Environmental Impact Assessment

Emerald Beach and Pelican Beach Nourishment and Stabilization
PR 15234

Emerald and Pelican Beach Owners Group
Turks and Caicos Islands

Revised May 2022

APPLIED TECHNOLOGY AND MANAGEMENT
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Notes on May 2022 Document Revisions:

The May 2022 version of this document is a minor revision of the January 2022 document which includes document revisions based on DECR correspondence dated 2/22/2022 and 5/4/2022. Additional information and analysis is provided within two new appendices. Appendix O provides DECR correspondence received regarding the original document and responses to the comments and recommendations received. This appendix includes more detailed figures of shoreline transport modeling conducted in support of this study which more clearly addresses the potential for project downdrift (erosion) impacts. Appendix P is a new appendix that provides additional analysis and discussion regarding the potential for storm surge impacts to the area including consideration of long-term climate change (sea level rise) impacts. Revisions to the main document primarily occur within Section 6.2 (page 103) with additional information provided within the new Appendix P. A clarification regarding potential rock sources has been added to Section 4.6 (page 75).

DECR recommendations against direct hydraulic placement are acknowledged and beach nourishment will be implemented through the use of sand containment facilities in lieu of direct placement. This adopted construction method has been added to the document within Section 4.6 (page 78).

Table of Contents

List of Appendices

List of Tables

List of Figures

List of Photos

1.0 Introduction and Overview

1.1 Reference Page

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Study Location:

Pelican and Emerald Beaches; The Eastern Portion of Providenciales shoreline extending from Leeward-Going-Through Inlet west for approximately 2,000 meters
Pelican Beach: Block 60904; Parcels 20 and 552 through 170
Emerald Beach: Block 60901; Parcels 160 through 171

Submittal Version:

Version 1. Submittal to the Department of Planning; January 2022
Version 2. Submittal to the Department of Planning; May 2022

1.2 Non-Technical Summary

The shoreline extending west from Leeward-Going-Through Inlet has historically experienced periods of chronic erosion due largely to the influence of the inlet on sediment transport and the lack of consistent sediment supply into the area. Multiple measures have been implemented over several decades to mitigate the impact including the installation of seawalls, groynes and beach nourishment. The success of these measures has localized and limited success, due largely to a lack of holistic, long-term planning to minimize the potential for adverse impacts to downdrift properties and ensure a consistent supply and distribution of sand throughout the costal system. The current plan as represented in the Outline Development Permission request (PR 15234) was developed based on current accepted international standards for shoreline management which consider impacts to the coastal sediment transport system. This plan was developed through a multi-year collaborative process involving over 25 individual properties within the project area to provide a systemic solution to the erosion issue. This level of consultation and ownership commitment is truly unprecedented in the management of coastal resources within the Turks and Caicos and may serve as a model for future management of developed shorelines within the Country.

This Environmental Impact Assessment (EIA) was conducted to assess the potential for environmental impact from the proposed project, which includes the construction or rehabilitation of nine groyne structures and placement of approximately 50,000 cubic metres of beach quality sand in the project area which spans Emerald and Pelican Beaches.

The main objective of this project is to stabilize the historically erosional 0.9 miles of beach within the project area to provide both a recreational amenity (to tourists and locals) and storm protection to upland development. The current state of the eroding beach has lowered property values, limited space for recreational activity and leaves structures and upland development along the shoreline vulnerable to wave and storm impact.

Providing a stable beach will have several positive impacts. Economic benefits include added appeal to investors, increased property values and the positive downstream taxes and fees from property sales. The reclaimed land will provide recreational use for locals and increase tourism potential, which will contribute to the local economy. In addition to the potential economic gains,

the project will provide protection to property which will eliminate the cost and potential impacts of constructing individual property protection measures such as seawalls.

The placement of sand on Emerald and Pelican Beaches will widen these beaches. The introduction of sand to the area will also benefit the surrounding areas through diffusion and longshore transport. The structural component of the project has been designed to stabilize the beaches in the project area, which are currently erosional. The reconstruction of existing and construction of new groynes will help reduce losses in the area. These structures have been designed to also reduce the potential for impacts to the surrounding area. The overall impact to the coastal environment and processes that the project will create a wider, more stable beach that will have minimal impacts outside of the project area.

Overlaying the proposed development components onto the results of landside and marine investigations reveals that the project will have minimal direct impacts on landside vegetative communities, and minimal to moderate direct impacts on sub-tidal marine areas. Overall, the ecological effects of the project are expected to be minimal, provided corals are relocated and other mitigation and monitoring activities described in this report are implemented.

Beach nourishment and groyne construction seaward of the Mean High Water location will occur within the defined limits of the Princess Alexandra Land and Sea National Park. Section 4 (1a) of the National Parks Ordinance requires approval from the Governor for elements of this project within the national park boundaries.

1.3 Project Description

The Emerald Beach and Pelican Beach Nourishment and Stabilisation Project aims to mitigate the historic shoreline recession and beach erosion issues identified at Emerald Beach and Pelican Beach in the eastern section of Providenciales island, Turks and Caicos. The project encompasses approximately 4,684 feet (0.9 miles) of shoreline, 25 individual private properties and 2 public beach access points. The project includes the construction and/or rehabilitation of nine (9) different sediment retention structures, and placement of approximately 50,000 cubic metres of beach compatible sand material in the Emerald and Pelican Beach area.

The project at Emerald Beach includes the construction of one (1) new T-head groyne (structure T-1), and the rehabilitation of one (1) existing T-head groyne at the west end of the beach (structure T-2) and the rehabilitation of one (1) groyne in the beach middle section (structure T-1b). Approximately 25,000 cubic metres of beach compatible sand will be placed between T-1 and T-2 in order to increase the existing dry beach width and provide coastal protection to the shoreline properties.

In the transition from Emerald Beach to Pelican Beach, one (1) new breakwater (structure T-3) will be installed in order to stabilize the pocket beach immediately to the west, and provide storm protection to the adjacent upland properties.

The stabilization work at Pelican Beach includes the transformation of three (3) existing groynes of various condition (structures T-4, T-7, and T-8) to T-head groynes; installation of three (3) new breakwaters (structures T-5, T-6, and T-9); and the removal of two (2) existing derelict groynes, one located between T-7 and T-8 and the other one between T-9 and the east end of the beach. Additionally, approximately 25,000 cubic metres of beach compatible sand will be placed between T-3 and T-8 with the same objective as described above for Pelican Beach.

A summary table with the dimensions of all the structures included as part of this project is presented in Table 1-1 and project drawings are provided in Appendix D.

Table 1-1. Summary of the Project Structures Dimensions

Structure id	Location	Type	Cross shore length (m)	Longshore length (m)
T-1	Emerald Beach	T-head groyne	61	40
T-1b	Emerald Beach	Groyne	25	0
T-2	Emerald Beach	T-head groyne	40	40
T-3	Transition section	Breakwater	45	0
T-4	Pelican Beach	T-head groyne	53	40
T-5	Pelican Beach	Offshore breakwater	0	25
T-6	Pelican Beach	Offshore breakwater	0	25
T-7	Pelican Beach	T-head groyne	52	55
T-8	Pelican Beach	T-head groyne	52	40
T-9	Pelican Beach	Offshore breakwater	0	25

Additional work that will be conducted throughout the project area as needed includes:

- Removal of assorted debris within the project footprint
- Rehabilitation as needed of existing coastal structures within the project footprint including seawalls and revetments within their existing footprint and orientation.

Given the highly eroded nature of the shoreline and the ongoing erosion and possible failure of existing coastal structures, initiation of work is intended to occur on an expedited basis once the required approvals are secured. The structure construction phase will occur first with sand placement occurring following structure implementation.

1.4 Aims and Objectives of the Assessment

The purpose of this Environmental Impact Assessment (EIA) study is to assess the potential environment impacts of the proposed beach nourishment and the construction and repair of beach stabilizing structures. The study also aims to provide a qualitative and quantitative assessment of the long-term impacts of the proposed project on the surrounding environment and offers long-term monitoring and adaptive management measures as a framework for long term management of the project shoreline.

This EIA was conducted with the following main objectives:

- To assess the existing environmental conditions, habitat and critical species within the project area;
- To provide qualitative and quantitative assessments of the biological and physical environment within the study area;
- To assess the impact of coastal structures and sand placement on the surrounding marine and terrestrial environments;
- To develop risk prevention and mitigation measures to minimize impact from the proposed beach nourishment and groyne construction.
- To develop a long-term monitoring and adaptive management plan to serve as a framework for coastal management;

1.5 Overview of the EIA

This Environmental Impact Assessment (EIA) report is organized in accordance with the guidelines provided in the Terms of Reference (ToR) dated July 20, 2021 and provided in Appendix A. The first section provides an introduction to the study, and offers a brief description of the project. Section two gives a detailed baseline assessment of the site and surrounding environment. Section three reviews the legislative and regulatory framework under which the proposed construction will be carried out. Section four provides a detailed description of the project design, construction and operational alternatives. Section five is the impact assessment which includes identification of various potential environmental and socio-economic impacts of the project. Section six provides a description of activities that will require mitigation, corrective, compensatory and other measures to be used to eliminate, minimize or mitigate adverse/significant impacts, and includes the environmental management plan (EMP). Section 7 lays out recommendations and conclusions. References are provided in Section 8 and appendices are included in Section 9.

1.6 Impact Assessment Methods/Analyses

The analysis conducted in support of this study included, but was not limited to, desktop review of existing data, previous studies and reports, and direct and indirect surveys. Direct surveys included qualitative and quantitative environmental assessment within the terrestrial and marine environments, bathymetric surveys, and sand mechanical analysis. A numerical model of coastal sediment transport was developed and used as a basis for design development and alternative assessment.

Assessment of coastal dynamics – including sediment transport patterns, tidal and current data and baseline quantitative description of all organisms and habitats in the near shore region that will conceivably be affected by the proposed beach nourishment and groyne construction was conducted.

During late September and October 2021, ecological assessments of landside and nearshore marine areas were conducted on the site on the northeast side of Providenciales on which a beach creation project is proposed to be constructed in the areas known as Emerald Beach and Pelican Beach (Figure 1-1). The assessments were performed consistent with a Terms of Reference that had been issued by the Turks and Caicos Government's Planning Department to

determine the potential impacts that could occur as a result of the installation of several shore-protection groynes and the creation of sandy beach areas. The assessments included qualitative and quantitative evaluations of the floral and faunal communities present on the site, within 100 metres of the shoreline in the marine environment and 33 metres on adjoining landside communities, where they existed and where doing so would not intrude onto private properties. The assessments were completed to determine potential environmental impacts of the project.

The investigations were conducted by staff of Applied Technology and Management (ATM), a firm that has extensive experience in coastal and terrestrial ecosystems in the Turks and Caicos Islands, the Bahamas, the Caribbean and the southeastern United States. The assessments involved visual inspections of terrestrial and marine areas within the footprint of the proposed activities and in adjacent areas that could be affected by the proposed activities.

The baseline ecological assessment for the Beach Project associated with the Emerald and Pelican Beaches included both a literature search and field surveys, as described hereafter.

The literature search involved querying the databases used by the Government of the Turks and Caicos Islands for information pertinent to the site, including lists of terrestrial and aquatic flora and fauna that are designated as Endangered, Threatened and/or Endemic. It also included querying protected species lists maintained by international conservation organizations to which the Turks and Caicos Islands are signatories, including the International Union for the Conservation of Nature (IUCN) and the Convention on International Trade of Endangered Species (CITES).

The field assessments involved visual inspections of terrestrial and marine areas within the footprint of the proposed activity and in adjacent areas that could be affected by the proposed activity.

The landside assessment involved direct visual observation of conditions in three areas:

1) Within the footprint of the proposed groyne structures;
2) Along the shoreline between the proposed groynes where sand is proposed to be added to create a sandy beach; and

3) In variable-width areas landward of the water's edge. Although the target distance was 33 metres from the shoreline, in most areas private properties were limiting factors and the landward edge of the assessment area was less than 33 metres.

The marine assessment involved direct visual observation of conditions in two areas:

1) Marine areas within the footprint of the proposed groyne structures; and
2) Marine areas within 100 metres of the proposed groynes and beach placement areas.

A Canon EOS Rebel T3i, Olympus TG-870 and Nikon 3A digital cameras were used to photograph representative landside and marine areas and notable flora and fauna. A hand-held Garmin GPSmap 62sc Global Positioning System (GPS) was used to record latitude and longitude waypoints at landside and marine investigation plots and at locations where notable flora and/or fauna or community boundaries were observed. Bushnell 10 x 42 binoculars were used during bird surveys, which included observations during early morning and late afternoon hours. Records were also kept of observations of birds and other wildlife that were seen while qualitative and quantitative landside transects were being conducted.

In land-side communities, a total of twenty-nine 3m x 3m temporary vegetation plots along 16 transects were established and analysed. A tape measure was extended around the perimeter of each plot and the flora and fauna within the plot were documented.

The abundance of all floral species (actual counts of individual species of trees and shrubs), and estimates of percent cover of groundcover and vine species), indications of faunal use and a qualitative assessment of conditions that occur within each plot were recorded. Inventorying of flora and fauna also included documentation of observations along pedestrian transects that traversed other areas outside the transects but within the various vegetative communities within the assessment area. Within each plot, all plants were identified to species level, whenever possible. Cumulative percent cover of all vegetation was estimated. Trees (woody species greater than 2.1 metres (7 feet in height), and shrubs (woody species at heights between 0.3 and 2.1 metres (1 to 7 feet) were counted numerically. Plants less than 0.3 metres (1 foot) in height were considered to be "groundcover" species, even if they were young plants that could eventually grow to shrub or tree heights. The percent cover of individual groundcover species

and vines was estimated. The presence of fauna observed within the plot or in the vicinity, was recorded. Evidence of human-related and natural (e.g., hurricanes) impacts was recorded to assist in determining the quality of the vegetative community in each plot.

For marine communities, an underwater Nikon Coolpix AW130 and Olympus Stylus TG-870 digital waterproof cameras were used to document existing marine conditions. A 50 cm x 50 cm PVC grid was used as a scale reference to assist in estimating percent cover of benthic resources and as a size reference in underwater photographs. Notes of observations of marine life were recorded on waterproof paper while snorkelling and/or SCUBA diving.

Visual inspections of underwater conditions were assessed along 16 mostly shore-parallel transects that started on the uplands, continued past the water's edge and extended in a north-south orientation to a distance of approximately 100 metres (328 feet) from the shore. The groyne near the western boundary of the project is in a shore-parallel orientation. Underwater photos were taken of representative and notable features and are included in the applicable section of the text and in Appendix M.

Plant names follow the *Flora of the Bahamas Archipelago*, by D.S. H.B. Correll, *Flowers of the Bahamas and Turks and Caicos Islands* by K. McNary Wood, with updates of plant names where utilized as primary reference documents. Additional reference materials for landside flora and fauna included *The Birds of the Turks and Caicos Islands* (Ground, 2001), *Birds of the Bahamas and Turks and Caicos Islands* (Hallett, 2006), *Wildlife of the Caribbean* (Raffaele & Wiley, 2014) and *The Natural History of the Bahamas* (Currie, Wunderle et al., 2019).

Qualitative ratings were based on best professional judgement considering factors such as biodiversity, location-appropriate floral and faunal assemblages, the presence, absence and/or abundance of notable and invasive floral and/or faunal species, and the extent to which the area appeared to have been subjected to damage as a result of human and natural processes. Note that Hurricanes Maria and Irma caused widespread damage in some areas of the TCI during October 2017. The qualitative rankings vary from Low (i.e., low biodiversity, absence of notable floral and faunal species, and impacted by human and/or natural processes) to High (e.g., high biodiversity, abundant notable floral and faunal species, pristine condition).

The boundaries of the landside and marine assessment areas were mostly readily visible in the field, but pre-calculated GPS coordinates were programmed into the portable GPS unit that was used in the field. In some areas, shoreline erosion had been so severe that establishment of landside plots was not possible.

Field surveys were conducted primarily from September 27 through October 1, 2021. Additional ground-truthing and visual inspections were conducted during the week of October 11-16, 2021.

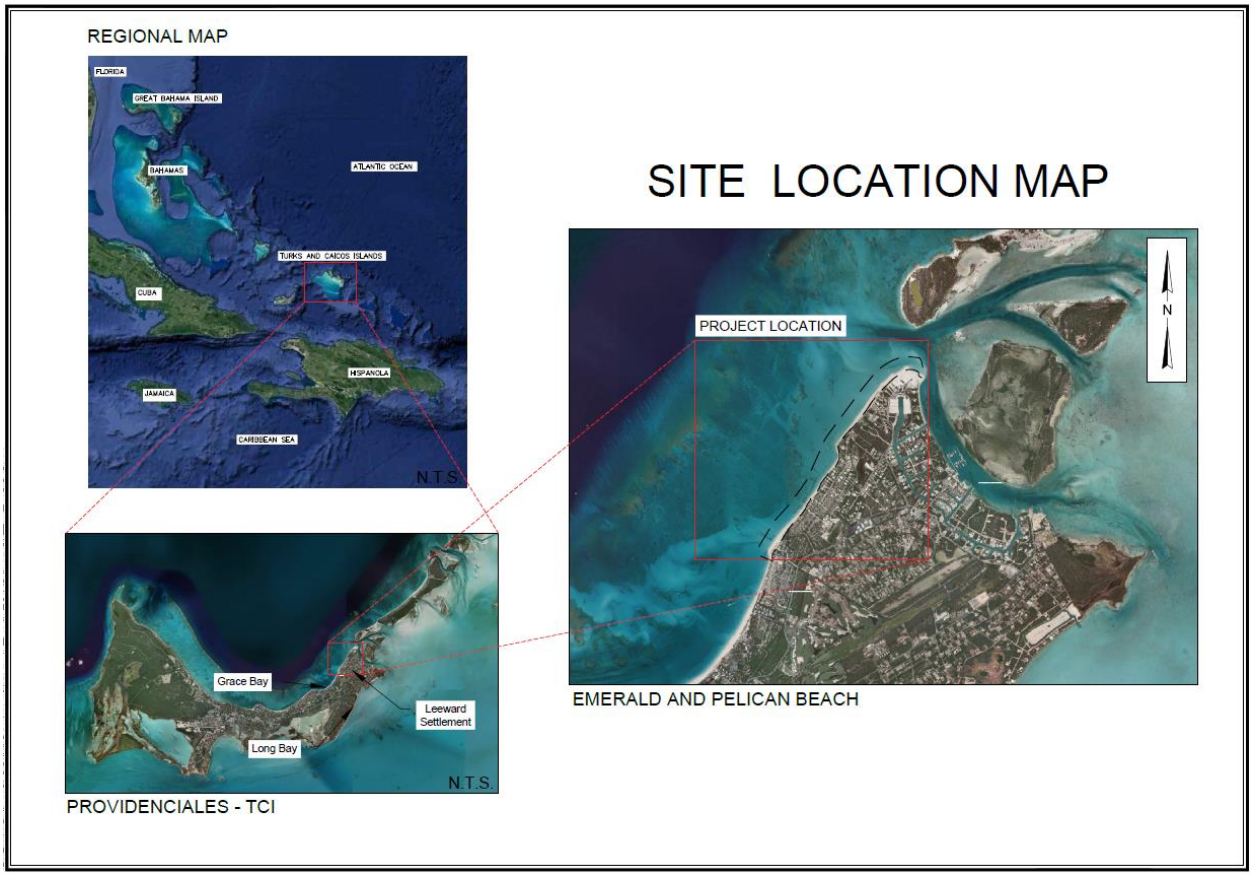


Figure 1-1. Location Map

2.0 Baseline Studies

2.1 Historical Overview of the Site and Existing Development

The Leeward Settlement is located on the northeastern tip of the island of Providenciales in the Turk and Caicos Islands and includes many beachfront properties. The area is highly dynamic due primarily to the location adjacent to the Leeward-Going-Through Inlet.

Along the over 2000 metres shoreline, there are two sandy beaches separated by a rocky/hard headland. Towards the east, the Emerald Beach is less developed and has a nominal beach with signs of shoreline retreat. Towards the west, Pelican Beach has experienced significant shoreline recession with a notable difference between the current vegetation line and the previous property boundaries that are currently defined by seawall structures.

In the past, property owners have invested in protecting their properties and beaches by implementing various groyne and seawall structures. These measures in general were focused on the stabilization of individual properties and did not address the overall cause of erosion or address the adverse impacts of structure implementation. On Pelican Beach, seawalls were implemented around 20 years ago within the central portion of the reach. Further, groynes have been built in the nearshore with various levels of success in stabilizing the beach. However, these structures have deteriorated over time and the beach has also receded. On Emerald Beach, significant modifications to the shoreline have been carried out. Major shore reclamation (nourishment) was implemented but the shoreline has since been on the retreat. Of note was a groyne built at the headland between Pelican and Emerald Beaches that was modified several years after construction as it was deemed to be causing downdrift erosion along Pelican Beach. A summary of the history of the evolution of the shorelines based on existing literature is provided for each beach below.

With regards to the Emerald Beach:

- The main beach work that occurred on Emerald Beach was a significant beach nourishment and land reclamation exercise that was carried out in 2003/2004 and 2008. Geotube T-groyne structures were also built in 2008. In that region the shoreline has subsequently eroded by over 20 metres.

- The shoreline has varied from 2003, with a 55-metre increase noted in 2012 from nourishment works followed by a 30-metre retreat since 2012.
- There is sand build-up on the west side of the T-groynes at Emerald Beach.
- At Pelican Point, a T-groyne was implemented in 2007. Based on beach profile monitoring results, the shoreline appears to have remained relatively stable during the measurement period (2007-2011).
- The Pelican Point T-groyne was reportedly lowered. After this, a reduction in beach width was observed along Emerald Beach with a corresponding increase in beach width at Pelican Beach.
- This shoreline has undergone significant erosion since the two major beach nourishment activities. Towards the western end of Emerald Beach was relatively stable until 2015 when the T-groyne was reportedly modified. This indicates that the shoreline needs structural intervention to retain sand.

With regards to Pelican Beach:

- The shoreline along Pelican Beach has experienced significant changes in recent years. A groyne field was built in 1988, after which sand was retained on the eastern side of the structures. The structures were not maintained and have deteriorated over time. By 2015, the groynes were no long retaining sand. Currently they are not functional.
- The shoreline change has not been as significant as at Emerald Beach due primarily to the but there has been variation of up to 20 metres in beach width. Pelican Beach has been a relatively narrow beach. The beach was at its widest around 2015/2016 when it was similar to 2003.
- Pelican Beach has not had any significant beach nourishment. However, west of the area (East Grace Bay) was nourished with 178,600 cubic yards of sand in 2007. At this time, a T-groyne was also built. This part of the shoreline has been accreting since 2012.
- Pelican Beach is currently in a highly eroded condition.

An analysis of the shoreline along Pelican and Emerald Beaches, adjacent to the Leeward-Going-Through Channel, was conducted using the available Google Earth imagery. Images dated from 2003 to 2021 were analysed.

The analysis of images revealed changes in the appearance of sand and rock along the shoreline and impacts from coastal structures constructed along the shoreline.

In a 2003 image, the Pelican Beach shoreline is segmented by five groyne structures that are holding sand updrift within the cells with a classic down-drift effect. The headland that transitions into Emerald Beach to the northeast is rocky during this time. In 2003, Emerald Beach is dotted by several small groynes and breakwaters from the approximate centre of the shoreline extending to the northeastern most extent of the beach. The beach was thin towards the southwest end, with visible nearshore hardbottom, and the beach thickness increased moving toward the centre and northeastern sections of the beach, which were holding sand due to the structures.

By 2012, the Pelican Beach and Emerald Beach shorelines widened significantly. In the 2012 images, some of groynes along Pelican Beach have been modified to be smaller structures. The beach to the is wider in this area than in 2003, however there appears to be an erosional hot spot moving toward the northeastern extent of the beach. The headland that transitions into Emerald Beach to the northeast is primarily covered by sand during this time, having only small amounts of rock visible along the western facing segment. In 2012, a terminal groyne at the southwestern end and three T-head groynes at the northeastern edge of Emerald Beach can be seen. The beach thickness increased considerably in this timeframe and there are no visible shore attached rock outcrops at this time.

By 2015, the Pelican Beach shoreline appears to be more stable, with sand more evenly distributed along a moderately wide beach. The erosional hot spot seen in 2012 has diminished and the western face of the headland is primarily covered in sand. In 2015, Emerald Beach is thinner than in 2012, however it is still wider than in 2003.

By the end of 2018, the Pelican Beach shoreline is thinner than it was in 2003, and the erosional hot spot has re-emerged along the northeastern side of the beach leading up to the headland. The headland itself is considerably more exposed as well. The Emerald Beach shoreline also appears to have thinned, but to a lesser degree than along the Pelican Beach Shoreline.

The most recent image was taken in August 2021, and much of the headland and Emerald Beach is obscured by cloud cover in this image. Pelican Beach is extremely eroded with exposed seawall from the centre of the beach moving northeast. While most of the headland and Emerald Beach is obscured in the image, there appears to be less sand in the system overall and the visible sections appear to be very thin.

The images used in this rough analysis were not taken at the same time of year and may depict regular seasonal changes. Since the images were not taken during the same tidal cycle, many unnoticed sandy segments are likely in images taken during high tides.

2.2 Biological Environmental Baseline Assessment

The list of flora and fauna that are designated as protected because they are endemic, rare and endangered [entitled “The Schedules” (Appendix G)] was received from the Department of Environment & Coastal Resources (DECR) and was used as a primary basis for this study. This list was used as the primary reference list for notable flora and fauna that could potentially be present on the site.

