay Cay has been privately owned for many decades and was generally used as a residential retreat. During that time, the island's several owners have collectively cleared or developed only a small fraction of the island. Existing development-related land cover and land uses are listed in Table 4-1.

#### 4.8.11.1 Buildings and Other Structures

This existing development included the still actively used residence, two detached guest houses, and housing for a small contingent of on-island staff (Photos 4-52 through 4-54). Additional actively used buildings were those used for infrastructure support, including a diesel generator (Photo 4-55) building with fuel storage tanks, and a building housing a reverse osmosis (RO) water plant (Photos 4-56 and 4-57). Some additional abandoned buildings were formerly used for staff housing. Other abandoned infrastructure included three concrete-lined pools (Photo 4-58), similar in structure to swimming pools, but used for capturing and storing rainwater. These pools were all dry and appeared to have been long abandoned, presumably since the RO plant was installed.

***Photo 4-52. Existing Development on Children's Bay Cay as Viewed from South Side of Island. Residence and guest house on hilltop to left, pier and waterside storage in center, diesel-powered generator and RO plant in buildings behind coconut trees on right.***

***Photo 4-53. Main Residence on Children's Bay Cay***

***Photo 4-54. Guest House adjacent to Main Residence on Children's Bay Cay***

***Photo 4-55. Diesel-Powered Generator***

**Photo 4-56. Reverse Osmosis Plant**

**Photo 4-57. Exterior of Building Housing Reverse Osmosis Plant**

***Photo 4-58. Abandoned Concrete-Lined Water Storage Structure adjacent to Former Staff Housing on Children's Bay Cay***

The existing RO plant can produce 300 gallons of fresh water per hour. The seawater source water intake is beneath the dock to the west. The waste brine is discharged onto some rock rubble at the shoreline. The salinity of the waste brine was 45 ppt, as measured with a refractometer, which is only modestly higher than the 35 ppt salinity of normal seawater. No adverse effects along the shoreline were noted as a result of the brine discharge.

#### 4.8.11.2 Existing Docks/Seaplane Ramp

There were two existing docks located along the west shoreline. One is located at the west end of Welcome Beach and is a combination of concrete and wood (Photo 4-59). The other dock is located just south of the marina basin.

In addition to the docks, a concrete seaplane ramp is at the western end of Welcome Beach. This was used by a past owner who accessed the island using a seaplane (Photo 4-60).

***Photo 4-59. Pier Located at West End of Welcome Beach, Children's Bay Cay***

***Photo 4-60. Concrete Seaplane Ramp at the West End of Welcome Beach, Children's Bay Cay***

### 4.8.11.3 Marina Basin

Children's Bay Cay includes a small marina basin that was excavated in 2007 and designed for 14 vessels in the 20- to 30-ft size class (Photo 4-61). Material excavated from the marina basin is stockpiled east of the basin.

***Photo 4-61. Marina Basin and Surrounding Area, Children's Bay Cay***

### 4.8.11.4 Abandoned Agricultural Area

Just east of the marina basin is an abandoned agricultural area that was actively used as a kitchen garden and fruit tree orchard when the island was used as a residential retreat. To grow fruit trees, holes were excavated in the limestone and backfilled with soil. Papaya (*Carica papaya*), Barbados cherry (*Malpighia punicifolia*), sugar apple (*Annona squamosa*), mango (*Mangifera indica*) and banana (*Musa acuminate*) were still present.

An open shallow well was found within the former agricultural area (Photo 4-62). The surface of the water in the well was measured to be about 6 ft below the land surface. Water dipped from the well was found to be completely fresh, having a salinity of zero ppt, as measured with the refractometer.

***Photo 4-62. Abandoned Well Structure at the Former Agricultural Area near the Marina Basin on Children's Bay Cay***

### 4.8.11.5 Unpaved Roads

Although most of the existing development was clustered toward the western end of Children's Bay Cay, there were a few unpaved roads that provided access to other points on the island. The longest of these ran the length of the island to the eastern tip and was approximately one mile long (Photo 4-63). A paved footpath provides access from the residence area to the northwestern tip of the island. In total, the existing unpaved roads covered 3.54 acres, or less than 2 percent, of the island.

### 4.8.11.6 Waste Management Area

As noted on Figure 4-16, a small (0.12 acre) waste management area was located just south of the marina basin. This was a shallow pit for trash disposal (Photo 4-64). The on-island staff stated the accumulated trash was periodically burned. This pit will be removed as part of the new resort development.

***Photo 4-63. View eastward along main east-west road on Children's Bay Cay***

***Photo 4-64. Trash Pit Just South of Marina Basin***

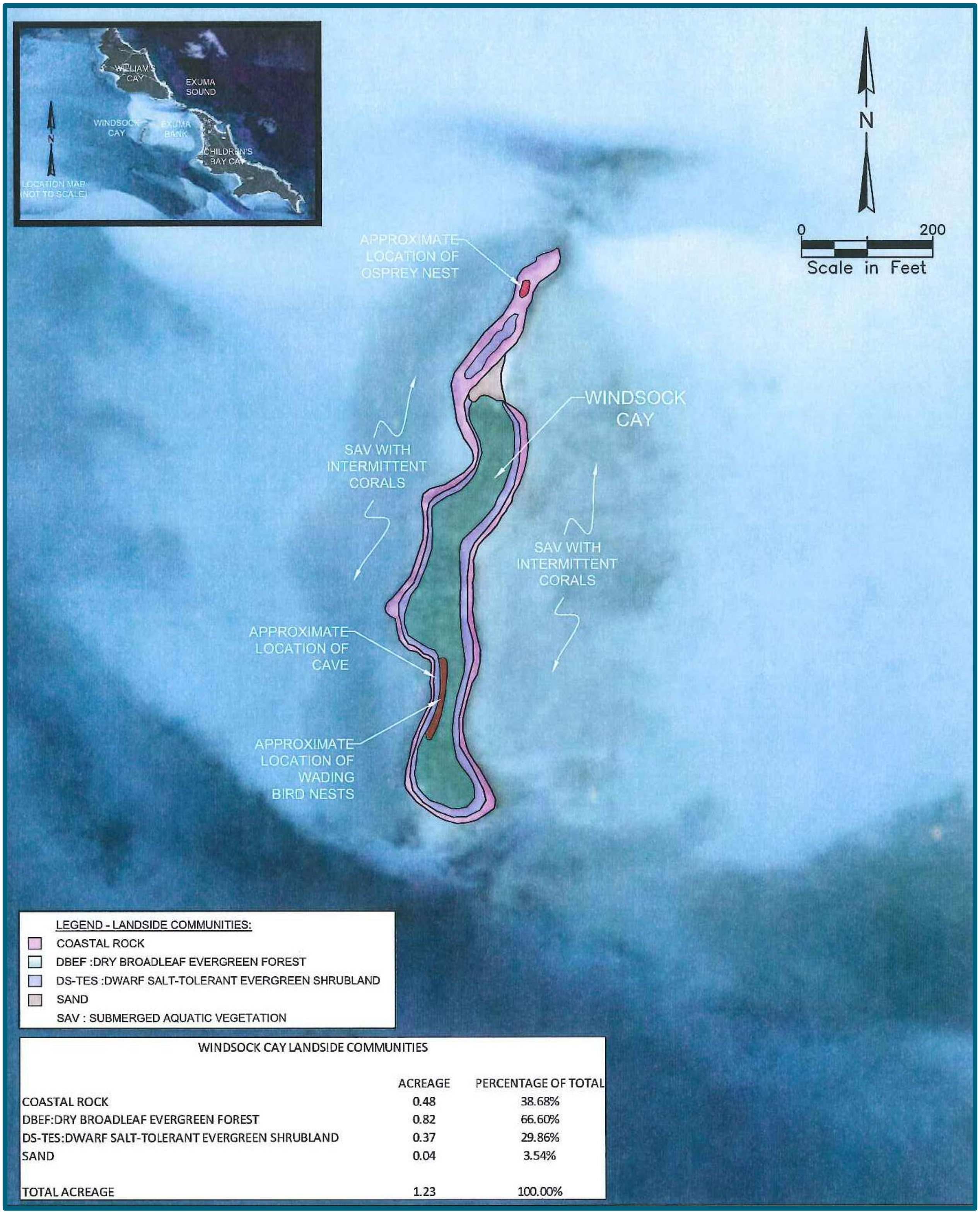
Various ornamental plantings, e.g., white cedar (*Tabebuia heterophylla*), bougainvillea (*Bougainvillea spectabilis*), cocoplum (*Chrysobalanus icaco*), hibiscus (*Hibiscus rosa-sinensis*), oleander (*Nerium oleander*), and accent plants, e.g., aloe (*Aloe barbadensis*), Asian lily (*Crinum asiaticum*), and oyster plant (*Rhoeo spathacea*), were present in the vicinity of existing buildings. Additionally, a variety of opportunistic plants typically associated with disturbed areas, e.g., wild cotton (*Gossypium hirsutum*), bowstring hemp (*Sansevieria hyacinthoides*), woe-vine (*Cassytha filiformis*), jumbay (*Leucaena luecocephala*), were present along roadsides and in the vicinity of the abandoned buildings.

### 4.8.12 Windsock Cay Terrestrial Ecology

Figure 4-17 provides a terrestrial habitat map for Windsock Cay, which is a very small cay located about 2,500 ft directly west of Welcome Beach on Children's Bay Cay. Oriented almost directly north south, Windsock Cay is long and narrow, approximately 1,000 ft long, but only 75 to 100 ft wide along most of its length, and only 150 ft wide at its widest point. The highest elevation on Windsock Cay is about 8 ft above water level. With the exception of a very small pocket beach near its north end, the Windsock Cay perimeter was completely surrounded by protruding coastal rock ironshore (Photo 4-65). A narrow band of DS-TES, dominated by *Rachicallis* and buttonwoods, served as a transition between the barren ironshore perimeter and island interior, which was densely vegetated by DBEF.

Windsock Cay was accessed by boat and, by staying on the barren ironshore perimeter along its west side, walked from the south end to the north end. The small cay was completely undeveloped, with no obvious human impacts. Despite its high density, the DBEF vegetation was not very tall, most being of shrub-like stature. The tallest trees reached only 10 to 15 ft in height (Photo 4-66). The low-growing tree canopy was generally dominated by buttonwood, however, numerous other trees were mixed with the buttonwood including sea grape, buccaneer palm, seven-year apple, lignum vitae, wild dilly, pigeon plum, silver top palm, cinnecord, and bay cedar. Prickly pear and queen-of-the-night cactus were numerous in the understory, as was sea oxeye (*Borrichia* sp.). Saltmeadow cordgrass (*Spartina patens*) was growing near the high tide line on the small pocket beach.

## *Figure 4-17 - Windsock Cay*




WINDSOCK CAY LANDSIDE COMMUNITIES

| | ACREAGE | PERCENTAGE OF TOTAL |
|---|---|---|
| COASTAL ROCK | 0.48 | 38.68% |
| DBEF:DRY BROADLEAF EVERGREEN FOREST | 0.82 | 66.60% |
| DS-TES:DWARF SALT-TOLERANT EVERGREEN SHRUBLAND | 0.37 | 29.86% |
| SAND | 0.04 | 3.54% |
| TOTAL ACREAGE | 1.23 | 100.00% |

***Photo 4-65. View to South along Windsock Cay's Western Shoreline***

***Photo 4-66. Dense DBEF Vegetation on Windsock Cay***

During the time on Windsock Cay, four wading bird nests were observed within the tree branches of the DBEF vegetation (Photo 4-67). Five yellow-crowned night herons (*Nyctanassa violacea*) roosted in the tree limbs around these nests (Photo 4-68), which were about 5 ft from the ground, but no active nesting was noted. A shallow cave (about 8 ft from front to back) in the rocky shoreline sheltered another nest, which although unidentified was not a wading bird nest (Photo 4-69).

***Photo 4-67. One of four wading bird nests observed on Windsock Cay, April 2015***

***Photo 4-68. One of five Yellow-crowned night herons observed on Windsock Cay, April 2015***

***Photo 4-69. Nest observed in shallow cave on Windsock Cay, April 2015***

An osprey nest was located in an open area on the northern tip of the island, where the vegetation was sparse (Photo 4-70). Built directly on the rocky ground, the large nest was about 4 ft in diameter and about 8 ft above the water level. No active nesting was underway, although ospreys were observed in the immediate area. In addition to the typical driftwood and sticks used for construction, the nest materials included an eclectic collection of natural and synthetic materials including sponges, nylon rope, fishing net, a coconut, and a sea fan.

Other birds observed on Windsock Cay included green heron (*Butorides virescens*) (Photo 4-71), common ground dove (*Columba passerina*), and white-crowned pigeon. The white-crowned pigeons arrived in a small group right at sunset, so it appeared they were using Windsock Cay as a night roost.

***Photo 4-70. Osprey nest on north tip of Windsock Cay, April 2015***

***Photo 4-71. Green heron observed on Windsock Cay, April 2015***

### 1.1.12 BEST Commission National Invasive Species Strategy

The BEST Commission issued a national invasive species strategy in 2003. A copy of this document is provided in Appendix C. This strategy identifies nonnative plants and animals that represent a threat to the biodiversity of The Bahamas and, therefore, recommends their eradication or control. The Children's Bay Cay baseline assessment conducted in April 2015 identified three plant species (Table 4-2), but no animal species, listed in the invasive species strategy document.

**Table 4-2 - Invasive Plant Species Identified on Children's Bay Cay, April 2015**

| Genus/Species | Common Name | Occurrence Notes | Recommendation[a] |
|---|---|---|---|
| *Casuarina equisetifolia* | Australian pine | Occasional along sandy shorelines and disturbed areas | Control |
| *Scaevola taccada* | Ornamental candlewood, Asian Scaevola, white inkberry, Hawaiian seagrape | Abundant along beaches | Eradication |
| *Leucaena luecocephala* (formerly *L. glauca*) | Jumbay, jumbie bean | Common in coppices and disturbed areas | Control |

[a]As noted in BEST Commission (2003), *The National Invasive Species Strategy for The Bahamas*. BEST, Nassau, The Bahamas, 34 pp.

For the Australian pine, which the strategy document recommends for control (versus total eradication), the current landowner has already undertaken an Australian pine removal program that is ongoing as of mid-2015. Only a few Australian pines remain in isolated locations on Children's Bay

## 4.9 Socioeconomic Aspects

### 4.9.1 Adjacent Communities

The only adjacent community to Children's Bay Cay is Barraterre located on Great Exuma. The adjacent community and its geographic relationship to Children's Bay Cay is shown on Figure 3-1. The total population of Great Exuma is approximately 7,300 (2010 census), with the entry point generally located at George Town. Based on the 2010 census, Barraterre has a permanent population of approximately 120 residents.

### 4.9.2 Economic Base and Status

Children's Bay Cay has no significant settlements and, therefore, no existing economic base, although its proximity to Barraterre would make it a component of its economic base.

### 4.9.3 Existing Opportunities for Employment

Based on the undeveloped nature of Children's Bay Cay, there is currently little direct opportunity for employment on the island except for limited maintenance and service staff.

### 4.9.4 Current Land Uses

Current land uses on the island are primarily undeveloped land, with several residential buildings and maintenance structures. There is a limited road network and two docks used for delivering supplies. The only other use of the island area is currently as a stopover for cruising sailors and boaters, although access to island itself is prohibited.

### 4.9.5 Existing Transportation

A limited, informal roadway network exists on the island. This roadway extends to both docks and connects the northwest end of the island to the southeast end of the island. Several pathways connect to this roadway and provide access to the various beach areas.

### 4.9.6 Existing Infrastructure and Public Services

Existing infrastructure on Children's Bay Cay is limited to a reverse osmosis water treatment plant with a limited distribution network and several diesel generators. This is a private island and no public services are provided.

### Air Quality

No specific testing was accomplished to measure ambient air quality on Children's Bay Cay but based upon present conditions and the lack of potential pollutant sources, air quality is deemed to be good.

## 4.10 Cultural Resources

### 4.10.1 Historic Overview of Children's Bay Cay and Vicinity

The Lucayans, indigenous people in The Bahamas, lived throughout the Bahamas archipelago (that includes the Turks & Caicos Islands). Archaeological evidence of their presence is generally categorized by the size and intensity of the occupation. Living sites would have been villages or groups of households. Processing sites are those locations where it seems residents gathered their catch of fish, conch, etc. to package for taking back to their village. Many of the smaller cays have these type of sites. Sacred sites would include burials in caves as well as caves used exclusively for duho (the cacique's/ chief's seat) ceremonies. Based on a site visit by a member of the Bahamian Archeological Society, no indication of this type of site was found on Children's Bay Cay.

### 4.10.2 Assessment of Cultural Resources

Dr. Grace Turner conducted an archaeological surface survey of Williams and Children's Bay Cays on July 16, 2015. This survey noted that the profile of both cays is similar and that there was little non-native vegetation. From a distance, the only non-local trees visible were noted as the occasional coconut palm, casuarina and sisal bloom. This led to the conclusion that these islands have not had any large-scale land clearing for at least 100 years. A number of random stops were conducted along the shoreline and further inland to search for evidence of human activity. The usual materials seen were a variety of plastics and aluminum containers, which corroborates anecdotal evidence that there was some development on Children's Bay Cay in the 1960s and 1970s.

The only cultural evidence more than 50 year old found during this survey was dry stone walls found on both islands (Photo 4-72). Historically this type wall was erected to mark property boundaries and to keep grazing animals out of cultivated fields. The island's caretaker stated that several older locals claimed the walls were to keep sheep and goats within designated areas. He also said that an elderly man told him that his grandparents told him they used to gather rocks to build these walls. This oral history fits with information from archival documents.

***Photo 4-72. Dry Stone Wall – Children's Bay Cay***

Resident Justice Reports from the late 1800s and Commissioners' Reports from the early 1900s indicate that the cultivation of sisal (*Agave sisalana*) began in the Exumas by 1889. Sisal was still a major export crop in 1918, but the effects of drought and hurricanes and the difficulty of getting the fibre to market presented constant challenges. By the 1920s, stock raising was the more prevalent economic activity for the Exumas. These administrative reports do not specifically refer to the Exuma Cays but the assumption is that persons living on Great Exuma travelled by boat to tend fields and livestock on the cays. This hypothesis is supported by the fact that so little older cultural material can be found on these cays. The only cultural material found other than the stone walls was the base of an early 20th century clear glass bottle found on the north coast of the cay and was likely washed ashore (Photo 4-73). This find fits the historical pattern of people travelling by dinghy boats to work their fields and tend their flocks on the cays.

***Photo 4-73. Clear Glass Bottle Base - c. early 20th century***

Throughout The Bahamas, these stone walls are a common reminder of a by-gone era. Since these walls were part of the historical landscape, it has become usual for the Antiquities, Monuments & Museum Corporation to recommend that developers save these walls wherever possible. In the absence of buildings, these walls represent a part of the historical built environment of these islands.

The knowledge of how to construct such walls remains within the local community even today (Photo 4-74). It was the opinion of Dr. Turner that including this historical technique of dry stone wall construction during development would serve to enhance the historical ambience of any future development on these cays.

***Photo 4-74. Contemporary dry stone wall – Children's Bay Cay***

## 4.11 Existing Utility Services

### 4.11.1 Potable Water

Potable water is currently provided to Children's Bay Cay via the reverse osmosis water treatment plant. Influent water to the treatment plant is drawn from surface waters and concentrate water is discharged overland to surface waters. Several concrete-lined cisterns on the island are not utilized currently.

### 4.11.2 Wastewater

Presently no wastewater treatment facility is located on Children's Bay Cay. All wastewater generated by the staff that routinely visits and stay on the island is discharged to septic tanks, with disposal via soak aways.

### 4.11.3 Electricity

Electricity is produced onsite by several diesel generators.

### 4.11.4 Roads

The island is relatively undeveloped, with minimal roadways and paths. The paths are primarily concrete and the informal roadways are constructed of native materials.

### 4.11.5 Solid Waste

Solid wastes generated on Children's Bay Cay are currently transported to Barraterre for disposal or burned onsite.

## 4.12 Regulatory and Legal

The current Bahamian Building and Land Development Code does not set forth a definitive permit application and land development approval process. In order to best interpret the Bahamian Code and relevant legislation, a list of applicable legal and regulatory statutes together with relevant Government Agencies will be developed during the planning process.

# 5.0 Environmental Impact Analyses

## 5.1 Impacts to Shoreline/Nearshore and Coastal Processes

With the exception of six small overwater bungalows and 14 overwater docks and porches to allow water access, no in-water structures, such as jetties, groins, or navigation channels, are proposed. No shoreline erosion, changes in littoral transport, or shoaling are anticipated to result from any aspect of the project. The overwater bungalows will be placed on pilings over a sand and rock bottom, adjacent to ironshore; no detrimental erosion or shoaling is anticipated.

## 5.2 Impacts to Local Circulation and Currents

Since there will be limited placement of in-water structures and minimal dredging outside the existing shoreline boundary, only the dredging to deepen the entrance to the marina basin could impact local circulation and currents, however these impacts should not be negative with respect to local circulation and currents.

## 5.3 Impacts to Surface Water and Ground Water Quality

Existing surface waters on Children's Bay Cay are limited to two small, ephemeral salt ponds that are often dry. These two salt ponds will be expanded and deepened to create two ponds with permanent water. A third lined pond will also be created in the Spa area. It is expected these ponds will be salt water ponds. Maintaining good water quality in these ponds will require that stormwater and irrigation runoff be intercepted and not be allowed to drain directly into the ponds without pretreatment in vegetative swales or buffers.

## 5.4 Terrestrial Ecology and Land Use Impacts

### 5.4.1 Upland Impacts

This section describes the expected direct impacts to terrestrial habitats that are likely to occur as a result of the construction and operation of the proposed project. Impacts to terrestrial habitats were determined by overlaying the master plan (Figures 2-1) onto the terrestrial land cover map (Figure 4-16) and totaling the acreage of each land cover type impacted by the master plan components. The resulting terrestrial impacts are summarized in Table 5-1.