A query of the database maintained by the International Union for the Conservation of Nature (IUCN) revealed the potential presence of over 500 floral and faunal species that occur in the Turks and Caicos Islands that are designated, in descending order of vulnerability, as Critically Endangered, Endangered, Near Threatened, Vulnerable, Least Concern, and Data Deficient. The IUCN database does not allow for filtering by island, so the list (Appendix H) is for all the Turks and Caicos Islands. Although it includes many species that exist in habitats that are not present on the subject property or within the sphere of influence of the proposed project, it does include several marine species and several species of terrestrial flora and fauna that were observed during the assessment and/or have the potential to be affected by the proposed activities. Species that were observed and/or are likely to occur on the subject site and/or within the sphere of influence of the project have been highlighted in the appendices.

The Turks and Caicos Islands are not registered as a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), but a search of its database of listed species was conducted for this project because the Turks and Caicos Islands are a dependent territory of a signatory party and the DECR has been determined by CITES to be an

"authority competent to issue comparable documentation" and "A scientific institution capable of advising that an export is not detrimental to the survival of the species concerned." The CITES database does not allow for filtering by island, so the list (Appendix I) is for all the Turks and Caicos Islands. It identifies numerous marine species and several species of terrestrial flora and fauna that have the potential to be affected by the proposed activities. Species that were observed and/or are likely to occur on the subject site and/or within the sphere of influence of the project have also been highlighted in this appendix.

A total of twenty-nine 3 m x 3 m vegetative community plots and twenty-seven 0.5 m x 0.5 m marine community plots were established along sixteen transects that generally expanded outward in a shore-perpendicular orientation (Figure 2-1 and Appendix D). Floral and faunal species observed in these plots are identified in Table 2-1.

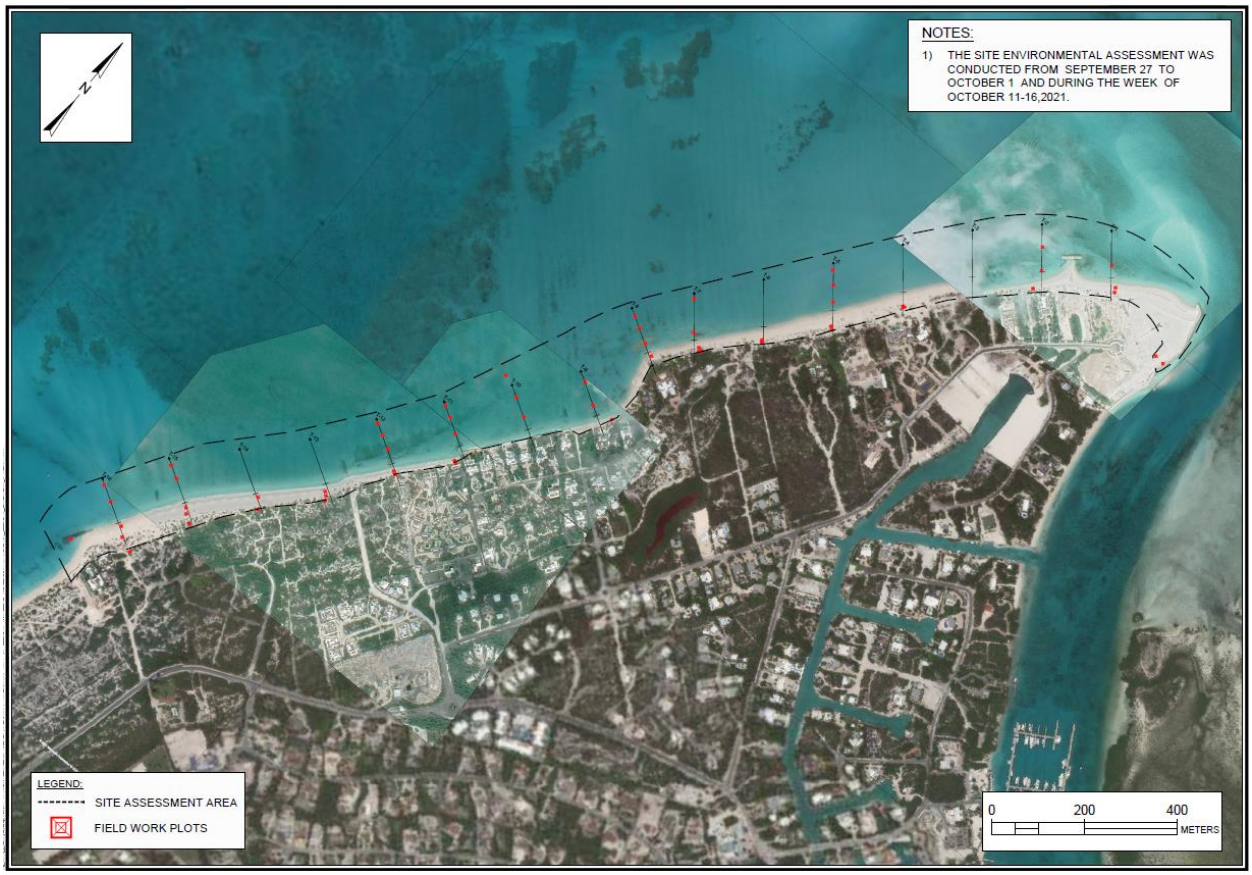


Figure 2-1. Field Assessment

2.2.1 Baseline Terrestrial Environment

The landside assessment involved direct visual observation of conditions in three areas:

1) Within the footprint of the proposed groyne structures;
2) Along the shoreline between the proposed groynes where sand is proposed to be added to create a sandy beach; and
3) In variable-width areas landward of the water's edge. Although the target distance was 30 metres from the shore, because in most areas this would have required accessing private properties, the landward edge of the assessment area was mostly considerably less.

Lists of flora (Appendix J) and fauna (Appendix K) observed and identified during the site assessment are provided in the appendices.

The footprint of the proposed beach project was found to be in a heavily degraded condition. To varying extents along the 2.25-kilometre (about 7382 linear feet) length of the project, beach erosion and littoral drift had scoured project area, leaving some areas with no sandy beach, where homes and properties were protected from impact by vertical seawalls

In areas where a sandy beach was present, it varied from being very narrow to a maximum width of approximately 40 metres (about 125 feet.). No caves, dissolution holes, blue holes, bluffs or other particularly notable landscape scale features were encountered on the property. Where pioneer plants and dune vegetation were accessible, the vegetative communities were in a more natural and less-impacted condition, as described hereafter.

A total of twenty-nine 3-metre by 3-metre vegetative community plots were established along sixteen transects that generally expanded outward in a shore-perpendicular orientation (Figure 2-2 and Appendix D). Floral and faunal species observed in these plots are identified in Table 2-1.

Table 2-1. Landside Flora in Vegetation Analysis Plots

Scientific Name	Common Name	Emerald 1	Emerald 2	Transect 1 Plot 1	Transect 1 Plot 2	Transect 2 Plot 1	Transect 4 Plot 1	Transect 4 Plot 2	Transect 5 Plot 1	Transect 5 Plot 2	Transect 6 Plot 1	Transect 6 Plot 2	Transect 7 Plot 1	Transect 7 Plot 2	Transect 8 Plot 1	Transect 11 Plot 1	Transect 11 Plot 2	Transect 12 Plot 1	Transect 12 Plot 2	Transect 13 Plot 1	Transect 13 Plot 2	Transect 13 Plot 3	Transect 14 Plot 1	Transect 14 Plot 2	Transect 15 Plot 1	Transect 15 Plot 2	Transect 15 Plot 3	Transect 16 Plot 1	Transect 16 Plot 2	Transect 16 Plot 3	# Occurrences
Ambrosia hispida	Sweet Bay, Bay tansy, Soap-bush																						< 1%					< 5%			2
Canavalia rosea	Bay Bean, Beach Pea						10%																								1
Cassytha filiformis	Woe-vine, Love Vine																			< 1%								1%			2
Casuarina equisetifolia	Beefwood, Australian Pine	0/1/0							0/1/0														0/1/0		1/0/0						4
Cenchrus tribuloides	Burgrass																														0
Chamaecrista lineata																															0
Coccoloba uvifera	Seagrape								0/2/0											0/1/0			0/3/0					0/0/< 1%			4
Coccothrinax argentata	Silver Thatch, Silver Top		0/0/< 1%																				0/1/0					0/0/< 1%			3
Cocos nucifera	Coconut Palm																														0
Conocarpus erectus	Buttonwood																														0
Corchorus hirsutus	Wooly Corchorus, Jack Switch																														0
Dactyloctenium aegyptium	Crowfoot Grass	< 5%	< 5%																									1%			3
Euphorbia abbreviata	aka E. inauguensis																											0/5/0			1
Euphorbia mesembrianthemifolia	Coast spurge, Seaside spurge	< 1%				0/2/< 1%			< 1%																						3
Eustachys petraea	Finger Grass																			< 1%											1
Eustoma exalatatum	Marsh Gentian																														0
Genipa (fka Casasia) clusiifolia	Seven-year Apple																						0/1/0					0/1/0			2
Gundlachia corymbosa	Horse Bush																														0
Hibiscus tiliaceus	Mahoe																														0
Ipomoea pes-caprae	Bay Hops, Bay Winders					< 5%					< 5%		45%																		3
Iva imbricata	Beach Iva																				0/1/0										1
Launaea (Lactuca) intybacea	Wild Lettuce																														0
Leonotis nepetifolia	Lion's Ear																														0
Leucaena leucocephala	Cow Bush																														0
Pluchea odorata	Marsh Fleabane																														0
Scaevola plumieri	Inkberry, Black-soap																				0/1/0				0/1/0			0/0/1%			3
Scaevola taccada	Ornamental Candlewood	0/10/0	0/8/0	1/0/0		0/1/0			0/2/0		0/8/0		0/10/0 dead			0/2/0		0/15/0		0/9/0	0/1/0		0/1/0		0/1/0	0/1/0					13
Sesbania sp.			0/3/0																												1
Sesuvium portulacastrum	Pondweed, Sea purslane										< 5%					25%		10%			< 1%								20%		5
Spermacoce tenuior	False Button Weed																														0
Sporobolus virginicus	Seashore Rush-grass			5%					< 1%		< 5%		5%							< 1%			< 1%					5%			7
Stachytarpheta fruticosa	Bahama Vervain, Blue Rat Tail																														0
Strumpfia maritima	Mosquito Bush, Candle Torch																			0/2/0											1
Suriana maritima	Bay Cedar																														0
Uniola paniculata	Sea Oats					< 5%			15%				15%			10%									30%	10%			30%		7
Vachellia (fka Acacia) choriophylla	Cinnecord																											0/2/0			1
Waltheria indica	Sleepy Morning																														0
Fauna		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Hermit Crab	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Cerion snails	Ghost Crab burrow	N/A	
Percent Cover:		20%	60%	30%	0%	10%	50%	0%	50%	0%	70%	0%	80%	0%	0%	75%	0%	75%	0%	85%	10	0%	70%	0%	60%	10%	0%	50%	50%	0%	
Quality:		Poor	Poor	Fair	Poor	Poor	Poor	Poor	Good	Poor	Poor	Poor	Good	Poor	Poor	Poor	Poor	Poor	Poor	Good	Fair	Poor	Good	Poor	Fair	Fair	Poor	Good	Fair	Poor	

Legend and Notes

Plot size = 3 meter x 3 meter

Trees = > 7' tall

Shrubs = 1-7' tall

Groundcovers = < 1'; % groundcover shown

For species that can grow to tree size, #/# /# = # tree size / # shrub size / seedlings less than 1' in height

% Groundcover provided when individual was < 1' tall, regardless of height when mature

For species which have had name changes since they were designated as protected or invasive, the following apply

Euphorbia abbreviata = Euphorbia inaguensis

Genipa clusiifolia was formerly known as Casasia clusiifolia

Vachellia choriophylla (cinnecord) formerly known as Acacia choriophylla

Three vegetative community types were found to be present within the assessment area. The location of each community type is shown on Figure 2-2, and the corresponding size of each area, its percentage of the overall assessment area, relative quality and comments are identified in Table 2-2, and as described hereafter.

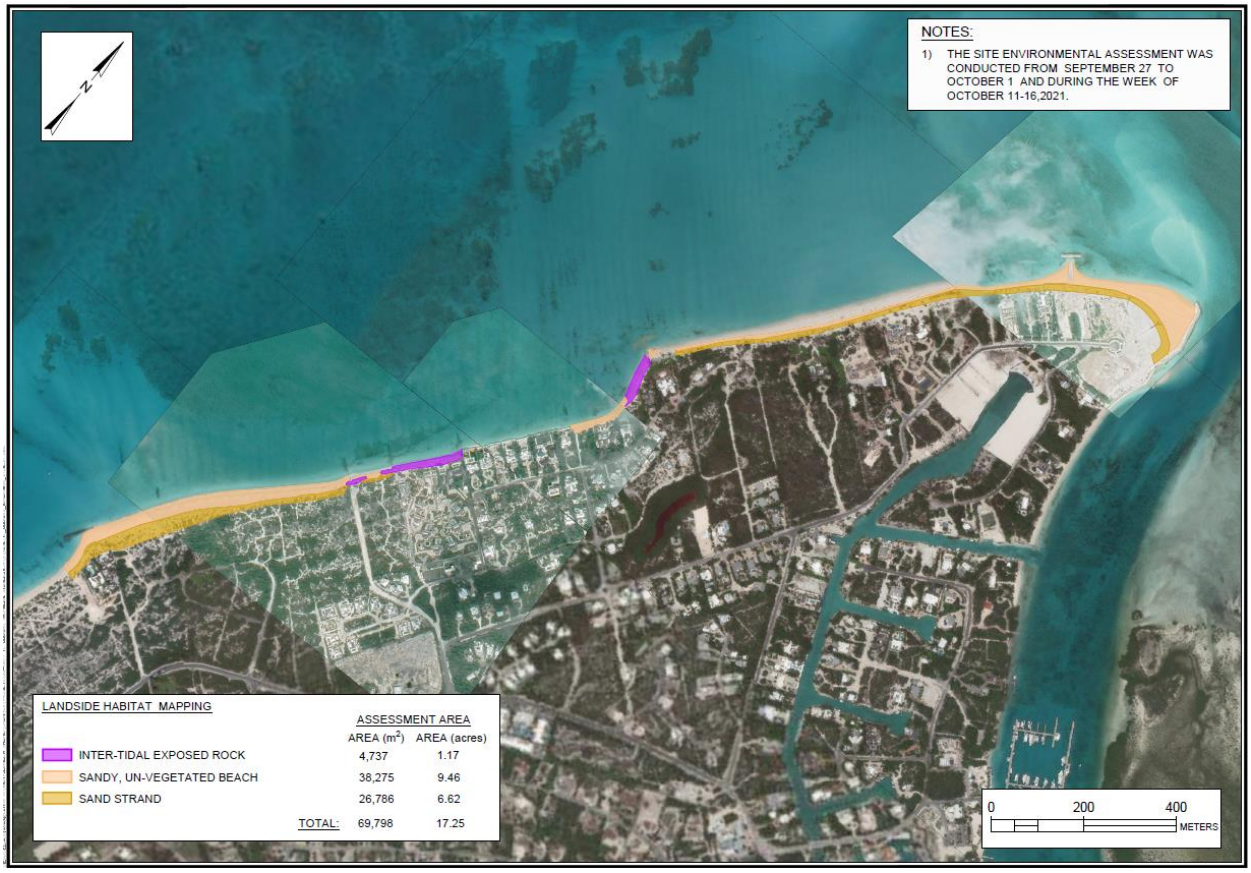


Figure 2-2. Landside Habitat Map

Table 2-2. Existing Landside Community Types

Community Type	Size w/in Assessment Area Acres	Percentage of area w/in Assessment Area	Qualitative Rating[1]	Comments
Inter-tidal Exposed Rock	1.17	~6.8	Poor	Previous-constructed groynes
Sandy, un-vegetated beach	9.46	54.8	Good	Historical natural community intact to varying degrees
Sand Strand	6.62	38.4	Fair	Native geologic & vegetative community moderately impacted by previous human use & non-native vegetation.
Total:	17.25	100		

Inter-tidal Exposed Rock, including Seawalls

Approximately 1.17 acres (6.8% of the assessment area) was found to consist of consolidated substrate in the form of naturally occurring slabs of rock pavement, previously constructed seawalls and rock groynes. This community was generally devoid of terrestrial vegetation. Marine organisms adapted for life on rock substrates in the inter-tidal zone (e.g., knobby littorina/beaded periwinkles (*Cenchritus muricatus*), chitons (*Acanthopluera granulata*), nerites (*Nerita* spp.) were occasionally present where these habitats were present in the inter-tidal zone, as described in the results of the baseline marine assessment. Photo 2-1, Photo 2-2 and Photo 2-3 are representative of this community type.

Photo 2-1. Naturally occurring slabs of Rock Pavement. View looking west
Date of Photo: September 28, 2021

Openings of burrows of curly-tailed lizards (*Leiocephalus psammodromus*) and/or other typical beach-dwelling species (e.g., ghost crabs (*Oxypode quadrata*) were occasionally observed.

Along two stretches, 242 metres (794 feet) and 55 metres (180 feet) respectively, vertical seawalls were directly exposed to sea (Photo 2-2). Terrestrial vegetation was non-existent on the seawalls.

Photo 2-2. Vertical Seawalls. View looking southwest
Date of Photo: September 29, 2021

The highest elevation portions of the easternmost, recently constructed groyne appeared to be potentially suitable for the future existence of a terrestrial vegetative community (Photo 2-3), but no plants had become established.

Photo 2-3. Uppermost areas of Rock Groyne. View looking northeast.
Date of Photo: September 28, 2021

Brown pelicans and royal terns were observed aerially in this area, but the exposed rock community within the assessment area did not appear to consist of suitable foraging or nesting areas for these species. Although no oystercatchers were observed in this area during the assessment, this species is known to nest on elevated rock substrates such as this, which they appear to select primarily due to the protection from land-based predators.

This community was mostly in Poor condition, due to it being an artificially created substrate nearly totally devoid of existing native flora and fauna. This community does, however, provide structural value for coastal resiliency and protection from storms and potential effects of sea level rise.

Sandy, Non-vegetated Beach

Approximately 9.46 acres (57.8% of the assessment area) was found to consist of non-vegetated sandy beach, much of which was either within normal or intermittent tidal inundation or situated slightly landward of mean high water (Photo 2-4).

Photo 2-4. Barren Sandy Beach. View looking Northeast.
Date of Photo: September 27, 2021

Openings of ghost crab burrows or other typical beach-dwelling species were occasionally observed.

Few birds were observed in this area during the assessment, but shorebirds, including sanderlings, turnstones, sandpipers, plovers and oystercatchers are well-documented to be occasionally present and/or to forage in this habitat. No evidence of shorebird nesting was observed because the assessment was not conducted during the bird nesting season, but the area appeared to be suitable for nesting by Wilson's plovers and least terns.

One notable bird sighting was a small flock of mostly piping plovers (*Charadrius melodus*). Eight individuals, at times accompanied by ruddy turnstones (*Arenaria interpres*) were observed near the eastern-most terminus of the project. Diligent observations revealed that one of the piping plovers was banded (Photo 2-5).

Photo 2-5. Piping Plover J4. Taken at approximately 21^0 49' 42.14" North; 072^0 19' 05.61" West
Date of Photo: October 16, 2021

With the alpha-numeric code of J4 in black lettering on a white flag clearly visible on the left leg and a silver band (numbers illegible), the sighting was reported in the online website monitored by the Bird Banding Lab. A response from the U.S. Fish and Wildlife Service (FWS) indicated that the bird was a female that had hatched in 2016 or before and had been banded on June 13, 2017 on its nesting grounds near Tabusintac, New Brunswick, Canada. This bird was previously known from this area, having been documented "several years ago" on Little Water Cay, approximately 630 metres (about 2,100 feet) northeast of this observation. The bird had also been observed during migration, where she had been reported from North Carolina in spring 2018, in New Jersey and Georgia during spring 2019; and in North Carolina during the fall 2017 and 2018.

Marine turtles also are known to nest on sandy beaches. No data was found that indicate that this area is known for sea turtle nesting, and the shallow depth of sand overlaying the rock substrate that was present in most of the area appeared too thin for successful nesting by marine turtles. No evidence of turtle nesting (or hatching of young) was observed, but October

is late in the nesting season, so it is not surprising that there were no observations of nests or hatchlings.

This community was ranked as being in Good or Poor condition at varying locations along the 2.25 kilometre length of the assessment area. Beach width varied from less than 6 metres (about 18 feet) to approximately 40 metres (about125 feet). The upper limit of this community transitioned into pioneer-zone vegetation species (e.g., sea oats – *Uniola paniculata*), which appeared to likely have been previously planted. Portions of this community were heavily eroded, as evidenced by a steep escarpment, where previously occurring sand strand vegetation was eroding due to sea/wave action. Photo 2-6 is representative of conditions in this area.

Photo 2-6. Example of heavily eroded upper portion of Sandy, Un-vegetated Beach. View looking west. Date of Photo: September 28, 2021

Sand Strand

Approximately 6.62 acres (38.4% of the assessment area), was found to consist of floral species representative of a Sand Strand community. This habitat was present in a series of

narrow, shore-parallel polygons oriented between the unvegetated sandy beach and shrub-dominated coastal coppice located to the landward (i.e., south). Trees were mostly non-existent in this area but did include some coconut (*Cocos nucifera*) trees – likely planted – and Australian pines (*Casuarina equisetifolia*). Salt-tolerant shrubs in this community included bay cedar (*Remirea maritima*), sea grape (*Coccoloba uvifera*), beach cabbage (*Scaevola taccada*), seven year apple (*Genipa casasia clusiifolia*) and others. Low-growing vegetation in this area included seapurslane (*Sesuvium portulacastrum*), *Chamaesyce mesembrianthfolium*), burr-grass (*Cenchrus* sp.), bay hops (*Ambrosia hispida*) and others. Photo 2-7 is representative of conditions in this area.

Photo 2-7. Typical Sand Strand. View looking southeast
Date of Photo: September 28, 2021

Two notable plant species were encountered in the Sand Strand community: Wild thyme (*Euphorbia abbreviata*) and cinnecord/leatherleaf casha – *Vachellia* (formerly *Acacia*) *choriophylla*. *Euphorbia abbreviata* is designated as a Lucayan Archipelago endemic, and cinnecord is designated as a Native Plant of Special Conservation Concern.

Overall, this habitat was ranked in Good condition, but some areas were rated Poor. It was Good in areas where the backdune community was intact and was Poor in areas where the foredune or backdune was absent or minimally present. As it appeared to have been subjected to erosion over a long period, floral diversity was generally low in comparison to typical, naturally occurring areas of this community, and its narrow width did not appear to provide significant protection from sea level rise or climatic resiliency.

Few faunal species were observed in the Sand Strand community, but included brown anoles (*Anolis sagrei*), peanut snails (*Cerion* sp.), curly-tailed lizards, Cicadas (*Proarna* sp.), fritillary butterflies [*Agraulis (Dione) vanilla*], Bahama mockingbirds and birds overhead (e.g., brown pelicans, royal terns). Other birds known to use this habitat during various times of the annual cycle but that were not observed during the assessment included gull-billed terns, gray kingbirds and Antillean nighthawks.

Notable Landside Resources

As identified on Table 2-3, several faunal and floral species that are listed in "The Schedules" were observed on the site. Descriptions of each species follow.

The only non-bird animal species observed within the assessment area that is listed for conservation is the curly-tailed lizard (*Leiocephalus psammodromus*). This species is fairly common on Providenciales and is not one of the less common subspecies that is found on the smaller out islands. Several adults and juveniles of this species were observed in areas of the Coastal Rock and Sand Strand communities.

Table 2-3. Notable Species of Flora and Fauna Designated by the Turks and Caicos Government that were observed or are likely to occur on the Site[1]

Scientific Name	Common Name Scientific Name	Designating Entity	Designation	Abundance within the assessment area
Fauna				
Columbina passerinae	Common Ground Dove	DECR	Native resident bird	No nesting observed, but potential nesting habitat present on the site
Larus atricilla	Laughing Gull	DECR	Native resident bird	Occasional, observed in flight over property
Pelecanus occidentalis	Brown Pelican	DECR	Native resident bird	Occasional, observed in flight over property
Thalasseus maxima	Royal Tern	DECR	Native resident bird	Occasional, observed in flight over property & perched on pilings
Mimus gundlachii	Bahama Mockingbird	DECR	Native resident bird	Observed in coppice Appeared territorial. Potential nesting habitat present on the site
Nyctanassa violacea	Yellow-crowned Night-heron	DECR	Native resident bird	Observed along shoreline
Tyrannus dominicensis	Gray Kingbird	DECR	Native resident bird	Observed intermittently. Potential nesting habitat present on the site
Charadrius melodius	Piping Plover	DECR	Native resident bird, Threatened	Flock of 8 observed, one banded.
Arenaria interpres	Ruddy Turnstone	DECR	Migrant – fall, winter spring	Observed foraging along shoreline
Flora				
Euphorbia inauguensis	Wild Thyme	DECR	Lucayan Archipelago Endemic	Occasional
Vachellia coriophylla	Leatherleaf Casha, Cinnecord	DECR	Native Plant of Special Conservation Concern	Occasional

[1] Lists of species of flora and fauna that are designated by the International Union for the Conservation of Nature and the Convention on International Trade in Endangered Species of Wild Fauna and Flora are included as Appendices 9.4-2 and 9.4-3, respectively.

Species that are included on the IUCN and CITES lists for the Turks and Caicos Islands are included in Appendices H and I. Species that were observed during the site investigation are highlighted in these appendices.

Individuals of several species of birds (i.e., Antillean nighthawk, common ground-dove, gull-billed tern, laughing gull, Bahamas mockingbird, yellow-crowned night-heron, white-tailed tropicbird, gray kingbird and mourning dove) were observed during the assessment. No nesting of any of these species was observed, but potentially suitable nesting habitat for some of these species appeared to be present on the property. Additional species of migratory birds (e.g., shorebirds, warblers) may also use portions of the property seasonally but were not observed during the September and October 2021 investigations.