***Table 5-1 - Impacts to Children's Bay Cay Vegetative Communities and Land Cover/Land Use Types***

| Impacts to Vegetative Community or Land Cover/Land Use Type | Code | Areal Extent | |
|---|---|---|---|
| | | **Existing Acres** | **Impacted Acres** |
| **Vegetative Community or Natural Land Cover** | | | |
| Dry Broad-Leaved Evergreen Forest | DBEF | 130.82 | 14.30 |
| Coastal Rock | CR | 21.73 | 0.08 |
| Sand (Beach) | SAND | 9.76 | 1.67 |
| Sand Strand (Dune) | SS | 6.65 | 1.55 |
| Dwarf Salt-Tolerant Evergreen Shrubland | DS-TES | 4.59 | 1.00 |
| Mangrove | M | 1.52 | 0.09 |
| Coconut Grove | CG | 1.26 | 0.50 |
| DBEF - Impacted | DBEF-i | 0.55 | 0.21 |
| Salt Pond | SP | 0.52 | 0.52 |
| | **Subtotal** | **177.40 ac** | **19.92 ac** |
| **Existing Development-Related Land Cover and Land Uses Converted to Other Uses** | | | |
| Roads (unpaved/dirt) | | 3.54 | 3.54 |
| Marina Area Unpaved | | 0.99 | 0.99 |
| Existing Buildings and Associated Infrastructure | | 0.81 | 0.81 |
| Abandoned Groves | | 0.43 | 0.43 |
| Docks/Piers | | 0.19 | 0.19 |
| Waste Management Area | | 0.12 | 0.12 |
| | **Subtotal** | **6.08 ac** | **6.08 ac** |
| | **Total** | **183.48 ac** | **26.00 ac** |

Master plan construction and implementation will require a total of 26 acres of the existing terrestrial habitats and land cover, about 14% of the total land area on Children's Bay Cay. The remainder will be left in its natural state. Of the individual habitat types impacted by master plan construction, the DBEF receives the greatest impact (14.3 acres) simply because it is the most common habitat type on the cay. Currently, Children's Bay Cay has 130.20 acres of DBEF, which covers about 70% of the cay. After construction some 89% of the existing DBEF will remain and retain its ecological functions.

In addition to the DBEF discussed above, Children's Bay Cay has an additional 0.55 acres of DBEF that has been previously impacted by the existing resort and infrastructure. Of this 0.55 acres of previously impacted DBEF, 0.21 acres will be removed for master plan construction. The remainder will remain undisturbed and is expected to regenerate into mature DBEF in a relatively short time. As discussed in Section 4.10.2 (Assessment of Cultural Resources), much of Children's Bay Cay was previously cleared for agricultural production of sisal and for livestock grazing; land uses that probably persisted into the early 1900s. The existing DBEF cover is mature natural forest that has regenerated since that time and demonstrates the rapidity with which native forest regeneration occurs on Bahamian cays.

The sand strand community type currently covers 6.70 acres of Children's Bay Cay (see Figure 4-16). Master plan construction will impact 1.55 acres of the sand strand. Sand strand is merely former beach dune and sand communities that over time have become overgrown with dense trees, including seagrape trees and buccaneer palms, and lush shrubs, such as inkberry and bay cedar. All of these species are desirable for landscaping and will be generously planted among the newly constructed resort buildings and facilities.

Children's Bay Cay has 1.57 acres of mangrove located in four discrete stands (see Figure 4-16 and description in Section 4.8 above). A portion (0.09 acres) of these mangrove stands will be removed for master plan construction; however, the largest and best quality black mangroves, as well as the only red mangroves on Children's Bay Cay, are incorporated into the master plan and preserved. Portions of two other mangrove stands are incorporated into the new ponds but, as discussed more fully below, will be replaced with new mangrove plantings around the pond shorelines.

As discussed in the terrestrial ecology baseline section (Section 4.8), none of the four mangrove stands is intertidal or has any surface water connection to marine waters. All four mangrove stands are surrounded by upland communities and are isolated from marine habitats. Accordingly, they do not contribute organic detritus or provide nursery habitat that would support marine fauna or fisheries in the waters surrounding Children's Bay Cay. In addition, the mangrove stands did not appear to provide any unique or high-quality foraging opportunities for wading birds and, in fact, a lack of fiddler crab burrows within the stands indicates these areas do not support invertebrate communities that, in turn, would support bird foraging.

Minimal impacts will result to the barren coastal rock (0.08 acres impact) cover type, its closely associated dwarf salt-tolerant evergreen shrubland (1.00 acres impact), which is merely the coastal rock with a very sparse vegetative cover. Some 1.67 acres of impact will occur to sand beach, primarily at Saba Beach for construction of the new marina channel.

The coconut grove is an existing managed greenspace that will be modified for the master plan construction. The site consists of the abundant coconut trees surrounded by mowed grass. The coconut trees will provide a desirable aesthetic amenity to the planned resort. Approximately 0.50 acres of the existing 1.78-acre coconut grove will be removed for the resort construction.

Children's Bay Cay currently has two small (0.52 acres total) salt ponds. These two ponds will be replaced with three constructed ponds that will have permanent pools. The existing ponds are ephemeral, holding water only in response to rainfall and frequently going dry, exposing an unvegetated mud substrate. During the field reconnaissance conducted in April 2015, one pond was completely dry and the other held only a small, shallow puddle. At that time, neither pond showed any wading bird activity or bird footprints indicating use as a forage site. In addition, there was a lack of invertebrates, such as fiddler crabs, that would indicate potential value as forage sites. The new ponds will have permanent pools that will allow more substantial invertebrate colonization, and possibly even fish populations, that may improve foraging opportunities for wading birds working the pond shorelines.

### 5.4.2 Fill

While final grading plans have not been completed, it is expected that fill will be required for some areas of the project. What cannot be sourced on island by balancing cut and fill needs will be sourced locally from the Bahamas from an area to be approved by the BEST Commission.

## 5.5 Marine Ecology Impacts

This section describes the expected direct and potential indirect impacts to marine habitats that are likely to occur as a result of the construction and operation of the proposed project.

### 5.5.1 Area Under and in the Vicinity of the Over-Water Guest Pavilions

Six over-water guest pavilions are proposed to be constructed in the shallows on the Exuma Bank side of Children's Bay Cay. These six guest pavilions will be constructed in pairs at three locations along the shoreline, as shown on the master plan. Access to each pair of these overwater guest pavilions will be provided by a shore-perpendicular pier leading from the uplands of Children's Bay Cay. The length of the access pier will vary from site to site, but will generally be between 10 and 20 ft in length. Each pavilion is proposed to be approximately 1,900 square feet ($ft^2$) in size. Potable water and electricity will be provided in conduits leading from the uplands of Children's Bay Cay. Wastewater will be collected in above water holding tanks with a duplex pump that will transfer collected wastewater to the upland collection system. Each holding tanks will be equipped with a high-level alarm. Each pavilion will also include a staircase leading to the water.

The two westernmost overwater guest pavilions are sited at a location where they will have minimal impacts on the marine environment. An underwater investigation in this area conducted during April 2015 revealed that the benthic community was primarily sand sparsely vegetated with SAV. Along the shoreline, intertidal and subtidal rock communities were found to provide limited habitat for corals, sponges and other algae. Immediately offshore of the shoreline rock, turtle grass was the predominant vegetation growing on a sandy substrate, with various macroalgae (e.g., *Halimeda* and *Rhipocephalus*) interspersed. The cover of SAV in this area was generally rather sparse, typically varying from 5 to 30 percent cover. The remaining four overwater guest pavilions are located in areas that transition from the shoreline rock to sandy subsurface interspersed with sparse submerged vegetation. Any hard bottom resources that occur in these areas will either be relocated or the location of the overwater pavilion will be shifted to avoid any impacts.

The six feet wide access walkways for each of the overwater guest pavilions are expected to have limited impact on intertidal and subtidal rock. Marine life growing in each of these areas will not be removed nor directly impacted, but secondary impacts may occur as these areas become shaded from direct sunlight, which may affect the abundance of photosynthesizing flora and fauna.

In total, the overwater guest pavilions may also impact up to approximately 11,600 $ft^2$ of sparse SAV, totaling approximately 0.27 acres of moderate impact. In this area also, the marine life growing on the sea floor under each pavilion will not be removed, but impacts are likely to occur, as these areas are shaded from direct sunlight.

Impacts to these areas are likely to occur primarily during initial construction, especially during the setting of the pilings for the construction of each structure. Temporarily elevated turbidity levels could be encountered during the construction and could be reduced if the pilings were to be set during periods of slack tide and/or contained by weighted surface-to-bottom turbidity screens.

Secondary adverse impacts could occur as the pavilions are occupied over time by guests who may collect marine souvenirs (e.g., sea stars), and/or inadvertently trample seagrasses outside the villa footprints.

Seagrasses are nursery and foraging habitats for important Bahamian fisheries, including conch, reef fishes, and lobster. Therefore, from a regional perspective, cumulative impacts to seagrass beds could affect the Bahamian economy. Seagrasses provide valuable ecological services, including provision of physical habitat structure/shelter, alteration of water flow, nutrient cycling, and food web structure (Hemminga and Duarte, 2000). Seagrasses are also important physical stabilizers of the seabed. Trapping of fine sediments aids in the prevention of siltation on adjacent coral reef habitats. Seagrass beds also provide storm protection and help prevent coastal erosion (Erftemeijer and Lewis, 2006; Di Carlo et al., 2005; Czerny and Dunton, 1995). A reduction in seagrass could also increase the area's susceptibility to strong channel currents and promote erosion.

Overall though, the potential reduction of 0.27 acres of moderate to sparse SAV and secondary impacts is expected to be minimal. These impacts could be offset if the project is successful in having the nearby Windsock Cay area designated as a no-take marine protected area.

Fourteen of the guest pavilions and other structures will be equipped with overwater decks. The decks will be approximately 300 $ft^2$ or less as shown on the master plan. The decks will primarily be located in areas transitioning from shoreline rock to sandy subsurface interspersed with sparse SAV. In total, the overwater decks may impact up to approximately 2,400 $ft^2$ of sparse SAV, totaling approximately 0.06 acres of moderate impact. In this area also, the marine life growing on the sea floor under each deck will not be removed, but some impacts are likely to occur, since these areas will be shaded from direct sunlight.

Impacts to these areas are likely to occur primarily during initial construction, especially during the setting of the pilings for the construction of each deck. Temporarily elevated turbidity levels could be encountered during the construction and could be reduced if the pilings were to be set during periods of slack tide and/or contained by weighted surface-to-bottom turbidity screens.

Secondary adverse impacts could occur as the pavilions associated with the decks are occupied over time by guests who may collect marine souvenirs (e.g., sea stars), and/or inadvertently trample seagrasses outside the deck footprints.

### 5.5.2 Areas Adjacent to Beaches

With the exception of the marina channel that will be realigned through Saba Beach, no direct impacts are expected in areas adjacent to existing beaches. No beach widening is proposed through beach nourishment, although the effective width of beaches may be increased by the removal of sand strand and/or coastal coppice/dry broadleaf evergreen vegetation located landward of the existing sand beaches.

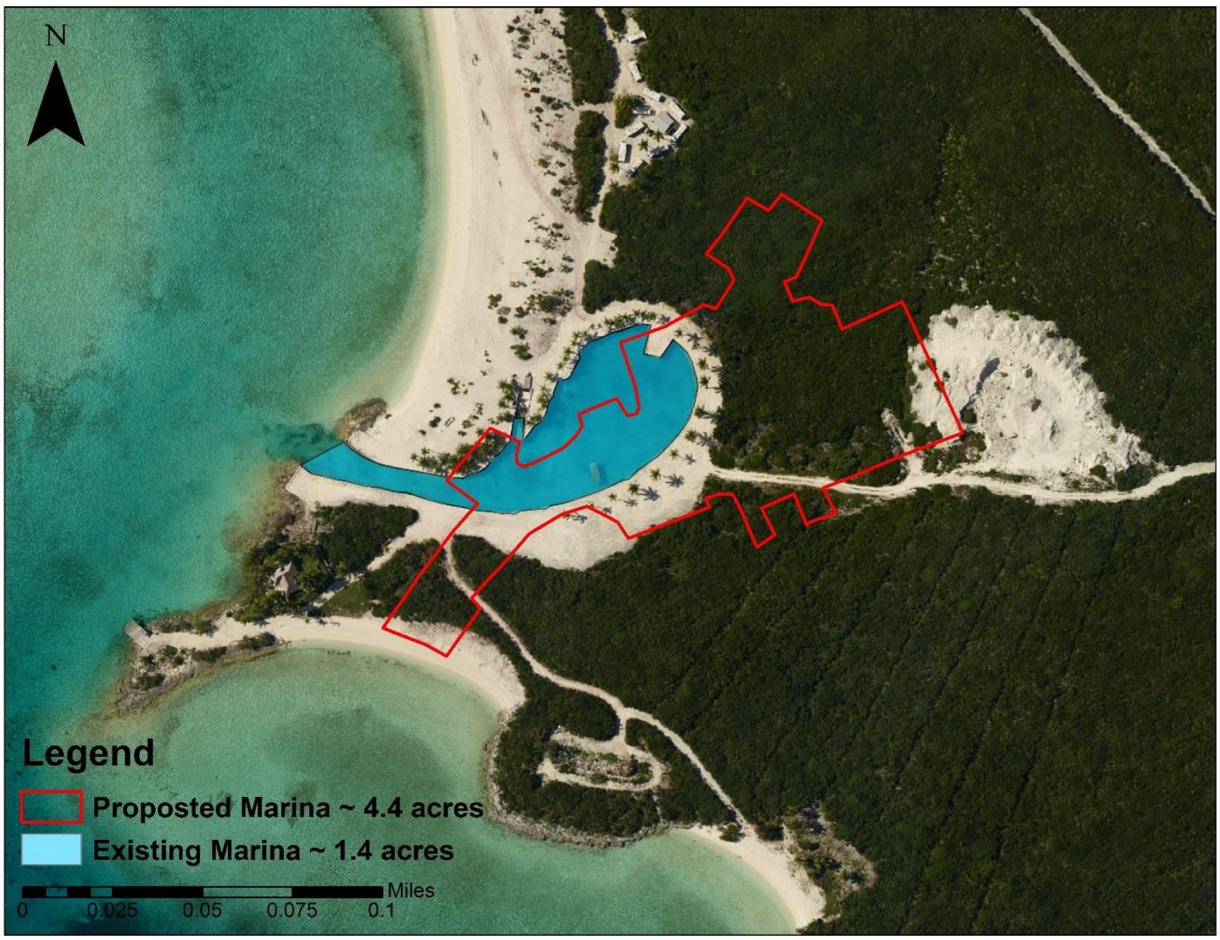
Secondary impacts could occur if subsurface runoff carries land-based nutrients into the marine environment, but nearshore currents and wave action along most of the water frontage of Children's Bay Cay are substantial enough that runoff is expected to have an insignificant effect on the marine ecosystem. Additional secondary impacts that could occur include the collection of marine souvenirs (e.g., sea stars), the trampling of seagrasses in the nearshore waters, unintentional or careless kicking of corals and/or disturbance to birds that are present along the beaches.

### 5.5.3 Marina Channel Realignment

The existing marina channel will be realigned to the south, passing through the existing Saba Beach and will have a controlling depth of 12 feet. Figure 5-1 provides a comparison of the existing marina to the proposed marina showing the new configuration and entrance location.

The new channel will be approximately 100 feet wide where it will cut through Saba Beach. Approximately 300 feet of dredging will be required waterward of Saba Beach for the new channel to reach deep water, resulting in up to 8,000 cubic yards of excavated material. Excavated material will consist of clean sand and rock, which will be used for filling the existing marina channel that currently cuts through the eastern end of Welcome Beach or as fill on Williams Cay. The new channel will facilitate restoration of Welcome Beach and also direct boat traffic to the south.

***Figure 5-1 - Comparison of Existing to Proposed Marina Configuration***




The proposed channel cut will impact an estimated 30,000 ft$^2$ of submerged area that appears to consist of sparse areas of SAV with some hardbottom resources. Impacts to this area during construction will consist of removal of existing SAV within the channel limits during dredging.

Prior to initiating any dredging activities, a survey will be conducted of the proposed area of impact to identify any hardbottom resources in this area. Any significant resources identified will be relocated outside of the immediate area of dredging. Some degree of turbidity is expected to occur during dredging operations.  To limit these impacts, turbidity curtains will be required to be utilized during dredging operations. Should future maintenance dredging activities be required, these activities will prevent the reestablishment of SAV in the channel area.

Secondary impacts in this area could include changes that result from the modification of water flow around the proposed marina entrance channel, which could affect the near-shore communities on both sides of the proposed channel.

Even with a larger entrance channel, it is not expected that the proposed new marina would provide for better flushing than the current marina basis. The flushing analysis for the new marina configuration is provided in Appendix D.  The flushing study indicates that to meet the U.S. EPA flushing recommendation that the percent dye remaining after 4 days should be down to 10 percent, pumping will be required to augment natural flushing in the marina basin. To meet these requirements, the Owner will install and operate a 4,000 GPM flushing pump as recommended by the study.

The marina will be operated to meet clean marina standards, have limited use as a private facility, be equipped with a pumpout, and have minimal stormwater runoff entering the basin, water quality is expected to remain acceptable.

### 5.5.4 Areas Adjacent to Overhanging Coastal Rock

As noted in Section 4.7 (Description of Existing Marine Environment), the solid substrate situated in the intertidal and subtidal zone along most of the southwest facing side of the island provides a narrow band of habitat for corals, sponges, and other types of marine life that require a rock substrate.  Construction and operation of the proposed project is not expected to result in any direct impacts in these areas.

Secondary impacts could occur to this habitat type if over-land and/or subsurface run-off carries land-based nutrients into the marine environment.  As noted previously for the beaches, however, currents and waves along most of the water frontage of Children's Bay Cay are substantial enough that run-off is not expected to have a significant effect on the marine ecosystem.

Secondary impacts that could occur in this area do include the collection of marine "souvenirs" (e.g., sea urchins), the unintentional trampling or careless kicking of corals and/or disturbance to birds that forage and rest along the intertidal hardbottom.

### 5.5.5 Area Adjacent to Proposed Back-of-House Marina

Construction and operation of the new back-of-house marina has the potential to adversely affect the marine environment in the direct vicinity of these structural modifications. While the proposed basin and docking facility will be excavated from existing upland and no channel dredging will be required, construction impacts to the adjacent nearshore bottom would be expected simply due to proximity. An underwater investigation in this area conducted during April 2015 revealed that the benthic community in this area is primarily a sparsely vegetated bed of SAV. Along the shoreline, intertidal and subtidal rock communities were found to provide limited habitat for corals, sponges and other algae. Offshore of the SAV bed, the route of the proposed access corridor is close to the soft coral garden, the only such natural resource area encountered in the vicinity of Children's Bay Cay. Water depths appear adequate so dredging will not be necessary in the soft coral garden, but care will be needed to ensure that temporarily elevated turbidity generated during the initial channel excavation, maintenance dredging and/or the installation of utility lines is controlled and not allowed to settle on SAV and/or other turbidity-sensitive species, including sea plumes and sea rods. Consideration should also be given to the potential effect of prop-wash from barge tugs and other vessels that are docking at the back of house facility. The soft coral garden is in relatively deep water, however, strong prop-wash may cause scour that undermines the corals or causes detrimental turbidity or sedimentation.

Secondary impacts in this area could include changes that result from the modification of water flow around the proposed jetty that will protect the marina. Sand typically accumulates on the downstream side of shore-perpendicular structures, which could affect the near-shore communities on both sides of the proposed marina entrance channel.

### 5.5.6 Area Adjacent to Proposed Marina Expansion

The existing small-boat marina is proposed to be enlarged to create a marina village that will accommodate more and larger vessels, a retail area, dive center, water sports rental area, dock master's office, marine supply shop, environmental center, an over-water restaurant/bar, a pier for new arrivals, and other improvements. The marina entrance channel will be realigned to the southeast. The existing marina channel will be filled in and the new land used for adult beach club.

An underwater investigation in this area conducted during April 2015 revealed that the benthic community in this area is primarily a sparsely vegetated bed of SAV, with intermittent coral-dominated rocks. Along the shoreline, intertidal and subtidal rock communities were found to provide limited habitat for corals, sponges and algae. The coral rocks, which had been recommended for protection prior to the excavation of the existing marina entrance channel, remained in fair condition. Due to their fairly exposed location, they appear to be occasionally battered by sea conditions, which naturally limit their biodiversity and size. Care will be needed to ensure that temporarily elevated turbidity generated during the initial channel widening and/or maintenance dredging is controlled and not allowed to settle on SAV and/or other turbidity-sensitive species, including corals and sponges.

### 5.5.7 Summary of Potential Direct and Indirect Impacts to the Marine Environment

The proposed construction and operation of the project are expected have minimal impacts on the marine environment. With the exception of the pilings for the over-water pavilions and decks, no fill is proposed to be placed atop any submerged natural resources. As the existing seagrass and benthic algae cover is already sparse at the overwater pavilion and deck sites, the modest bottom shading immediately around the pavilions is not a substantial concern. No dense seagrass beds or coral outcrops will be directly removed or buried by the proposed project. Additionally, water circulation and sediment stability are unlikely to be affected by the proposed project, so proposed development activities are unlikely to result in fragmentation of the hardbottom and seagrass habitats.

As no open-water, entrance channel dredging is proposed at the back of house marina, direct or secondary dredging impacts are not expected to seagrasses and/or the only high-quality soft coral garden in the vicinity. Open-water entrance channel dredging is proposed for the relocated

marina entrance. An estimated 30,000-$ft^2$ area will be dredged to obtain a controlling depth of 12 feet in the marina basin. Direct impacts include removal of sparse SAV and relocation of hardbottom resources as well as turbidity impacts on adjacent SAV.
The environmental management plan will address quantifying and relocating hardbottom resources directly in the path of the proposed marina channel realignment. The environmental management plan will also address prevention of silt deposits on environmentally sensitive resources during construction. Turbidity, siltation and sedimentation can be detrimental to the growth and survival of coral reef organisms, particularly filter-feeding organisms such as brachiopods, bryozoans, crinoids, and sponges. Turbidity impacts can lead to chronic perturbations that cause long-term reductions in primary and secondary productivity of coral reef communities by reducing the amount of light available for photosynthesis. Most effects of sedimentation upon stony corals are sub-lethal, causing excessive mucous production and increased respiration rates (Porter and Tougas, 2001; Rogers, 1990). Depending upon the species and life stage, direct mortality can result if the sedimentation load is excessive or if sediments accumulate in depressions of large, massive colonies, causing tissue death. Stony coral recruitment can also be negatively affected by sedimentation through increased mortality of juvenile corals and reduced larval settlement rates (Rogers, 1990).