As noted above, two species of plants that are designated by the Turks and Caicos Island Government and/or international treaties as Endangered, threatened or endemic were observed within the assessment area. Brief descriptions of the presence of these species within the assessment area follow.

Wild thyme, (*Euphorbia inaguensis*) (Photo 2-8), which was formerly known as *Euphorbia abbreviate* and *Vachellia coriophylla* (Photo 2-9) are designated as a “Lucayan Archipelago Endemic” by the Turks and Caicos Island’s Department of Environment and Coastal Resources. They are locally abundant on Providenciales and are fairly common on Providenciales. They were minimally present within the vegetation analysis plots, being present in only one of the 29 (about 3%) plots, and on the subject site, in particular. Their presence on the property was limited to the sandy soils in the Sand Strand community.

Photo 2-8. *Euphorbia inaguensis* (abbreviata)
Date of Photo: September 27, 2021

Photo 2-9. Vachellia coriophylla
Date of Photo: September 27, 2021

Lists of flora and fauna observed within the assessment areas are provided in Appendices J and K, respectively. These include both the species present within the vegetation analysis plots and other species observed on the property during the assessment.

Invasive Plants

Individuals of three of the six species of non-native plants that are designated by the Turks and Caicos Island Government as invasive were observed on the property: Beefwood (*Casuarina equisetifolia*), (also known as Australian pine, Casuarina), cow bush (*Leucaena leucocephala*), and beach cabbage (*Scaevola taccada*), the presence of each of which is described hereafter.

Mature *Casuarina* trees (Photo 2-10) were fairly common in some portions of the project, but absent or rare in other areas. Heights were mostly less than 10 metres (about 30 feet) above grade. They were mostly present in the Sand Strand community on undeveloped lots.

Photo 2-10. Mature *Casuarina equisetifolia* trees
Date of Photo: September 27, 2021

Beach cabbage plants were extremely common to abundant in most areas of the Sand Strand community. In some areas, they had outcompeted native dune vegetation and had become virtually the only plant species present (Photo 2-11).

Photo 2-11. Mature *Scaevola taccada* bushes
Date of Photo: September 28, 2021

2.2.2 Baseline Marine Environment

Visual inspections of underwater conditions were assessed in 30 quantitative and qualitative plots along 16 generally shore-parallel transects that began at the water's edge and extended in a shore-perpendicular orientation for a distance of approximately 100 metres (about 328 feet). Species observed in the plots are identified in Table 2-4. A list of all marine flora and fauna encountered is included as Appendix L.

Table 2-4. Marine plot species

Species/Plot	Common Name	Transect 0 Plot 1	Transect 1 Plot 1	Transect 2 Plot 1	Transect 2 Plot 2	Transect 5 Plot 1	Transect 5 Plot 2	Transect 5 Plot 3	Transect 7 Plot 1	Transect 7 Plot 2	Transect 8 Plot 1	Transect 8 Plot 2	Transect 8 Plot 3- Groyne	Transect 9 Plot 1	Transect 9 Plot 2	Transect 10 Plot 1	Transect 10 Plot 2	Transect 10 Plot 3	Transect 11 Plot 1	Transect 11 Plot 2	Transect 11 Plot 3	Transect 12 Plot 1	Transect 12 Plot 2	Transect 12 Plot 3	Transect 15 Plot 1	Transect 15 Plot 2	Transect 16 Plot 1	Transect 16 Plot 2	2 Groynes	Dark Patch
MARINE PLANTS																														
SEAGRASSES		✓																												
Halodule wrightii	Shoal-grass				✓																									
Syringodium filiforme	Manatee-grass																													
Thalassia testudinum	Turtle grass				✓							✓																		
MACROALGAE																														
Rhodophyta																														
Acanthophora spicifera																														
Hypnea sp.																														
Jania sp.																														
Laurencia sp.	Laurencia								✓			✓		✓										✓						
Neogoniolithon spectabile													✓																✓	
Phaeophyta																														
Sargassum sp.	Sargassum Weed																													
Chlorophyta																														
Acetabularia crenulata	Mermaid's Wine Glass																													
Batophora oerstedii	Batophora	✓	✓	✓	✓				✓		✓	✓		✓								✓	✓	✓						
Caulerpa prolifera	Oval-blade Algae																													
Cladophoropsis sp.																														
Halimeda incrassata	Three-finger Leaf Algae											✓									✓			✓						
Halimeda monile												✓																		
Neomeris sp.																														
Penicillus capitatus	Bristle Ball Brush				✓																									
Penicillus dumetosus	Bristle Ball Brush																													
Penicillus pyriformis	Flat-top Bristle Brush																													
Rhipocephalus phoenix	Pine cone Algae																													
Udotea flabellum																								✓						
SPONGES																														
Aaptos pernucleata	Black encrusting																													
Aplysina insularis	Branchlet Sponge																												✓	
Ircinia strobilina	Black-ball Sponge										✓																		✓	
Demospongae	Sponge												✓																✓	
CRUSTACEANS																														
Squillidae	Mantis Shrimp																													

Species/Plot	Common Name	Transect 0 Plot 1	Transect 1 Plot 1	Transect 2 Plot 1	Transect 2 Plot 2	Transect 5 Plot 1	Transect 5 Plot 2	Transect 5 Plot 3	Transect 7 Plot 1	Transect 7 Plot 2	Transect 8 Plot 1	Transect 8 Plot 2	Transect 8 Plot 3- Groyne	Transect 9 Plot 1	Transect 9 Plot 2	Transect 10 Plot 1	Transect 10 Plot 2	Transect 10 Plot 3	Transect 11 Plot 1	Transect 11 Plot 2	Transect 11 Plot 3	Transect 12 Plot 1	Transect 12 Plot 2	Transect 12 Plot 3	Transect 15 Plot 1	Transect 15 Plot 2	Transect 16 Plot 1	Transect 16 Plot 2	2 Groynes	Dark Patch
MOLLUSCS																														
Acanthopleura granulata	Fuzzy Chiton																													
Batillaria oerstedi			✓	✓	✓						✓			✓										✓						
Cerithium sp.																														
Pinnidae	Sea pen																													
Pteria colymbus	Atlantic Wing-oyster																													
Strombus gigas	Queen Conch																													
Unidentified snail	Snail																													
ECHINODERMS																														
Diadema antillarum	Long-spined Urchin												✓																	
Echinometra lucunter	Rock-boring Urchin																													
ANNELIDS																														
Spirobranchus giganteus	Christmas-tree Worm																													
CNIDARIANS																														
Actinoporus elegans	Elegant Anemone																													
Cassiopea frondosa	Upsidedown jellyfish		✓																											
Condylactis gigantea	Pink-tipped (Giant) Anemone																													
Hydroida	Hydroid																													
CORALS																														
Hydrocorals																														
Millepora alcicornis	Fire Coral																													
Millepora squarrosa	Box Fire Coral																													
Octocorals																														
Carijoa nisei	White Telesto																													
Stony Corals																														
Agaricia agaricites	Lettuce Coral																						✓							
Dendrogyra cylindrus	Pillar Coral																													
Diploria labyrinthiformis	Grooved Brain Coral																													
Favia fragum	Golfball Coral										✓		✓																	
Orbicella franksi	Boulder Star Coral																													
Porites astreoides	Mustard Hill Coral										✓																		✓	
Porites	Finger Coral										✓		✓						✓											
Pseudodiploria clivosa	Knobby Brain																													
Pseudodiploria strigosa	Brain Coral																													
Siderastrea radians	Lesser Starlet Coral													✓																
Siderastrea sidera	Massive Starlet Coral				✓								✓						✓											
Stephanocoenia intersepta	Blushing Star Coral																													

Species/Plot	Common Name	Transect 0 Plot 1	Transect 1 Plot 1	Transect 2 Plot 1	Transect 2 Plot 2	Transect 5 Plot 1	Transect 5 Plot 2	Transect 5 Plot 3	Transect 7 Plot 1	Transect 7 Plot 2	Transect 8 Plot 1	Transect 8 Plot 2	Transect 8 Plot 3- Groyne	Transect 9 Plot 1	Transect 9 Plot 2	Transect 10 Plot 1	Transect 10 Plot 2	Transect 10 Plot 3	Transect 11 Plot 1	Transect 11 Plot 2	Transect 11 Plot 3	Transect 12 Plot 1	Transect 12 Plot 2	Transect 12 Plot 3	Transect 15 Plot 1	Transect 15 Plot 2	Transect 16 Plot 1	Transect 16 Plot 2	2 Groynes	Dark Patch
FISH																														
Acanthus caeruleus	Blue Tang												✓																✓	
Acanthurus chirurgus	Doctorfish																													
Caranx ruber	Bar Jack																													
Trachinotus goodei	Palometa																													
Haemulon parra	Sailor's Choice																													
Haemulon sp.	Grunt																												✓	
Lutjanus griseus	Gray/mangrove Snapper																													
Lutjanus apodus	Schoolmaster																													
Lutjanus mahogoni	Mahogany Snapper																													
Ocyurus chrysurus	Yellow-tail Snapper																													
Stegastes diencaeus	Longfin Damselfish																													
Microspathodon chrysurus	Yellow-tail Damselfish																													
Abudefduf saxatilis	Sergeant Major												✓																	
Epinephelus striatus	Nassau Grouper																													
Thalassoma bifasciatum	Bluehead Wrasse	✓									✓		✓																✓	
Halichoeres maculipinna	Clown Wrasse																													
Pseudupeneus maculatus	Spotted Goatfish																													
Dasyatis centoura	Roughtail Stingray																													
Percent Cover:		80		5	60	0	0	0	90	90	85	80	40	20	0	0	0	0	10	0	2	60	40	<1	0	0	0	0	N/A	0
Quality:		Good	Poor	Poor	Good	Poor	Poor	Poor	Fair	Good	Good	Good	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Fair	Poor

No coral reefs, mangroves, blue holes, underwater vents, elkhorn (*Acropora palmata*), staghorn (*Acropora cervicornis*) or other notable reef-building corals, or other particularly notable marine features were observed within the assessment area, although corals have become established on the existing groyne substrate.

The assessment area was found to include approximately 1,082 feet (about 330 metres) of primarily north-facing water frontage. Five structural/epi-benthic marine communities were found to be present within the assessment area (Figure 2-3 and Appendix D), as identified below in lowest-to-highest abundances, and described thereafter:

- Vertical Seawalls
- Coastal Structures (groynes)
- Rubble (hardbottom) with Submerged Aquatic Vegetation
- Sand with Submerged Aquatic Vegetation (varying cover and abundances of seagrasses and rooted macroalgae
- Barren Sand

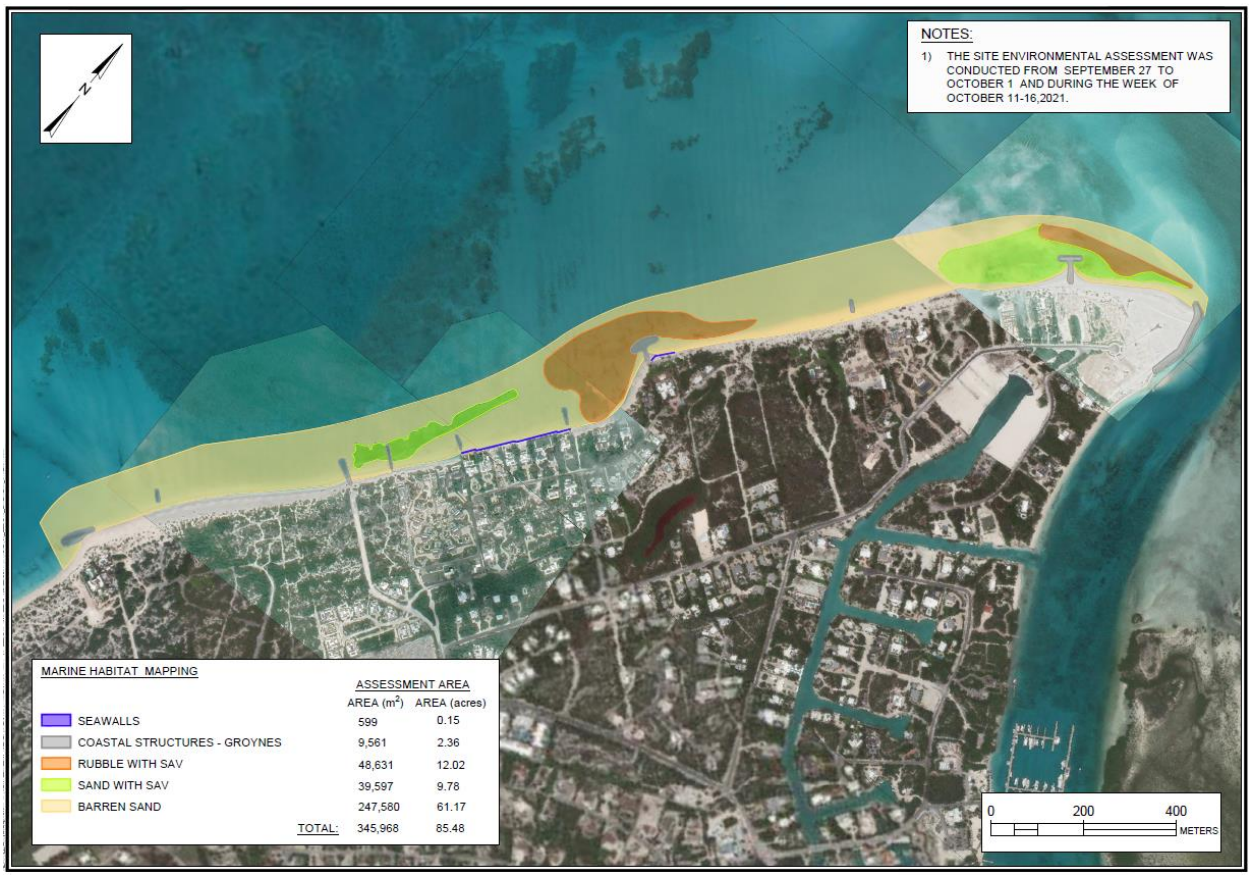


Figure 2-3. Marine Habitat Map

Vertical Seawalls

Approximately 297 metres (974 feet) of the shoreline consisted of seawalls with no appreciable beach. The condition of the walls is in general poor, with evidence of active failure of significant portions of the walls (Photo 2-12).

Photo 2-12. Vertical Seawalls. View looking southwest
Date of Photo: September 29, 2021

In some places rip-rap has been placed at the toe of the seawall to provide toe scour protection to the wall (Photo 2-12).

The combination of intermittently rough seas, abrasive nature of sand in the littoral drift and extremely harsh conditions have resulted in negligible habitat value from these structures, and wave reflection from the walls limits the ability of sand accumulation in front of the walls.

Coastal Structures – Groynes

Seven comparatively small, manmade groynes, were present within the assessment area. Most were approximately shore-perpendicular and extended to a maximum distance of approximately 50 metres (about 150 feet) from the present shoreline. With the exception of one new T-groyne situated near the easterly boundary of the assessment area, all were fully submerged. Each groyne consisted of rock material, including significant portions of gabion type (wire cage with

small rock) construction. The majority of the gabion type structures are in a state of failure resulting in significant wire debris. A variety of marine life had become established on submerged portions of each groyne. In general terms, the most abundant constituent was macroalgae growing directly on the solid substrate (i.e., rock, wire cage). Low-profile stony corals were present in varying abundances and sizes, and included the species identified on Table 2-5.

Table 2-5. Corals present on the submerged groynes on Emerald and Pelican Beaches during inspections during September and October 2021

Scientific Name	Common Name	Abundance
Dendrogyra cylindrus	Pillar Coral	Uncommon
Diplora labyrinthiformis	Grooved Brain Coral	Uncommon
Favia fragum	Golfball Coral	Occasional
Millepora alcicornis	Branching fire coral	Common
Millepora squarrosa	Box Fire Coral	Uncommon
Porites astreoides	Mustard Hill Coral	Abundant
Porites porites	Finger Coral	Abundant
Pseudodiplora clivosa	Knobby Brain Coral	Uncommon
Pseudodiplora strigosa	Symmetrical Brain Coral	Uncommon
Siderastrea radians	Lesser Starlet Coral	Common
Stephanocoenia intercepta	Blushing Star Coral	Uncommon

The size of the corals appeared to be limited by the harsh conditions associated with the shallow water depth and location near the shoreline. Photo 2-13 and Photo 2-14 are representative of conditions on the groynes.

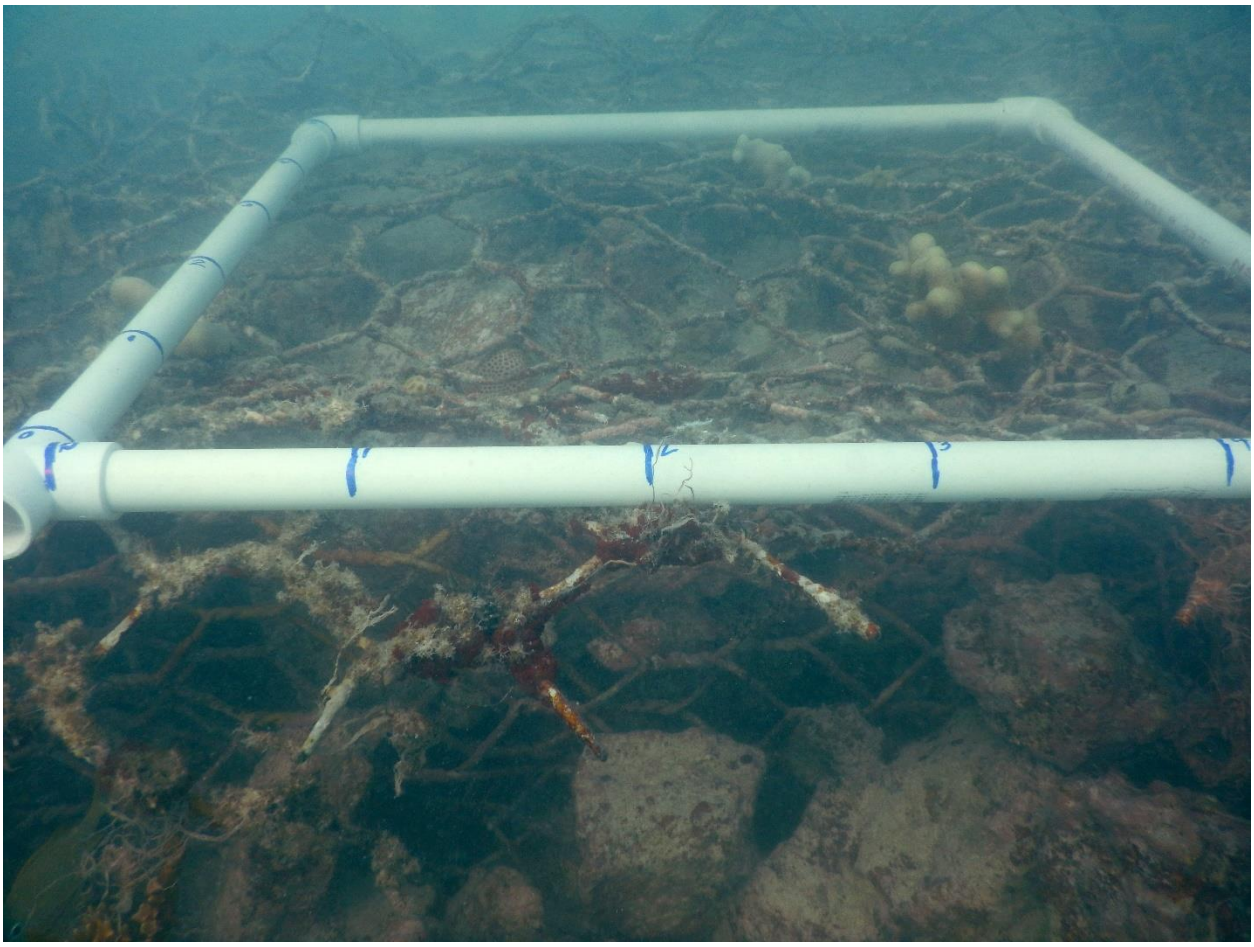


Photo 2-13. Small stony corals on existing Rock Groyne. Date of Photo: September 29, 2021

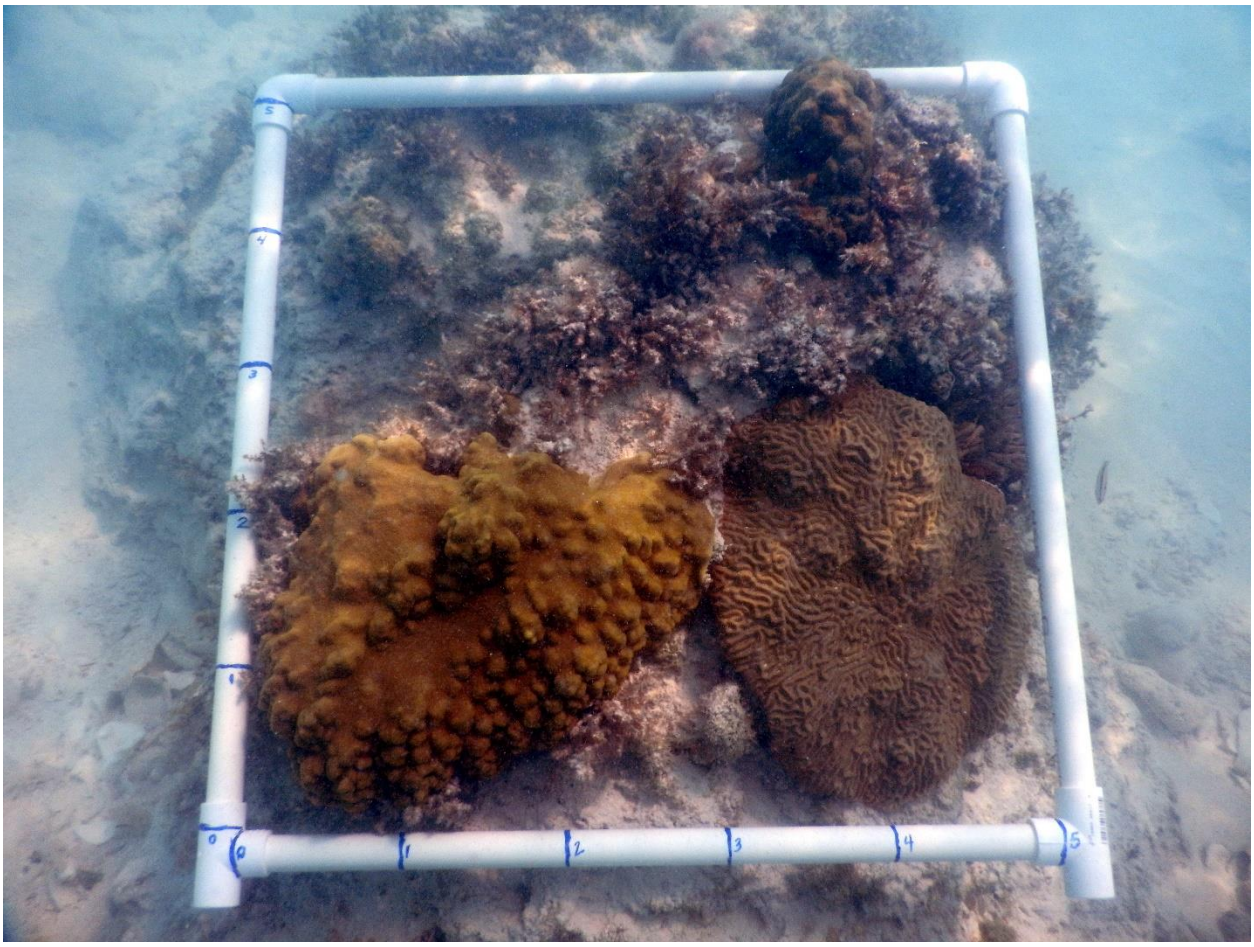


Photo 2-14. Larger stony corals (*Porites astreoides* and *Pseudodiplora clivosa*) and macroalgae on existing Rock Groyne. Date of Photo: September 30, 2021

Juvenile reef-fish, including sergeant majors, damselfish, blue tangs and wrasses were common in the vicinity of the groynes. Schoolmaster, grunts, goatfish and various snapper were also observed.

Rubble with Submerged Aquatic Vegetation

Rocks of varying small sizes and rubble, composed primarily of shell hash and long-dead corals upon which submerged aquatic vegetation was growing was found to be the next most abundant benthic community type. Various Chlorophytes, including *Penicillus dumetosus*, *Penicillus capitatus*, *Halimeda incrasata*, *Batophora oerstedi*, *Acetabularia* spp., and *Udotea flabellum* were common. Phaeophytes included *Laurencia* spp. and *Dictyota* spp. Seagrasses, which were present in varying abundances and assemblages, included turtle grass (*Thalassia testiduinum*), manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*).

Photo 2-15 is representative of the algae-dominated areas in this community.