Additionally, overland and subsurface flow have the potential to introduce land-based pollutants into the marine environment. However, because all wastewater is proposed to be carried by pipeline to Williams Cay for treatment, the potential for contamination of nearshore natural resources is reduced. Development and implementation of an environmental management plan that controls the type, amount and location of pesticides, herbicides and other chemicals and outlines environmental sensitive stewardship is recommended to minimize the potential for contamination of marine resources.

## 5.6 Air Quality Impacts

Air emissions from the operational resort facility will be limited to diesel exhaust from the back-up electrical generators. These air emissions will be diluted and carried away by the nearly constant trade winds so no impaired air quality is expected. Construction work may also generate some limited dust emissions, however, these will be temporary and are not expected to be an issue since there are no nearby populated areas.

## 5.7 Impacts to Utilities and Local Infrastructure

As Children's Bay Cay is privately owned and has very limited development, the existing infrastructure and utilities on the cay is only sized to serve the existing residences and support buildings. There are no existing connections to public utilities of any kind. All existing utilities and infrastructure will be removed upon construction of the new resort and completely replaced with new utilities to be sited in Barraterre and Williams Cay to be connected via pipelines and cables.

### 5.7.1 Potable Water

All proposed development on Children's Bay Cay will be served by a potable water distribution network extending throughout the island. Potable water will be delivered to the island via subsea water line extending from a reverse osmosis water treatment plant located in Barraterre. The specific locations of the reverse osmosis water treatment plant and water line have not been identified yet. When formally identified, this is information will be provided in a report for Barraterre to be provided under separate cover.

### 5.7.2 Wastewater

There will be no onsite treatment and disposal of wastewater on Children's Bay Cay. All wastewater will be collected throughout the island development via a gravity or low-pressure collection system, where gravity lines are not feasible. The wastewater collection system will terminate at a lift station in the BOH area and will be pumped to Williams Cay for treatment. The treatment plant will use a Membrane Bioreactor (MBR) Process which combines the physical removal process using filtration with biological treatment using a suspended growth bioreactor. The MBR process allows for high level treatment without the need for additional tanks and reactors. This allows the plant to operate more efficiently, with lower energy consumption and in a smaller footprint than a conventional return sludge wastewater treatment process. Treated effluent from the MBR wastewater treatment facility will be utilized for irrigation of nursery areas and other areas as needed on Lee Stocking Island. There will be no surface water discharge of treated effluent.

### 5.7.3 Electricity

Children's Bay Cay will contain no electrical-generating equipment with the exception of several diesel generators used for backup power only. Electricity will be provided via a new subsea cable from Barraterre or connection to the existing electrical system on Williams Cay. Williams Cay is currently served via subsea cable from Barraterre. The specific location of the subsea electrical cable from Barraterre, along with the landing locations of the cable will be addressed in a report for Barraterre to be provided under separate cover. All electrical distribution wiring required for this development will be below ground in conduit.

### 5.7.4 Solid Waste

No permanent solid waste disposal facilities will be constructed on Children's Bay Cay. All solid wastes generated both during and after construction will be collected, processed for volume reduction and barged to Great Exuma for disposal in an appropriate manner. Landscape clippings and other organic wastes may be composted onsite for reuse as a soil amendment. The Department of Environmental Health Services will be consulted to determine the preferred landfill to send these materials to.

## 5.8 Socioeconomic Impacts

The proposed project is expected to provide positive socioeconomic impacts to the Great Exuma area. With the exception of a few caretaker staff, Children's Bay Cay is currently uninhabited. However, resort construction and operation and expected to generate several hundred jobs. Temporary construction jobs will evolve into 200 to 300 permanent staff jobs once the resort becomes operational. In addition, businesses on Great Exuma will directly benefit from increased demand for local goods and services. The airport at Great Exuma will see an increase in passenger traffic.

## 5.9 Cultural Resource Impacts

Existing cultural resources on the cay is limited to historical stone walls reflecting past agricultural land uses, possibly as animal pens. Walls that remain within undisturbed DBEF will themselves remain undisturbed. Sections of the historical stone walls that are exposed by clearing will be also preserved and incorporated into the resort landscaping.

# 6.0 Proposed Mitigation Measures

## 6.1 Marine Protected Area Establishment

The owner of the Children's Bay Cay proposes to work with Government to establish a marine protected area (MPA) on the leeward side of the island that will encompass Windsock Cay. The MPA would seek to exclude power vessels from entering the area. Fishing, including the collecting of conch, will also be prohibited.

Figure 3-1 provides the boundaries for the proposed MPA. The boundary passes Windsock Cay to the south and west and extends to Williams Cay to the north, and Children's Bay Cay to the east, where it will take in the length of Welcome Beach. These boundaries were selected to encompass the shallow, sand-dominated flood-tide shoal that is a product of the channel between Williams Cay and Children's Bay Cay. Very strong tidal currents are generated through the channel and they sculpt the bottom for a wide area on the Bahamas bank side. This shoal is readily apparent on the aerial photographs shown in Figures 1-1 and 1-2, which reflects the robust hydrodynamic conditions under which it was formed and is maintained. Windsock Cay is located at the western edge of the shoal.

The marine reconnaissance found this shoal to be a high quality marine benthic habitat consisting of a patchwork mosaic of sand and SAV of varying densities. However, the shoal is constantly subjected to high speed boat traffic numerous times per day from tourist boats and jet skis out of Great Exuma that are running excursions to the islands to the northwest of Williams Cay. This is especially concerning for the extremely shallow waters along the east side of Windsock Cay. As this boat traffic has increased over the years, the local island caretakers on both Williams Cay and Children's Bay Cay state they have noticed a significant decline in marine life over and on the shoal. For example, sting rays that used to burrow in the sand are now scarce, indicating the boat traffic is impacting the basic habitat value of the shoal. Also, conch should be fairly frequent on the shoal, but are rare. However, shells of harvested conch are mounded in shallow water on the west side of Windsock, indicating the conch have been stripped from the shoal through overharvesting. The restriction on fishing and conch harvesting within the MPA is anticipated to create a refuge for fish and marine bottom species.

The proposed MPA will be restricted to non-power vessels. The MPA will not interfere with the tourist traffic, which will simply have to bypass Windsock Cay on its west side and not on its east. The realigned marina channel will also help in keeping motorized boat traffic away from the MPA. Boats exiting the marina will travel south toward Rat Island.

## 6.2 Mangrove Replacement

Pond construction will remove a portion of the existing mangroves. To offset this loss, the new ponds will incorporate mangroves as shoreline plantings and islands. Planting extent and locations will be determined in coordination with BEST during detailed design. Shoreline plantings will include red mangroves near the mean high water point, with black mangroves planted landward at a slightly higher topographic elevation.

Mangroves will be planted as nursery-grown seedlings. Planting locations will incorporate a mixed sand and organic substrate to facilitate root establishment and robust growth. As much of the pond shoreline will be excavated from limerock, over excavation of rock and backfill with planting substrate will ensure that mangrove roots have a minimum of 3-feet of growth medium before meeting the underlying rock.

## 6.3 Leachate Prevention

Open areas surrounding the proposed structures on Children's Bay Cay will primarily be revegetated with native vegetation.  Limited lawn areas will be strictly regulated under BMPs that will be established in the EMP to limit fertilizer, pesticide and herbicide applications to prevent leaching into groundwater and potential lateral transport to open marine waters.  Any landscaping requiring irrigation will be required to utilize low volume irrigation BMPs such as drip irrigation. All domestic wastewater generated by activities on Children's Bay Cay will be conveyed to Williams Cay for treatment. Treated effluent from the MBR wastewater treatment facility will be utilized for irrigation of nursery areas and other areas as needed on Lee Stocking Island.  There will be no surface water discharge of treated effluent.

# 7.0 Environmental Management Plan

## 7.1 Summary

An environmental management plan (EMP) will be developed in coordination with the BEST commission. The EMP will ensure that the development of Children's Bay Cay proceeds with adequate controls that protect the long-term health of the environmental resources of the project site and immediate vicinity. The EMP addresses several areas as follows:

1. Construction planning
2. Upland Best Management Practices
3. BMP for stormwater management from roadways
4. Construction safety issues
5. Marina and docking facility construction
6. Marina and docking facility operations
7. Cultural resources

## 7.2 Environmental Management Plan - Table of Contents

An Environmental Management Plan should be considered a "living document" that is adapted to incorporate changes during the progression of the project due to increased available information, including items such as the contractor awarded the project, changes in equipment, construction methodologies and site conditions, and final plans for infrastructure improvements. The proposed Table of Contents for the Children's Bay Cay Construction and Operational Phase EMPs are as follows:

### 7.2.1 CHILDREN'S BAY CAY EMP OUTLINE – CONSTRUCTION PHASE

The Children's Bay Cay EMP for the Construction Phase will include the items listed in the Table of Contents outline below.

**1.0 Introduction**

**2.0 Environmental Vision & Policy**

2.1 Legislative Requirements

2.1.1 Domestic Legislation

2.1.2 International Laws & Standards

2.2 References and Contact Information

2.3 Scope and Purpose

**3.0 EMP Administration & Responsibilities**

3.1 Roles and Responsibilities

3.2 Environmental Management Team

3.3 Records and Documentation Requirements

3.4 Monitoring Requirements

3.5 Construction and Monitoring Reporting

3.6 Incident Reporting Requirements

**4.0 Environmental Procedures for Upland Construction & Operations**

4.1 Construction Planning

4.1.1 EMP Implementation Planning

4.1.2 Construction Sequencing and Schedule

4.1.3 Construction Staging and Laydown Areas

4.1.4 Construction Accommodations, Equipment and Materials

4.2 BMP Implementation

4.3 BMP Training

4.3.1 Maintenance Procedure Implementation and Inspection

4.3.2 Pollution Prevention/Spill Awareness

4.4 Upland Clearing and Earthwork

4.4.1 Site Perimeter Controls

4.4.2 Construction Staging Areas

4.4.3 Land Clearing Operations

4.4.4 Earthwork

4.4.5 Disposal or Composting of Waste Materials

4.4.6 Contaminated Soils or Debris

4.5 Construction Best Management Practices

4.5.1 Inspections

4.5.2 Tree Protection & Vegetative Buffer Strips

4.5.3 Erosion and Turbidity Control

4.5.4 Control of Dust & Particulates

4.5.5 Stormwater Runoff during Construction

4.5.6 Spill Prevention Planning

4.6 Construction Safety

4.6.1 Safe Work Plan

4.6.2 Jobsite Medical Plan

4.6.3 Hurricane Plan

**5.0 Environmental Procedures for Dewatering, Marine & Nearshore Construction**

5.1 Dewatering, Marina Basins and Bridge Construction

5.2 Turbidity Control during Construction

5.3 Cultural Resources

5.4 Coastal Construction BMPs

**6.0 Construction Water Quality & Turbidity Monitoring Requirements**

6.1 Preconstruction Baseline Monitoring

6.2 Monitoring Frequency

6.3 Water Quality Parameters

6.5 Water Quality Sampling

6.6 Summary Report

**7.0 Environmental Mitigation Procedures**

7.1 Mangrove Restoration Conceptual Plan

7.2 Marine Protected Area Establishment

7.3 Leachate Control

7.4 Pre-Construction Species Relocation

7.5 Education and Environmental Awareness

**8.0 Pollution and Spill Prevention**

8.1 Management and Control of Hazardous Substances

8.2 Management and Control of Hazardous Substances – Marina Operations

8.3 Chemical Inventory

8.4 Procedure for Reporting a Spill and/or Hazardous Material

8.5 Spill Containment and Cleanup

8.6 Guidelines for Hazardous Materials Handling

8.7 Operational Controls

8.7.1 Transport and Handling

8.7.2 Vehicle Fueling

8.7.3 Maintenance and Repair

8.7.4 Vehicle Parking

8.7.5 Washing

**9.0 Glossary of Terms**

9.1 Acronyms and Abbreviations

### 7.2.2 CHILDREN'S BAY CAY EMP OUTLINE – OPERATIONS PHASE

The Children's Bay Cay EMP for the Operations Phase will include the items listed in the Table of Contents outline below.

**1.0 Introduction**

**2.0 Environmental Vision & Policy**

2.1 Legislative Requirements

2.1.1 Domestic Legislation

2.1.2 International Laws & Standards

2.2 References and Contact Information

2.3 Scope and Purpose

**3.0 EMP Administration & Responsibilities**

3.1 Roles and Responsibilities

3.2 Environmental Management Team

3.3 Records and Documentation Requirements

3.4 Monitoring Requirements

3.5 Incident Reporting Requirements

**4.0 Environmental Procedures**

4.1 Marina Operations - Best Management Practices

4.2 Landscaping Best Management Practices

4.3 Irrigation and Water Reuse

4.4 Pest Management

4.5 Invasive Species Control Plan

4.6 Solid Waste Handling

4.7 Wastewater Generation including RO Brine

**5.0 Pollution and Spill Prevention**

5.1 Management and Control of Hazardous Substances

5.2 Management and Control of Hazardous Substances – Marina Operations

5.3 Chemical Inventory

5.4 Procedure for Reporting a Spill and/or Hazardous Material

5.5 Spill Containment and Cleanup

5.6 Guidelines for Hazardous Materials Handling

5.7 Operational Controls

5.7.1 Transport and Handling

5.7.2 Vehicle Fueling

5.7.3 Maintenance and Repair

5.7.4 Vehicle Parking

5.7.5 Washing

**6.0 Glossary of Terms**

6.1 Acronyms and Abbreviations

# 8.0 Public Consultation

Public consultation will be as advised and directed by Government.

# 9.0 Conclusions

To prepare this environmental impact assessment document, studies were conducted addressing infrastructure and utility requirements, marina basin flushing and water quality, and terrestrial and marine ecological impacts.

The majority of the shoreline is to remain unaltered, and protection of existing coastal rock communities is anticipated to provide adequate storm protection to the upland development and residents. The conceptual master plan includes realignment of the private marina entrance channel that will make the resort an attractive destination for residents and guests. The larger marina entrance channel and pump system will improve flushing in the marina basin and the adjacent waters.

From an impact perspective, a field assessment was conducted that included the characterization of marine and terrestrial natural resources, topography and geology, among others. The project will cause some minor adverse impacts to two existing salt ponds and several areas of isolated mangroves and the marine environment from the overwater villas and docks and realigned marina channel. However, potential impacts can be minimized through best management practices (BMPs) during construction and operation. A detailed environmental management plan will be developed to assure that potential impacts from stormwater runoff, turbidity, etc. during construction and operations are minimized to the greatest extent possible. A total of approximately 26 acres of direct upland impacts are expected as a result of the resort development, the remainder of Children's Bay Cay will be managed to preserve and enhance native vegetation and habitats as much as possible.

Ultimately, a well-designed and conscientiously managed low-density resort development can provide for long-term maintenance and preservation of habitat for native wildlife and have manageable environmental impacts through comprehensive environmental planning that focuses on wildlife conservation, habitat enhancement, sediment quality and water quality.

Developing a comprehensive project environmental management plan (EMP) will be critical to the sustainability and controlling the potential for environmental impacts from the proposed development. It is expected that the residents of the Exuma Cays will benefit from the proposed

Children's Bay Cay development project. The project construction is expected to occur over a several year period, providing short-term employment opportunities in construction and services. Once completed, there will be significant permanent employment opportunities.

The project will also catalyze a substantial population increase for the Exuma Cays area. People moving to the area will include not only resort residents and visitors, but staff and employees of the development, as well as their families. In addition to persons directly employed by or at Children's Bay Cay, new entrepreneurial opportunities to provide goods and services will emerge and result in the creation of a number of new businesses that will also need employees. All of these employees and their families will in turn require housing at nearby settlements, health care, utilities, schools, and consumer goods, such as groceries and gasoline, and services, such as auto repair and garbage removal. The long-term sustainable economic and civic growth should be a positive effect on the local community of Barraterre.

Despite a potential for some minimal short term environmental impacts, the project has the potential to catalyze the local economy and create viable, long-term opportunities for local employment at an extremely low-density resort development. With the proper planning, application and monitoring of the Environmental Management Plan and if Best Management Practices are conscientiously planned, engineered and implemented, many of the impacts that are generated during construction and operation should be minimized or completely eliminated for the proposed project.

# 10.0 References

Areces-Mallea, A.E., A. Weakley, X. Li, R.G. Sayre, J.D. Parrish, C.V. Tipton, and T. Boucher. 1999. A Guide to Caribbean Vegetation Types: Preliminary Classification Systems and Descriptions. The Nature Conservancy, Arlington VA, USA.

Bahamas National Trust. 2006. General Management Plan – the Exuma Cays Land and Sea Park. Media Enterprises Ltd., Nassau. 40 pp.

Bain, Sherrie. 2000. Human Impact and the Marine Environment in the Bahamas. In Bahamas Journal of Science, Volume 8; Number 1, November 2000.

Buden, Donald W. 1995. Bahamian Land Mammals, with a guide to the Identification of Bats. In Bahamas Journal of Science, Volume 2; Number 2, February 1995.

Chiappone, Mark, K.M. Sullivan and R. Sluka. 1997. Reef Invertebrates of the Exuma Cays, Bahamas. Part 1 - Corals in Bahamas Journal of Science Volume 4, Number 2 – February 1997 and Part 2 – Octocorals in Bahamas Journal of Science Volume 4, Number 3 – June 1997.

Convention of International Trade of Endangered Species (CITES). 1987. CITES-Listed Species Database. Retrieved on February 8th, 2005 from http://www.cites.org/eng/resources/species.html.

Government of the Commonwealth of the Bahamas. May 23, 1997. Conservation and Physical Landscape Act of the Bahamas, 1997. Gazette, 12: 1-18.

Humann, P. 1998. Reef Coral Identification. New World Publications, Inc. Jacksonville, Florida, USA.

International Union for Conservation of Nature and Natural Resources (IUCN). 2009. IUCN Red List of Threatened Species Version 2009.2. Downloaded on 11 November 2009.

Lee, David S. and M.K. Clark. 1994. Seabirds of the Bahamas Land and Sea Park. In Bahamas Journal of Science. Volume 2, Number 1 – October 1994.

Lee, David S. and W Mackin. Demise of White-Tailed Tropicbird Colony in the Exumas Land and Sea Park. In Bahamas Journal of Science. Volume 11, Number 2 – May 2004.

National Hurricane Center. 2007. National Hurricane Center Archive of Hurricane Seasons. www.nhc.noaa.gov/pastall.shtml

Popov, Jane and Nicolas. 1998. Saving the Exuma Cays Land and Sea Park. In Bahamas Journal of Science, Volume 5; Number 2 – February 1998.

Ray, G. Carleton. 1998. Bahamian Protected Areas; Part 1: How It All Began. In Bahamas Journal of Science; Volume 6; Number 1 – November 1998.

Shaklee, Ronald V. 1998. Historical Hurricane Impacts on the Bahamas Part II: 1750-1799. In Bahamas Journal of Science; Volume 5; Number 2 – February 1998.

SLUKA, Robert D., M. Chiappone and K.M. Sullivan. 1996. Habitat Preferences of Groupers in the Exuma Cays. In: Bahamas Journal of Science; Volume 4; Number 1 – October 1996.

Sullivan, Kathleen M. 1991. Guide to the Shallow Water Marine Habitats and Benthic Communities of the Exuma Cays Land and Sea Park. Sea and Sky Foundation, Coral Gables, Florida.

United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). 11 November, 2009. UNEP-WCMC Species Database: CITES-listed Species.

U.S. Army Corps of Engineers (USACE). December 2004. Water Resources Assessment of the Bahamas. Mobile District and Topographic Engineering Center. United States Southern Command.

White, A. 1998. A Birder's Guide to the Bahamas Islands. The American Birding Association, Inc., USA.