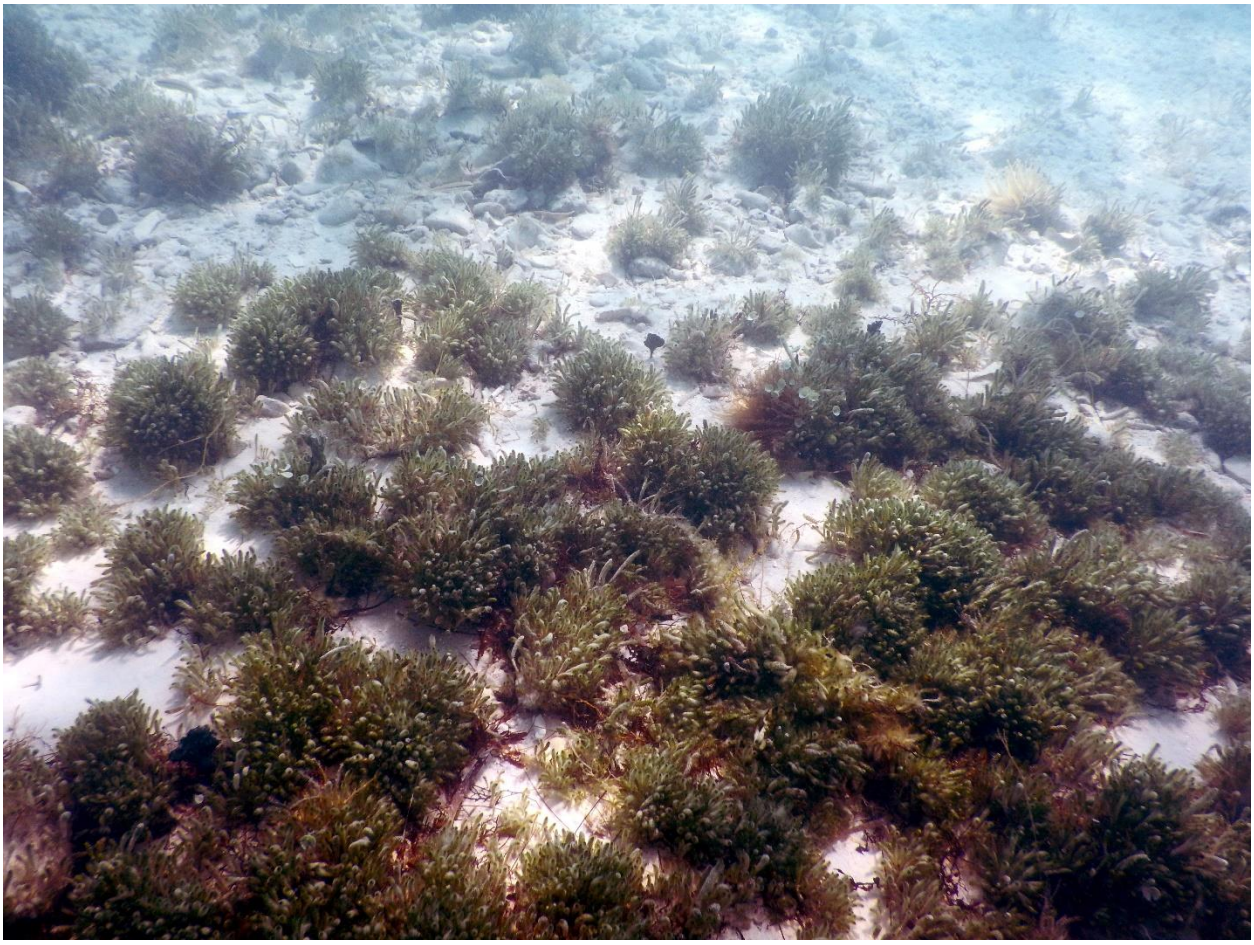


Photo 2-15. Algae-dominated Rubble. Date of Photo: September 30, 2021

Juvenile reef-fish, queen conch and other marine molluscs inhabit this epi-benthic community, and mantis shrimp, octopus and other organisms live much of their lives in the relative safety of burrows in excavations below the sediment surface.

<u>Sand with submerged aquatic vegetation (varying cover and abundances of seagrasses and rooted macroalgae)</u>

Sand with submerged aquatic vegetation was a common benthic community within the assessment area. In some areas, seagrasses were more abundant than rooted macroalgae in this community, primarily because most macroalgae grow attached to shell and rubble fragments.

The percent cover of submerged aquatic vegetation within this mapped community varied considerably from location to location, but in general was mapped as this community type whenever the cumulative cover of seagrass and macroalgae exceeded approximately 5%. Areas where submerged aquatic vegetation or patches of drift algae were present in abundances less than approximately 5% were designated and mapped as Barren Sand.

Photo 2-16 and Photo 2-17 are representative of the areas within this mapped unit where seagrasses were dominant, within the highly variable conditions in this community.

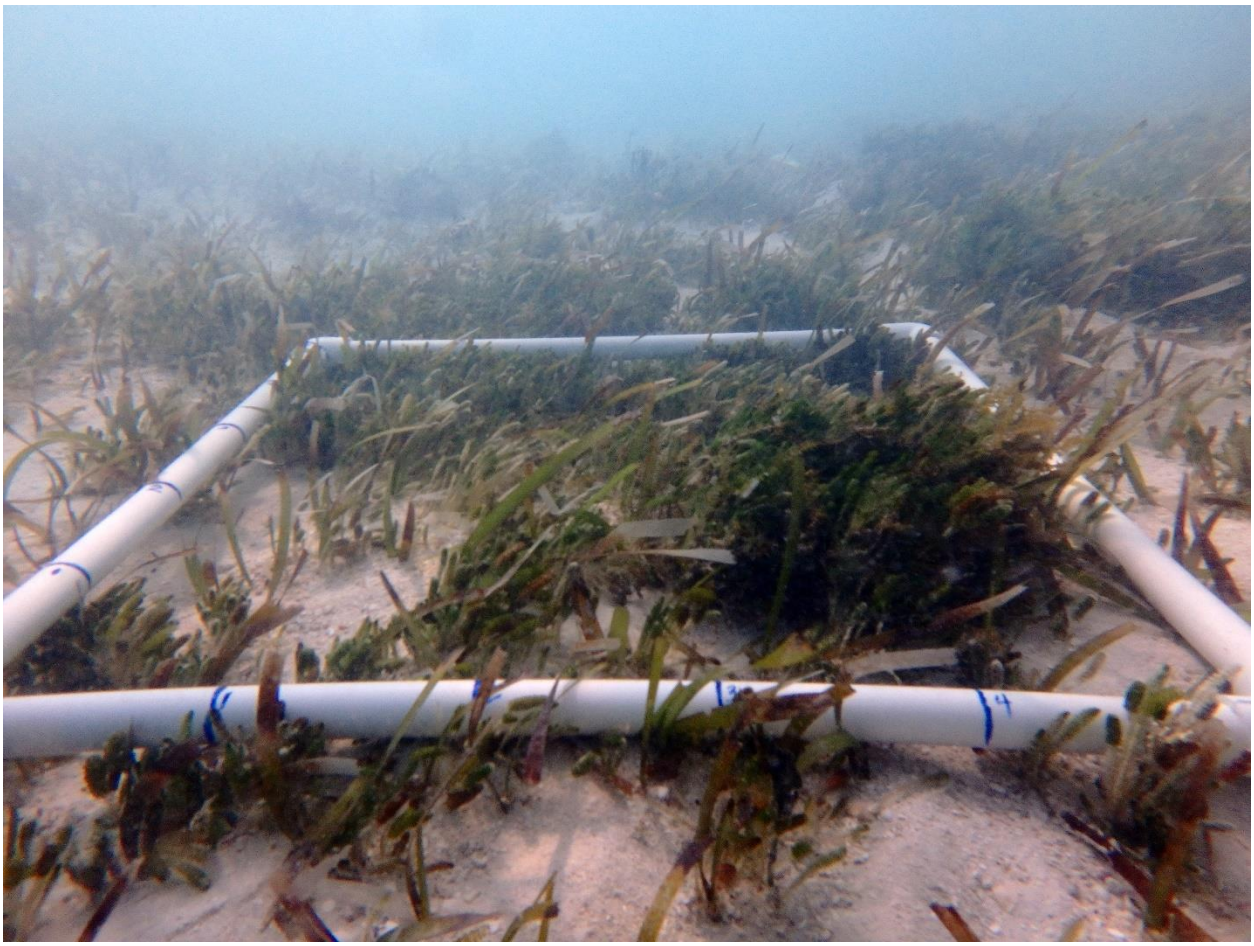


Photo 2-16. Dense submerged aquatic vegetation, dominated by Seagrass on Sandy Bottom. Date of Photo: October 13, 2021

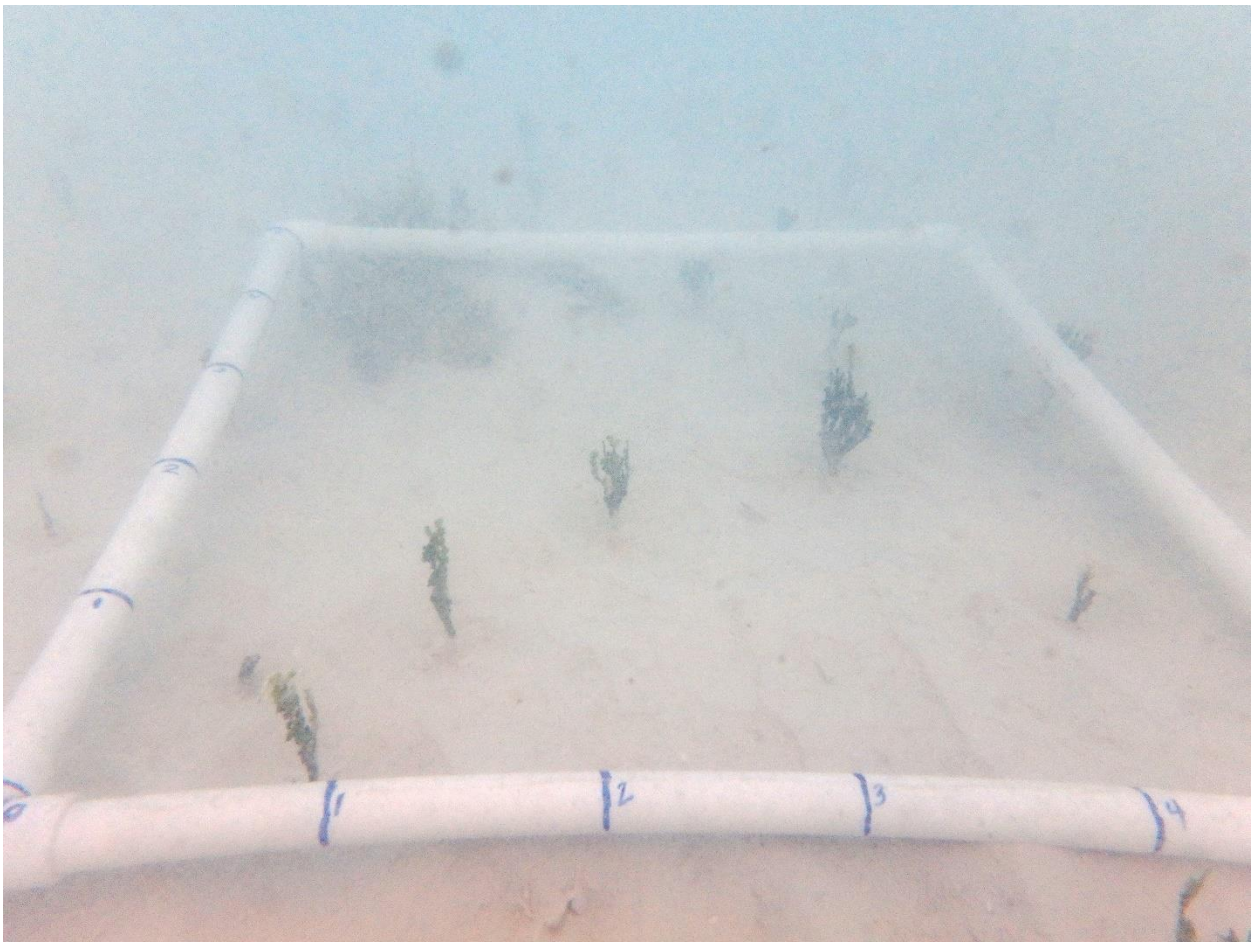


Photo 2-17. Sparse rooted macroalgae (*Halimeda incrassata*) in mostly-barren Sandy Bottom. Date of Photo: October 13, 2021

Submerged aquatic vegetation, consisting of both seagrasses and macroalgae and intermittent sandy or sparsely vegetated bottoms, are well documented for providing habitat for a variety of marine life, including fish and molluscs (including queen conch), sea cucumbers, and crabs. Fish observed during the assessment in this habitat included blue runner.

Barren Sand

The vast majority of the substrate within the assessment area consisted of barren or minimally vegetated sand. Photo 2-18 is representative of conditions in this community.

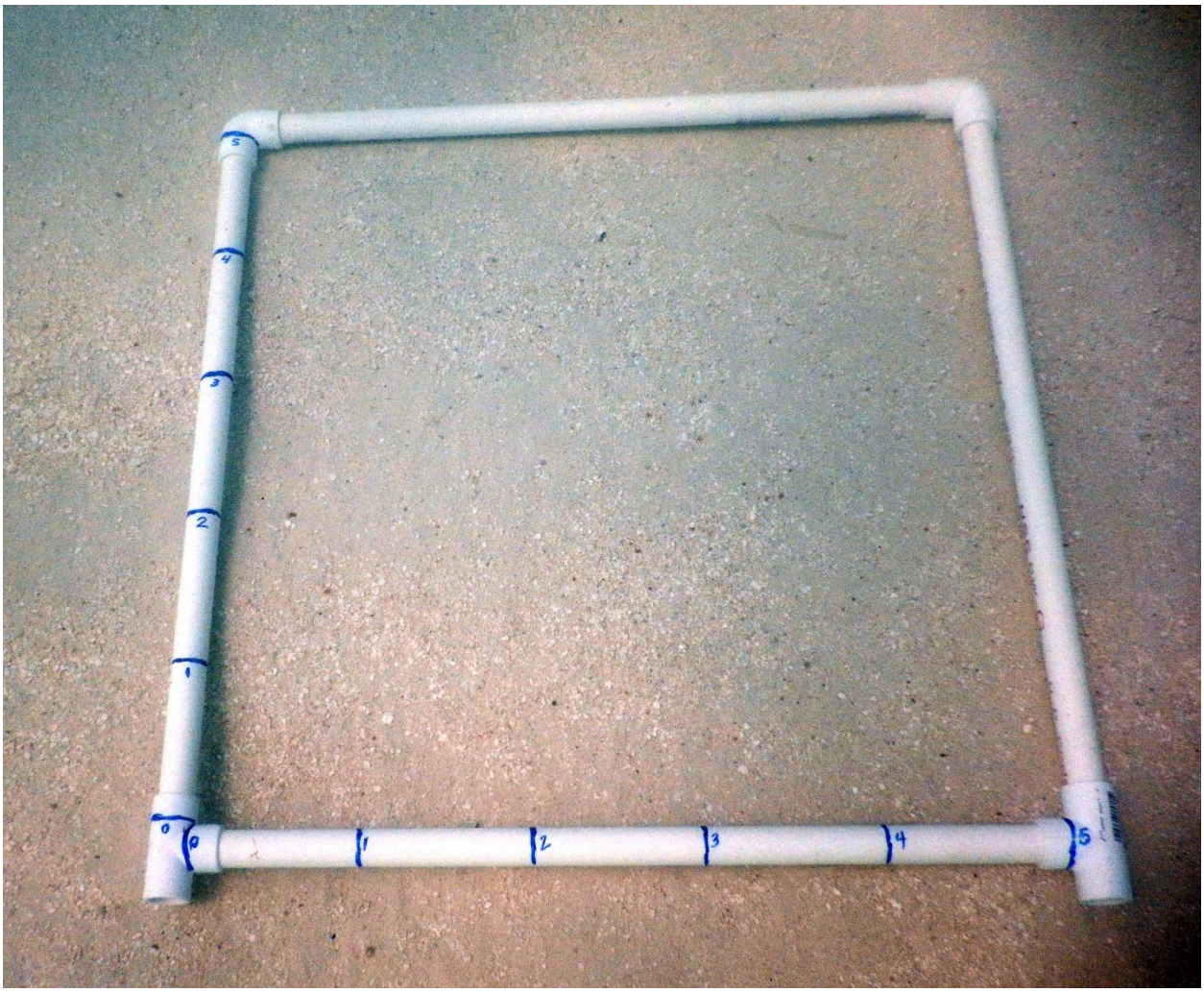


Photo 2-18. Barren Sand. Date of Photo: September 30, 2021

This category includes areas where a minimal amount (i.e., < 5% cover) of submerged aquatic vegetation was present.

It also includes areas where direct visual observation of the barren sandy bottom may be obscured due to presence of patches of drift algae. Broken blades of seagrasses and sargassum were intermittently abundant, swaying back and forth with waves and tidal surge (Photo 2-19).

This phenomenon is the likely explanation of situations where dark outlines on aerial photographs suggested the presence of rooted seagrasses but which, during underwater ground-truthing investigations, turned out to be barren.

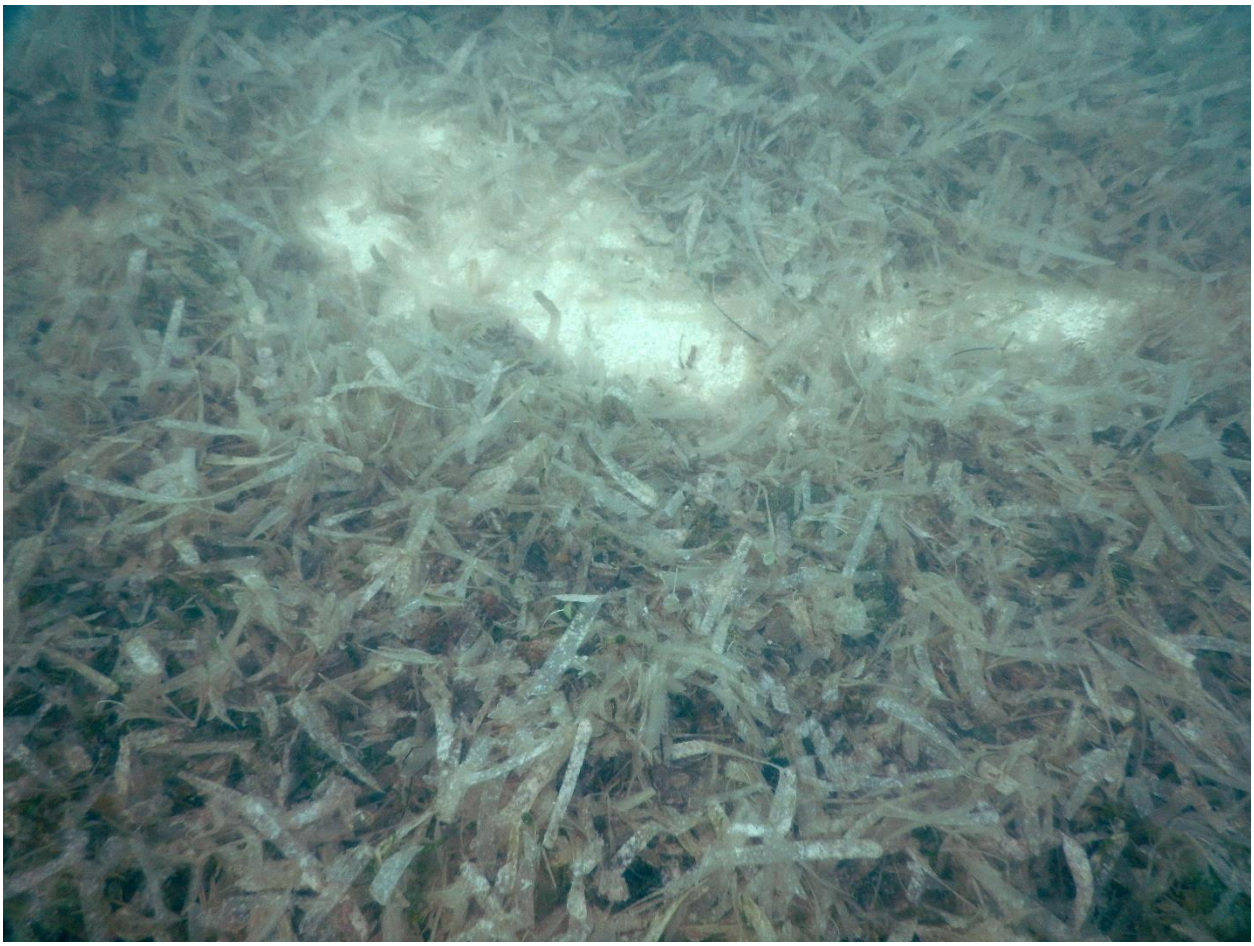


Photo 2-19. Dead seagrass and non-rooted Sargassum in large mass drifting just above the sediment surface. Date of Photo: September 30, 2021

It is possible that bonefish (*Albula vulpes*) and other fishes typically associated with sandy bottoms (e.g., sting rays, jawfish) likely inhabit the area, although none were observed in this community during this assessment.

Qualitative ratings of each of these benthic community types are identified on Table 2-6.

Table 2-6. Marine Communities – Qualitative Ratings

Community Type	Qualitative Rating[1]	Brief Description
Vertical Seawalls	1	Minimal substrate available
Coastal Structures (groynes)	3	Consolidated substrate provides habitat for low-profile corals, macroalgae, sponges and juvenile fish. Intermittently rough seas and abundance of suspended sediment appear to limit the size and diversity of corals
Rubble with SAV[2]	2	Un-attached rock and coral rubble with macroalgae prevent existence of higher trophic level species
Sand with SAV	3	Varying density assemblages of seagrass and attached macroalgae
Barren Sand	1	Mostly barren sand, with sparse and/or patchy seagrasses and/or macroalgae

[1] Qualitative ratings were based on best professional judgement considering factors such as biodiversity, the presence, absence and/or abundance of notable floral and/or faunal species, and the extent to which the area had been subjected to damage as a result of human and natural processes. The qualitative rankings vary from 1 (Low - low biodiversity, absence of notable floral and faunal species, and impacted by human and/or natural processes) to 5 (High - high biodiversity, abundant notable floral and faunal species, pristine condition).

[2] SAV = Submerged Aquatic Vegetation

At the time of the field investigation, *Sargassum* was only moderately abundant within the project area. Although some species of *Sargassum* are rooted and were minimally present within the assessment area, non-rooted *Sargassum* is a drift algae that is transported by winds and waves, which has become an increasingly common problem in the Caribbean in recent years. Its lack of presence at the time of the assessment is not an indication that it will not become a problem in the future. The property's location near a natural curve of the land, makes it vulnerable to the accumulation of *Sargassum* when winds are from the northwest.

2.3 Physical Environmental Baseline Assessment

2.3.1 Topography of the Area

The topography of Turks and Caicos is very low-lying (Figure 2-4). Higher terrain for each island is normally near the outside (seaside) of each island. Areas near the Caicos Bank are lower in elevation with many sections of North Caicos, East Caicos and Middle Caicos being low-lying swamp/marsh areas. The highest points in the country are Blue Mountain on Providenciales and Flamingo Hill on East Caicos, each with a height of approximately 48 metres.

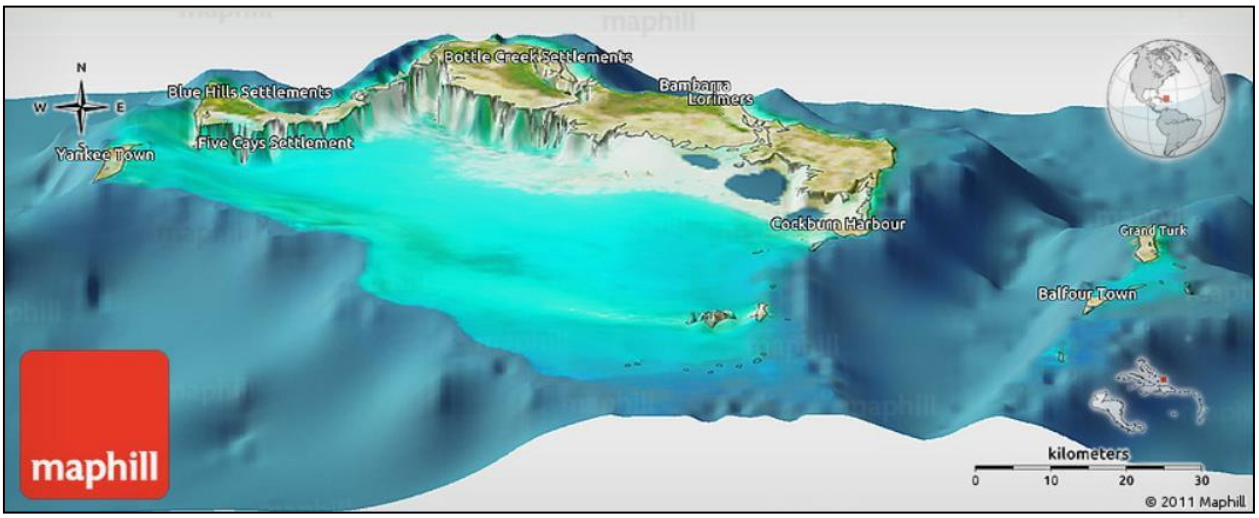


Figure 2-4. General topography and bathymetry of Turks and Caicos

The topography of the project site primarily consists of a narrow beach which extends from the shoreline landward to a dune system or seawall that varies in elevation from 2 metres to 3 metres above mean sea level. Along Emerald Beach there is severe erosion from high seas and waves resulting in vertical cliffs from the top of dune to the high tide line. Along Pelican Beach sections of the shoreline were fortified with seawalls that have begun to fail. There is currently no beach along the seawalls. Significant losses of sand along the Emerald and Pelican Beaches occurred due to the passing of Hurricanes Irma and Maria in 2017 (Photo 2-20) (Photo 2-21).

Photo 2-20. Erosion along Emerald Beach

Photo 2-21. Seawalls along Pelican Beach

2.3.2 Bathymetry for Site Shoreline

The Caicos Islands (Providenciales, North Caicos, West Caicos, Middle Caicos, East Caicos) are located on the Caicos Bank. This area is shallow with depths between 2 metres and 4 metres. The Turks Islands are located to the east of the Caicos Islands. The joint state has a deep underwater canyon called the Turks Island Passage (34 kilometres long) between the set of islands.

The overall bathymetry of the area is quite varied. From the land to the reef that surrounds most of the Caicos Islands the water depths are quite shallow, with an average depth of 2 metres. However, just outside of the reef is a steep drop off. Water depths outside of the reef quickly dive to 20 metres. The reefs provide good protection for coastal areas in the state and help to provide defence against larger waves and swells. This helps to counteract the overall low topography of the islands.