# *Appendix A*

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

The following marine life species were observed and identified during underwater inspections conducted during the week of April 6, 2015 in the nearshore ocean waters in the vicinity of Childrens Bay Cay and Windsock Cay, Exumas, Bahamas. The list should be considered as preliminary, and it is likely that additional species would be identified if additional surveys were conducted.

| Family/Scientific Name | Common Name | Life Form | Habitat | Abundance | Comments |
|---|---|---|---|---|---|
| **CRUSTACEANS** | | | | | |
| *Cardisoma guanhumi* | Land Crab | Crab | Mangrove edges | Common | In landside habitats |
| Diogenidae | Hermit Crab | Crab | Reefs, hardbottom | Occasional | also landside habitats |
| *Ocypode albicans* | Ghost Crab | Crab | Beaches | Occasional | only at sandy beaches |
| *Percnon gibbesi* | Nimble Spray Crab | Crab | Reefs, rocky areas | Occasional | Intertidal |
| Pinnotheridae | Pea crab | Crab | Reefs | Occasional | usually hidden |
| **MOLLUSKS** | | | | | |
| *Acanthopleura granulata* | Fuzzy Chiton | Chiton | Intertidal rocks | Occasional | Edible |
| *Batillaria minima* | Black Horn Snail | Snail | Intertidal rocks | Common | Intermittently abundant |
| *Cassis flammea* | Flame Helmet | Snail | Seagrass beds | Occasional | Attractive to tourists |
| *Cerithium litteratum* | Stocky Cerith | Snail | Seagrass beds | Common | Occasional in lg groups |
| *Cyphoma gibbosum* | Flamingo Tongue | Snail | Reefs, esp sea fans | Occasional | Attractive to tourists |
| *Fasciolaria tulipa* | Tulip | Snail | Shallow areas, bays | Occasional | only on bank side |
| *Laevicardium laevigatum* | Common Egg Cockle | Clam | Sandy bottoms | Occasional | only on bank side |
| *Nerita peloronta* | Bleeding Tooth | Snail | Intertidal rocks | Occasional | only on bank side |
| *Pinna carnea* | Sea pen | Clam | Sands & grassbeds | Common | only on bank side |
| *Strombus costatus* | Milk Conch | Conch | Grassbeds, sand flats | Occasional | Mostly juveniles |
| *Strombus gigas* | Queen Conch | Conch | Grassbeds, sand flats | Occasional | Mostly juveniles |
| *Tectarius muricatus* | Beaded Periwinkle | Snail | Shoreline Coastal Rock | Common | On rocks near water line |
| *Turbinella anglata* | West Indian Chank Shell | Snail | Sandy bottoms | Occasional | Edible |
| **ECHINODERMS** | | | | | |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| *Diadema antillarum* | Long-spined Urchin | Sea urchin | Reefs | Common | Mainly on bank side |
| *Echinometra lucunter* | Rock-boring Urchin | Sea urchin | Reefs, coral rubble | Occasional | Reef grazer |
| *Lytechinus variegatus* | Variegated Urchin | Sea urchin | Reefs, ruuble, grassbeds | Occasional | White spines |
| *Oreaster reticulatus* | Cushion Sea Star | Starfish | Grassbeds, sand flats | Occasional | Attractive to tourists |
| *Tripneustes ventricosus* | West Indian Sea Egg Urchin | Sea urchin | Seagrass beds, reefs | Occasional | Reef grazer |
| **SHORELINE VEGETATION** | | | | | |
| *Avicennia germinans* | Black Mangrove | Tree | Shorelines | Occasional | In transition zone to land |
| *Conocarpus erectus* | Buttonwood Mangrove | Tree | Shorelines | Occasional | In transition zone to land |
| *Rhizophora mangle* | Red Mangrove | Tree | Shorelines | Occasional | In transition zone to land |
| **MARINE PLANTS** | | | | | |
| SEAGRASSES | | | | | |
| *Halodule wrightii* | Shoal-grass | Seagrass | Typically shallow bays | Common | Sparse to dense |
| *Syringodium filiforme* | Manatee-grass | Seagrass | Typically shallow bays | Occasional | Moderate to sparse |
| *Thalassia testudinum* | Turtle grass | Seagrass | Typically shallow bays | Abundant | Density variable |
| MACROALGAE | | | | | |
| Rhodophyta | | | | | |
| *Acanthophora spicifera* | | Red Algae | On hard substrates | Occasional | On shell fragments |
| *Amphiroa tribulus* | | Red Algae | On hard substrates | Occasional | vulnerable to damage |
| *Galaxaura obtusata* | Calcareous red algae | Red Algae | On hard substrates | Occasional | vulnerable to damage |
| *Galaxaura rugosa* | Calcareous red algae | Red Algae | On hard substrates | Occasional | vulnerable to damage |
| *Gracilaria* sp. | | Red Algae | On hard substrates | Occasional | |
| *Jania adhaerens* | | Red Algae | Attached to rubble | Occasional | |
| *Laurencia* sp. | Laurencia | Red Algae | On hard substrates | Occasional | |
| *Neogoniolithon spectabile* | | Red Algae | On hard substrates | Occasional | |
| *Trichogloea* sp. | | White Algae | On hard substrates | Occasional | Only saw one colony |
| *Tricleocarpa* sp. | | Red Algae | on hard substrates | Occasional | |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| Phaeophyta | | | | | |
| *Dictyota cervicornis* | | Brown Algae | On hard substrates | Occasional | In healthly abundances |
| *Dictyota pinnatifida* | | Brown Algae | On hard substrates | Occasional | In healthly abundances |
| *Lobophora variegata* | Fluffy Ruffles | Brown Algae | On hard substrates | Occasional | In healthly abundances |
| *Padina haitiensis* | Scroll Algae | Brown Algae | On hard substrates | Occasional | In healthly abundances |
| *Padina pavonica* | Scroll Algae | Brown Algae | On hard substrates | Common | In healthly abundances |
| *Padina sanctae-crucis* | Scroll Algae | Brown Algae | On hard substrates | Abundant | In healthly abundances |
| *Padina* sp. | Scroll Algae | Brown Algae | On hard substrates | Occasional | In healthly abundances |
| *Sargassum hystrix* | Sargassum Weed | Seaweed | Drift, sometimes rooted | Occasional | In healthly abundances |
| *Sargassum platycarpum* | Sargassum Weed | Seaweed | Drift, sometimes rooted | Occasional | In healthly abundances |
| *Trichogloea requienii* | | Seaweed | Solid substrates | Occasional | In healthly abundances |
| *Turbinaria turbinata* | (Thick-stalk) | Brown Algae | Solid substrates | Occasional | In healthly abundances |
| Chlorophyta | | | | | |
| *Acetabularia crenulata* | Mermaid's Wine Glass | Green Algae | Sandy areas nr reefs | Occasional | In healthly abundances |
| *Batophora aerstedii* | | Green Algae | On hard substrates | Common | In healthly abundances |
| *Caulerpa cupressiodes* | Cactus tree algae | Green Algae | Sandy areas, betw reefs | Occasional | In healthly abundances |
| *Caulerpa paspaloides* | | Green Algae | Shallows | Occasional | In healthly abundances |
| *Caulerpa racemosa* | Green grape algae | Green Algae | Sandy areas | Occasional | In healthly abundances |
| *Caulerpa racemosa occidentali* | Green grape algae | Green Algae | Sandy areas | Occasional | In healthly abundances |
| *Cladocephalus scoparius* | | Green Algae | Grassbeds | Occasional | In healthly abundances |
| *Dasycladus vermicularis* | Fuzzy finger algae | Green Algae | ttached to solid substrat | Common | In healthly abundances |
| *Halimeda incrassata* | Three-finger Leaf Algae | Green Algae | Grassbeds and reefs | Common | Interspersed w/ seagrass |
| *Microdictyon sp.* | Network Algae | Green Algae | Attached to reefs | Occasional | In healthly abundances |
| *Neomeris annulata* | | Green Algae | Solid substrates | Occasional | Only saw nr Windsock |
| *Penicillus capitatus* | Bristle Ball Brush | Green Algae | Mud and sand bottoms | Occasional | Variable densities |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| Chlorophyta Continued | | | | | |
| *Rhipocephalus phoenix* | | Green Algae | Sandy bottoms | Common | Interspersed w/ seagrass |
| *Udotea cyathiformis* | Mermaid's Tea Cup | Green Algae | Sandy areas, betw reefs | Occasional | Interspersed w/ seagrass |
| *Valoniopsis pachynema* | | Green Algae | Reefs, hardbottom | Occasional | primarily on bank side |
| **FISH** | | | | | |
| *Chaetodon ocellatus* | Spotfin Butterflyfish | Fish | Reefs | Occasional | In healthly abundances |
| *Holacanthus ciliaris* | Queen Angelfish | Fish | Reefs | Occasional | In healthly abundances |
| *Pomacanthus arcuatus* | Gray Angelfish | Fish | Reefs | Occasional | In healthly abundances |
| *Pomacanthus paru* | French Angelfish | Fish | Reefs | Occasional | In healthly abundances |
| *Acanthus caeruleus* | Blue Tangs | Fish | Reefs | Common | In healthly abundances |
| *Acanthurus chirurgus* | Doctorfish | Fish | Reefs | Occasional | In healthly abundances |
| *Caranx crysos* | Blue Runner | Fish | Reefs & Sandy bottoms | Occasional | In healthly abundances |
| *Sphyraena barracuda* | Great Barracuda | Fish | Reefs & Sandy bottoms | Occasional | Over grassbeds & reefs |
| Gerridae | Mojarra | Fish | Sandy Bottoms | Occasional | In shallows at grassbeds |
| Atherinidae, Clupeidae | Silversides, Herrings, Anchovies | Fish | Reefs, mangroves | Common | Schools of thousands |
| *Haemulon macrostomum* | Spanish Grunt | Fish | Nearshore reefs | Occasional | Only saw nr Windsock |
| *Haemulon* sp. | Grunt | Fish | Reefs | Occasional | Likley several species |
| *Lutjanus analis* | Mutton Snapper | Fish | Reefs | Common | Food fish |
| *Lutjanus apodus* | Schoolmaster | Fish | Reefs | Common | In healthly abundances |
| *Lutjanus mahogoni* | Mahogany Snapper | Fish | Reefs | Common | In healthly abundances |
| *Ocyurus chrysurus* | Yellow-tail Snapper | Fish | Reefs | Occasional | Food fish |
| *Stegastes leucostictus* | Beaugregory | Fish | Reefs, hardbottom | Common | In healthly abundances |
| *Stegastes variabilis* | Cocoa Damselfish | Fish | Reefs, hardbottom | Occasional | In healthly abundances |
| Pomacentridae | Damselfish | Fish | Reefs, hardbottom | Common | In healthly abundances |
| *Abudefduf saxatilis* | Sergeant Major | Fish | Rocks, shorelines | Common | In healthly abundances |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| *Chromis cyanea* | Blue Chromis | Fish | Reefs | Occasional | In healthly abundances |
| *Epinephelus adscensionis* | Rock Hind | Fish | Reef ledges | Occasional | In healthly abundances |
| *Epinephelus striatus* | Nassau Grouper | Fish | Reef ledges | Common | Many juveniles |
| *Epinephelus fulvus* | Coney | Fish | patch reefs | Occasional | East reefs |
| *Epinephelus sp.* | Grouper | Fish | patch reefs | Occasional | juv - in grasbed |
| *Sparisoma viridae* | Stoplight Parrotfish | Fish | Reefs | Common | East reefs |
| *Sparisoma rubripinne* | Redfin Parrotfish | Fish | Reefs | Occasional | East reefs |
| *Bodianus rufus* | Spanish Hogfish | Fish | Reefs | Occasional | East reefs |
| *Thalassoma bifasciatum* | Bluehead Wrasse | Fish | Reefs | Abundant | Bank & Sound |
| *Halichoeres bivittatus* | Slippery Dick | Fish | Reefs, grassbeds | Common | East reefs |
| *Holocentrus* sp. | Squirrelfish | Fish | Crevices in reef/rocks | Occasional | Bank & Sound |
| *Gobiosoma sp* | Goby | Fish | Reefs | Uncommon | Cleaner |
| Clinidae | Blenny | Fish | On reef & rocks | Occasional | East reefs |
| *Diodon holocanthus* | Balloonfish | Fish | Grassbeds | Occasional | Bank seagrasses |
| *Diodon hystrix* | Porcupinefish | Fish | Caves, recesses | Occasional | East reefs |
| *Dasyatis americana* | Southern Stingray | Fish | Sandy Areas | Occasional | Common nr Windsock |
| *Urolophus jamaicensis* | Yellow Stingray | Fish | Sandy Areas | Uncommon | Bank Grassbeds |
| **CORALS** | | | | | |
| Hydrocorals | | | | | |
| *Millepora alcicornis* | Fire Coral | Coral | Reefs | Common | East reefs |
| *Millepora complanata* | Blade Fire Coral | Coral | Reefs | Occasional | Most colonies low |
| **Octocorals** | | | | | |
| *Briareum asbestinum* | Corky Sea Fingers | Coral | Reefs | Common | only saw at patch reef |
| Octocorals, Continued | | | | | |
| *Eunicea* sp. | Sea Rod | Coral | Reefs, walls | Occasional | Most < 3' in height |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| *Eunicea mammosa* | Swollen-knob Canldeabrum | Coral | hallow hardbottoms, ree | Occasional | Bank and Sound |
| *Gorgonia ventalina* | Common Sea Fan | Coral | Reefs, esp seaward side | Common | East reefs |
| *Plexaura flexuosa* | Bent Sea Rod | Coral | Reefs | Occasional | Bank and Sound |
| *Plexaura homomalla* | Black Sea Rods | Coral | Reefs | Occasional | Bank and Sound |
| *Pseudoplexaura* sp. | Porous Sea Rods | Coral | Reefs | Occasional | Bank and Sound |
| *Pseudopterogorgia* sp. | Sea Plumes | Coral | Reefs | Common | to + 1 meter height |
| *Pseudopterogorgia americana* | Slimy Sea Plume | Coral | Reefs | Common | to + 1 meter height |
| *Pterogorgia citrina* | Yellow Sea Whip | Coral | Reefs, hardbottom | Occasional | East reefs |
| **Stony Corals** | | | | | |
| *Acropora palmata* | Elkhorn Coral | Coral | Shallow reefs | Occasional | Only Horseshoe Cove |
| *Agaricia agarcites* | Lettuce Coral | Coral | Reefs | Occasional | Mostly East reefs |
| *Diploria clivosa* | Knobby Brain Coral | Coral | Reefs | Occasional | Mostly East reefs |
| *Diploria labyrinthiformis* | Grooved Brain Coral | Coral | Reefs | Occasional | Some to 1 meter |
| *Diploria strigosa* | Brain Coral | Coral | Reefs | Occasional | Some to 80 cm diameter |
| *Eusmilia fastigiata* | Smooth Flower Coral | Coral | Reefs | Occasional | only saw at patch reef |
| *Favia fragum* | Golfball Coral | Coral | Shallow reefs | Occasional | Bank and Sound |
| *Manicina areolata* | Rose Coral | Coral | sandy bottoms | Occasional | Amid seagrasses |
| *Montastrea annularis* | Boulder Star Coral | Coral | Reefs | Occasional | East reefs only |
| *Porites astreoides* | Mustard Hill Coral | Coral | Reefs | Occasional | Bank and Sound |
| *Porites porites* | Finger Coral | Coral | Reefs & grassbeds | Occasional | Bank and Sound |
| *Siderastrea sidera* | Massive Starlet Coral | Coral | Hardbottom, reefs | Occasional | Bank and Sound |
| *Solenastrea bournoni* | Smooth Star Coral | Coral | Reefs | Occasional | Bank and Sound |
| **SPONGES** | | | | | |
| *Anthosigmella varians* | Brown Variable Sponge | Sponge | Coral Reefs | Occasional | East Reefs |
| Aplysina sp. | Rope Sponge | Sponge | Coral reefs | Occasional | East Reefs |

Appendix A
Marine Life Observed at/near Childrens Bay Cay and Windsock Cay

| | | | | | |
|---|---|---|---|---|---|
| Demospongiae | Green Encrusting Sponge | Sponge | Hardbottom | Common | East Reefs |
| *Diplastrella* sp. | Orange Encrusting Sponge | Sponge | Hardbottom | Occasional | East Reefs |
| *Ircinia strobilina* | Black-ball Sponge | Sponge | Coral Reefs | Occasional | Bank and Sound |
| *Niphates digitalis* | Pink Vase Sponge | Sponge | Coral Reefs | Occasional | East Reefs |
| *Phorbas amaranthus* | Red Encrusting Sponge | Sponge | Shaded hardbottom | Occasional | East Reefs |
| *Verongula* gigantea | Netted Barrel Sponge | Sponge | Reefs | Occasional | East Reefs |
| **CNIDARIANS** | | | | | |
| *Condylactis gigantea* | Pink-tipped (Giant) Anemone | Anemone | Reefs & Lagoons | Occasional | Bank and Sound |
| Hydroida | Hydroid | Hydroid | Reefs | Occasional | Bank and Sound |
| *Zoanthus pulchellus* | Mat Zoanthid | Hydroid | Reefs, hardbottom | Occasional | Bank and Sound |
| **ANNELIDS** | | | | | |
| *Anamobaea orstedi* | Split-crown feather-duster | Worm | Reefs | Occasional | Bank and Sound |
| *Arenicola cristata* | Southern Lugworm | Worm | Sandy bottoms | Common | Sound only |
| *Bispira brunnea* | Social Feather Duster | Worm | Reefs | Common | Bank and Sound |
| *Spirobranchus giganteus* | Christmas-tree Worm | Worm | Coral reefs | Occasional | Bank and Sound |
| *Pomatostegus stellatus* | Star Horseshoe Worm | Worm | Reefs | Occasional | Bank and Sound |

# *Appendix B*

Appendix B

Children's Bay Cay Landside Fauna List

The following species were observed during landside field assessments conducted on Childrens Bay Cay, Bahamas during the week of April 5, 2015. This list should be considered preliminary, and that additional species would be identified if additional surveys were conducted, particularly during different times of the year.

| **Scientific Name** | **Common Name** | **Habitat** | **Abundance** | **Residential Status** |
|---|---|---|---|---|
| **CRUSTACEANS and ARTHROPODS** | | | | |
| *Ocypode albicans* | Ghost Crab | Sandy Shorelines | Uncommon | Resident |
| *Cardisoma guanhumi* | Land Crab | Coastal lowlands | Occasional | Resident |
| *Coenobita clypeatus* | Land Hermit Crab | Above mean high water, among plants | Uncommon | Resident |
| *Percnon gibbesi* | Nimble Spray Crab | Rocky intertidal | Uncommon | Resident |
| **MOLLUSKS** | | | | |
| *Cerion* sp. | Peanut snail | Herbaceous & other low-growing vegetation | Common | Resident |
| *Tectarius muricatus* | Beaded Periwinkle | Supra-tidal rocks | Common | Resident |
| *Species unidentified* | Land snail | Herbaceous & other low-growing vegetation | Occasional | Resident |
| **BIRDS** | | | | |
| *Larus atricilla* | Laughing Gull | Shorelines, scavenger | Occasional | Resident |
| *Sterna antiallarum* | Least Tern | Nearshore open waters, roosts on beaches | Occasional | Summer resident |
| *Sterna maxima* | Royal Tern | Nearshore open waters, roosts on beaches | Occasional | Resident |
| *Ardea alba* | Great Egret | Shorelines & shallow inland wetlands | | Resident |
| *Butorides virescens* | Green Heron | Shorelines & shallow inland wetlands | Occasional | Resident |
| *Nyctanassa violacea* | Yellow-crowned Night-heron | Shorelines & shallow inland wetlands | Occasional | Resident |
| *Pluvialis squatarola* | Black-bellied Plover | Sandy Shorelines | Occasional | Winter Resident |

# Appendix B
## Children's Bay Cay Landside Fauna List

| | | | | |
|---|---|---|---|---|
| **BIRDS, Continued** | | | | |
| *Charadrius wilsonia* | Wilson's Plover | Sandy beaches | Occasional | Resident |
| *Charadrius melodus* | Piping Plover | Sandy beaches, salt pond fringes | Occasional | Winter Resident |
| Haematopus palliatus | American Oystercatcher | Rocky Shorelines | Occasional | Resident |
| *Pandion haliaetus* | Osprey | Coastal areas, feeds on fish, nests nr water | Uncommon | Nests nearby |
| *Columba leucocephala* | White-crowned Pigeon | Coastal hammock, usu roosts & nests on island | Uncommon | Resident |
| *Columba passerina* | Common Ground-dove | Sparsely-vegetated uplands | Common | Resident |
| *Calliphlox evelynae* | Bahama Woodstar | Coppice, typically nr nectar-producing flowers | Uncommon | Resident |
| *Mimus gundlachii* | Bahama Mockingbird | Coppice, Scrub, woodlands | Occasional | Resident |
| *Dumetella carolinensis* | Gray Catbird | Thickets, shrublands | Occasional | Winter resident |
| *Vireo crassirostris* | Thick-billed Vireo | Thick coppice, bushy forest edges | Occasional | Resident |
| *Dendroica discolor* | Prairie Warbler | Coppice, thicket & forest | Common | Winter resident |
| *Seiurus aurocapillus* | Ovenbird | Semi-open, muddy/wet areas | Uncommon | Migrant |
| *Coerba flaveola* | Bananaquit | Coppice, thicket & forest | Common | Resident |
| *Loxigilla violacea violacea* | Greater Antillean Bullfinch | Dense thickets, dense coppice | Occasional | Resident |
| **REPTILES and AMPHIBIANS** | | | | |
| *Anolis sagrei ordinatus* | Bahamian Brown Anole | Semi-open uplands | Common | Resident |
| *Leiocephalus carinatus oryi* | Curly-tailed Lizard | Coppices, urban areas (Neighbor Cay only) | Abundant | Resident |
| *Epicrates striatus strigulatus* | Bahama Boa [1] | Coppice, shed skin found in agricultural areas | Occasional | Resident |

1 = Not observed during field assessment, but reported by residents to be year-round resident

# *Appendix C*

# THE BAHAMAS NATIONAL WETLANDS POLICY

Prepared by The BEST Commission
National Wetlands Committee

# TABLE OF CONTENTS

FOREWORD 1

Development of the National Wetlands Policy of the Government of The Bahamas

1. INTRODUCTION 2
   a. What are wetlands?
      i. Definition
      ii. Functions of Wetlands
   b. Threats to Bahamian wetlands
   c. Economic Potential and Consequences of Wetland Loss
   d. Hurricanes

2. POLICY 5
   a. Why Is a Wetland Policy Needed?
   b. Purpose for the Policy
   c. Goal
   d. Objectives
   e. Guiding Principles
   f. Partnership and Cooperation

3. STRATEGIES 8
   a. Managing the Wetlands
      i. Classification
      ii. Duty of Landowners in Respect to Use of Wetlands
      iii. Restoration and rehabilitation
      iv. Monitoring
   b. Policies and Delivering Programmes 11
      i. Guidelines for Environmental Impact Assessments
      ii. Education, Public Awareness and Training Programme
      iii. Management Programme for Publicly-Owned Wetlands
      iv. Looking at Wetlands to Assist in Stormwater Management
   c. Involving the Bahamian People in Wetlands Management 13
   d. Working in Partnership with Local Government
   e. Ensuring a Sound Scientific Basis for Policy and Management
   f. International Actions

4. LEGISLATION 15
   a. Bahamian Laws
   b. International Conventions

5. IMPLEMENTATION OF THE POLICY 17

ANNEXES
   ANNEX A: Guidelines for Environmental Impact Assessments A-1
   ANNEX B: A Summary of the National Parks Regulations A-8
   ANNEX C: List of "Protected Parks" A-10
   ANNEX D: Definitions A-11

# FOREWORD

## DEVELOPMENT OF THE NATIONAL WETLANDS POLICY OF THE GOVERNMENT OF THE BAHAMAS

On June 7, 1997 The Bahamas signed the Ramsar Convention on Wetlands. Earlier in 1971, in the city of Ramsar Iran, a global agreement was reached when countries around the world recognized that globally wetlands were disappearing at an alarming rate. This loss was being felt in the areas of declining freshwater resources, declining fisheries, increasing flood episodes, and declining water fowl populations. Due to this intergovernmental treaty, a framework was established for national action and international cooperation for the conservation and wise use of wetlands and their resources worldwide. There are presently 146 Contracting Parties to the Convention, with 1429 wetland sites of which The Bahamas' Inagua National Park (Lake Rosa) is included.