During September-October 2021, ATM appointed a local contractor, Benchmark Surveying, to conduct a beach cross-section survey at the project site from Emerald Beach to Grace Bay. Survey lines were spaced nominally 150 feet apart along Emerald Beach. Survey lines were spaced closer together along Pelican Beach from Pelican Point groyne through the seawall section of the beach. Survey cross-section locations and contours are presented in Figure 2-5 (Appendix D).

Figure 2-5. Survey Plan Lines and Contours

2.3.3 Geology

The Turks and Caicos Banks, like the Bahamas, are interpreted to overlie continental crust that was rifted from the North American continental land mass after it separated from northwest Africa during the break up of Pangea in the Triassic (Pindell, 1993). The Triassic sedimentary and volcanic section and earlier continental crust are interpreted to be buried beneath a cover of Jurassic, Cretaceous and Tertiary carbonate sediments.

Remains from the continental drift are buried under hundreds of metres of limestone rock that has been formed by the decomposition of skeletal remains from marine organisms and

precipitation of calcium carbonate material. Precipitation is the process in which, under the right conditions, dissolved minerals in the sea water are deposited to form small particles called ooids. Ooids then cement together to form oolite rock, which makes up most of the Turks and Caicos area. Additional rock was formed by the fossilized remains of plankton, algae, coral, shellfish, and the waste pellets of flat fish.

Caves are present on all the islands. These are formed when slightly acidic water dissolves the limestone. The caves on Middle Caicos form the largest cave network in the Bahamian archipelago. These caves are ideal habitats for wildlife and were used by the Lucayans (original inhabitants), for whom they had religious significance. For a short while there was a guano industry, where bat droppings were collected for use in the production of fertilizer.

The porous nature of the limestone means it does not hold water well. As a result, fresh water is difficult to find and occurs where rainwater has accumulated and floats on the denser saltwater table. There are several natural wells on the Turks and Caicos Islands, but locals mainly rely on collecting rainwater and, recently, this has been done through collecting rain runoff from the roofs in large storage tanks.

The material within the project site is dominated by Pleistocene Limestone landward of the highwater mark. Seaward of the vegetation line, the limestone continues into the water, where it becomes covered in unconsolidated Holocene Sands. The limestone formation is characterized by a mature, thin layer of hard brown crust/soil that appears in isolated patches around the site. Well-compacted limestone underlies the soil. Weathered limestone outcroppings are found along the entirety of the site.

The geology of the development site is predominantly composed of Pleistocene Limestone and Holocene Sands. Beyond the beach project footprint, the limestone outcrops as surface layers of a dark brown hardpacked sediment and weathered beach sands cap rocks.

2.3.4 Hydrology

Sand placement and construction of coastal structures will occur in the littoral zone of the project area and no upland modifications are associated with this project. The project is within the area of influence of the adjacent sea and outside of any freshwater lens or resource.

2.3.5 Sediment Analyses

The sediment present on a coast may be used to provide insight when assessing the coastal processes and is an important component of the aesthetics and comfort of the beach or coastal zone. During a 2018 study (Appendix E2), four samples were taken along the Leeward coastline as shown in Figure 2-6. Samples SS2 and SS3 were taken in the swash zone and sample SS1 and SS4 were taken on the sand dunes. These samples were sent to a geotechnical lab to be visually inspected, air dried and subjected to a standard dry sieve analysis to determine their grain size distribution as well as other characteristic parameters. The results are summarized in Table 2-7.

Figure 2-6. Sand sample locations

Table 2-7. Sediment sample sieve analysis results

Specimen	Type	D50	D60	D30	D10	% Gravel	% Sand	% Silt	% Clay
SS1	**Poor Graded Sand**	**0.27**	0.30	0.211	0.1655	0.0	98.7	1.3	
SS2		**0.28**	0.32	0.206	0.1532	0.0	96.8	3.2	
SS3		**0.29**	0.33	0.217	0.1609	0.0	96.6	3.4	
SS4		**0.22**	0.25	0.178	0.1112	0.0	96.9	3.1	

The analysis indicates that the samples are poorly graded sand, composed on average of 97% sand, and less than 3% silt and clay, which coincides with observations made during site visits. These results were used in beach response modelling to identify sediment transport patterns.

2.3.6 Climate and Meteorology

The climate of the Turks and Caicos Islands is tropical, with a year-round average temperature of 78.9 degrees Fahrenheit (°F) and an average rainfall of 30.0 inches. The wettest months tend to occur in late summer and early autumn, and the driest months occur in the winter. Hurricanes and tropical storms may occur typically between July and November.

2.4 Baseline Aesthetics

The aesthetics of the shoreline will remain natural. Sand placement will retain a natural grade terminating at the current vegetation line of the dune or, in the cases of private property/seawalls, to an elevation consistent with neighbouring properties (Photo 2-22).

Photo 2-22. Natural aesthetics of existing beach will be preserved

No formal landscaping plan is included in this project however, homeowners should be encouraged to plant beach stabilizing native species in the upper part of the beach, and remove invasive exotic species (Photo 2-23).

Photo 2-23. Beach sand placement and encouraged planting of dune vegetation will enhance the aesthetics of eroded areas.

2.5 Baseline Coastal Processes and Dynamics

2.5.1 Currents and Tides

Local tides are semi-diurnal (i.e., two high tides and two low tides per day), with an inequality between successive highs and lows. A 30-day tide study carried out to support maintenance dredging of the Leeward channel had determined that the area experiences a tide range of 1.8 feet (0.55 metres) between mean higher high water (MHHW) and mean lower low water (MLLW) values (ATM, 2012). This is in line with the U.S. National Oceanic and Atmospheric Administration (NOAA) tide predictions for Hawk's Nest Anchorage, Grand Turk (1988), which reports a mean tide range of 2.1 feet. and a spring range of 2.6 feet. The site can also be subject to potential storm surge due to tropical storm systems that could produce higher water levels. Surge potential in this region is limited and typically less than a metre for most storm events.

2.5.2 Sediment Transport

Detailed analysis and numerical modelling of sediment transport in the vicinity of the project has been conducted and is further discussed in Appendix E. Sand transport within the project area is influenced by both wave littoral processes and tidal currents associated with the Leeward-Going-Through Inlet. There is an area of sand transport divergence (a nodal point) within the Emerald Point area. Sand within this area is transported to the east into the inlet by net tidal currents. Sand is also transported to the west out of this area by wave induced longshore currents. As such this area exhibits a net loss of sand in both directions. Sand transported to the east is ultimately sequestered within inlet ebb and flood shoals and is lost to the active beach system. Sand lost to the west ultimately feeds beaches to the west and contributes to the overall stability of beaches towards Grace Bay.

Prior to the development of Leeward, dynamic changes in shoreline position and erosion patterns occurred in the vicinity of the inlet. With development this dynamic transport environment contributed to the erosion of platted properties in the area and quickly resulted in the series of coastal structures that have been construed within the area and the intermitted use of beach nourishment to offset the net losses of sand. Prior to dredging of the inlet for navigation purposes, a marginal ebb shoal was present in the area which did allow for some transport of sand around the inlet and into the Emerald beach area. This sediment pathway was severed by the establishment of a deeper, stabilized navigational channel and has contributed to the net loss of sand from the study area.

The construction of a groyne in the vicinity of Coral House (to the west of this project) and renourishment associated with the construction has resulted in the establishment of a relatively stable beach profile to the west of the project area. Further, it does not appear that long term the groyne structure has resulting in an appreciable downdrift impact or interruption of the natural supply of sand to beaches to the west. This project is designed to transition into the area stabilized by this existing groyne structure to minimise the potential for net downdrift impacts.

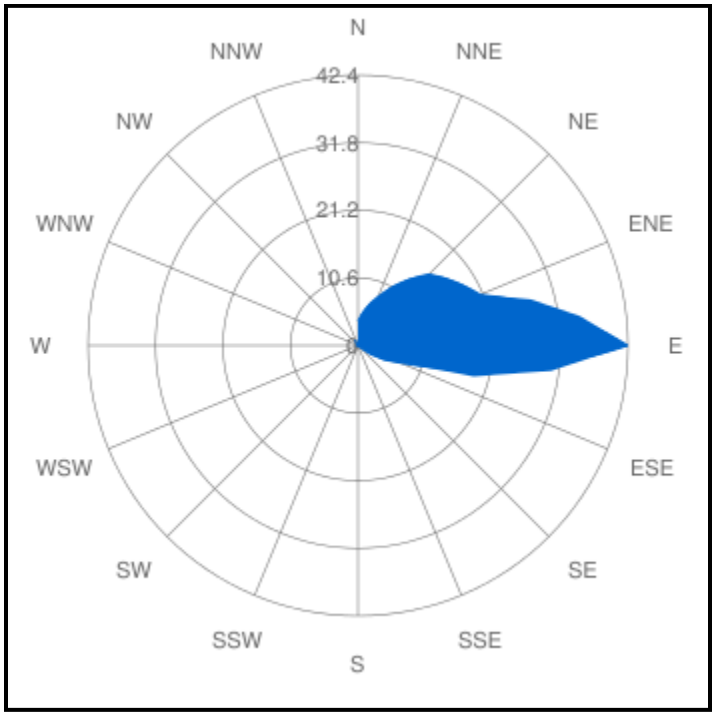


Figure 2-7. Annual Predominant Wave Direction.
Source: https://wisuki.com/statistics/936/long-bay

2.5.3 Erosion and Accretion

In general, the entire study area exhibits significant erosion and net volumetric loss. Areas of gain (accretion) are only associated with the updrift influence of coastal structures in the area and the relict remaining influence of previous nourishment efforts. Additional discussion regarding coastal processes including numerical modelling of the coastal system is provided in Appendix E1 and E2.

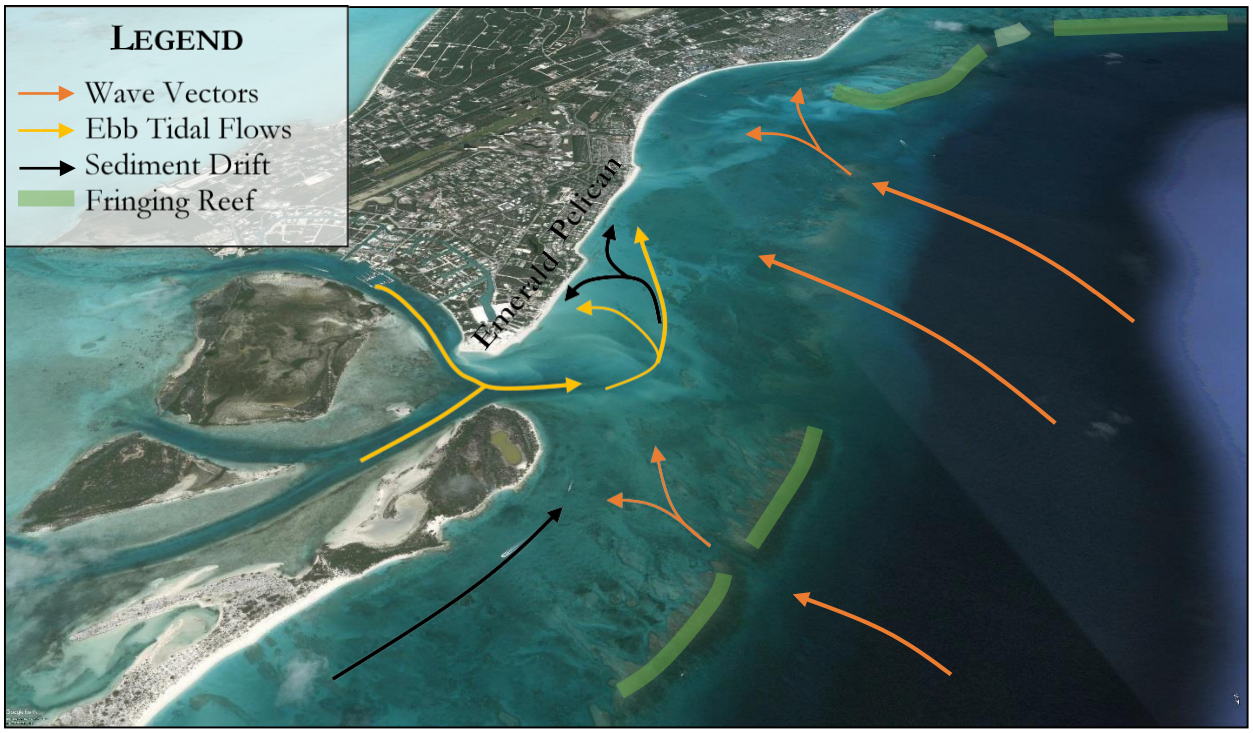


Figure 2-8. Dominant forces along the shoreline (Smith Warner 2018).

2.5.4 Coastal Dynamics

The project is designed with structures to stabilize the placed sand volume and maintain the newly constructed shoreline. The structures will also minimize the potential for down drift impacts to Grace Bay and the Bight. Projects were constructed along 920 metres of Emerald Beach in 2003 and again in 2011, and an additional project was constructed along 560 metres of Pelican Beach in 2007 (Smith Warner 2018). Effects of beach loss from these projects has long term served as a supply of sand to beaches to the west including Grace Bay. Sand migration into the Leeward-Going-Through Channel can be seen in the shoal seaward of Emerald Point and infilling of the Channel to the east of Emerald Point.

2.6 Water Quality

Baseline water quality testing was conducted to document existing water quality conditions prior to project construction. A sample of sea water collected within the project area was tested to determine concentrations of iron, nitrate and nitrite, sulphate and sulphide, phosphate, total dissolved solids, pH and salinity. The results are provided in Appendix F. The sample is representative of seawater and with no measured constituents of concern.

3.0 Legislative and Regulative Context

3.1 TCI Development Plan/Master Plan

The Leeward Master Land Use Development Plan has the entire area zoned for mixed-use with the vast majority of the area zoned predominantly low-density residential development (Figure 3-1). The coastal areas have a mixed-use commercial development – hotels, marina and retail store units and dive shop operations.

Figure 3-1. Master Land Use Zoning Plan

3.2 Physical Planning Ordinance and Subsidiary Legislations

Section 34 (1) of the Physical Planning Ordinance of the Turks and Caicos Islands (1989) authorizes the Physical Planning Board while considering an application to take into account a

number of factors order to make a proper decision on the application. These factors include, among other factors:

- The impact of the proposed development on the ecology of the island where it is to take place;
- The impact of the proposed development on the natural or built environment and the uses of the adjacent land, and
- The benefits likely to accrue to and the disadvantages that may be imposed on the economic, social and welfare facilities, including prospects of employment and the effect on the infrastructure of the islands as a result of the proposed development.

Section 32 (10 (b) of the Physical Planning Ordinance (1989) gives the Director of Planning the authority to request that a developer (at the expense of the developer) provide an environmental impact or economic feasibility study for developments falling within certain categories where the impact on the environment and/or the economy of the Turks and Caicos Islands may be affected. One category is Marine Works, which includes marinas; boatyards and slipways; piers; wharves; jetties; sea defence structures; dredging; sand mining; reclamation; landfill; and wetlands development. The proposed maintenance dredging of Leeward-Going-Through Channel, which is the subject of this EIA, proposes serious environmental challenges, which this study sets out to address.

Other legislations and regulations that governor the proposed maintenance dredging operation include Public and Environmental Health Regulations, Coastal Protection Ordinance and National Parks Ordinance (1992).

3.3 Turks and Caicos Islands Development Manual

Special attention is paid to building line setbacks in coastal areas. The Turks and Caicos Development Manual (1996) specifies that for coastal developments the EIS - Maintenance Dredging Leeward Channel PR. 11342 - Caribbean Environmental Design Associates Page 91, minimum setbacks from the high-water mark should be determined by appropriate studies and by an examination of the known effect of high seas on the beach frontages. As a general rule for slopes of beach less than 1:20, a permitted building line setback (measured from the high-water mark) of 100 feet. is permitted for developments in coastal areas (Turks and Caicos Islands Development Manual).

3.4 TCI Building Code

Providenciales Land Use Zoning Plan is an instrument used to control and regulate the orderly and progressive use of land. It designates various land areas to specific uses. Although the plan's life span expired in 1989, it remains the instrument used to govern land development on the island today. Preparation work is in the advance stages for a comprehensive review of the plan.

A Grant of Outline Development Permission (ODP) dated April 16, 2015 for the proposed dredging operation was granted by the Physical Planning Board under planning application reference number PR.11342 to Leeward Yacht Club Marina Limited and requires a number of conditions to be met, among them:

- That an Environmental Impact Assessment Study be carried out on the proposed development and be submitted for consideration and determination prior to the preparation of any final plans for Detailed Development Permission and Building Permit.

3.5 Coast Protection Ordinance and Subsidiary Legislations

The National Parks Ordinance (1975) provides for the establishment of National Parks, Nature Reserves; Sanctuaries and Historic Sites and for the imposition of restrictions on development in such areas.

Beach nourishment and groyne construction seaward of the Mean High Water location will occur within the defined limits of the Princess Alexandra Land and Sea National Park. Section 4 (1a) of the National Parks Ordinance requires approval from the Governor for elements of this project within the national park boundaries.

3.6 Mineral

Under the Minerals Ordinance, all minerals beneath Turks and Caicos Islands territorial waters and contained within the subsoil are the property of the Crown (§s 3 and 4). Therefore, the exploration for and exploitation of minerals are governed under the Minerals Ordinance, and any such exploration and exploitation of minerals may take place only with the issuance of a license (Section §7) and a grant of development permission from the Department of Planning (Section §5).

All materials should be obtained from a proprietor who is legally licensed under the Minerals Ordinance and the applicable royalties on said materials shall be paid.

3.7 Marine Pollution Ordinance and Subsidiary Legislations

The Marine Pollution Ordinance governs all vessels within the territorial waters of the Turks and Caicos Islands and the discharge of pollutants therein. It also governs pollutants that may be discharged on land but enter the marine environment (§s 4 and 5). Therefore, the operation of construction equipment for the project is subject to conformity with the Ordinance.

Under this Ordinance, it is unlawful to discharge oil (§9), noxious liquid substances (§12), harmful substances as defined by MARPOL (§15), garbage (§21) and/or hazardous waste (§30) into the marine environment.

3.8 Fisheries Protection Ordinance and Subsidiary Legislations

Part Ill of the Fisheries Protection Ordinance contains provisions for conservation, including restrictions relating to the seabed (Regulation 10), including prohibitions against employing activities or devices that are harmful to marine life, removing, shifting or in any way disturbing coral, seagrass, sand, rock or other substances forming part of the seabed. Such activities are allowable with endorsement or other licensing by the Governor.

3.9 International Treaties and Conventions

While the Turks and Caicos is not a formal signatory to either the International Union for the Conservation of Nature (IUCN) or the Convention for International Trade in Endangered Species of Wild Fora or Fauna (CITES), the Turks and Caicos does acknowledge, regulate and protect multiple species that are addressed through these international agreements. Of particular not regarding this project is the presence of several listed coral species within the project vicinity. These are discussed further within Sections 2.2 and 5.2 of this study.

4.0 Project Description and Construction and Operation and Alternatives

4.1 Description of the Proposed Project

The project includes the construction and/or reconstruction of nine different sediment retention structures and installation of approximately 50,000 cubic metres of beach-compatible sand material in the Emerald and Pelican Beach area (Figure 4-1 and Appendix D). In addition, the project includes removal of derelict groyne material and debris within the project footprint and rehabilitation of existing coastal structures (seawalls and revetments) on an as needed basis.

The project at Emerald Beach includes:

- The construction of one new T-head groyne at the east end of the client's property plot (structure T-1),
- The repair of one existing T-head groyne at the west end of the beach (structure T-2) and one groyne in the beach middle section (structure T-1b).
- The placement of approximately 25,000 cubic metres of beach-compatible sand between T-1 and T-2 to increase the existing dry beach width and provide coastal protection to the shoreline properties.

Transition from Emerald Beach to Pelican Beach includes:

- The construction of one new breakwater (structure T-3) to stabilize the pocket beach immediately to the west and to provide shelter to a small launch pontoon located on the lee side of the structure.

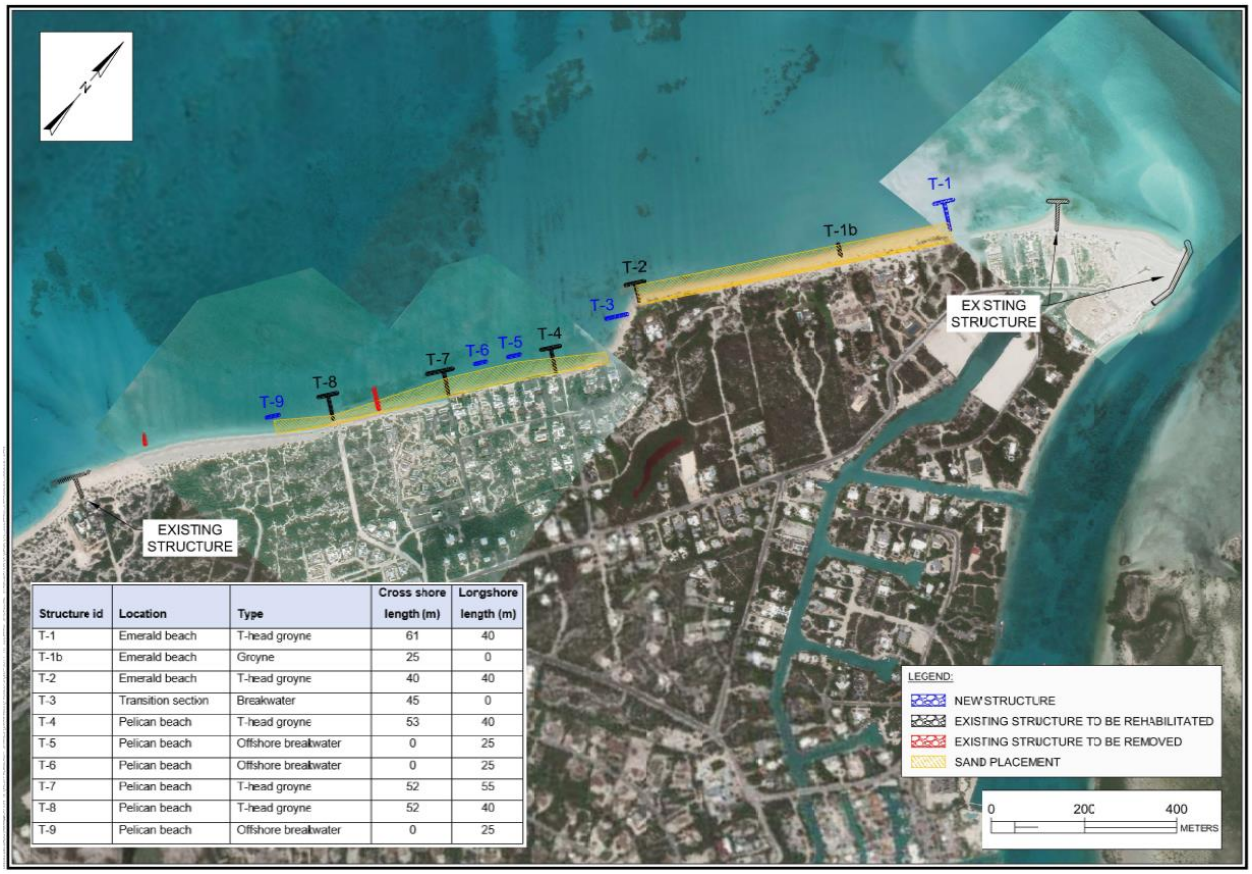
The stabilization work at Pelican Beach includes:

- The transformation of three existing groynes (structures T-4, T-7, and T-8) to T-head groynes;
- Installation of three new offshore breakwaters (structures T-5, T-6, and T-9);
- The removal of two existing groynes, one located between T-7 and T-8 and the other one between T-9 and the east end of the beach; and
- The placement of approximately 25,000 cubic metres of beach-compatible sand between T-3 and T-8 with the same objective as described above for Pelican Beach.

Additional work that will be conducted throughout the project area as needed includes:

- Removal of assorted debris within the project footprint
- Rehabilitation as needed of existing coastal structures within the project footprint including seawalls and revetments within their existing footprint and orientation.

Given the highly eroded nature of the shoreline and the ongoing erosion and possible failure of existing coastal structures, initiation of work is intended to occur on an expedited basis once the required approvals are secured. The structure construction phase will occur first with sand placement occurring following structure implementation.



Structure id	Location	Type	Cross shore length (m)	Longshore length (m)
T-1	Emerald beach	T-head groyne	61	40
T-1b	Emerald beach	Groyne	25	0
T-2	Emerald beach	T-head groyne	40	40
T-3	Transition section	Breakwater	45	0
T-4	Pelican beach	T-head groyne	53	40
T-5	Pelican beach	Offshore breakwater	0	25
T-6	Pelican beach	Offshore breakwater	0	25
T-7	Pelican beach	T-head groyne	52	55
T-8	Pelican beach	T-head groyne	52	40
T-9	Pelican beach	Offshore breakwater	0	25

Figure 4-1. Construction Plan

4.2 Project Justification

Corrective actions to address the erosion issue (namely, coastal structures and nourishment) have been implemented within the project area on multiple occasions and protection of existing upland properties is a reasonable (and anticipated) response from upland owners. Unlike

previous projects within the area, this effort includes a coordinated, holistic approach to the problem that addresses the impacts to the coastal system and minimizes the potential for adverse impacts through design and adaptive management. This includes the development of an owner funded mechanism for long term monitoring, adaptive management and corrective action if needed. Construction of the project as a single, regional effort will minimize the impacts from multiple projects by individual property owners and minimizes the potential for conflict between adjacent properties.