In The Bahamas the administrative authority for the implementation of the Ramsar Convention is The BEST Commission and it is through its global obligations and in the national interest that the government pursued the development of a National Wetlands Policy. One unique approach to wetlands management within the convention is the concept of "Wise-Use".

The Convention defines 'wise use' as:

> *Sustainable utilization [of wetlands] for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem.*

The National Wetlands Policy of the Government of The Bahamas contains a goal, objectives and a number of guiding principles. These provide specific direction for the Government's actions that directly or indirectly affect wetlands. The objectives and principles recognize the national importance of wetlands and will serve to ensure that there is a consistent approach to wetlands management by all organizations with responsibilities in this area.

The National Wetlands Committee commenced public consultations in August, 2004. For an eight-month period, public meetings were held on the islands of Eleuthera, San Salvador, Mayaguana, Central and South Andros, Long Island, Grand Bahama and in New Providence. Based on input from the public meetings, stakeholder group meetings and input from Local Government and Central Government, a policy was drafted and circulated for comment before final submission to Cabinet for endorsement.

# 1. INTRODUCTION

WHAT ARE WETLANDS?

*Definition*

According to the Ramsar Convention, the term "wetlands" is defined as: *'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"* including areas which *"may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands".*

Wetlands mainly occur in transitional areas between terrestrial and aquatic systems. The associated aquatic systems may be tidal or nontidal, and may be freshwater, brackish, or marine systems. Wetlands may also occur in upland areas and areas unassociated with any open surface water bodies or aquatic systems. Areas not associated with aquatic systems may exhibit the characteristics listed above due to the flow of groundwater to surface, the presence of groundwater at the surface, the presence of groundwater near the surface, or the influx of precipitation. In addition to freshwater wetlands, there are coastal wetlands, brackish or salt, tidal creeks, blue holes and coral reefs.

Areas not directly associated with the marine environment that exhibit the characteristics listed above due to the flow of groundwater to the surface, or from an influx of rainfall, are also defined as wetlands. All wetlands in The Bahamas fit within the Ramsar definition.

*Functions of Wetlands*

Water is the source of all life as all organisms contain water and depend upon it for survival. Water is crucial for all biodiversity including man. Freshwater wetlands are vital for the provision of potable water and recharge of the aquifers.

- Wetlands are one of the most important eco-systems on Earth due to the vast biodiversity, nutrient rich soils. Wetlands are vital to the survival of a vast array of plants, animals, fish, birds, insects, reptiles and other flora and fauna. Coastal wetlands, including, tidal creeks, and coral reefs sustain most forms of marine life (e.g. grouper, lobster, crabs, etc.), which are important to the economy of The Bahamas.

- Wetlands, including coastal wetlands and tidal creeks, provide natural flood control and coastline protection by absorbing water, trapping sediment and by stabilizing the shoreline.

- Wetlands, because of their importance to birds, animals and fish, provide recreational areas to many and offer the potential for an expanded eco-tourism industry along with educational opportunities.

## THREATS TO BAHAMIAN WETLANDS

One of the primary threats to the Bahamian wetlands can be attributed to the lack of awareness. Most residents living near wetland features are unaware of the importance and vital functions that wetlands provide to their community. One of the contributors to this problem is that the benefits provided by wetlands are less obvious and difficult to quantify in economic terms. Historically, wetlands were considered wastelands or swamps. The low topographic relief of these areas in the islands is why wetlands were historically used as dumpsites, and even today some settlements continue this practice.

Development of resorts, housing, businesses, marinas and roads, constantly fragments the wetlands, contributing to the destruction of these precious resources. Each development may bring benefits such as jobs or services, but it also brings the potential for increased flood damage and loss of habitat for fisheries and wildlife if not done in an environmental conscience way.

Traditionally, throughout The Bahamas septic systems are used for sewage treatment. Unfortunately a vast number of them are built improperly or clustered in small areas, resulting in a non-point source of contamination that can potentially seep into the groundwater table, the marine environment and wetlands. Other forms of pollutants are fertilizers and pesticides utilized on farms, which cause agricultural run-off, another non-point source of contamination.

Another threat to wetlands is the introduction of foreign plants and animals to the systems. Foreign species are introduced intentionally and unintentionally through imported garden plants, ship ballast water and even on the hulls of boats and ships.

## ECONOMIC POTENTIAL AND CONSEQUENCES OF WETLAND LOSS

Due to the numerous benefits that wetlands provide it is very difficult to place a measure on their economic value or loss. As The Bahamas expands its eco-tourism market, wetlands are utilized for canoeing, birding, nature walks and educational experiences. In 2004, utilizing small areas of wetlands, small business and organizations generated an estimated $30,000 from using the wetlands for recreational purposes on Grand Bahama and Inagua. This figure does not include the estimated $15 million from the Central Andros National Parks, which include several important wetland areas that contribute to the local Andros economy through its lucrative fly-fishing industry.

One of the reasons that the fishing industry has thrived in The Bahamas is because of the vast amount of coastal wetlands that serve as marine nurseries. As a direct result of these nurseries the fishing industry is the third largest industry in the Bahamas, generating millions of dollars annually in exports. The fishing industry currently contributes 1-3% of the Bahamian GDP.

HURRICANES

The Bahamas is no stranger to hurricanes and the damage caused as a result of these storms. Every year the number, frequency and intensity of hurricanes increase along with the destruction of wetlands by man. As the wetlands are degraded or lost, they lose their natural capacity to absorb water, retain sediment and protect the shoreline, increasing the threat of flooding. The Bahamas has seen an increase in the amount of infrastructure damage as a result of construction in and along wetlands and coastal areas. In 2004, the flood and surge damage from hurricanes was calculated to exceed an estimated $500 million. While wetlands will not prevent damage due to hurricane events they do offer a natural means of defense and remediation.

## 2. POLICY

WHY IS A WETLAND POLICY NEEDED?

In The Bahamas, despite the vital role they play in the ecosystem, wetlands are currently not being given proper consideration when it comes to conservation versus development. Therefore, due to the lack of a national policy decision with respect to wetlands protection, wetlands are being fragmented and lost in the face of growing national development. When faced with the decision of wetland development or protection, communities bear the majority of the cost associated with wetland lost as opposed to the individuals who gain as a result of its development. For this reason public education and awareness, as it relates to the importance and benefits that wetlands offer to communities, should be included in the decision-making process.

At present there is neither Government policy nor legislation that provides comprehensive protection to wetlands. The existing laws for wetlands protection are adhoc and based on a multitude of laws that do not specifically deal with wetlands.
Since every island in The Bahamas has wetlands, it is imperative that a policy be put in place to provide specific mandates for The Bahamas' actions that directly or indirectly affect wetlands.

PURPOSE FOR THE POLICY

The purpose for this document is to have an all encompassing wetland policy which would clearly outline the guidelines and objectives of the Government of The Bahamas for wetlands protection. It aims to provide those responsible for administering the existing laws and regulations related to wetlands with guidelines and a course of procedure to ensure wetlands are managed in a sustainable manner. It will provide a guide for activities which are likely to occur in and around wetlands.

GOAL

The goal of the National Wetlands Policy is to conserve, restore and manage wetlands wisely in conjunction with sustainable development practices.

OBJECTIVES

1. To manage human activity on or near wetlands in a manner which, will achieve no loss of significant wetland habitat and no net loss of wetland functions.

2. To promote the recognition and integration of wetland functions in resource management and economic development decision-making with regard to sector policies and programs.
3. To promote and facilitate the development of wetland stewardship, awareness, and education through government initiatives and cooperative relationships with local citizens, private sector stakeholders, and municipal, provincial and local governments.
4. To develop a shared vision between all spheres of Government and promote the application of wise-use practices in relation to wetland management and conservation.
5. To meet The Bahamas' commitments, as a signatory to relevant international treaties, in relation to management of the wetlands.

## GUIDING PRINCIPLES

The basic principles of wetland management are the following:

- The conservation of wetlands and their basic ecological functions is essential to the environmental and economic well-being of The Bahamas;

- Wetlands in The Bahamas will be managed in a sustainable manner, so that current and future generations of The Bahamas citizens and visitors will be able to benefit from these resources;

- Wetlands management in The Bahamas will embrace the" wise use of wetlands" concept adopted under the Ramsar Convention on Wetlands. This concept includes:

    - "sustainable utilization of wetlands for the benefit of human kind in a way compatible with the maintenance of the natural properties of the ecosystem"; and

    - "human use of wetlands may yield the greatest continuous benefit to present generations while maintaining their potential to meet the needs and aspirations of future generations".

- An environmental impact assessment (EIA) will be required for all activities in wetlands where such activities are likely to have an adverse impact on the wetlands.

- For wetland conservation and management it is vital that the present attitudes and perceptions of Bahamians regarding wetlands be changed.

PARTNERSHIP AND COOPERATION

The Government of The Bahamas is committed to having its agencies, departments and corporations working cooperatively, in partnership, and to achieve sound wetland management outcomes. The Government has recognized the need to define the roles and responsibilities of the relevant government agencies for the protection, mitigation and wise-use of the wetlands.

The success of this Policy is reliant upon the development of a cooperative partnership approach with all spheres of government, community groups, private landholders and the business sector. Through the Policy, the government can set the framework for working cooperatively with these other players to meet a common goal.

The Ramsar Convention on Wetlands is of international importance, especially as to waterfowl habitats. An important fact that is overlooked is that some of the species that reside in the wetlands are migratory. In an attempt to address this, international partnerships will be sought between the Government of the Bahamas and non-government organizations. Through these partnerships a wider range of resources and expertise can be utilized in dealing with wetlands.

## 3. STRATEGIES

MANAGING THE WETLANDS

*Classification*

Wetlands are characterized as: "Protected wetlands", "Partially Protected wetlands" or subjected to conservation by the local community and "Developed Wetlands".

A wetland declared "protected" shall be an area of international and national importance because of its biological diversity, ecological importance, landscape, natural heritage or recreational purposes in which the following activities may be allowed only after the granting of a permit:

a. Research;
b. Limited Ecotourism (only includes birding, wildlife viewing and walking); and
c. Restoration or enhancement of the wetland.

The following rules must be observed for "Protected Wetlands":

a. A minimum 150-ft buffer around the wetland from any permanent structure;
b. No watercrafts are allowed with in the wetlands;
c. No dredging or filling (except for restoration purposes)
d. No dumping; and
e. No construction.

A "partially protected" wetland may be declared as being capable of conservation by the local community and be in areas where persons who have property rights inland may carry out traditional activities, subject to such restrictions as may be imposed by the permitting agency and other relevant government agencies. These wetlands shall be areas where regulated activities may be permitted. Some of those activities are listed:

1. Ecotourism;
2. Research;
3. Restoration or enhancement of the wetlands;
4. Recreational activities such as spot fishing;
5. Maintenance of green spaces;
6. Drainage and/or coastal protection;
7. Commercial exploitation of wetland resources;
8. Construction of transport and communication facilities such as roads, railways, telephone lines; and
9. Construction of benches, boardwalks and jogging trails.

The following rules must be observed for "Partially Protected Wetlands":

a. A 100-ft buffer around the wetland;
b. Limited dredging or in-filling possibilities (require an environmental assessment)
c. Limited use of watercrafts; and

d. No dumping.

A "developed wetland" is a wetland that has already been or will be impacted by development. These wetlands can be modified but the developer will be required to either establish wetlands elsewhere or provide compensation in another form.

No person shall carry out any activity in a wetland without a permit. An application for the use of wetlands may be rejected where impacts are likely to be significant to communities and/or the environment.

It is implied that in any permit issued, the holder thereof shall:

a. Not substantially affect the hydrological and ecological characteristics of the wetland beyond the terms and conditions contained therein;
b. Keep and maintain the margins of the wetlands;
c. The permit is non-transferable;
d. If within a period of one year after the expiration or revocation of the permit under which the intend of the permit was not completed, the holder shall restore the wetland to as near the state it was in immediately before the commencement of the permitted activities, if such a state would prevent impacts to communities or damage to the environment.
e. Any deviation from the conditions of the permit can result in the termination of the project and the permit and a fine levied.

*Duty of Land Owners in Respect to Use of Wetlands*

Every landowner, occupier or user whose property is adjacent or contiguous with a wetland shall have a duty to prevent the degradation or destruction of the wetland and shall maintain the ecological and other functions of the wetlands within the limits of their boundaries.

Any land owner, occupier or user of land which is adjacent or contiguous with a wetland, which undertakes activities which degrades, damages, negatively impacts, or fails to take actions which will prevent impacts to the wetland based on those activities shall commit an offence that is punishable by a fine that would cover the cost to restore the wetland back to its original state.

*Restoration and Rehabilitation*

The goal of restoration is to restore an ecosystem structure, composition and natural processes of the wetlands biotic communities and its physical environment to near its natural state. Restoration of the natural functions can be achieved by altering the system, by removing stresses from the system, by excavation, by using vegetation (native species and avoiding non-native species), dams, dikes, levees, water control structures, substrate seals, and accessory structures (gabions).

The following steps should be followed for restoration and rehabilitation of wetlands:

1. Preserve and protect existing ecosystems (preventive measures are cheaper than reactive measures);
2. Site selection;
3. Develop clear, achievable and measurable goals
    i. Define the problem.
        - Topography, soils, hydrology, etc.
    ii. Identify types of solutions needed
    iii. Develop a strategy and goals for restoration and rehabilitation
    iv. Design for self sustainability
4. Determine feasibility
5. Address ongoing causes of degradation
    i. Identify ongoing stresses
    ii. Eliminate/remediate ongoing stresses
6. Use passive restoration that requires removal or remediation of the stresses on the system, and then the system is monitored for a designated time period to determine if the system has naturally restored itself.
7. Monitor and adapt where changes are necessary.
8. Utilize a skilled and multi-disciplinary team for the projects.

*Monitoring*

- Short and long-term goals for monitoring of the wetlands are to be established for a reasonable period after any works are complete in or around a wetland which might have an impact.

- Methods and standards for monitoring are to be established for works completed in or around a wetland which might have an impact.

- Partnerships with educational institutes, community groups and non-government organizations for monitoring will be established.

- Information collected on the systems will be developed into a database.

## POLICIES AND DELIVERING PROGRAMMES

The following policies, guidelines and programmes shall be implemented to facilitate the management of the wetlands:

- Guidelines for Environmental Impact Assessments
- Education, Public Awareness and Training Programme
- Management Programme for Publicly-Owned Wetlands
- Wetlands Study Programme

### *Guidelines for Environmental Impact Assessment*

An essential part of wise use related to wetlands is to have an established criterion which can be employed in determining whether the impacts associated with a proposed project on wetlands is acceptable and therefore whether the project as proposed is acceptable and meets the further environment, social and cultural development goals of The Bahamas.

*Details are outlined in Annex A.*

### *Education, Public Awareness and Training Programme*

The following steps should be undertaken to improve public awareness regarding wetlands:

- To develop a National Wetlands Awareness Campaign that will communicate the importance and values of wetlands.
- To promote wetland conservation in the formal educational system.
- To provide the public with information on the sustainable use of wetlands.
- To provide opportunities for the public and community-based organizations to be involved in wetland conservation.
- To provide training and capacity-building within the educational system.

### *Management Programme for Publicly -Owned Wetlands.*

- Encourage actions which enhance and preserve wetland functions on publicly-owned lands.
- To develop guidelines for mitigation of wetland conversions on publicly-owned lands.
- To expand and enhance government policies, programmes and regulations which have a positive effect on wetland conservation.
- To eliminate or reduce government policies, programmes and regulations, which have a negative effect on wetland conservation.

*Wetlands Study Programme*

- Develop a programme for the educational system to utilize the wetlands for a research and study area.
- Create partnerships with local and international universities to develop study programmes for the wetlands.
- Provide incentives for the private sector to develop and undertake research projects in the wetlands.
- Develop monitoring systems for wetland rehabilitation projects.

*Looking at Wetlands to Assist in Stormwater Management*

A vital component to the hydrological cycle and a known interface between the surface waters and groundwater, are wetlands. In the context of The Bahamas, wetlands are the vital component between the coastal zone/marine waters and the groundwater reserves. Certain wetland areas naturally have a beneficial role in pollution control, the attenuation of flood peaks, and erosion and sediment control. In addition to these environmental benefits, the social and cultural aspects are also a key component to their protection and artificial development. Due to the decreasing natural areas for groundwater recharge, wetlands along with storm water must therefore be recognized in the management of water resources.

In the context of climate change and gradual rising sea levels, wetlands are the primary defense for the vulnerable groundwater resources. They serve as the transitional areas between the wet (sea/marine water) and dry (land-overlying freshwater resources) environments.

In the Bahamian context, the relationship between groundwater and associated wetlands is still not fully understood or at least adequately documented. Aside from their support of biodiversity, the importance of their point of exchange between groundwater and the atmosphere through precipitation, infiltration, ex-filtration, and evapotranspiration has not successfully been documented. A sustainable approach to the functional roles of wetlands can assist in the reduction of costs associated with both stormwater management and groundwater recharge structures.

Wetland retention and their creation offer a more sustainable approach to flood management. Additionally, the requirement of flood defenses such as walls, culverts, canals, and man-made ponds can be condensed in controlling the impacts of flooding. Wetlands can act as retention areas since surplus water is absorbed and retained by them. Once the storm water being channeled to the wetland area is filtered/ screened, it can then be retained within the wetland for long-term groundwater recharge.

Wetlands for hydrological balance must be explored in The Bahamas. Water managers should make the effort to disclose how a 'Bahamian wetland' can assist in the attenuation of flood peaks, erosion and sediment control, and potential recharge of the Ghyben-Herzberg lens. This will require a detailed analysis of the typical oils and organics (peat) from specific wetland areas, to determine precise composition and retention characteristics. Natural coastal flood protection, and the associated protection of the inland areas (including the freshwater resources) by the wetland should also be emphasized.

## INVOLVING THE BAHAMIAN PEOPLE IN WETLANDS MANAGEMENT

Effective ways of involving Bahamians in wetland management:

- Provide incentives for the communities to maintain and upkeep the wetland systems.
- Encourage private eco-tourism companies to enhance the area by adding signage, boardwalks, nature trails, and look-out points, etc.
- Create educational programmes that include tours into the wetlands to make the public more aware of the importance of the wetlands.
- Have meetings with private land-owners that have wetlands and develop a management plan for the use and maintenance of the wetlands.

## WORKING IN PARTNERSHIP WITH LOCAL GOVERNMENT

- Establish training sessions for local government representatives to raise awareness and to develop management strategies for the wetlands in their islands.
- Develop measures to strengthen the links between the relevant government agencies.
- Develop programs in conjunction with local governments where such programmes can be hosted by local government.
- To ensure that local government is aware of their vital role in monitoring activities near or in wetlands within their municipal boundaries.
- To allow local government access to all related project plans and permit requirements to facilitate monitoring of wetland activities; to increase compliance and provide additional influence over local wetland management.

## ENSURING A SOUND SCIENTIFIC BASIS FOR POLICY AND MANAGEMENT

- Develop standard methods/criteria for:
    - assessing the health of wetlands; and
    - defining the size of the wetlands.

- Develop programmes in conjunction with educational institutions to study aspects of the wetlands that are not well understood; for example, hydrology, nutrient cycling, etc.
- Develop programmes with the private sector and NGO's to study aspects of the wetlands and to lend technical expertise and resources.

INTERNATIONAL ACTIONS

- Maintain partnerships with international donors.
- Encourage foreign investments that adhere to the wetlands policies and sustainable development.
- Develop partnerships with other countries and international non-governmental organizations.
- Develop regional and international programmes that deal with the wise use and sustainability of wetlands.

## 4. LEGISLATION

BAHAMIAN LAWS

Acts relevant to wetlands and waterfowls:

*Statue Law*

- Volume 1 (Constitution) Chapter 37: Local Government Act
  This legislation allows local government to develop planning boards in some districts to assume the responsibilities of the Town Planning Committee, empowering the local committees to be responsible for local planning matters.

*Subsidiary Legislation*

- Chapter 248: Wild Animals (Protection)
  The legislation deals with the taking or capturing of wild animals.

- Chapter 249: Wild Birds Protection
  The legislation outlines areas which have been preserved as habitats for wild birds.

- Chapter 255: Town Planning Act
  The legislation deals with zoning of land through subdivisions, zoning orders, issuance of licenses, and approval of applications.

- Chapter 260: Conservation and Protection of The Physical Landscape of The Bahamas
  The legislation deals with the harvesting of protected trees and the filling in of water bodies.

*Other Regulations*

- National Parks Regulations (Annex B)
  The regulations state the activities that can and cannot occur in the national parks.

INTERNATIONAL CONVENTIONS

1. The Ramsar Convention on Wetlands (Ramsar, Iran, 2 February 1971)
   The Ramsar Convention on Wetlands is an intergovernmental treaty that provides the framework for action and international cooperation for the sustainable use and management of wetlands. The primary focus of the treaty is to curtail the systematic loss of wetlands of international importance. Lake Rosa, in Inagua is the designated Ramsar site for The Bahamas. The Bahamas became a signatory on 7 June 1997.

2. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Washington, DC, 3 March 1973).
   This treaty deals with the regulating of imports and exports of endangered flora and fauna to help prevent over-exploitation of the species. This is carried out through an agreed list of species and through the monitoring and regulating of trade in other species that might become endangered. The Bahamas became a signatory on 20 March 1979.

3. United Nations Convention on the Law of the Sea (Montego Bay, Jamaica, 10 December 1982).
   This convention regulates the seabed by a set of rules agreed upon by the international community. The Bahamas became a signatory on 29 July 1983.

4. Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea 10 December 1982. (New York, United States, 11 August 1995).
   This agreement deals with the conservation and management of straddling fish stocks and highly migratory fish stocks. The Bahamas became a signatory 16 January 1997.

5. Convention on Biological Diversity (Rio de Janeiro, Brazil, Earth Summit 1992)
   This convention deals with the preservation of biological diversity as it relates to food security, medicines, fresh air and water, shelter and the state of the environment. The Bahamas became a signatory on 2 September 1993.

6. The United Nations Convention to Combat Desertification (Paris, France, 15 October 1994).
   This convention addresses the degradation of land in arid, semi-arid and dry sub-humid areas which is caused mainly by human activities and climatic variations. The Bahamas became a signatory on 10 November 2000.

## 5. IMPLEMENTATION OF THE POLICY

- Establish national standards and guidelines for assessing the quantity and quality of wetlands in the Bahamas.
- Create maps for the islands indicating the location, size and classification of the wetlands.
- Develop an inventory/database (location, size, state/condition) of the wetlands on each island and classify them according to the policy.
- The inventory list and maps will be distributed to the relevant government agencies and made available to the public.
- Ensure the wetlands of national significance are included in the system of national parks and other protected areas and designated as Environmentally Sensitive Areas.
- Research the ownership rights for the land where the wetlands are located and add this information to the inventory list.
- Private land owners and developments bordering wetlands will be distributed guidelines governing their activities surrounding and in the wetlands.

# ANNEX A

## GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENTS

Criteria Defining Acceptable Impacts on Wetlands

The following basic criteria will be applied in determining whether the impacts associated with a proposed project on wetlands are acceptable, and therefore whether the project as proposed is acceptable with regard to its impacts on wetlands. Projects must meet all four of these criteria in order to be deemed acceptable. The subsequent sections of this guidance document explain each criterion in more detail, and provide guidance for assessing whether a given project meets each criterion.

**Criterion 1:**

Projects may not significantly impact or alter unique or sensitive wetland areas. Any project that would be located in or significantly impact or alter a unique or sensitive wetland area is unacceptable.

**Criterion 2:**

Project impacts must not substantially reduce the capacity a wetland or wetland system to provide key ecological or environmental functions to the associated service area. Where functional capacity can be quantified, substantial reduction is defined as the reduction of the functional capacity of the assessed wetlands to a level of less than 70% of the original functional capacity of these wetlands. Any project that would result in substantial reduction in wetland functional capacity is unacceptable.

**Criterion 3:**

The value of the project to society must exceed the value of the wetland functions lost due to the impacts of the project. Any project that would cause losses in wetland functions of a greater value than the value of the project to society is unacceptable.

**Criterion 4:**

The impacts of any project on wetlands must be kept to the absolute minimum feasible, consistent with the viability and objectives of the project. Any project that would needlessly impact wetlands, or that overlooks or forgoes opportunities to avoid or minimize impacts on wetlands, is unacceptable.

**Approach for Assessment of Impacts on Wetlands**

**Determining Whether Wetlands are Unique or Sensitive - Criterion 1**

*Elaboration of the Criterion*

In keeping with The Bahamas' policy of wise use of wetlands, wetlands with certain unique or sensitive characteristics will be protected from any form of development or negative impacts. Unique or sensitive wetlands are wetland areas that:

- constitute a unique biogeophysical or ecological system;
- constitute or contain critical habitat for species of special concern (unique, culturally important, rare, threatened or endangered species);
- support rare or unique plant communities;
- are within or provide critical wetland functions to marine reserve areas, or any other form of protected areas or human communities;
- constitute floodplains, floodways, or flood prone areas;
- receive high public use; or are popular cultural, religious, or recreational areas;
- contain structures or artifacts of historic or archeological significance;
- have been set aside as a green belt, conservation corridor, or other form of protected or natural area by any national or local land use plans or coastal zone management plans.

As this list suggests, wetlands falling into the unique or sensitive category include not only those wetlands with unique biogeophysical characteristics that require preservation, but also wetland areas that are not amenable to development (e.g. flood-prone areas) or in which development is undesirable for sociological or cultural reasons (e.g. areas of high public use or important cultural significance).

In assessing the compliance of a proposed wetland use with Criterion 1, a reasonable and thorough effort must be made to determine whether the subject wetland exhibits any of the characteristics listed in Section 6.1. Sources of information should include: Department of Agriculture (Wildlife Division); Department of Fisheries; Department of Lands and Surveys, The Bahamas National Trust; authorities of the local government with jurisdiction over the wetland area, and members of local communities.

Wetland areas that fall into the unique and sensitive category must be left undisturbed. No project may be located within or cause any discernable impact on these wetland areas. Projects that would do neither of these are in compliance with Criterion 1.

## Assessing Whether a Project Substantially Reduces Wetland Functional Capacity – Criterion 2

### *Elaboration of the Criterion*

The objective of Criterion 2 above is to maintain a certain minimal level of wetland function for a given service area. In many cases, the wetland area immediately impacted by a project (the "impacted wetland area, or IWA") is the sole wetland area providing a particular function to the associated service area. Any reduction in the functional capacity within the IWA brings about a direct, equal reduction in functional benefits to the service area. In such cases the reduction in the functional capacity of the IWA itself must be assessed with regard to criterion No. 2 above. If the proposed project would result in a substantial reduction of the functional capacity of the IWA, the project is unacceptable.

Often, however, the IWA is only one of many wetland areas (or only a portion of a larger wetland area) providing the same function to a common service area (for example, where numerous coastal wetland areas provide recruitment populations to a single, large marine system). The full set of wetland areas providing the same function as the IWA to the same service area as the IWA is termed in these guidelines the "cohort wetland area". In such cases, any reduction in functional capacity within in the IWA causes only an incremental change in the provision of that function to the service area, since the capacity of the remainder of the cohort wetland area to provide that function remains unchanged. In such cases it is the reduction in the functional capacity of the *entire cohort wetland area* that must be assessed with regard to criterion No. 2 above. The functional capacity of the IWA may well be substantially reduced, or even eliminated, without substantially reducing the functional capacity of the cohort wetland area.

Note, however, that the substantial reduction measure applies to past and current alterations to the cohort wetland area, as well as to the projected future impacts associated with the proposed project. The baseline functional capacity against which reduction in cohort wetland area functional capacity is measured is the estimated natural functional capacity of the cohort wetland areas prior to any human intervention.

Hence, if the functional capacity of the cohort wetland area has already been substantially reduced from its natural state by past development (e.g., if >30% of the historic wetland area within the cohort wetland area has already been eliminated by filling) then no further reduction in functional capacity can be tolerated within the IWA. In areas where wetlands have already been seriously degraded by past development, new projects that would further impact wetlands are unacceptable.

For purposes of these interim guidelines, assessment of functional capacity will be on a qualitative basis, and will be based largely on scientific judgment. Reduction in functional capacity from the natural baseline, in particular, can not be quantified in the absence of reference baseline data for the various biogeophysical categories of wetlands in The Bahamas. This reference information, and more detailed procedures for quantifying wetland functional capacity and functional capacity loss will be developed as a part of the wetland management program developed pursuant to The Bahamas wetland policy. For purposes of these interim guidelines, impacts on wetland functional capacity can be assessed in general terms, such as mild, moderate, substantial, or severe.

***Steps in Assessing Compliance with Criterion 2***

The steps in determining whether a project meets Criterion 2 are as follows:

(a) assess the activities of the proposed project, and identify and describe all activities that would affect wetland areas in any way;

(b) assess the areal extent of each of the proposed projects' effects on wetlands, and delineate the wetland area that will be impacted by the project - i.e., the IWA;

(c) identify the key functions provided by the IWA (refer to Table 1);

(d) for each function, identify and delineate the cohort wetland area;

(e) for each function, assess the extent to which the functional capacity of the cohort area has already been reduced by past and current human activity (i.e., the baseline condition of the cohort area before the proposed project);

(f) for each function, determine what percent of the total cohort area the IWA represents;

(g) for each function, determine the extent to which the proposed project would reduce the functional capacity of the IWA itself;

(h) Determine whether:

- the functional capacity of the cohort area has already been substantially affected by past and current human activity; or
- the incremental loss in functional capacity of the cohort area caused by the impacts of the project on the IWA and resultant loss in functional capacity within the IWA will bring the cohort area to the point that its functional capacity is substantially affected.

(i) if neither of the conditions in (h) is true, the project meets Criterion No. 2.

**Assessing Whether the Value of the Project to Society Exceeds the Value of the Wetland Functions Lost Due to the Impacts of the Project – Criterion 3**

***Elaboration of the Criterion***

The objective of Criterion 3 is to prevent wetland development or conversion that constitutes a net, long-term loss to the people of The Bahamas. A quantitative, dollar and cents evaluation is generally not possible since many of the amenities and functions provided by wetlands can not be fully evaluated in dollar terms. The value of these amenities to society, and, therefore, compliance with Criterion 2, are therefore ultimately assessed on the basis of scientific and economic judgment.

However, the value of several of the key functions and amenities provided by wetlands can be roughly estimated. Table 1 indicates the relationship of several key wetland functions to economic goods and services. Estimation of the value of a given wetland area to society generally begins with an estimate of the value of goods and services that are provided by the wetland (Table 1), and is then modified with judgment-based estimates of the value of other amenities provided by the wetland that can not be evaluated in dollar terms.

***Steps in Assessing Compliance with Criterion 3***

The general steps in assessing whether a proposed project complies with Criterion 3 are as follows:

(a) determine the extent to which the proposed project would reduce the functional capacity of the IWA for its various key functions;

(b) based on Table 1, identify the goods and services lost or reduced in extent as a result of the reduction in functional capacity of the IWA, and the rough level of reduction in these goods and services;

(c) estimate the cost of providing or replacing these goods and services by alternate means;

(d) estimate the value of the development proposed, focusing on those components of the development that rely on or result in wetland conversion or impacts. Where a non-wetland development alternative exists, the value of the proposed wetland development = (value of developed wetland site) - (value of next best alternative site, developed in same manner). Where no non-wetland development alternative exists, the value of the proposed wetland development = (value of developed wetland site) - (cost of development)[1];

(e) Consider the non-quantifiable benefits of wetlands in their undisturbed state (e.g. aesthetic value, biodiversity conservation value, etc);

---

[1] USACE/WES 1994. *Procedures for Evaluating Wetlands Non-Market Values and Functions.* US Army Corps of Engineers Waterway Experiment Station. Wetlands Research Program Technical Note WG-EV-2.1

*Table 1: Relationship of Wetlands Functions to Economic Goods and Services*

| Functions | Value of Functions | Economic Goods and Services |
|---|---|---|
| Detain, remove, and transform contaminants | Maintain surface and groundwater quality | Wastewater treatment/water quality |
| Detain and remove sediments | Maintain surface water quality | Wastewater treatment/water quality |
| Provide ecosystem, landscape and global integrity | Maintain ecosystem, landscape, and global processes | Educational/Cultural Habitat |
| Provide wetland ecosystem structure | Maintain populations of wetland dependent plants and animals species, preserve endangered species, maintain biodiversity, provide dispersal corridors | Fish and wildlife habitat |
| Provide a setting for cultural activities | Produce food and fiber, provide recreational opportunities, provide education and research opportunities, provide aesthetic enjoyment, preserve archaeological/historic sites | Commercial fisheries; agriculture, timber, peat production; Education/Cultural Habitat |
| Store surface water | Reduce flood-related damage | Flood control |
| Reduce the energy level of surface water | Reduce erosion from storms and floodwater | Land development |
| Recharge groundwater | Maintain pumpable supplies of groundwater | Water supply |
| Discharge groundwater | Maintain stream and lake water levels | Water supply |
| Stabilize soils | Reduce erosion of shorelines and stream banks from storms and floods | Land development |
| Detain, remove, and transform nutrients | Maintain surface and groundwater quality | Wastewater treatment/water quality |

Source: USACE/WES 1994

(f) Compare (1), the value of the IWA and its functions without the proposed development, to (2), the value of the wetland-reliant portions of the proposed development. If the latter value exceeds the former, the project is in compliance with Criterion 3.

**Determining Whether Impacts to Wetlands Are Kept to the Absolute Minimum Feasible – Criterion 4**

***Elaboration of the Criterion***

The purpose of Criterion 4 is to ensure that every effort is made to conserve wetlands and their functions to the greatest extent possible, consistent with development goals. Where projects have been shown to comply with Criteria 1 through 3, the final consideration is whether any adjustments can be made in the project to minimize its impacts on wetlands. Where any such adjustments or mitigation measures can be identified and are shown to be feasible, they must be adopted in order for the project to be in compliance with Criterion 4.

In many cases mitigation measures or alternative project plans will have been adopted in order to ensure that proposed projects comply with Criteria 1 through 3. However, in assessing compliance with Criterion 4, it is necessary to determine whether any further impact-mitigation measures are available that may not be necessary for compliance with the previous 3 criteria, but that help to minimize impacts on the IWA.

In many cases the feasibility of an impact mitigation measure is based on its cost relative to the value of the proposed development project. Some mitigation measures, while technically feasible, are too costly to be viable. Criterion 4 requires adoption of that every available impact mitigation measure that is feasible and consistent with the viability and objectives of the project. Mitigation measures that would render the project financially nonviable, therefore, are not required under this criterion. Similarly, project mitigation measures or alternatives that would substantially alter the nature of the project or preclude the project from achieving its objectives are also not required.

In assessing compliance with Criterion 4, a reasonable and thorough effort must be undertaken to identify all feasible impact mitigation measures and alternatives, based on international standards and state of the art in wetland impact mitigation and avoidance.

***Approach to Assessing Compliance with Criterion 4***

Assessment compliance with Criterion 4 consists of two key steps:

(a) identification of any alternatives to the project plan that would still meet the project objectives but would not involve conversion of or impact on wetlands. Where such alternatives can be identified, clear justification must be provided for proceeding with the proposed project plan that involves wetland impacts;

(b) identification of any modifications to the proposed project plan that would reduce the project's impacts on wetlands, and that are readily available, and feasible.

If no feasible alternatives, modifications, or mitigation measures are identifiable, and it can be demonstrated that every available measure has been taken to minimize the proposed project's impacts on the wetlands, then the project is in compliance with Criterion 4.

## ANNEX B

### A SUMMARY OF THE NATIONAL PARKS REGULATIONS BAHAMAS NATIONAL TRUST

1. These rules may be cited as the rules of the Land and Sea Parks of The Bahamas National Trust and are made under Section 24 of The Bahamas National Trust Act.

2. The bye-laws operate in conjunction with all other laws of The Bahamas

3. The Land and Sea Parks have been designated marine replenishment areas and nurseries for The Bahamas therefore the hunting, trapping, netting, capture, or removal of any fish, turtle, crawfish, conch, whelk, in or form the Parks is prohibited.

4. The destruction, injury or removal of any living or dead plant life, beach sand, coral, sea fan or gorgonian from the Parks is prohibited.

5. The molestation, injury or destruction of any land animal or bird life or the eggs of any animal or bird is prohibited as is the use of nets or snares for the taking or destruction of any animal or bird life in the Parks.

6. Permission may be granted in individual instances for the capture or removal of any designated number of land or sea animals or plants required for valid scientific research. In each instance the scientific institution concerned must obtain a permit from The Bahamas National Trust prior to capture or removal of the specimens.

7. Dumping of any wastes, oil or rubbish either on land or in the sea is prohibited.

8. No person shall injure, deface, or remove any building, structure, sign, ruin, or other artifacts within the Parks.

9. The posting of any sign, placard, advertisement or notice within the Parks is prohibited as is the erection of any building, shed, tent or other structure.

10. No person shall display/use fire or discharge any explosives, firearm or harpoon gun within the Parks.

11. With reference to privately owned property, these bye-laws do not affect the existing rights of any person acting legally by virtue of any estate, right or interest in, over or affecting the land of the Parks.

12. Willful obstruction, disturbance or annoyance of anyone in the proper use of the lands and submarine areas or of any officer of The Bahamas National Trust in the exercise of his or her duties is prohibited.

13. Any person charged with an offence against any of these bye-laws shall be liable on summary conviction to a penalty not exceeding $500 and to the confiscation of any boat, vessel or aircraft and all equipment, stores, provisions or other effects used for the purpose of committing the offence.

## ANNEX C

### LIST OF "PROTECTED PARKS"

Currently there are 25 National Parks throughout The Bahamas that occupy more than 700,000 acres consisting of marine and terrestrial sites. Below is a partial list of ten national parks.

| Name of the Park | Acreage | Comments |
|---|---|---|
| Abaco National Park | 20,500 | - Important bird area<br>- Bahama parrot habitat<br>- 5,000-pine forest |
| Central Andros National Park | 286,080 | - Mangroves<br>- Wetland nursery area |
| Exuma Cays Land and Sea Park | 112,640 | - First land and sea park in the Caribbean |
| Harrold & Wilson Pond National Park | 250 | - Largest rockery on New Providence for certain wetland avian species |
| Inagua National Park | 183,740 | - Lake Rosa (the national Ramsar site) |
| Lucayan National Park | 40 | - One of the longest-known underwater cave systems in the world |
| Moriah Harbour Cay National Park | 13,440 | - Mangroves creek |
| Rand Nature Center | 100 | - Habitat for a variety of avian species |
| The Retreat | 11 | - one of the largest private collections of palms in the world |
| Union Creek National Reserve | 4,940 | - Important sea turtle research site |

## ANNEX D

**DEFINITIONS**

CONSERVATION: The wise use and protection of natural resources.

ECOTOURISM: Tourism which involves traveling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring and enjoying the scenery with its wild plants and animals as well as existing cultural areas.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA): The process by which predictions are made of the environmental consequences of development activity. Its aim is to ensure that potential environmental risks are foreseen and necessary measures to avoid, mitigate or compensate for damage are identified.

MITIGATION: Actions taken during the planning, design, construction, operation and decommissioning of projects or programmes to alleviate potential adverse effects on the ecological character or any natural area over time.

MONITORING: The process of measuring changes in the ecological character or any natural area over time.

PROTECTED AREA: A legally established land or water area under either public or private ownership that is regulated and managed to achieve specific conservation objectives.

REHABILITATION: Actions taken to assist in the recovery of specific ecosystem services in degraded ecosystems or habitats.

# *Appendix D*

# Basin Flushing Study

# Children's Bay Cay Marina

November 2015

Applied Technology and Management, Inc.
2201 NW 40 Terrace.
Gainesville, Florida 32605
386-256-1477

## TABLE OF CONTENTS


| | | | |
|---|---|---|---|
| 1.0 | INTRODUCTION | | 1-1 |
| 2.0 | SITE AND PROJECT DESCRIPTION | | 2-2 |
| 3.0 | HYDRODYNAMIC MODEL | | 3-1 |
| | 3.1 | Model Description | 3-1 |
| | 3.2 | Model Set Up | 3-2 |
| | | 3.2.1 Model Geometry | 3-2 |
| | | 3.2.2 Model Bathymetry | 3-3 |
| | | 3.2.3 Tidal Forcing | 3-5 |
| | | 3.2.4 Wind | 3-5 |
| 4.0 | FLUSHING ASSESSMENT | | 4-1 |

## LIST OF FIGURES


2-1 Project Site Location Overview

2-2 Site Location

2-3 Norman's Cay Chart

3-1 Model Grid and Bathymetry

3-2 Eastern Boundary Surface Elevation for Simulation Period

3-3 Measured Current Plot

3-4 Modeled Current Plot

3-5 Wind Rose for Nassau International Airport

4-1 Initial Dye Concentration Used in Flushing Analyses

4-2 Percent Mass Remaining over Time for Proposed Marina Basin

# 1.0 INTRODUCTION

Applied Technology and Management, Inc. (ATM) has been retained to provide engineering services related to assessment of flushing of a proposed marina basin along the western shoreline of Children's Bay Cay, Exuma, Bahamas. The existing upland cut marina basin at Children's Bay Cay will be enlarged to accommodate additional vessels and allow adequate room for safe maneuvering. The existing marina channel will be realigned to the south to better accommodate vessel approach from the south, which is the preferred access direction. Channel realignment will require cutting through Saba Beach and dredging a short distance offshore to reach deep water. The existing marina channel will be filled in to accommodate construction of the adult beach club. Proposed depths within the marina basin and entrance channel are 10 feet mean low water (MLW).

In support of the proposed marina basin flushing study, a hydrodynamic model was developed to evaluate the degree of flushing that would occur within the interior basin. Adequate flushing reduces the potential for the stagnation of water within a closed basin, helps to maintain appropriate levels of biological productivity, and reduces the potential for toxic accumulation in bottom sediments. Flushing is one aspect of maintenance of good water quality within an interior basin.

## 2.0 SITE AND PROJECT DESCRIPTION

The project site is Children's Bay Cay, a sparsely developed island approximately 1.5 miles off the northern tip of Great Exuma, which is located on the Exuma archipelago in the Bahamas, as shown in Figure 2-1. Figure 2-2 presents a zoomed in view of Children's Bay Cay from a local nautical chart, showing the bathymetric conditions. Figure 2-3 presents a portion of the Master Plan showing the configuration of the marina basin and location of the entrance. At present, it is anticipated that the marina basin depths will be at -10.0 feet MLW.