Potential and anticipated environmental impacts from the project are primarily associated with construction activities, in particular the dredging of sand from the inlet and the placement of sand within the beach template. These impacts are similar to impacts from previous projects, are generally short term and can be minimized through the adoption of construction best management practices and construction monitoring. Additional impacts will occur to limited coral resources in the project footprint, but it is important to note that these resources exist on anthropogenic (non-natural) substrate that is not stable and where possible existing coral resources will be relocated to suitable substrate outside of the project area. The resulting stabilized beach will provide habitat functions that are not currently present due to the highly eroded nature of the current shoreline.

As the erosion issue is largely attributable to the interruption of sand transport caused by the Leeward-Going-Through Inlet (and in particular the dredging of a navigation channel through the inlet), beneficial use of sand from inlet dredging is a mitigative action to offset inlet impacts. This approach is consistent with accepted coastal engineering practice and provides a long-term sustainable and environmentally appropriate strategy for both inlet and shoreline management.

The main objective of this project is to provide a more stable and sustainable beach for property owners and the general public (tourists and locals) within the project area and to offset the adverse impacts of the Leeward-Going-Through Inlet on the adjacent shoreline. The current state of the eroding beach has lowered property values, limited space for recreational activity and leaves structures along the shoreline vulnerable to coastal storms. A number of coastal structures within the project area are currently failing and will be rehabilitated through this project reducing the need for additional coastal construction within the project area. Continued erosion and loss of property and structures will persist if no action is taken and there will be

increased tendency to request and install coastal armouring to protect upland development, most likely on an emergency basis. An increase in coastal armouring is not desirable as it would further exacerbate the highly eroded condition of the project area and result in increases in beach habitat loss.

Providing a stable beach will have several positive impacts. Economic benefits include added appeal to investors, increased property values and the positive downstream taxes and fees from property sales. Increased beach width will improve beach habitat and provide recreational use for locals and increase tourism potential, which will contribute to the local economy. In addition to the potential economic gains, the project will also avoid the cost and potential impacts of constructing individual property protection measures such as seawalls on an unplanned and ongoing basis.

4.3 Effects on Erosion or Accretion

It is anticipated that the combination of sand placement (renourishment) and the establishment of a coherent system of costal structures will result in a stable, relatively uniform beach throughout the project area. Further the structure plan will limit the loss of sand into the inlet while maintaining nominal transport of sand through existing littoral processes to the west. The preferred project design transitions the use of structures into the updrift stable beach associated with the existing groyne at Coral House. This approach limits the potential for downdrift impacts from the project as the area of influence of the last structure in this plan overlaps with the positive area of influence of the Coral House groyne. A plan for monitoring and adaptive management of the project performance is further proposed do document shoreline performance and provide a mechanism for corrective action if warranted.

4.4 Coastal Engineering Plans

A shoreline evolution model has been developed to evaluate the performance of the proposed beach stabilization solution and to assess the potential downdrift impact of the proposed works. A detailed explanation of the numerical model is presented in Appendix E1.

4.5 Coastal/Beach Development and Management

The project area is largely developed as large, single family residences. There are only a few remaining open lots which are anticipated to be developed. The project area is currently accessed by local homeowners from their properties and by tourists and locals through two

public beach access points and from the western end of the beach. The other beach access point is located at the end of Nightjar Lane between Aiwa and Saving Grace Villas on Tranquillity Lane. Access to the public from Emerald Point has been limited since the construction of the Terminal Groyne at Leeward-Going-Through Channel and ongoing development of the adjacent coastal properties.

4.6 Source and Quality of Beach Sand and Fill

The construction materials required for completion of this project include rock and sand. The technical requirements and sources are discussed in this section.

Rock material performance requirements will be specified by performance standards and technical specifications aligned with international industry standards. Performance requirements for technical parameters such as rock density, size, shape, water absorption, block integrity, etc. will be included as part of the project technical specifications documentation. Local sources for rock material will be explored; however, based on previous project experience, it is anticipated that local sources will not be able to deliver rock material with the quality and dimensions required to fully support this project. For this reason, the recommendation is to procure the required rock material through a commercial competitive process from regional quarries which can produce material of sufficient size and quality. Appropriate quarries are located in Dominican Republic, Puerto Rico and Jamaica. The source of rock will be determined at the time of construction based on availably and market forces. These sources shall be upland sources that will not impose any potential marine risk for contamination.

The beach nourishment works included as part of this project will be executed with beach-compatible sand material. Performance requirements for this sand material will also be specified as part of the project technical specification documentation for several parameters including grain size, composition, silt/fine fraction and colour.

Sand material can be sourced externally by purchase from Turks and Caicos, Bahamas or Barbuda; however, the material quantities required for this project potentially make this alternative economically unfeasible. Based on previous practice for similar beach sourcing projects in this area and based on the fundamental coastal marine processes in the project area that deposit sand from Emerald Beach into the channel, the recommended source for the sand is by dredging the inlet channel acknowledging the limits of the Princess Alexandra National

Park. This alternative includes significant benefits because this sand material is already known as good quality and compatible beach sand because it has been transported to the inlet from the adjacent project beach. This approach also represents a sustainable approach to beach and inlet management which mitigates for the impact of the inlet on the adjacent beach and provides for beneficial use of sand excavated from the established navigation channel. Excavation of the inlet navigation channel has been conducted previously and has been evaluated through a previous EIA study. No modification to this plan is proposed here, only that beach compatible sand once excavated is placed within the project area as has occurred with previous inlet maintenance projects.

With regards to the sand placement methodology, three different means and methods have been considered as follows:

- Direct hydraulic placement

  This method consists of pumping a sediment slurry of sand and water directly to the placement location at the beach through a pipeline. Existing beach material and material placed in the operation would be utilized to construct dikes on an ongoing basis to contain the placed material and minimize turbidity. Once the slurry is deposited at the project beach, heavy machinery equipment would mechanically distribute the sand material over the beach profile. Considering the low silt fraction of the dredged material, (the dredge material silt/fraction is equivalent to beach sand) it is anticipated that this method can be implemented with acceptable levels of construction related turbidity. Turbidity represents the most significant concern with this approach, though monitoring, corrective action and potential shut-downs if an exceedance occurs are accepted standard practice for this type methodology. This methodology is both efficient and cost effective because it allows installation of the material at the same rate of dredging with no material rehandling. The methodology also minimizes impacts to upland property and infrastructure.

- Mechanical placement using a Confined Disposal Facility (CDF)

  The use of CDFs is a common solution when managing contaminated or poor quality dredged material. A CDF is an area specifically designed for the containment of dredged material that provides greater control of discharged water back into the environment. The main, basic objective of a CDF is to retain dredge material solids that are and allow the discharge of process water from the confined area. In the case of using an upland

CDF and considering the sand material quantity required for this project, an approximate area of 4.5 acres with 10 feet high dikes would be required for material containment. An upland area this size is not currently available in the vicinity of the placement area. A smaller containment site could be considered, but this would be less efficient and would require shut-down of the dredge operation to allow periodic removal of material to provide sufficient capacity for the dredge operation.

After completion of the dredging and upland containment, the sand material would be transported to the appropriate placement location at the beach utilizing upland trucks. Considering a standard 10 cubic metres tipper truck, approximately 5,000 truck trips would be required to transport the sand material from the CDF to the project beach, with the consequent disruption to the local traffic, discomfort to the neighbours, noise, damage to the pavement and increased carbon footprint. The limited beach access to the project site would provide an additional issue for this approach given the magnitude of trucking required.

While this approach would provide greater control of turbidity during sand placement, it would not alter the total magnitude of fine material discharged in total, as the silt/fine fraction would be retained within the beach sand that would then be placed mechanically. If placed in this manner, the silt/fine fraction would likely be suspended over time during wave events post construction. Depending on the magnitude of wave impact, the results could be similar to turbidity levels associated with direct hydraulic placement during these post construction wave events.

- Semi-containment solution

  A semi-containment solution consists of a hybrid solution between the two alternatives proposed above. In this alternative a partially confined placement area would be constructed utilizing the proposed coastal structures to form portions of the containment area. Additional diking would be constructed utilizing existing and placed sand material to form a containment area. Material would then be transported along the beach as needed to construct the design beach template. This approach would significantly reduce the impacts to upland properties and infrastructure and would increase the ability to control the discharge of turbidity into the environment. This approach, however, is fairly similar to the direct hydraulic placement alternative, and only differs in the extent to

which the placed material is contained. As noted above, the volume of silt/fine material placed by each alternative is relatively the same, the main difference is the extent to which turbidity is controlled in the initial hydraulic placement.

All placement alternatives would include similar turbidity monitoring protocols with requirements for corrective action including shut-down if turbidity exceedances occur. The direct placement alternative exhibits the greatest risk of exceedance and possible need for periodic shut down. This approach, however, exhibits a lesser likelihood of post project turbidity events associated with wave events as the fine material will be distributed within the environment as part of the construction phase.

DECR recommendations against direct hydraulic placement are acknowledged (ref. Appendix O) and beach nourishment will be implemented through the use of sand containment facilities in lieu of direct placement for this project.

4.7 Solid Waste Management During Construction and Operation

All solid waste generated by the construction and the operation of the facility will be handled by environmentally sustainable collection and disposal. During construction, contractors will provide enough portable toilets for the number of employees on site. Trash bins will be placed within the work zones for collecting localized employee and work-related trash. Bins will be collected and properly disposed of on a daily basis.

4.8 Surface Runoff Management/ Storm Water Runoff and Treatment

No evidence of any direct discharge to the beach was observed during field studies and stormwater management for the area is primarily associated with existing development and infrastructure. The project will have minimal impacts to existing stormwater management on adjacent upland properties. The establishment of a consistent beach and nominal dune within the project area will reduce the potential for stormwater discharge (including nutrient migration) into the nearshore environment.

4.9 Traffic Flow and Safety

The project will have no long-term direct impact on existing or future vehicular traffic within the study area. Impacts will be limited to project construction phases and will be primarily

associated with the ingress and egress of equipment and material to the project site. Impacts will be minimized through the implementation of appropriate MOT measures to ensure safe vehicle ingress and egress. Except for on beach dredge operations, vehicle and material ingress and egress will only occur during daylight hours with appropriate safety measures.

Safety perimeters will be established around areas of active construction including beach and groyne construction areas and in the vicinity of dredge operations. Where possible beach areas outside of the active construction zones will remain open to the public and dedicated security resources will be implemented to secure the security perimeter.

A security perimeter will be established around the active dredge site including marking of any hydraulic lines with lighted buoys. The dredge shall maintain appropriate lighting and signage throughout construction and shall monitor hailing frequencies for any construction related communication. Coordination with appropriate governmental entities and users of the inlet shall occur during pre-construction planning and the pre-construction meeting. Access through the inlet will be maintained throughout construction.

4.10 Water and Electrical Demand and Source

Current and proposed upland development within the project area is serviced though the existing on-island utility companies. This project is not anticipated to have a measurable impact on utility demand, as the majority of properties within the area are already developed and the few remaining do not represent a significant increase in utility demand and will be developed regardless of the implementation of this project. Project utility requirements for project construction are minimal as the contractors anticipated for this project will be largely self-sufficient.

4.11 Landscaping

The project does not have a landscaping plan in place because the project design does not include placement of material landward of the existing vegetation line. It is recommended that any homeowners who wish to plant in the upper portion of the dune region of the beach should utilize native species of plants to provide stabilization of the placed material and eliminate the potential of spreading of invasive species. The post-project condition of the beach will be assessed and if warranted planting of the area will be implemented through the owner's

association as a single construction effort utilizing appropriate native species procured from established nursery-based sources.

4.12 Construction Phase Activities

4.12.1 Construction Methods and Program

The project will be constructed in two major phases. Structure construction will occur first utilizing land-based equipment. It is anticipated that this phase will require up to six months to complete. Following completion of the structures sand from the inlet channel will be hydraulically dredged and transported by pipeline along the beach to the placement template. It is anticipated that this project phase will require up to two months to complete.

4.12.2 Site Security and Hoarding

A security perimeter will be maintained around active construction sites including areas of structure construction, sand placement and around the dredge. Dredge equipment will be secured within the area of active construction within the inlet but will allow for the ongoing use of the inlet. Beach equipment will be maintained within a security perimeter on the constructed beach profile. Beach access and use will be maintained outside the areas of active construction.

4.12.3 Sources of Sand for Beach Nourishment

Approximately 50,000 cubic metres of sand will be dredged from the Leeward-Going-Through Channel shoal. The sediment within the borrow area is beach compatible, having an approximate mean grain size of m0.25 mm and contains approximately 3% silt. The colour of the sand within the borrow area is beach compatible and very closely matches the colour of the existing beach. The Leeward-Going-Through Channel has been previously dredged as part of channel maintenance. Photo 4-1 presents a stockpile of dredged material from the channel, which is representative of the material that will be dredged and placed on Emerald and Pelican Beaches.

Photo 4-1. Sand stockpile dredged from the Leeward-Going-Through Channel.

4.12.4 Storage of Materials and Equipment

The only materials and equipment to be stored on the site are those that are essential for the proposed project. Heavy equipment is to be stored on site in an enclosed area. Hazardous materials including fuel shall be kept in appropriate containers and best management processes shall be applied to the use, storage and monitoring of these materials. The contractor shall prepare a hazardous material management plan for review and approval by the Owner prior to mobilization. The Owner's representative shall regularly observe the project site for deviations from the adopted plan with immediate report to the contractor for corrective action.

4.12.5 Beach Traffic Impact and Safety

Land based equipment mobilization shall utilize existing roads and access to the beach will be provided by the project owners. An enforced security perimeter shall be established around the active work area including areas for the storage of equipment and materials. Areas outside of the active project construction area shall remain open to the public during construction. The

contractor shall provide dedicated security personnel to maintain the established security perimeter and ensure public safety.

4.12.6 Temporary Sanitary Facilities

All solid waste generated by the construction and the operation of the facility will be handled by environmentally sustainable collection and disposal. During construction, contractors will provide enough portable toilets for the number of employees on site and facilities will be maintained by established, on-island resources.

4.12.7 Access and Staging

Access and staging areas will be provided through the upland properties. Access to the beach placement area and staging of the equipment (pipes, heavy equipment, etc.) will utilize available space on and near the beach. It is the contractor's responsibility to return the construction staging areas and beach access points to the natural state, including grading and revegetation with native species. Access to the beach will be provided through upland properties where possible including public beach access points if necessary. Public access to the beach outside of the active construction areas will be maintained throughout active construction.

4.12.8 Placement and Spreading of Sand

Approximately 25,000 cubic metres of beach-compatible sand will be placed between T-1 and T-2 at Emerald Beach, and approximately 25,000 cubic metres of beach-compatible sand will be placed between T-3 and T-8 on Pelican Beach.

Beach-quality sand will be placed using a hydraulic dredge. The dredged material will be pumped through a pipeline to the shore and deposited on the beach. The use of sand dikes along the seaward edge of the placement area, nominally 200 feet long, will allow the sand to settle before the water is returned to the sea. As the dredged material builds up, the sand will be spread with bulldozers down the beach, in the direction the sand is pumping. When the placed sand reaches the designed elevation and width, the pipes will be extended and pumping will advance down the beach, and the dynamic containment area around the disposal site will also advance down the beach through continuous building and advancement of the dike system.

Construction of the rock groynes will require the use of excavators and front-end loaders. The excavator will have a hydraulic claw on the end to pick up the boulders and place them with

precision. The front-end loaders will bring the stone boulders to the site of the groyne placement.

4.12.9 Protection of Sand from Erosion during Swells

Sediment transport data within the project area and surrounding region were used to design a structural system to limit the potential loss of sand due to swells and currents. The design includes the construction and/or reconstruction of nine different sediment retention structures, and installation of approximately 50,000 cubic metres of beach-compatible sand material in the Emerald and Pelican Beaches area. The sand will be placed to widen the beach and provide coastal protection. The structural components have been designed to help retain the placed sand.

4.12.10 Solid Waste Management during Construction

All solid waste generated by the construction and the operation of the facility will be handled by environmentally sustainable collection and disposal. Construction materials debris will be stockpiled during construction activity and containerized and then will be disposed at a suitable landfill facility or other destinations with recycling capabilities. This will be the contractor's responsibility and regular observation by the Owner's representative will be conducted to ensure compliance with contractual requirements for waste management.

4.12.11 Liquid Waste Management

The contractor will be contractually required to develop a hazardous waste management plan for review and approval by the Owner. This will include the identification of potential hazardous liquid waste on the site, means and methods of use, storage and disposal. The Owner's representative shall conduct regular observations of the project site to ensure compliance with the approved management plan.

4.12.12 Control of Air, Dust, Water and Noise Pollution

The activities that are associated with the project that are most likely to raise the ambient noise levels in the area are the dredging equipment, and heavy earth moving equipment utilized on the beach. All equipment shall be required to be in good working order and have appropriately installed exhaust systems. Any equipment that is in non-compliance shall be either fixed immediately or removed from the site. No material shall be discharged on the beach or into

adjacent waters. The Owner's representative shall conduct regular observations of the project site to ensure compliance.

4.12.13 Control/Storage of Fuels and Other Dangerous Substances

Hazardous materials will be stored in a secure location using appropriate storage cabinets, if applicable. Non-compatible chemicals (i.e., acids and bases) will be segregated to prevent mixing in the event of a spill. Employees are to read information on labels and safety data sheet (SDS). Storage areas are to be kept clean, with aisles kept clear. Instructions on signs must be obeyed. Appropriate personal protection clothing must be worn, if necessary.

4.12.14 Emergency Mitigation Plan

Potential hazards in the Turks and Caicos Islands can occur due to natural and anthropogenic causes. Potential emergencies associated the project include accidental spillages of hazardous materials and fuel in terrestrial and marine environments, tropical cyclones and other unforeseen natural and manmade events. The Turks and Caicos Islands 's geography, small economic structures and limited resources make the country particularly vulnerable to potential disasters and emergencies. Effective planning helps to reduce potential impacts. In the case of the project, the threat of emergencies is small and can be largely avoided with conscientious planning.

This plan outlines strategies to avoid and mitigate spills of hazardous materials on land and in the marine environment. The following are events that can require emergency and mitigation responses:

- Hurricanes and Tropical Storms
- Noxious Liquid Spill
- Public Safety Issues

Successful emergency management may require the participation of key government agencies, including:

- The Turks and Caicos Islands Fire Department
- The Department of Disaster Management and Emergencies (DDME)
- Environmental Health
- Department of Environment and Coastal Resources (DECR)

- Maritime Affairs
- The Ports Authority
- The Turks and Caicos Islands National Healthcare Agency

Success also depends on financial resources, administration and trained personnel for implementation. Any emergency and mitigation plan should be seen as a "living" document, in that revision and review should take place, incorporating newly available information, changing circumstances and lessons learned.

Any pollution incident that poses a threat to the natural environment should be reported immediately to DECR, the Department of Environmental Health, DDME and Maritime Affairs. Spill mitigation materials should be immediately available to the construction crew, including booms and absorbent materials. The turbidity curtains, which should be in place throughout the construction process, will help to avoid and reduce impacts from potential spills. However, the emergency mitigation plan should remain in place in the event that a spill occurs and the turbidity curtains fail.

The following are the roles and responsibilities are assigned to the various project principles:

Project management/monitoring team - Pre-, during and post-construction mitigation, contract administration and oversight ensures that work is compliant with the mitigation measures outlined in the EMP. The Project Manager ensures that the necessary equipment, manpower and resources are available to provide an effective and immediate response to an emergency or hazard and to alert relevant authorities immediately. The Project Manager should also ensure that construction crews are adequately trained to discharge disaster management responsibilities and/or arrange for additional assistance, if required. All staff members should be informed of emergency procedures, and applicable signage and information should be posted at key locations. If a spill occurs, which enters the Princess Alexandra National Park, then a preliminary quantitative biological monitoring of offshore benthic assets is recommended. The Global Coral Reef Monitoring Network (GCRMN) is the preferred method for monitoring (Annex A); however, the Atlantic and Gulf Rapid Reef Assessment (AGRRA) is also acceptable.

Project Contractor - Pre, during- and post-construction operations are to be conducted in accordance with the recommended monitoring and mitigation measures in the EMP to ensure

that siltation, spills and pollution are avoided, reduced, restored and offset, where required. All solid wastes generated are to be disposed of daily, and any solid wastes with the potential to become airborne are not to be permitted in coastal areas. Fuelling, if required, is to take place outside of the coastal zone. No replacement of hydraulic or machine fluids is to take place on site. Silt curtains with a floating boom shell shall be employed throughout all construction activities. The silt curtains shall also be capable of capturing any floating debris. Spills of construction equipment fluids or other hazardous materials shall be immediately contained onsite and disposed of in an environmentally safe manner as soon as possible. Equipment and machinery shall be serviced, maintained and washed offsite, away from the marine environment.

Hurricane/tropical storm response measures - The following procedures are to be taken in the event of a weather statement regarding hurricanes and tropical storms.

- In the event of a tropical storm/hurricane watch, construction can proceed to within 24 hours of expected landfall. No construction activities should take place under an active tropical storm/hurricane watch at the time of predicted landfall. All equipment should be removed from site and all other materials secured within 24 hours of predicted landfall so that they cannot become windborne.
- In the event of a tropical storm/hurricane warning, all construction activities should cease once the warning has been issued. All equipment should be removed from site to a secure area until the storm has passed. Any materials onsite that have the potential to become windborne should be removed to a secure location. No construction activities should take place until warnings have been lifted.

Spill response measures - The following procedures are to be taken in the event of a spill of hazardous materials:

- Recording of the actions and decisions taken during an accident should be undertaken to ensure lessons are learned. Any improvements shall be enforced in response to improved technologies, capabilities, etc.
- All relevant factors are to be immediately assessed, including the nature, amount, location, wind and current directions and speeds, areas potentially affected and resources needed and available.
- Priorities are to be established and response initiated, based on most-critical factors first. The employment of chemical dispersants/ oil herders is to be used only under the

approval of DECR. Response shall include reduction of impacts in sensitive areas, via the removal of the pollutant in all affected areas.

- Contaminated materials shall be recovered and disposed of on land at the PLS landfill. DECR shall oversee and dictate the clean-up strategy and risk assessment.
- Prevailing weather conditions and hazardous material types will determine the equipment and methods to be used.
- Biological and other environmental values, accessibility and ability to utilize such equipment shall be considerations in selecting the clean-up method.
- Any solid materials, such as tar balls, will be put into plastic bags and disposed of at the PLS landfill.
- Floating booms and skimmers will be used to contain and remove oil and other hazardous liquids on the sea surface, for pumping into containment tanks and disposal at the PLS landfill.
- Response shall also include during- and post-incident biological monitoring to determine the effectiveness of the response.

Reporting Information Requirements for Hazardous Materials Management (HAZMAT) - measures for reporting shall include the following:

- Name of person reporting
- Date and time of incident
- Nature of incident (leak, explosion, spill, fire, etc.)
- Location and source of incident
- Details of injuries and fatalities, causes of injuries, treatments applied
- Identification of material(s) released (if known), manufacturer, label information, characteristics, physical state (e.g., gas, liquid, solid), etc.
- Amount of material released/duration of release
- Affected resources and amount of materials released (e.g., air, water, land), including a description of direction, height, colour, odour, plumes, vapor, etc., including wind, current speeds and directions
- Local weather conditions
- Response personnel

Public safety response - In the event of a public safety incident of any magnitude, emergency medical assistance is to be sought immediately. Note it is preferable to have someone within the construction/management team who is familiar with and can administer first aid. If emergency medical assistance cannot be reached in a timely manner, then affected persons should be transported, if feasible, to Grace Bay Medical Centre (the nearest medical facility). In the case of a public safety incident, documentation is critical. The following information should be recorded:

- Time and date of the incident
- Description of the incident/injury
- Name(s) of affected persons
- Actions taken
- Names and contact information of witnesses to the incident

Follow-up with witnesses may be necessary if legal proceedings are initiated.

Water quality management - In addition to previous measures, no washing down of equipment near the water shall take place during construction.

Emergency plan testing and review - This plan will be reviewed and updated as necessary as further information becomes available that may influence plan implementation and emergency operations. If an incident should occur prior to review, then the review is to take place immediately following the incident to adjust the plan as needed, incorporating lessons learned.

4.13 Social-Economic Impacts

4.13.1 Demographics

The project area consists of high-end single-family residences which are utilized by the property owners and to various extent are available as rental properties. The project will increase the level of storm protection to these properties and increase the extent and aesthetics of beach within the area. This will improve lateral access down the beach which in some areas is not currently present due to the extent of exposed seawalls. Overall, the project is anticipated to increase the value of upland properties and the associated benefits (and impacts) associated with this trend. Project implementation will likely increase incentives for the development of the few remaining available properties within the project area.

4.13.2 Employment

The project's labour requirements include only a limited number of labourers and professionals. Labourers include equipment operators and manual labourers. Professionals include coastal engineers, property managers and environmental scientists employed for obtaining development permissions. With the exception of coastal engineers, all other labour will be locally sourced, with a high percentage of Belonger participation where possible. Due to the limited nature of labour requirements, no negative impacts are anticipated, and payment of fees and wages to locally based persons are exclusively positive economic benefits. The positive economic benefits associated with local labour will be temporary.

4.13.3 Safety/Security

Traditional and existing uses of the project site are limited exclusively to recreational beach use by island residents and tourists. In the long-term, existing recreational beach uses should be positively impacted by increased beach area and improved stabilization; however, during construction, recreational use will be impeded by construction and access around the area of construction should be restricted to avoid public safety problems. Public notice of construction activities should be made at least two weeks in advance, advising beach users to avoid the area during the construction period. Furthermore, signage should be posted at the nearby beach access and at the boundaries of the project area informing the public of construction times and potential safety issues. The entire work area should be cordoned off with safety tape and flagging.

4.13.4 Issues Raised in the Public Consultation

The project feasibility study (Smith-Warner, 2018) included interviews with upland property owners and solicitation of a project questionnaire. Results of this effort are further described in Appendix E2. In general, feedback was supportive of efforts to widen and stabilize the beach in the area. Additional engagement with adjacent property owners has occurred throughout the design development process and it is noted that the project is supported and funded by an association of over 25 properties within the project area. Issues raised during this process have included the overall cost of the project, the means of securing funding for the effort and the need for costs to be shared by all properties deriving project benefit. Additional concerns have been raised regarding the potential for downdrift impacts from individual coastal structures and the need for an adaptive management plan.

Additional public comment and consultation will be solicited following initial review of the study by DECR. The draft EIA will be made available for public review and comment and a study outreach meeting will be held (either in person or virtually) to solicit public comment. If warranted the EIA document will be modified based on public comment and public comment and responses will be included as an additional appendix to the final document.

4.13.5 Public Beach Access

The project area includes two designated public beach access points. The project will increase the extent of beach available at these public access points and will significantly improve lateral beach access from both public beach access points. At present lateral beach access is severely restricted by the highly eroded nature of the beach and the extent of exposed seawalls. The project will result in an advance in beach area that will remain publicly accessible.

4.14 Potential Alternatives

Project alternatives are further discussed in the following. It is noted, however, that the general strategy of periodic nourishment and coastal structures has already been adopted for the area through multiple previous projects. The primary differentiator for the project is the holistic, regional nature of the effort which takes into account management of the coastal system.

4.14.1 No Go" Alternative

The shoreline could remain in its current condition. However, this would result in a lesser quality shoreline in terms of recreational use, aesthetics and environment, and an increased loss of dunes and private property due to continued erosion. This alternative would increase the potential for coastal armouring by individual properties and the long-term loss of beach habitat within the project area. This alternative would not mitigate for the net deficit of sand within the coastal cell associated with the interruption of sediment supply caused by the inlet. Long- term the sand deficit would become most apparent within the immediate project area, however, the deficit would also advance to the west beyond the immediate project area.

4.14.2 Design Alternatives

Feasible alternatives include permutations of the current design, which would involve variations in beach and structure sizes and locations. A range of design alternatives have been considered and are further discussed in Appendix E1. These alternatives would result in similar

results compared to the preferred design. Armouring of the shoreline could also be implemented. This would reduce the intended use for the shoreline and would not result in any appreciable environmental benefit.

4.14.3 Site Layout Alternatives

The preferred alternative optimizes the beach dimensions between designed structures. Various alternative layouts could be considered, with lesser dimensions resulting in less beach area and reduction in number and size of structures, which would increase the potential for down-drift impacts to Grace Bay.

4.14.4 Summary of All Alternatives

The preferred alternative provides a result that is most compatible with the intended use while providing a stability of the shoreline and protection of upland properties and environments. Other alternatives would not appreciably improve on this result. The primary risk of both the preferred and alternative designs is associated with the long-term performance post-construction and the potential for impacts associated with individual structures. This is best addressed through a long-term monitoring and adaptive management program which is proposed as part of this project.

4.15 Sand Source Alternatives

While sand from an off-site commercial source is theoretically possible, the increased cost of this alternative is not economically feasible for this project. Use of sand from inlet maintenance dredging represents a beneficial use of dredge spoil material as well as a mitigative action for impacts from the inlet to the adjacent beach. This approach is consistent with accepted inlet and coastal management practice and represents a sustainable strategy for long term management of both inlet and beach resources within the area.

In terms of means and methods of construction, additional discussion is provided in Section 4.6. Sand deposited within the inlet is beach compatible as it originated from the adjacent beach and the silt/fine fraction is similar to existing beach sand. Direct hydraulic transport of material to the placement area is the preferred methodology for construction for the following reasons:

- Direct placement limits the impacts to upland properties and infrastructure.

- This methodology is the most efficient, cost effective and quickest method of sand placement.
- The primary risk of turbidity can be controlled through appropriate construction measures including the dynamic construction of diking, corrective actions, proposed monitoring and if necessary periodic shut-down of dredge operations.
- Direct hydraulic placement is the most commonly utilized approach for beach nourishment.

5.0 Impact Assessment

5.1 Impact Identification

Impacts from this project can be categorized as direct, secondary or cumulative. Direct impacts associated with the placement of structures and sand are anticipated and are further discussed in the following. There is a potential for secondary impacts from the project, most significantly associated with project construction and in particular with regard to turbidity. There is also a long-term potential for cumulative impacts associated with the influence of this project on the coastal system.

5.2 Description of Impact

5.2.1 Potential Impacts to the Biotic Environment

Overlaying the proposed development components onto the results of landside and marine investigations reveals that the project will have minimal direct impacts on landside vegetative communities and minimal to moderate direct impacts on sub-tidal marine areas. Impacts to the specific habitat communities that were previously identified and described in Baseline Studies (Section 2) are described hereafter.

5.2.1.1 Impacts to the Terrestrial Environment

Overlaying the proposed site plan onto the results of the terrestrial community assessment indicate that the project will have a direct impact on landside communities to the extent shown on Figure 5-1 (Appendix D) and Table 5-1.

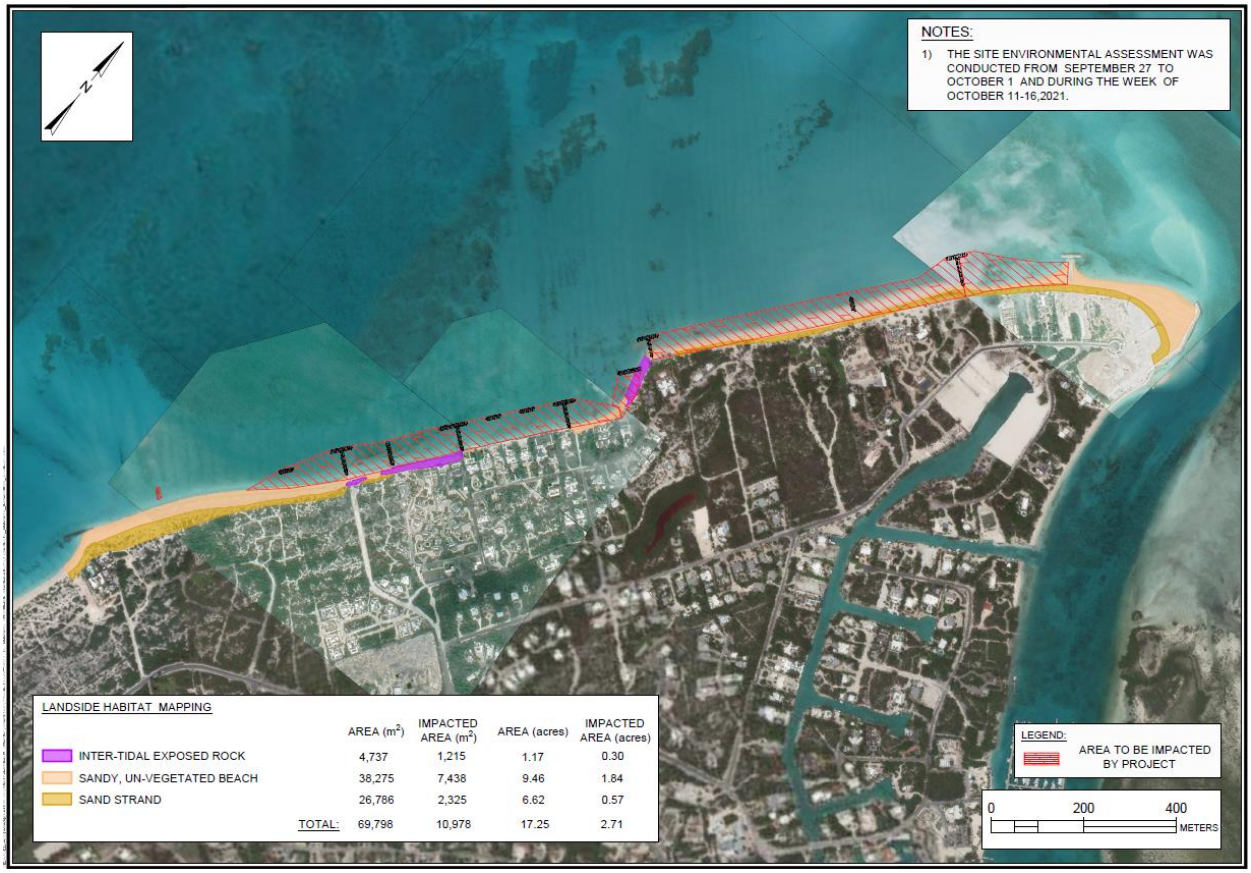


Figure 5-1. Landside Habitat Map

Table 5-1. Direct Impacts on Landside Communities

Community Type	Existing Size Acres	Acres to be Impacted	Comments
Inter-tidal Exposed Rock (including seawalls)	1.17	0.30	Most of this area will be covered by sand and/or the proposed groynes after corals in excess of 5-centimetre-diameter size are relocated
Sandy, un-vegetated beach	9.46	1.84	To be enhanced with sand
Sand Strand	6.62	0.57	A portion to be covered by sand

Indirect (secondary) impacts may include a temporarily reduction in habitat for nesting by resident birds (e.g., Wilson's plovers) and foraging habitat by migratory birds (e.g., ruddy turnstones, piping plovers).

A potential improvement will be an increased protection from hurricanes and increased resiliency to sea level rise.

A high percentage of the area that is proposed to be impacted consists of previously disturbed habitat and/or is of comparatively low value. Therefore, adverse ecological impacts are comparatively minimal, provided the material that is used for beach creation is of an acceptable quality that any potential future erosion will not increase suspended material to such an extent that it will have an adverse impact on other marine life. The low number of diversity of birds observed on the property during the assessment, together with the absence of any in-use or previously used bird nests, corroborates the comparatively low value of the property for birds.

Potential activities that could be considered to minimize and/or offset ecological impacts could include:

- Salvaging representative specimens of plant species that are designated by the government as Turks and Caicos Endemic Plants, Lucayan Archipelago Endemic Plants and Native Plants of Special Conservation Concern to areas where they will not be disturbed;
- Relocating *Tillandsia* air plants to common areas and setbacks;
- Enhancing plant abundance and biodiversity by planting sea oats and/or integrating other species of native plants that are not presently on the property [e.g., Turks caps (*Melocactus intortus*)] into the post-project landscape plan (all plants would be sourced from non-wild harvested nursery sources); and
- Conducting targeted monitoring to document the spatial and temporal presence of piping plovers in the portion of the area near the entry navigation channel into Leeward-Going-Through, to ensure that suitable habitat remains available to individuals of this species without undue human disturbance.

5.2.1.2 Impacts to the Marine Environment

The construction of the proposed Emerald and Pelican Beaches projects will result in direct impacts to moderate- and low-value marine environment habitats to the extent identified in Table 5-2 and Figure 5-2 (Appendix D).

Table 5-2. Direct Impacts on Marine Communities

Community Type	Existing Size Acres	Acres to be impacted	Comments
Vertical Seawalls	0.15	0.13	Most of this area will be covered by sand and/or proposed groynes
Coastal Structures (groynes)	2.36	0.87	Corals on existing groynes to be related? enhanced with sand
Rubble with SAV	12.02	1.90	A portion to be covered by sand
Sand with SAV	9.78	4.07	To be covered with new sand
Barren Sand	61.17	15.73	To be covered with new sand

SAV = Submerged Aquatic Vegetation

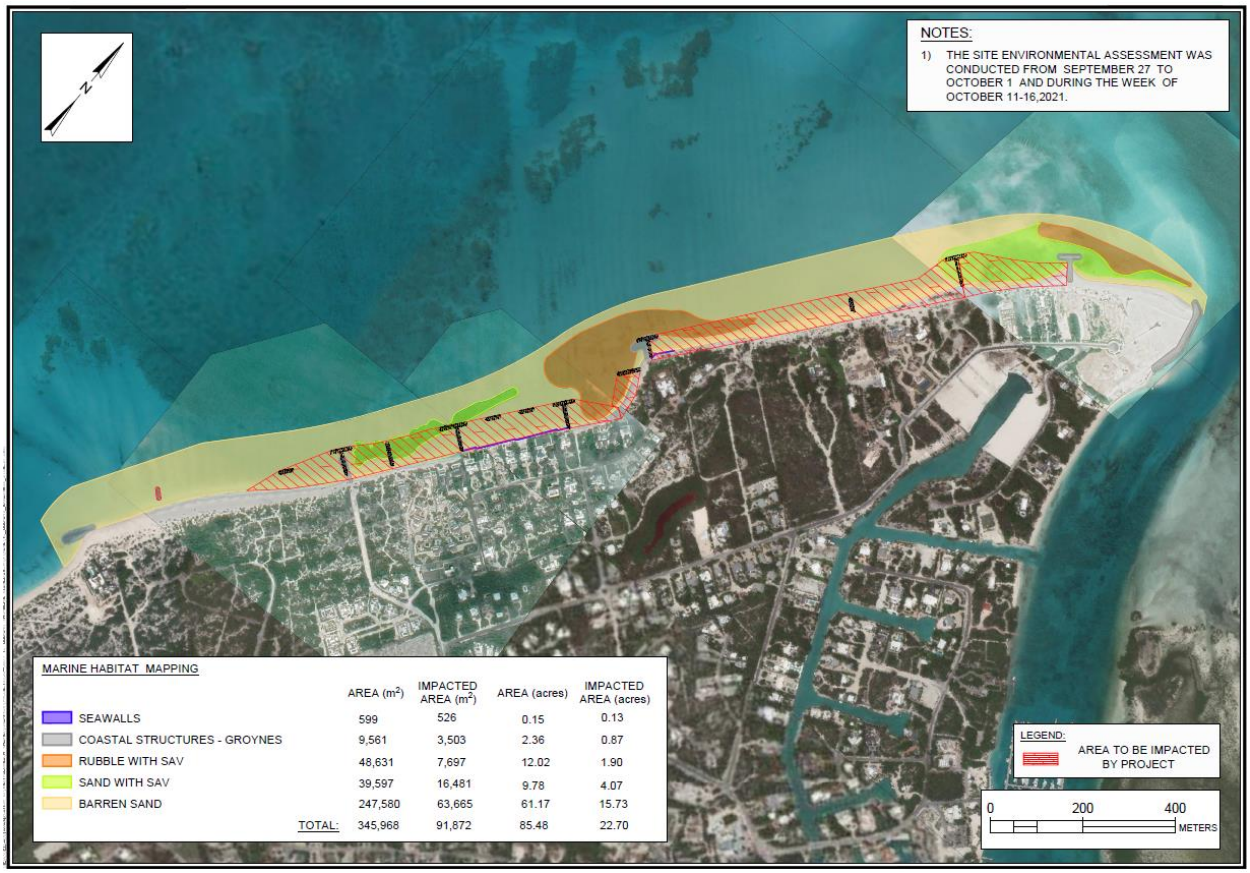


Figure 5-2. Direct Impacts on Marine Communities

Indirect or secondary impacts to moderate to low marine habitats could occur when/if sand that is placed on the beach gets re-distributed by storms into adjoining areas. There is also the potential for secondary impacts associated with construction turbidity.

Overall, the ecological effects of the project are expected to be minimal, provided corals are relocated and other mitigation and monitoring activities described below are implemented.

Sand placement on existing barren sandy bottoms may have temporary impacts to populations of interstitial organisms. Detailed monitoring in other areas has shown that populations of these organisms naturally re-colonize from updrift areas. The increase in habitat area may, over the long term, allow populations of these species to exceed current levels.

Impacts to the "Rubble with SAV" and "Sand with SAV" are expected to be similar to one another. Because these resources have become established in an environment where sand is frequently mobilized during rough sea conditions and may accrete or erode seasonally, some are likely to continue to exist. To varying extents based on the distance from the existing water line, these resources may be covered with varying amounts of sand or by the proposed groynes. Species of macroalgae that grow upright from the sediment, (e.g., *Halimeda* spp., *Udotea flabellum*, *Penicillus* spp.) and seagrasses are accustomed to growing taller when a thin veneer of sand accumulates at their base. They become more stressed and may perish as the depth of sand increases, particularly if they become entirely covered. Low-profile macroalgae (e.g., *Laurencia*, *Batophora*), whether rooted in the existing sand, or growing on the rubble sand, are more likely to be adversely affected, but the degree of impact again is related to the depth of sand or other material that is deposited on them. Moderately mobile organisms (e.g., queen conch, urchins) and highly mobile species (e.g., fish) are likely to flee the area as sand is brought in and groynes are constructed, so adverse impacts to populations of these organisms is expected to be minimal, although some individuals may perish.

No naturally occurring coral reefs are present within the project area or assessment area because corals have become established on the groynes that are proposed to be removed as part of the proposed project. Therefore, impacts to coral communities are unavoidable. A protocol for minimizing impacts to corals is included in Mitigation and Monitoring (Section 6).

Over time, corals and other marine life will colonize the new groynes and because the spatial extent of the new groynes exceeds the area of the existing groynes, there will be a net increase in habitat for corals.

Secondary and/or Indirect impacts will result from future storms that are likely to redistribute sand that is placed on the beach. If this sand is deposited on areas where benthic resources (e.g., seagrasses, submerged aquatic vegetation, corals) currently exist, there could be impacts in excess of those quantified above. It is not possible to speculate what the extent of these impacts, if any, would be.

The groynes are designed to withstand the impact of a major storm event, so potential adverse impacts to the marine and terrestrial environments as the result of storm impacts to structures is expected to be minimal.

5.2.2 Potential Impact to Coastal Environment and Processes

The placement of sand on Emerald and Pelican Beaches will widen these beaches. The introduction of sand to the area will also benefit the surrounding areas through diffusion and long-term transport. The structural component of the project has been designed to stabilize the beaches in the project area, which are currently erosional. The reconstruction of existing and construction of new groynes will help reduce losses in the area. These structures have been designed to reduce the potential for impacts to the surrounding area. The overall impact to the coastal environment and processes of the project will be the creation of a wider, more stable beach that will have minimal impacts outside of the project area.

5.2.3 Potential Impact to Geological Environment

Aside from widening the beach, there are no anticipated geological impacts. The project area surficial substrate is primarily sandy with occasional limestone outcrops. There are no known karstic features in the project vicinity.

5.2.4 Potential Impacts to the Aesthetic and Other Built Environment

The aesthetic impacts are anticipated to be entirely positive. Widening the beach will increase recreational space and improve the views of the beaches and coastline in general. The construction of the project will reduce the need for other stabilization methods, such as individual seawalls, which can be an eyesore.

5.2.5 Water Quality and Noise Pollution

The primary risk to water quality is associated with construction related turbidity which is further addressed through proposed monitoring and corrective action on an as needed basis. Long term the construction of a beach will provide an increased buffer between upland development and the nearshore environment reducing the potential for water quality impacts. Noise will be primarily associated with project construction, primarily with regarding to beach equipment. Noise will be minimized through appropriate best management practices including groyne construction only during daylight hours and the minimal use of equipment to support hydraulic placement at night.

5.2.6 Ecosystem and Economic Analyses

The proposed development will have some socio-economic impacts on the economy and residents of the Turks and Caicos Islands. The economic impacts are primarily associated with the potential for increased property values of adjacent upland properties. It is projected that the increased storm protection and recreational benefits that the project provides will drive future investment in the region.

The coastal marine environment, in particular, the coral reef ecosystems in the Turks and Caicos Islands, are vulnerable environmental resources that provide significant economic goods and services to the economy. The health of these ecosystems is critical to human well-being; they contribute to the livelihoods, food security and health of local people. Best practice methodologies will be employed by the contractor for dredging, sand placement and construction of this project to minimize the potential for impacts to these critical resources.

5.2.7 Socio-Economic Impact

The project area consists of high-end single-family residences which are utilized by the property owners and to various extent are available as rental properties. The project will increase the level of storm protection to these properties and increase the extent and aesthetics of beach within the area. This will improve lateral access down the beach which in some areas is not currently present due to the extent of exposed seawalls. Overall, the project is anticipated to increase the value of upland properties and the associated benefits (and impacts) associated with this trend. Project implementation will likely increase incentives for the development of the few remaining available properties within the project area.

5.2.7.1 Public Beach Access

The project area includes two designated public beach access points. The project will increase the extent of beach available at these public access points and will significantly improve lateral beach access from both public beach access points. At present lateral beach access is severely restricted by the highly eroded nature of the beach and the extent of exposed seawalls. The project will result in an advance in beach area that will remain publicly accessible.

5.2.7.2 Potential Impact to Neighbouring Developments, Businesses and Residential Houses

The project will result in a significant increase in recreational beach area that will remain accessible through upland properties and the two public beach accesses. This will have an overall positive affect on adjacent and neighbouring developments and businesses. The project is anticipated to increase overall demand and property values within the area. The potential risk of unanticipated impact from individual structures will be monitored long term and corrective action will be implemented if warranted. In general, it is anticipated that the implementation of structures in concert with beach nourishment will result in an overall positive improvement to the beach resource in the area.

5.3 Derivation of Significance

It is important to acknowledge that the project area has already been impacted by a range of prior actions and a history of erosion. As the area has been largely developed, corrective action is appropriate to both restore the beach and provide sufficient protection to existing and future upland development.

The primary differentiator for the plan as currently proposed in comparison to previous efforts is the holistic nature of the approach which addresses the regional influence of the erosion issue and proposes a solution that addresses the issue throughout the project area. In addition, the proposed approach includes both a long-term adaptive management and monitoring strategy to provide a basis for inlet and shoreline coastal management.

Impacts from the project are primarily associated with construction and can be minimized through appropriate monitoring and best management practices.

6.0 Mitigation and Monitoring

6.1 Proposed Actions and Schedule to Mitigate Against Any Environmental Impact

The proposed construction activities will impact comparatively small areas of low-quality terrestrial and marine habitats. Activities that could be considered to further reduce impacts include the following.

Landside Activities

1) Salvaging individuals of floral species that are designated as endemic, endangered or threatened and relocating specimens of these species that cannot be conserved in-situ.
2) Ensuring that additional ecological mapping of the location of notable plants be performed to assist in in-situ preservation and/or relocation of individuals of notable plant species once the boundaries of the project are field-staked and prior to construction.
3) If the clearing of vegetation is to be performed during the bird nesting season, ensuring that no active nests (i.e., nests with eggs or young incapable of sustained flight) will be damaged or destroyed and that the presence of construction workers will not cause abandonment of bird nests that may be present outside the footprint of the proposed construction.
4) Consider developing educational materials notifying future residents of the presence of species of notable plants that the collection and transport of endemic, endangered and/or threatened species is prohibited.
5) For the safety of users, consider removing individual plants of poisonwood (*Metopium toxiferum*) that are in areas that are accessible to residents and staff.
6) Ensuring coordination with the landscape team to verify that no ornamental species that are on the list of invasive plants are introduced onto the property.
7) If plant materials are introduced from off-island, ensuring protocols are in place to prevent the introduction of non-native (and potentially problematic) flora and/or fauna.
8) Removing all individuals of plant species that designated as invasive, conduct routine, ongoing inspections for the presence of invasive species, and implement a protocol for the removal of such species that may become established.

Marine Activities

1) Relocating colonies of stony corals in excess of 5 centimetres (about 2 inches) (perhaps including the substrate to which they are attached), onto the proposed groynes or other suitable receiver areas.
2) Consider developing educational materials notifying residents of the presence of seagrasses and macroalgae on the nearshore bottoms and advising that stepping on these resources should be avoided because it will result in damage to these valuable resources.
3) Although no sand dollars, sea biscuits and other minimally motile and/or sedentary marine organisms were observed during the marine investigation, species such as these are known to inhabit the sandy nearshore bottoms that will potentially be accessed by residents for recreational purposes. Collection of live specimens as souvenirs should be prohibited.

Other Mitigation Opportunities

1) Notifying DECR if nesting marine turtles, nesting birds (e.g., nighthawks on coastal rock), or piping plovers are observed within coastal portions of the property.
2) Identifying and implement appropriate countermeasures (e.g., prohibition on unleashed dogs) to eliminate or minimize adverse impacts on these resources if they are documented to occur within the project area.
3) Conducting periodic beach clean-ups to remove flotsam, jetsam and/or other solid waste or debris that may accumulate on the shore.
4) Resisting beach management initiatives that would mechanically remove naturally occurring tidal wrack (e.g., seaweed) from the beach, because it harbours prey for foraging shorebirds and is beneficial to the localized ecology.

If the recommendations identified in this section are implemented, the construction and long-term presence of the proposed activities are expected to have minimal or non-existent adverse environmental impacts.

6.2 Storm Surge Analysis and Mitigation Plan for Sea Level Rises

In general, storm surge values are limited for the region and are generally on the order of 1 meter or less for typical hurricane conditions. The presence of deep water adjacent to the archipelago and the ability of surge to flow around the islands limit the potential for extreme

storm surges in this area. Tide gauge data collected during the passing of Hurricane Frances (a direct major hurricane impact) on September 1 and 2, 2004, recorded a rise in sea level of only 1.5 feet. from storm surge. Similar surge magnitudes have been reported in the area for historic storm impacts. Project area specific storm surge modelling has been conducted and is provided in Appendix P. This modelling indicates significant reductions in upland property vulnerably associated with the proposed beach nourishment. In addition, the analysis suggests that there is sufficient elevation and setback within the project area to adapt to anticipated increases in sea level and storm surge over a 50-year planning horizon.

The project will not result in an appreciable change in storm surge magnitude. The project will, however, provide greater protection from storm surge and wave run-up to coastal assets within the project area than are currently in place and future development in the project area will be consistent with existing planning requirements for setback and building standards.

The proposed monitoring associated with this project provides a significant basis to further long-term management of storm surge potential within the project area and the project itself is an adaptive measure that long term can mitigate impacts from both storm surge and sea level rise.

6.3 Building Around, or Rescue and Removal of Rare, Threatened, and EndangeredSpecies of Plants

The project plans call for placement seaward of the current vegetation line to prevent the destruction of threatened, rare, and endangered plant species, however, construction access points may impact specific areas of vegetation. It is recommended that once these access points are identified, a professional with knowledge of Turks and Caicos Islands plant species conduct a survey to identify the location of any threatened, rare, and endangered plant species for transplantation to another site. Monitoring of the transplanted species should be conducted to ensure survival.