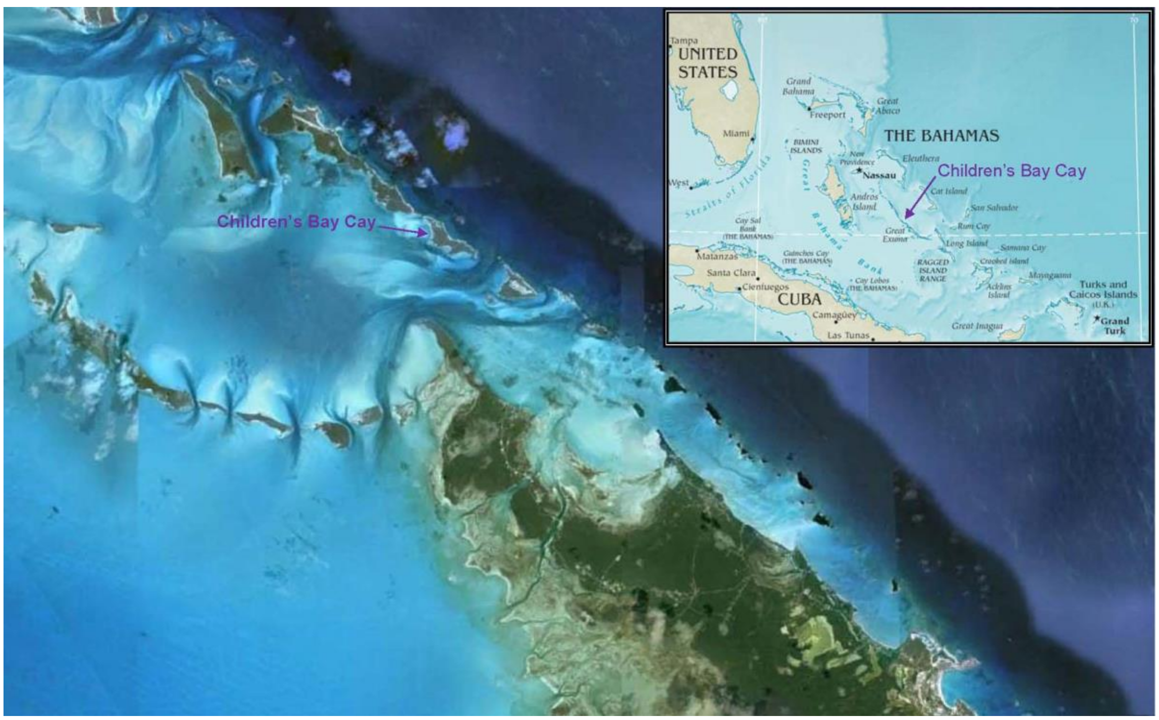



*Figure 2-1. Project Site Location Overview*

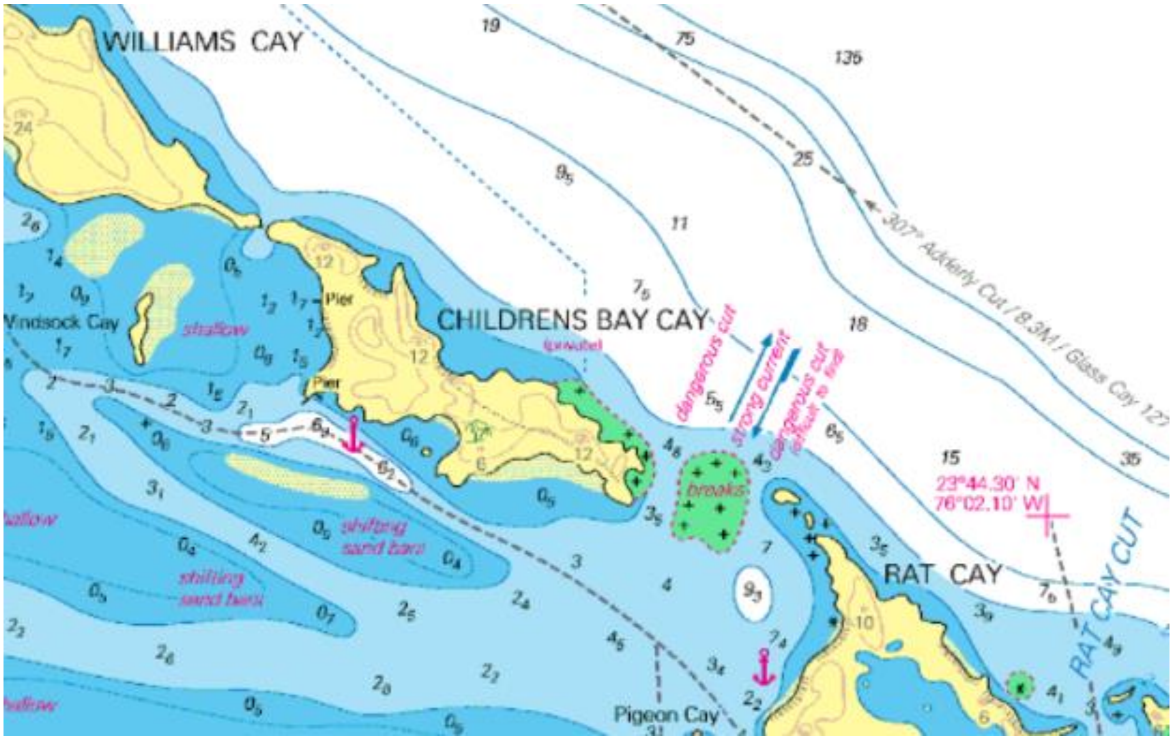



*Figure2-2 Regional Bathymetry*


*Figure 2-3 View of Master Plan in Vicinity of the Marina Basin*

# 3.0 HYDRODYNAMIC MODEL DEVELOPMENT

## 3.1 MODEL DESCRIPTION

The Environmental Fluid Dynamics Code (EFDC) was utilized for the hydrodynamic model development. EFDC is a general purpose modeling package for simulating two- and three-dimensional flow, transport and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands and near-shore to shelf-scale coastal regions. The EFDC model was originally developed by Dr. John Hamrick at the Virginia Institute of Marine Science and is considered public domain software. The U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD) currently supports EFDC for use in simulating estuarine and coastal hydrodynamics.

The EFDC model solves the three-dimensional, vertically hydrostatic, free surface, turbulent averaged equations of motions for a variable density fluid. Dynamically coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity and temperature are also solved. The two turbulence parameter transport equations implement the Mellor-Yamada level 2.5 turbulence closure scheme. The EFDC model uses a stretched or sigma vertical coordinate and curvilinear orthogonal horizontal coordinates.

The numerical scheme employed in EFDC to solve the equations of motion uses second-order accurate spatial finite differencing on a staggered or C grid. The model's time integration employs a second-order accurate three-time level, finite difference scheme with an internal-external mode splitting procedure to separate the internal shear or baroclinic mode from the external free surface gravity wave or barotropic mode. The external mode solution is semi-implicit and simultaneously computes the two-dimensional surface elevation field by a preconditioned conjugate gradient procedure. The external solution is completed by the calculation of the depth-average barotropic velocities using the new surface elevation field. The model's semi-implicit external solution allows large time steps that are constrained only by the stability criteria of the explicit central difference or higher order upwind advection scheme used for the nonlinear accelerations. Horizontal boundary conditions for the external mode solution include options for simultaneously specifying the surface elevation only, the characteristic of an incoming wave, free radiation of an outgoing wave or the normal volumetric flux on arbitrary portions of the boundary.

### 3.2 MODEL SET UP

The model setup included creating a model grid based on the geometry of the study area (i.e., the shorelines and bathymetry) and providing model inputs (i.e., the boundary forcings and model coefficients). The primary boundary forcings used for this study include tidal elevations and wind. The hydrodynamic simulation was run for a 10 day period coinciding with neap tide conditions based upon available tidal measurements over a 70 day period.

#### 3.2.1 MODEL GEOMETRY

The model geometry is defined by the shorelines of the island and the proposed marina basin. The shoreline was developed based upon GIS coverages showing the shoreline and the outline of the proposed marina basin. A model grid was developed to represent the marina basin and the offshore waters. Figure 3-1a present the overall model grid. The grid extents were set to provide for sufficient distance to allow mixing of the dye concentrations within the marina basin with the offshore waters. Figure 3-1b presents a zoomed in view showing the grid in the vicinity of the marina basin.

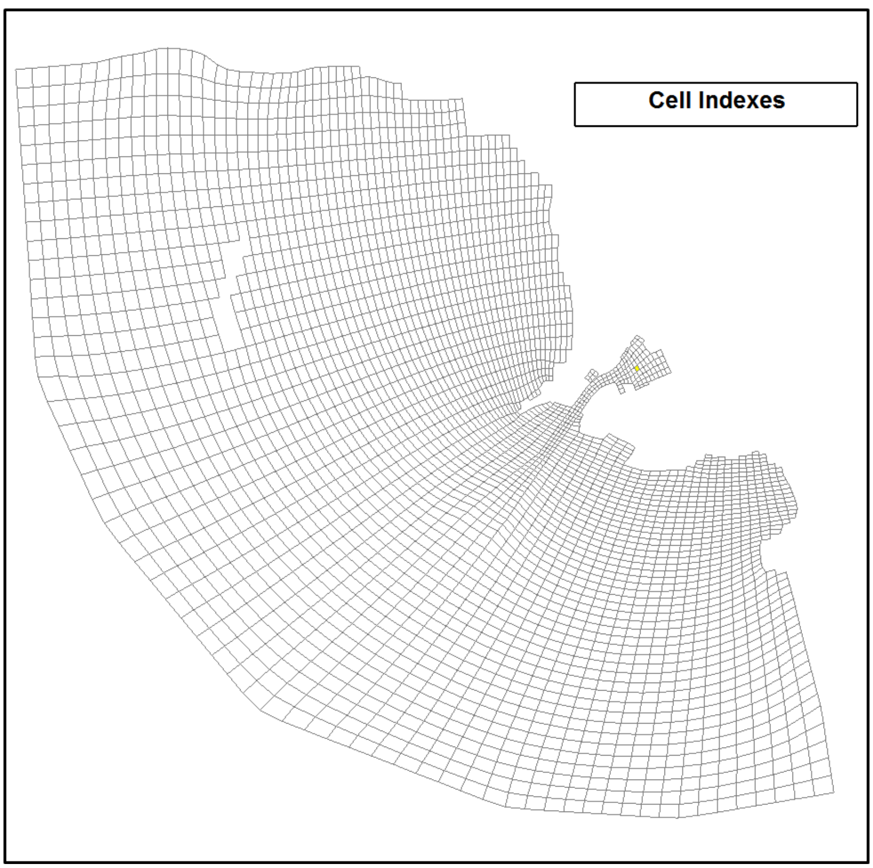



*Figure 3-1a. Overall Model Grid*

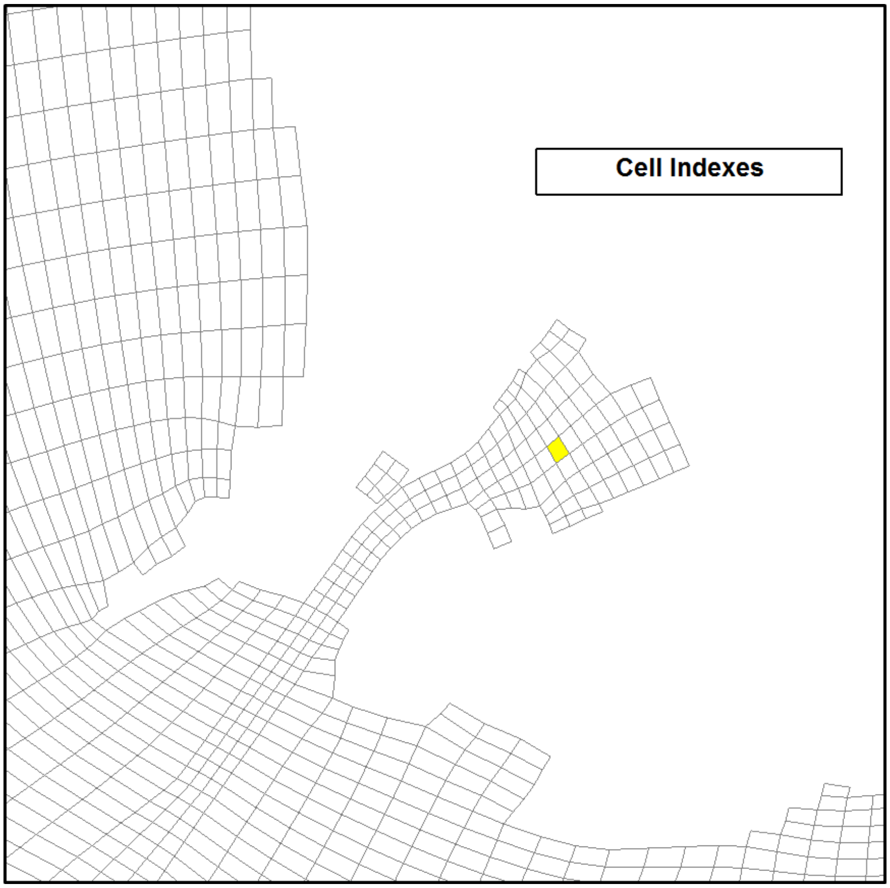



*Figure 3-1b.  Model Grid in Vicinity of Marina Basin*

### 3.2.2 MODEL BATHYMETRY

Bathymetric conditions were developed from a combination of locally measured bathymetry and available nautical charts.  The bathymetric conditions in the marina basin were based upon design depths for the marina, which as stated earlier are -10 feet MLW.  Figure 3-2a presents the bathymetric conditions for the overall model grid.  Figure 3-2b presents the bathymetric conditions with the zoomed in view of the marina basin.

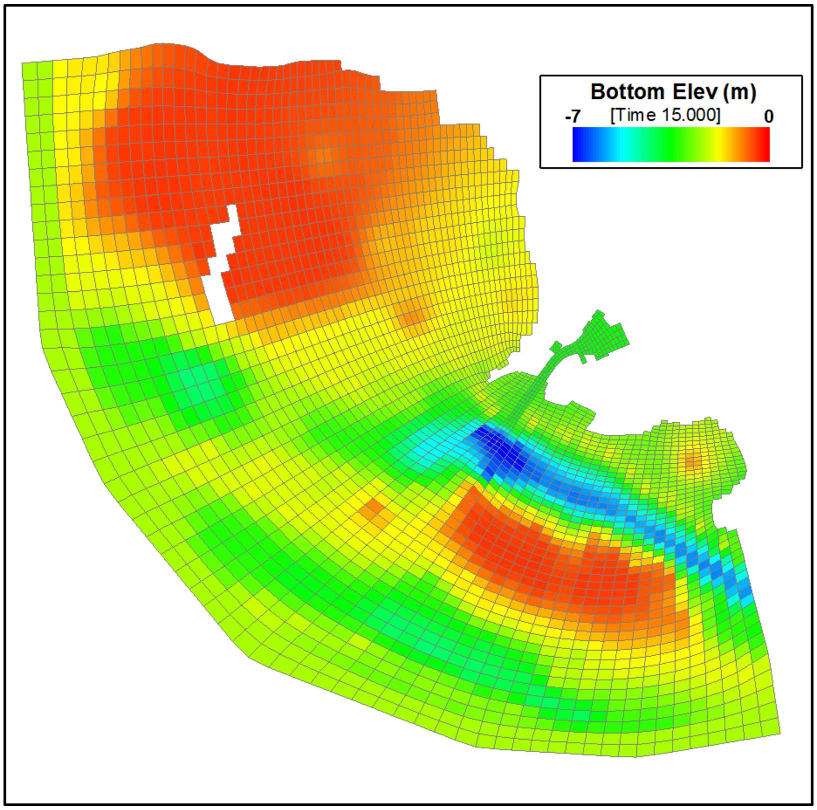



*Figure 3-2a. Overall Model Bathymetry*

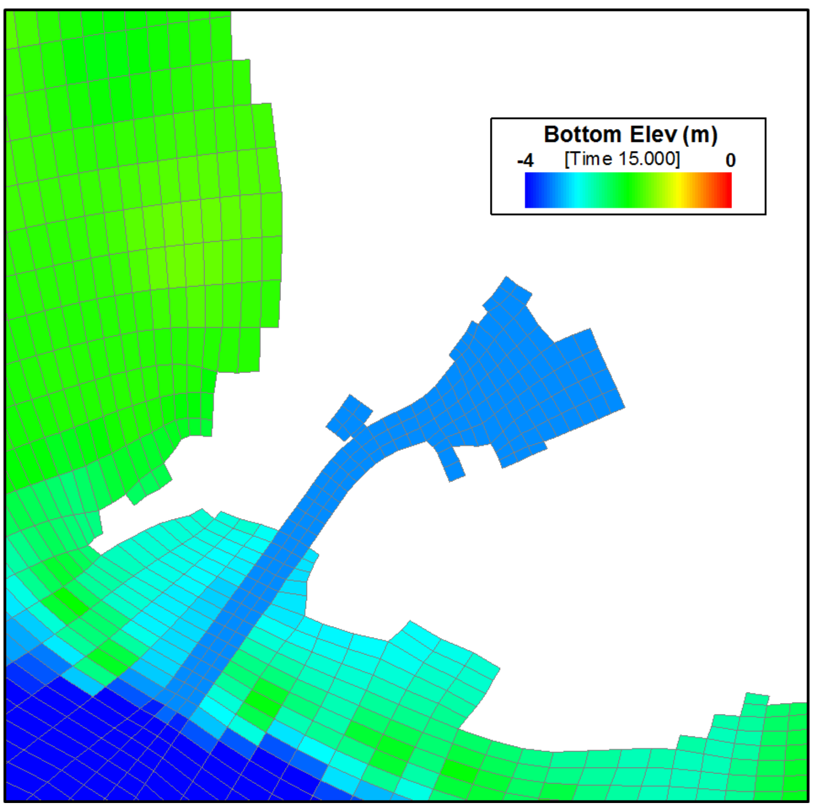



*Figure 3-2b. Model Bathymetry in Vicinity of Marina Basin*

### 3.2.3 TIDAL FORCING

Water surface elevations in the model were forced at the offshore boundary (the outer edge of the model grid shown in Figure 3-1) using measured elevations from a gage deployment at the site. The gage measured water levels over a 70 day period to capture the full extent of the tidal fluctuations. For the simulation of the flushing, a period of time was chosen where tidal fluctuations represented generally neap tide conditions and the overall mean water level was high so as to account for the largest volume of water within the marina basin. This provides a conservative estimate of the overall flushing of the system. The measured water levels for the 70 day period are presented in Figure 3-3. For the model simulations a 10-day period was chosen from day 15 to 25 (per Figure 3-3).

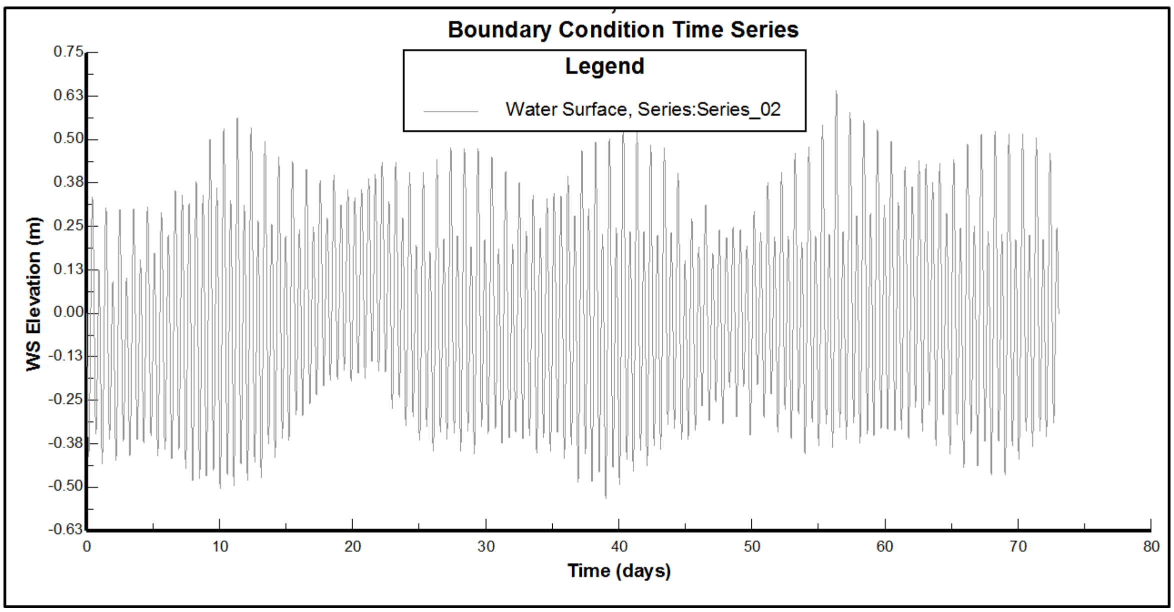



*Figure 3-3. Measured Water Levels Used as the Tidal Forcing*

### 3.2.4 WIND

Figure 3-4 presents the wind-rose for the project site based upon measured winds from 1990 to 1997. The wind-rose shows that generally winds are out of the east between 5 and 15 mph. Based upon this, a conservative wind condition of winds out of the east at 8 mph was utilized for the model simulations.

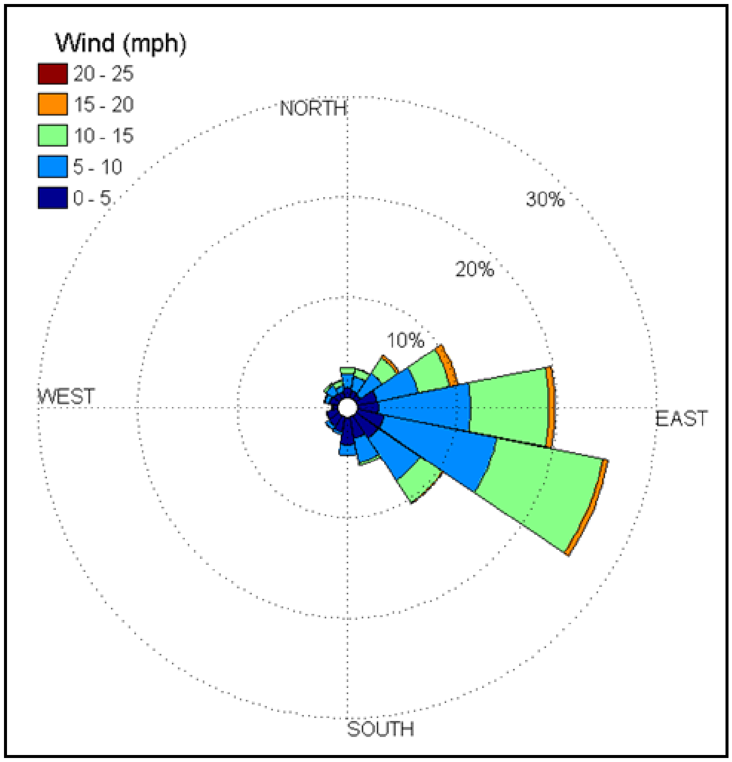



*Figure 3-4.  Annual Wind Rose (1990-1997)*

## 4.0 FLUSHING ASSESSMENT

Utilizing the model presented in Section 3, the flushing of the marina basin was assessed under the tide conditions presented in Section 3. For the analyses, the model was set up so that an initial dye concentration of 100 units was set within the marina basin, with 0 units in the areas outside of the basin. The model was then run for a period of 10 days to determine the remaining mass of dye within the interior basin.

Figure 4-1 presents the initial distribution of dye utilized in the model simulations. A concentration of 100 milligrams per liter (mg/L) was set up within the interior basin. The model was run over a 10-day period, and the mass of dye remaining in the system over time was calculated.

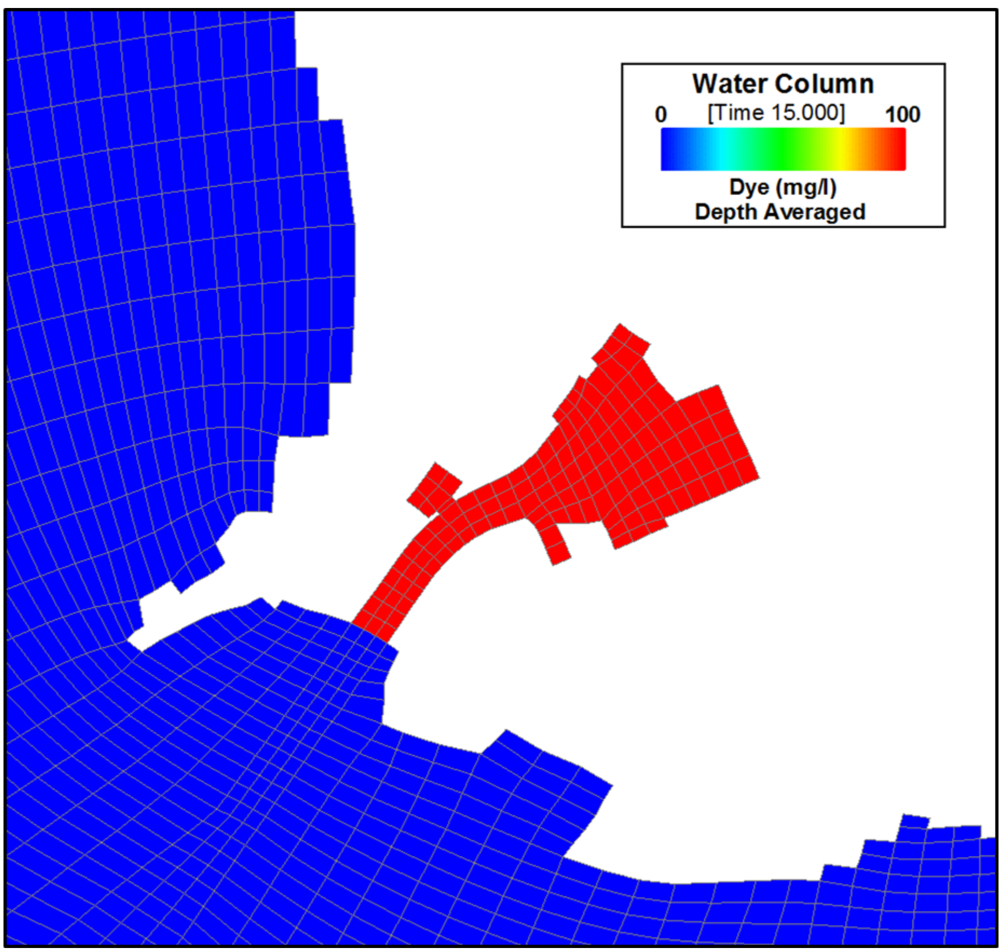



*Figure 4-1. Initial Dye Conditions in Marina*

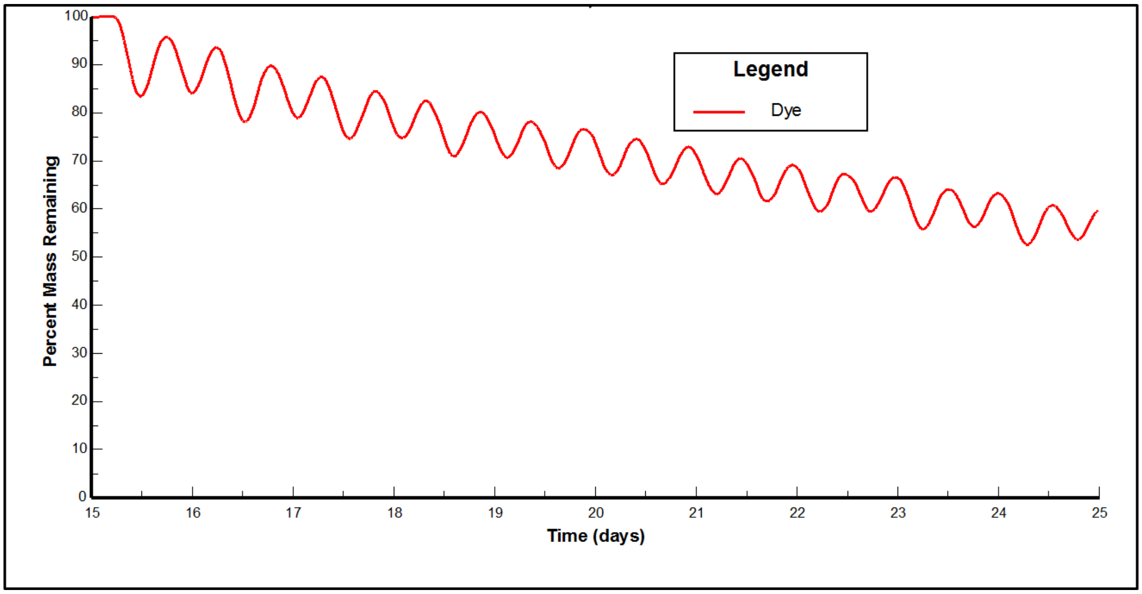



*Figure 4-2. Percent Mass Remaining Over Time (no pumping)*

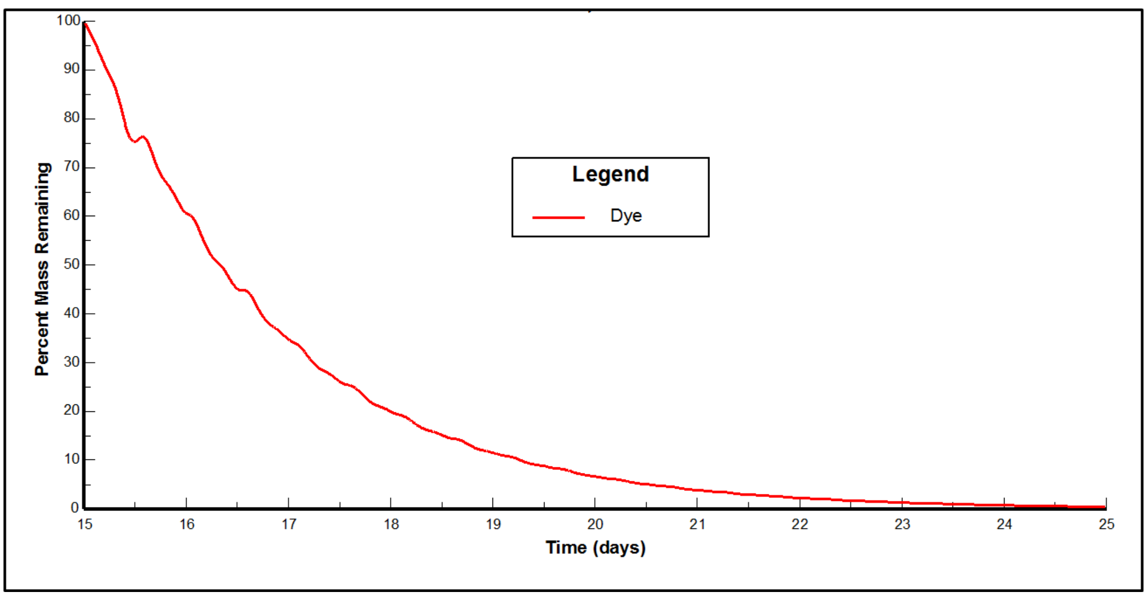



*Figure 4-3. Percent Mass Remaining Over Time (4000 GPM)*

Figure 4-2 presents a plot of the percent mass remaining for the marina basin over the 10-day simulation period. As the plot shows, the percent remaining after 10 days is between 50 and 60 percent. Generally for good marina flushing, EPA recommends that the percent dye remaining after 4 days should be down to 10 percent.

As there are limited options based on the site plan for the inclusion of a flushing channel or other structural modifications to improve the overall flushing, pumping was simulated to try and achieve the 4-day 10 percent target. The pumping inflows were set evenly at three locations across the upper end of the marina basin and a total flow volume was evenly distributed across the three ports. Based on iterative pumping runs, it was determined that 4000 gpm achieved the 10 percent dye remaining in 4-day target. Figure 4-3 presents the plot of the percent remaining in the marina basin over the 10-day simulation. The results show the dye down to 10 percent within 4 days (i.e. by day 19).

# *Appendix E*

## Literature Summary for Lee Stocking Island, Williams Cay, and Lee Stocking Island

John Perry purchased Lee Stocking Island in 1957 and established the Perry Institute for Marine Science (PIMS) and the Research Center in 1970. In 1984, the Caribbean Marine Research Center (CMRC) took over the Research Center as part of the United States National Ocean and Atmospheric Administration's (NOAA) National Undersea Research Program (NURP). Operations of PIMS on Lee Stocking Island ceased around 2010.

During its operation, PIMS was dedicated to ocean research and public education to advance conservation management. A voluntary no-take zone was promoted around Lee Stocking Island to enable long-term monitoring and research projects. The island hosted visiting scientists, graduate students and touring school groups to generate awareness for the marine environment. The Research Center and later CMRC, supported technology advances to marine submersibles and technical dives.

PIMS in-house research scientists focused on four (4) areas:

- Fisheries
- Ecosystems
- Coral Reefs
- Marine Biodiversity

CMRC NOAA's NURP focused on four (4) key areas:

- Building Sustainable Fisheries
- Maintaining Healthy Coastal Ecosystems
- Predicting Environmental Change
- Gaining New Biological and Economical Value from the Sea

With relation to the development, the following research topics are of relevance to Children's Bay Cay and Williams Cay.

**Stromatolites**. Stromatolites are composed of layers of cyanobacteria colonies. Cyanobacteria are able to photosynthesize which produces oxygen and allowed for the evolution of complex life. Stromatolites have been on earth for 3.5 billion years and provide a modern viewing of ancient life processes. With relation to Lee Stocking Island, two areas of stromatolites formations are growing in the channel between Norman's Pond Cay and the northwestern tip of Lee Stocking Island. The stromatolites here are considered modern giant stromatolites growing in a subtidal marine environment.

Selective Literature - Stromatolites


Dill, R.F., Kendall, C.G.St.C., & Shinn, E.A. (1989). *Giant subtidal stromatolites and related sedimentary features: field trip guidebook T373*. Washington, D.C.: American Geophysical Union.

Elliot, William M. (1994) Stromatolites of The Bahamas. Proceedings of the Fifth Symposium on the Natural Hisotry of The Bahamas. Bahamian Field Station Ltd., San Salvador, Bahamas.

Feldmann, Mark and Judith A. McKenzie. (1998). Stromatolite-thrombolite associations in a modern environment, Lee Stocking Island, Bahamas. *Society for Sedimentary Geology*. 13(2)

Riding, Robert; Awramik, Stanley M.; Winsborough, Barbara M.; Griffin, Karen M.; and Robert F. Dill. (1991) Bahamian giant stromatolites; microbial composition of surface mats. Geol. Mag 128(3) 227-234.

**Coral Research**. PIMS and CMRC created a Coral Research Program in 2000 to focus on the long-term study of shallow and deep coral reef systems. Scientists studied coral health an diseases, seawater temperatures, tides and currents, coral reef ecology, genetic diversity, and the like.

Selected Literature – Coral Research

Voss, Joshua D. and Laurie L. Richardson. (2006) Coral diseases near Lee Stocking Island, Bahamas, patterns and potential drivers. Diseases of Aquatic Organisms. Vol 69 (33-40).

Studies of trophic ecology on coral reef ecosystems (Steele and Forrester 2002, Webster 2002, 2003, 2004, Almany 2004, Almany and Webster 2004, Lesser et al. 2004)

Life history studies of economically and ecologically important taxa associated with coral reefs (Dahlgren and Eggleston 2000, Gutierrez-Rodriguez and Lasker 2004b)

Elucidation of coral reef ecosystem functions as well as the interrelationships between and among neighboring (estuaries, and back reef habitats) and distant ecosystems (Sahara Desert)(Garrison et al. 2003, Smith et al. 2004)

Identification of threats that degrade coral reefs and contribute to the incidence of coral disease (Fitt et al. 2000, 2001, Smith 2001, Denner et al. 2003, Lasker 2003, 2005, Duval et al. 2004)

Development of coral culture and storage in order to promote restoration of damaged coral reefs as well as establishing corals as "model" systems for biological and physiological study (Becker and Mueller 2001)

Using advanced diving techniques, to study caves and the deep fore reef (Iliffe and Bowen 2001, Lombardi 2004)

Determination of genetic diversity of and reproductive isolation among corals (Sanchez et al. 2003, Gutierrez-Rodriguez and Lasker 2004a, Levitan et al. 2004)

Long-term environmental monitoring to provide critical data that can be used to develop models to predict environmental change and associated impacts of such change (Powell et al. 2002)

**Fisheries**. CMRC conducted research on economically important Bahamian fisheries including the Nassau Grouper, Conch, and Caribbean Spiny Lobster. Research at Lee Stocking Island focused on life-cycles, recruitment, population dynamics, and fisheries management.

Selected Literature - Fisheries

Stoner, Allan; Davis, Martha; and Catherine Booker. (2011). Surveys of Queen Conch Populations and Reproductive Biology at Lee Stocking Island and the Exuma Cays Land and Sea Park, The Bahamas. Community Conch. www.communityconch.org

Mechanisms that regulate spatial and temporal patterns of biodiversity in various marine habitats, such as coral reefs, seagrasses, and mangroves (Dahlgren and Eggleston 2000, Hixon et al. 2002, Steele and Forrester 2002, Webster and Almany 2002, Almany 2003, Almany and Webster 2004)

Understanding of ecosystem function (Wellington et al. 2001, Smith 2004)

Effects of anthropogenic activities, including fishing, on fish populations and critical habitats (de Sylva et al. 2000, Crowder et al. 2000, Stockhausen et al. 2000, Lipcius et al. 2001, Choat et al. 2003)

Critical fish habitat, with particular emphasis on habitats that influence recruitment (Dahlgren and Eggleston 2000, Hixon et al. 2002, Serafy et al. 2003, Adam and Ebersole 2004)

Long-term oceanographic and climactic conditions, which are critical in the development of realistic simulation models that will predict future conditions (Wellington et al. 2001)

Life histories and associated requirements of economically and ecologically important species (Dahlgren and Eggleston 2000, 2001, Wilson and Meekan 2001)

Effects of fishing on trophic interactions (Adam and Ebersole 2004, Almany 2004, Almany and Webster 2004)

**NOAA Miami Regional Library**
**Selective Bibliography: Lee Stocking Island, Exuma, Bahamas**

The NOAA Miami Regional Library has a selective list of research available public viewing on its website: http://www.aoml.noaa.gov/general/lib/CREWS/cmrc3.htm. The list of publications is provided below.

Anthony, S.L. (1997). *Scleractinian coral mortality and color change on central Bahamian reefs: 1991-1995*. Master's Thesis, University of Texas, Austin.

Boidron-Metairon, I.F. (1988). A new approach to comparative studies of *Strombus gigas* larvae at the developmental and nutritional levels. (Unpublished manuscript).

Boss, S.K., & Neumann, A.C. (1993). Impacts of Hurricane Andrew on carbonate platform environments, northern Great Bahama Bank. *Geology, 21,* 897-900.

Caribbean Marine Research Center. (1993). *Workshop on pathogens and parasites of reef corals: field techniques*. Lee Stocking Island, Bahamas: Caribbean Marine Research Center.

Colin, P.L. (1989). Aspects of the spawning of Western Atlantic Butterflyfishes (*Pisces: Chaetodontidae*). *Environmental Biology of Fishes*, *25*(1-3), 131-141.

de Laubenfels, M.W. (1949). Sponges of the western Bahamas. *American Museum Novitates, 1431,* 1-25.

Dennis, G.D., & Wicklund, R.I. (1993). The relationship between environmental factors and coral bleaching at Lee Stocking Island, Bahamas in 1990. *Proceedings of the Colloquium on Global Aspects of Coral Reefs: Health, Hazards, and History.* Miami, FL: University of Miami, Florida, 167-173.

Dill, R.F., Kendall, C.G.St.C., & Shinn, E.A. (1989). *Giant subtidal stromatolites and related sedimentary features: field trip guidebook T373*. Washington, D.C.: American Geophysical Union.

Fitt, W.K., McFarland, F.K., Warner, M.E., & Chilcoat, G.C. (2000). Seasonal patterns of tissue biomass and densities of symbiotic dinoflagellates in reef corals and relation to coral bleaching. *Limnology and Oceanography, 45*(3), 677-685.

Ginsburg, R.N. (1987). *Environments and sediments of Lee Stocking Island, Bahamas*. Miami, Florida: University of Miami, Florida.

Hixon, M.A., & Carr, M.H. (1997). Synergistic predation, density dependence, and population regulation in marine fish. *Science, 277*(5328), 946-949.

King, A.L. (1995). *Digital analysis of a patch reef community: Rainbow Gardens Reef, Lee Stocking Island, Exuma Cays, Bahamas*. Master's Thesis, College of Charleston, South Carolina

Lang, J.C. (1988). *Ecological and economic importance of coral reefs*. S-HRG 100-499: Hearing before a subcommittee of the U.S. Senate Committee on Appropriations, Washington, D.C.

Lang, J.C. (1993). *Non-invasive research and monitoring techniques for coral reefs*. Multicharacter approaches to the Taxonomy of Coral Reefs (*Montastraea and Porites*). (Publisher unknown).

Lang, J.C., Lauderdale, M.C., Crawford, M.M., Dennis, G.D., Wicklund, R.I., & Hayes, J.A. (1993). *In situ* subsurface and remotely sensed sea surface temperatures: an initial comparison. (Unpublished manuscript).

le Campion-Alsumard Radtke, G.T., & Golubic, S. (1997). Microbial assemblages involved in tropical coastal bioerosion: an Atlantic-Pacific comparison. *Proceedings of the 8th Interational Coral Reef Symposium*. Balboa, Panama: Smithsonian Tropical Research Institute.

Lipcius, R.N., Stoner, A.W., Marshall Jr., L.S., & Bardales, A.T. (1988). Mass migration of juvenile queen conch, *Strombus gigas*, in the Bahamas. (Unpublished manuscript).

Lipcius, R.N., Marshall Jr., L.S., & Cox, C. (n.d.). Regulation of mortality rates in juvenile queen conch. (Unpublished manuscript).

Marshall Jr., L.S., Lipcius, R.N., & Cox, C. (n.d.). Mortality rates of hatchery-reared and wild juvenile queen conch in natural habitats. (Unpublished manuscript).

Morse, A. N. C., and D.E. Morse. (1996). Flypapers for coral and other planktonic larvae. *Bioscience, 46*(4), 254-262.

Morse, A.N.C., Iwao, K., Baba, M., Shimoike, K., Hayashibara, T., & Omore, M. (1996). An ancient chemosensory mechanism brings new life to coral reefs. *The Biological Bulletin, 191*(2), 149-154.

Parsons, K.M., Powell, E.N., Brett, C.E., Walker, S.E., & Callender, W.R. (1997). Shelf and Slope Experimental Taphonomy Initiative (SSETI): Bahamas and Gulf of Mexico. *Proceedings of the 8th International Coral Reef Symposium*. Balboa, Panama: Smithsonian Tropical Research Institute

Porter, J.W., Fitt, W.K., Spero, H.J., Rogers, C.S., & White, M.W. (1989). Bleaching in coral reefs: physiological and stable isotopic responses. *Proceedings of the National Academy of Sciences, 86,* 9342-9346.

Reaka-Kudla, M.L., O'Connell, D.S., Regan, J.D., & Wicklund, R.I. (1993). Effects of temperature and UV-B on different components of coral reef communities from the Bahamas. (Unpublished manuscript).

Regan, J.D., Carrier, W.L., Gucinski, H., Olla, B.L., & Wicklund, R.I. (n.d.). DNA as a solar dosimeter in the ocean. (Unpublished manuscript).

Sluka, L., Chiappone, M., Sullivan, K.M., & Wright, R. (1997). The benefits of a marine fishery reserve for Nassau grouper *Epinephelus striatus* in the central Bahamas. *Proceedings of the 8th International Coral Reef Symposium*. Balboa, Panama: Smithsonian Tropical Research Institute.

Stoner, A.W. (1988). Density-dependent growth and grazing effects of juvenile queen conch *Strombus gigas* linne in a tropical seagrass meadow. (Unpublished manuscript).

Stoner, A.W. (n.d.). Transplanting as a test procedure for determining habitat quality for juveile queen conch. (Unpublished manuscript).

Stoner, A.W. (1989). Winter mass migration of juvenile queen conch, *Strombus gigas*, and their influence on the benthic environment. (Unpublished manuscript).

Stoner, A.W., & Sandt, V.J. (1989). Experimental analysis of habitat quality for juvenile queen conch in seagrass meadows. (Unpublished manuscript).

Stoner, A.W. (1988). Transplanting as a test procedure before large-scale outplanting of juvenile queen conch. (Unpublished manuscript).

Wicklund, R. I., Hepp, L.J., & Wenz, G.A. (1991). Preliminary studies on the early life history of the queen conch, *Strombus gigas*, in the Exuma Bay, Bahamas. *Proceedings of the 40th Annual Gulf and Caribbean Fisheries Institute*. Miami, Florida: University of Miami, Florida.