6.4 Landscaping/Replanting Plan Utilizing Native Species

The project does not have a landscaping plan in place. It is recommended that any homeowners who wish to plant the upper portion of the dune region of the beach should do such using native species of plants to eliminate the potential of spreading of invasive species.

The contractor is responsible for returning any staging or access areas to the original natural state, inclusive of regrading and revegetating with natural species.

6.5 Financial Resources for Mitigation

This project was developed through an association of over 25 individual upland properties within the project area who have established a formal association to administer and oversee the project including securing funding from properties within the project area. Current funding includes reserve funds to support post construction monitoring and mitigation if required.

6.6 Environmental Monitoring and Financial Requirements

Environmental monitoring prior to, during, and post-construction will be the responsibility of the ownership association. Sufficient funds have been secured to support this effort.

6.7 Public Consultation/Social Listening/Monitoring

Engagement with the Department of Planning and DECR are ongoing and will continue through ongoing review and engagement regarding this study. Consultation with adjacent property owners has occurred throughout the design development process and it is noted that the project is supported and funded by an association of over 25 properties within the project area. Issues raised during this process have included the overall cost of the project, the means of securing funding for the effort and the need for costs to be shared by all properties deriving project benefit. Additional concerns have been raised regarding the potential for downdrift impacts from individual coastal structures and the need for an adaptive management plan.

6.8 Environmental Management Plan

Construction and permanent existence of the Emerald and Pelican Beaches projects have the potential to result in decreased biodiversity and adverse ecological impacts unless appropriate precautions are implemented, and erosion and sedimentation are controlled. Method that will be implemented to minimize the impacts from the project include the following.

6.8.1 Protection of Terrestrial Biodiversity

Currently, comparatively few non-native pest plants are present on the site. However, further site disturbance associated with construction and the introduction of ornamental vegetation have the potential to introduce non-native pest plants and animals to the site. Invasive, non-native plant species that have the potential to adversely affect native plant communities should

be removed, preferably before they have gone to seed. Not less than annually, non-native plants of species that are designated as invasive by the Turks and Caicos Islands Government should be targeted for eradication or control. Beach cabbage (*Scaevola taccada*) is particularly problematic, because it is currently abundant, and often occurs on private property, where some property owners may object to its removal.

Two plant species that are included in DECR's schedule of notable plants have been observed within the assessment area, where they have the potential to be affected by the beach project.

Wild Thyme (*Euphorbia inaguensis* (aka *Euphorbia abbreviata*) is designated as endemic to the Lucayan Archipelago. Leatherleaf casha (also known as Connecord) *Vachellia bahamensis* or *Acacia coriophylla*) is designated by DECR as a Native Plant of Special Conservation Concern. Neither of these plants is common within the project area and, to ensure there is no loss of biodiversity, it is recommended that the location of individuals of these species be mapped and avoided, if the placement of sand, groynes, or accessways to these structures would otherwise adversely affect them.

It is recommended that native, drought-tolerant and salt-tolerant dune vegetation, trees, shrubs and/or groundcovers be used if landscaping is to be completed following the construction of the beach project.

Dune walk-over structures are recommended to be constructed at locations where high levels of foot traffic could prevent the establishment and existence of native plant communities.

6.8.2 Protection of Marine Biodiversity

The development and implementation of a turbidity monitoring and protection plan is necessary for the protection of the nearshore communities. The plan will be submitted to DECR for comment and revision if necessary.

The use of sand dykes, nominally 200 feet in length from the discharge site are required to allow the sediment to fall out of the sand/water mixture before re-entering the nearshore. The installation of temporary, surface-to-bottom turbidity screens at the waterward boundary of the construction area and/or around important resources could be used. These screens will be adjusted, moved and maintained throughout the construction period.

If turbidity increases to more than 15 nephelometric turbidity units (NTUs) above ambient in areas outside the construction zone, operations will be temporarily suspended until excessive turbidity subsides, before resuming construction.

6.8.3 Summary of the Potential Impacts of the Proposal

The EMP is outlined in Table 6-1.

Table 6-1. Proposed Management

Resource	Potential Impacts	Overall Significance	Proposed Management	Schedule	Responsibility	Cost
Terrestrial Resources	Adverse impacts on populations of Endemic Species & Native Plants of Special Conservation Concern	Moderate	1. Perform thorough inspections for the presence, distribution & abundance of endemic species and Plants of Special Conservation Concern prior to initiating land clearing.	Pre-construction & Construction	Contractor	Low
			2. To the extent desirable or necessary to maintain biodiversity on the site, relocate transplantable Endemic Species and Native Plants of Special Conservation Concern, out of areas to be developed and into suitable habitat areas on site that are not to be disturbed.	Pre-construction & Construction	Contractor	Low
			3. Develop educational materials (e.g., kiosks, printed matter, etc.) about Endemic Species and Native Plants of Special Conservation Concern and make these materials readily available to residents and visitors in hard-copy and/or electronic versions	Post-construction	Owners	Moderate
	Clearing of vegetation	Moderate	1. Minimize clearing of native vegetation to only those areas necessary for grading and construction of proposed facilities.	Construction	Contractor	Low
			2. Where possible, maintain native landscapes and use native drought-tolerant and salt-tolerant plant materials for landscaping.	Pre-construction	Contractor	Low
			3. Preserve and transplant, to the extent practical.	Construction	Contractor	Low
	Risk of introducing non-native species, foreign diseases, and escape of pests	Moderate	1. Develop strict inspection systems at Customs and entry points, to eliminate or minimize the risk of un-intentional introduction of undesirable flora, fauna and pathogens.	Construction	Contractor	Low
			2. Ensure that construction equipment is clean and pest free before entering and leaving the property.	Construction	Contractor	Low
			3. Employ Early Detection-Rapid Response protocols to eradicate or control undesirable species.	Construction & Operation	Owners	Low
	Impacts to wildlife habitat	Low	1. Landscape setback areas for conservation, as these areas will serve to preserve native plant species and habitats.	Pre-construction & Construction	Owners	Low
			2. Wherever possible, maintain native landscapes and use native plant materials for landscaping.	Pre-construction & Construction	Owners	Low
			3. Minimize clearing of native vegetation to only those areas necessary for construction of proposed facilities.	Construction	Contractor	Low
			4. Design and construct beach access pathways to minimize the footprint in environmentally sensitive areas.	Construction	Owners	Low
			5. Implement an environmental monitoring program to include the monitoring and eradication or control of non-native species	Construction & Operation	Owners	Low
			6. Adopt and enforce covenants and protocols prohibiting the presence of unrestrained domestic pets.	Construction & Operation	Owners	Low
			7. Maintain floral and faunal lists and update them as new species are encountered.	Pre-construction, Construction & Operation	Owners	Low
			8. If possible, avoid land clearing during the bird nesting season in areas where birds are actively nesting.	Construction	Contractor	Low
			9. Consider the rescue of seagrape snails and their relocation to portions of the site that will not be disturbed.	Construction	Contractor	Low
Marine Resources	Prevent adverse impacts to water quality	High	1. Develop and implement a turbidity monitoring and protection plan. 2. Install temporary, surface-to-bottom turbidity screens at the waterward boundary of the construction area and ensure that they are maintained throughout the construction period. 3. If turbidity increases to more than 15 nephelometric turbidity units (NTUs) above ambient in areas outside the construction zone, temporarily suspend operations until excessive turbidity subsides before resuming construction. 4. Require minimum stand down time for turbidity exceedances and require a change in contractor methodology if more than one exceedance occurs during construction.	Pre-construction & during Construction	Contractor	Moderate
	Adverse impacts on populations of notable species	Moderate	1. Prior to construction, ensure that a detailed survey is completed to determine if any notable corals are present within the footprint of the proposed project. 2. Identify reef-building stony corals in excess of 5 centimetres in diameter present within the direct impact area, develop and implement a salvage/rescue program to protect or relocate these corals to suitable receiver sites.	Pre-construction	Owners	Low
	Impacts to non-motile and minimally motile littoral species	Low	1. Prior to construction of the two groynes and the addition of sand on top of the existing coastal rock community, implement a salvage/rescue project to collect littoral/inter-tidal organisms (e.g., *Nerita spp, Batillaria minima, Cenchritus muricatus*) and relocate them to areas of the property that will not be impacted.	Construction	Owners	Low

6.8.4 Monitoring and Construction Oversight

The following construction oversight and monitoring tasks are proposed in support of project construction.

6.8.4.1 Pre-Construction Oversight and Monitoring

It is anticipated that a design-build contract will be negotiated by Owners Representative with an appropriate dredge and marine construction contractor. Given the scope of the construction and the type of equipment required, this contractor will need to be an international firm with sufficient experience, resources and expertise. Appropriate oversight of the construction contractor will be required, as will monitoring of the project throughout the construction process. The following major oversight and monitoring tasks will be implemented.

6.8.4.1.1. *Baseline Surveys*

The following surveys will be conducted before project construction.

Pre-Construction Benthic Surveys: Baseline marine environmental surveys have been conducted in conjunction with this EIA study. Additional pre-construction surveys will be conducted to supplement existing site data and document pre-construction conditions. Survey effort will include identification and relocation of suitable resources within the project footprint to appropriate receiver sites outside the zone of influence of the project.

Pre-construction monitoring will set the protocols for use during construction monitoring tasks, immediate post-construction and for operational phases through 2 to 3 years of post-construction monitoring as relegated by DECR. Pre-construction monitoring is usually advised within 30 days of the start of construction, but additional tasks will also be included for items that need to be done as part of the set-up for construction activities.

Once the beach fill footprint has been identified, corals on the existing structures should be removed and transplanted to an appropriate receiver site as determined in consultation with DECR. Corals on the nearshore structure pilings should also be assessed for any damage or disease. Those corals with issues should be photo-documented and designated as per location.

All removable living organisms, such as anemones, urchins and corals need to be removed from the beach fill area. Areas for relocation should be established prior to this endeavour.

Pipeline Corridor Survey: A diver survey will be conducted of the proposed submerged pipeline route to the shoreline to ensure that the route avoids hardbottom and seagrass resources to the greatest extent practicable. This effort will include demarcation of the route to support pipeline deployment by the construction contractor and will include a post-deployment visual assessment of placement to document site condition after pipe deployment.

Water Quality Monitoring: A pre-construction water sampling event will be conducted at the four baseline sampling locations established and replicated as a baseline effort in support of this study.

Beach Profiles and Nearshore Bathymetry: A pre-construction survey of the adjacent beach and bathymetry in the vicinity of the project area will be conducted along the monitoring stations previously established for the Emerald and Pelican Beaches to document pre-construction conditions and provide a basis for the contractual determination of excavation volumes.

Baseline Sedimentation Rates: Background levels of sedimentation rates should be established during the pre-construction stage. Use of a series of sediment traps is one of the simplest means of measurement, where traps are set for an established period of time and then retrieved and measured by dry weight or volume for comparative purposes between sites and/or over time. Each sediment trap has a series of three cups, with two traps utilized per site giving six replicate samples per site for computing an average rate. Sediment traps should be set at a standard height above the seafloor (18 inches is recommended) and secured to a permanently mounted rebar stake. During the collection period, weather events should be recorded to indicate wind speed and direction and wave height, direction and period as these factors will affect sedimentation rates.

Sediment traps are recommended for all natural resources and one additional site per shore to reef crest at the approximate midway point of the line. Similarly, a site should be established to the east of Emerald Beach at least 250 metres north and midway between Emerald Beach and the Little Water Cay. Additionally, a trap should be set 250 metres south inside Leeward-Going-Through Channel.

6.8.4.2 Pre-Construction Conference

Emerald and Pelican Beaches Owner's Representative will facilitate a pre-construction conference to review salient elements of construction with all relevant parties. At a minimum, this conference will include representatives from Owners Representative, the construction contractor, the engineer of record, monitoring support staff, the Planning Department and DECR. The conference will be held in Grand Turk with the ability to participate by conference call.

6.8.4.3 Identification of Key Staff Roles and Responsibilities

The pre-construction conference will include identification of key points of contact for all relevant parties and a contact list will be prepared and distributed, delineating each key staff member and his or her role and responsibility. The role and responsibility of each key staff member will be discussed at the pre-construction conference and will include identification of staff with the contractual authority to suspend construction operations as a result of impacts. The pre-construction conference will provide a review of major project elements, appropriate means and methods of construction, and monitoring.

6.8.4.4 Review and Training of Oversight Monitoring Personnel

To the extent practicable, construction oversight will utilize local, on-island resources to provide daily observations of construction. Oversight procedures and responsibilities will be reviewed with individuals identified to support construction operations. This will include project-specific training of local staff to support construction oversight monitoring.

6.8.4.5 Oversight and Monitoring during Construction

The following subsections provide a summary of oversight and monitoring activities that will occur during construction operations.

6.8.4.6 Oversight of Construction Operations

Oversight of construction operations will be a shared responsibility of all relevant construction parties, including the construction contractor, Owner's Representative, the engineer of record and monitoring support staff. The roles and responsibilities between all parties will be clearly delineated and discussed at the pre-construction conference.

6.8.4.7 Daily Reporting

The construction contractor will prepare a daily report of project progress during active construction in a format agreeable to the project engineer. This daily report will be distributed to relevant parties and will include a summary of the previous day's progress, details of any issues or accidents, and assurance that turbidity curtains are in place and functional.

6.8.4.8 Turbidity Monitoring

The Turks and Caicos Islands policy since 2005 has been to avoid exceeding a maximum increase of 15 nephelometric turbidity units (NTU) above background concentration during dredging at all sampling locations.

Turbidity curtains should be installed at all sites of turbidity generating activity, including the groyne construction areas, dredge site, and the beach discharge site. The curtains may need to be removed during periods of rough weather to prevent damage to the curtain and surrounding habitat; however, storm conditions should also necessitate cessation of dredging activities.

Sampling locations should include the following areas:

1. Groyne construction area,
2. Dredge areas, and
3. Discharge site.

Background sample points should be taken at each site and east and west of each site, or whichever direction the turbidity plume is visible. The GPS coordinates of each turbidity sample location should be recorded, and samples should be taken from about the middle of the water column at each location.

Pre-construction in situ turbidity measurements shall be taken weekly within the month prior to the commencement of dredging. Turbidity samples (in NTUs) shall be collected and analysed at each sample location at the surface and mid-depth within the water column. The distance between the sample locations will be at least 500 feet. These measurements will help to characterize the conditions existing immediately prior to construction.

Turbidity monitoring will be conducted on a daily basis by a trained individual. The following paragraphs detail the protocol that will be utilized.

Equipment and Monitoring Protocol: Samples will be measured in NTUs per the device manufacturer's guidelines. The device shall be factory calibrated within at least the previous year. Field calibration shall be conducted at least every week or, if warranted, based on a reading comparison to a standard. A quality assurance check to a 10 NTU standard shall be conducted prior to each sampling event to ensure the device is calibrated and reading properly. Samples shall be collected at the surface and mid-depth utilizing a Niskin bottle or comparable sampling device. Samples shall be tested within 10 minutes of sample collection.

Frequency: Two sampling events will be conducted per day, nominally one in the morning and one in the afternoon, at least four hours apart. Samples will be taken during active construction when the dredge has been operational for a minimum of two hours. Samples will not be taken if the dredge is not operating for a period greater than 4 hours, and this condition will be noted in the daily sampling report. If a distinct turbidity plume is observed, a sampling event will occur regardless of dredge operation.

Background: A representative background sample will be collected a minimum of 1,200 feet up-current of the project in an area free of project influence.

Compliance Sampling (Dredge): The dredge compliance sample will be collected at 300-, 500-, and 1,000-foot distances down-current of the operational dredge, within the densest portion of any visible turbidity plume. Compliance stations should be altered if the plume is heading for the reef wall resources (sample should be taken at the location of the resource regardless of distance). Levels should be below the 15 NTU above background standard in this event.

Compliance Sampling (Discharge): The discharge sample will be collected at 300-, 500- and 1,000-foot distances of the discharge, within the densest portion of any visible turbidity plume. If a distinct plume extends beyond 1,000 feet down-current from the discharge site, monitoring should be extended at 1000-foot increments to the end of the plume.

Compliance Sampling (Groyne Construction): The discharge sample will be collected at 300-, 500- and 1,000-foot distances of the turbidity curtain perimeter, within the densest portion of any visible turbidity plume. Compliance stations should be altered if the plume is heading for the reef

wall resources, in which case, sample should be taken at the location of the resource regardless of distance. Levels should be below the 15 NTU above background standard in this event.

Compliance Standard: Compliance will be demonstrated through a compliance turbidity reading of no more than 15 NTUs above background.

If an exceedance is observed at any compliance station, the monitor will immediately notify the engineer, who will notify Owners Representative, the construction contractor and DECR. If an exceedance is observed, the contractor will immediately cease dredge operations for a period of twenty-four hours. The contractor will then make whatever practical modifications to the construction means and methods necessary to achieve turbidity compliance.

A daily report for each sampling event will be prepared and will include the following:

1. Date, time, and location of sampling
2. A schematic map with the sample site(s) shown
3. Water depth at sample site
4. Sample depth
5. Weather, wind, and current conditions
6. Approximate tide (e.g., incoming or outgoing)
7. Direction of the current.

Each report shall include a summary of turbidity values and a map delineating sample locations and relative extent of the turbidity plume. Reports will be submitted to DECR for review on a weekly basis.

Once construction is completed, the removal of the turbidity curtains should only occur when turbidity levels inside and outside the curtain are reasonably equal and consistent with background samples.

In addition to turbidity sampling at discharge sites, turbidity samples should be taken at each of the biological monitoring and control sites during bi-weekly monitoring events. Samples at these locations should be taken at the surface, mid-depth and near the seafloor.

Change of Means and Methods

The Contractor can construct the project through varying means and methods. If the Contractor is shut down twice for two separate exceedances of the 15 NTU limit, the Contractor must consider changing the means and methods of construction for the project to better limit the turbidity generated.

6.8.4.9 Weekly Reporting

A weekly onsite progress meeting will be conducted between the Contractor, Owners Representative, the engineer, the Planning Department, and DECR, with the ability to attend the meeting by conference call. This meeting will review construction progress to date and identify any issues or required corrective actions. A meeting summary will be prepared including action items and will be distributed to relevant parties.

6.8.4.10 During Construction Benthic Surveys

On a bi-weekly basis following the initiation of construction, a reconnaissance survey of benthic resources will be conducted within the project vicinity. This survey will generally adopt the protocols utilized for the baseline and post-construction surveys and will focus on the general health and levels of stress and sedimentation observed on these resources. A summary report will be prepared and distributed to the project team. The engineer will be notified of any excessive sedimentation or visible stress of coral resources and, if deemed significant, will direct the contractor to alter construction means and methods to further reduce project turbidity and sedimentation.

6.8.4.11 During Construction Sedimentation Monitoring

During construction, monitoring of sediment rates should occur utilizing the sediment traps deployed pre-construction. This should occur every two weeks in conjunction with the benthic surveys.

6.8.4.12 Post-Construction Oversight and Monitoring

The following post-construction tasks will be conducted to document post-project conditions and certify that construction was completed in compliance with project plans and specifications.

6.8.4.12.1. *Post-Construction Bathymetric Survey*

A post-construction bathymetric survey of the excavation area will be conducted and compared to the pre-construction survey. A comparison plot of the two surveys will be prepared to quantify the volume of material removed and to verify that all excavation occurred within the depths and spatial limits of the dredge template.

6.8.4.12.2. *Post-Construction Upland Survey*

A post-construction survey of the upland disposal area will be conducted and compared to the pre-construction elevations. A comparison plot of the two data sets will be prepared to quantify the volume of material placed and to verify that all placement occurred within the spatial limits of the delineated disposal area.

6.8.4.12.3. *Post-Construction Benthic Survey*

A post-construction benthic survey will be conducted to document post-construction condition. The survey will include the project vicinity, including the pipeline corridor (following pipe removal) and will include an assessment of any transplanted resources.

6.8.4.12.4. *Post-Construction Sedimentation Monitoring*

Post-construction monitoring of sediment rates should occur utilizing the sediment traps deployed pre-construction. This should occur in conjunction with the post-construction benthic surveys.

6.8.4.13 Project Certification

Following a review of all project data, the engineer of record will prepare a project certification attesting to the completion of the project in conformance with the project plans and specifications. Any deviations from the project plans will be identified, including justification, and any incidences of unanticipated project impacts will be identified and discussed. The certification will include a summary of project construction, including final volumes, dates of construction, and turbidity monitoring values.

6.8.4.14 Long-Term Monitoring

Two additional monitoring events will be conducted at years two and three post-construction utilizing the same protocols as the previous surveys (benthic, bathymetric, and upland surveys). These surveys will include any coral relocation sites. The surveys will document recovery and

recruitment within the areas of project impact and will identify any secondary or operational issues observed relative to this project.

6.8.5 Contingency Plan

The shoreline west of the project area will be surveyed prior to construction to establish a baseline of the conditions down-drift of the project. Post-construction monitoring events will include surveys of the shoreline west of the project area to compare with previous survey events to determine of any material from the project spreads outside of the planned limits. After each survey event, results of the survey data analysis will be evaluated and reported to DECR.

6.8.5.1 Monitoring Based Contingency

At any time, if monitoring surveys suggest impacts beyond those anticipated within this EIA, DECR will be notified of the nature of the impacts and consulted regarding corrective or mitigative actions. This may include the implementation of additional monitoring or specific mitigative action as determined through consultation with DECR.

6.9 Adaptive Management

While construction related impacts represent the most likely and significant potential impacts to the environment, the long-term performance of the project represents the most significant concern to long term impacts particularly with regard to coastal management. The project relies on both the placement of sand to increase the availability of sand withing the coastal system and a series of coastal structures to stabilize and distribute sand throughout the project area. The primary risk associated with this strategy is the relative performance of each coastal structure. If a given structure retains more sand than intended, this could result in potential impacts downdrift of the structure. Likewise, an underperforming structure will reduce the stability of the beach updrift of the structure. As the overall performance of the project is dependent on both the design and incident coastal forcing, a long term strategy of adaptive management is proposed to quantify long term project performance and provide a mechanism for project modification based on long term monitoring on an as needed basis. This approach is consistent with accepted coastal engineering practice and is summarized in the following:

- Annual physical monitoring surveys will be conducted at the established beach benchmark locations for a minimum of 5 years following project completion. Beach profiles will be conducted at each benchmark location from the upper beach seaward beyond the depth of closure.

- Visual observations will be conducted at the time of the beach profile surveys including shoreline parallel photography at each benchmark location.
- Annual surveys will be compared to previous beach surveys to quantify beach profile volume and sediment transport rate.
- Additional surveys will be conducted following major storm events if the impacts to the beach are significant enough to warrant further surveys.
- Results of the annual survey effort will be summarized within an annual monitoring report which will be provided to the ownership group and DECR and will provide the basis for consideration of any modification to the project (particularly with relative to structures).
- Shoreline erosion and recession will be quantified based on the annual surveys and will provide the basis for consideration of corrective action. Corrective action will be considered if recession is sufficient to advance to the existing platted boundary for upland properties.
- The primary mechanism for corrective action is the modification of structure dimensions; either reduction in structure dimension or increase in structure dimension depending on whether the issue is updrift or downdrift of the structure.
- Long-term the annual monitoring data will provide a basis for the evaluation of sand loss into the inlet as well as to the west towards Grace Bay. This data will provide a basis for the quantification of a long-term regional sediment budged and the need, timing and magnitude of project renourishment.

The owner's association will ultimately determine what future actions may be implemented in consultation with DECR. The owner's association will remain in place following construction to administer the project including a mechanism for the retention of funds for future project efforts.

7.0 Conclusions and Recommendations

It is important to acknowledge that the project area has already been impacted by a range of prior actions and a history of erosion. As the area has been largely developed, corrective action is appropriate to both restore the beach and provide sufficient protection to existing and future upland development. The adoption of a regional strategy of beach nourishment in concert with a coherent strategy of coastal structures to maintain a minimum beach throughout the project area is the most appropriate coastal management strategy. Beneficial use of sand from inlet navigation dredging represents a mitigative action for the impacts of the inlet on the adjacent beach and provides a long term environmentally appropriate coastal management strategy for both inlet and beach management.

The primary differentiator for the plan as currently proposed in comparison to previous efforts is the holistic nature of the approach which addresses the regional influence of the erosion issue and proposes a solution that addresses the issue throughout the project area. In addition, the proposed approach includes both a long-term adaptive management and monitoring strategy to provide a basis for inlet and shoreline coastal management and a local association of upland property owners to implement and fund this initiative.

Impacts from the project are primarily associated with construction and can be minimized through appropriate monitoring and best management practices. Implementation of best management practices, monitoring and corrective action as required (as delineated in Section 6) is highly recommended to minimize the potential for project impacts.

Further it is noted that the erosion issues mitigated by the project will require ongoing monitoring and adaptive management that is best addressed through a long term program as recommended within this study.

8.0 References

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9.0 Appendices

Appendix A - Terms of Reference (ToR)

Appendix B - Qualifications of the EIA Team of Experts - Resumes

Appendix C - Government Permits

Appendix D - Project Plans and Drawings

Appendix E - Reports of Independent Consultants Involved in the EIA

- Appendix E1 - ATM Shoreline Evolution Modelling Report
- Appendix E2 - Smith Warner International - Leeward Coastal Study

Appendix F - Scientific Analyses Reports (Water Sampling Analysis)

Appendix G - The Schedules - Turks and Caicos Protected and Endemic Species

Appendix H - International Union for the Conservation of Nature (IUCN) Red List

Appendix I - Index of CITES Species

Appendix J - Landside Plant List

Appendix K - Landside Animal List

Appendix L - Marine Flora and Fauna within the Assessment Area

Appendix M - Representative Photos

Appendix N - EIA Certification

Appendix O - DECR Correspondence and Responses

Appendix P - Vulnerability Analysis including Storm Surge and SLR