Environmental Baseline: *North Windermere Boat Basin*

Windermere Island, Eleuthera, The Bahamas

November 2019 Rev. 2

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Submitted on Behalf of North Windermere Island
To The Bahamas Environment, Science, & Technology Commission

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1 Executive Summary

This Environmental Baseline pertains to the boat basin at North Windermere Island, Eleuthera, The Bahamas. An Environmental Baseline documents existing site conditions and outlines environmental management techniques to manage construction practices. An Environmental Baseline shall not be considered an Environmental Impact Assessment.

The boat basin at North Windermere Island is located on Windermere Island which rests directly east of the island of Eleuthera. Windermere Island is connected to mainland Eleuthera via a private access bridge. The development of North Windermere Island is private with several homes already having been constructed and utilities infrastructure including power and water, installed. The boat basin is to be located on the interior of an outcrop of land abutting Savannah Sound. This Environmental Baseline documents conditions within the area of the proposed boat basin only.

The 1.36 acre boat basin will be comprised of a timber pile boardwalk capable of berthing 26 vessels across thirteen (13) docks while accommodating a maximum vessel size of 37 and three (3) foot draft. Excavated depth of the boat basin and entrance channel is five (5) feet below mean low sea level. Total volume of excavated materials is estimated at 14,500 cubic yards. This material will be used for land building purposes. A bridge will span the boat basin to allow access to homes on the western portion of the peninsula.

Vessels will access the boat basin from a southern approach. The boat basin is located immediately upon entrance with additional docks beyond the bridge to the north for use by adjacent private homes. Box culverts are proposed to the north through the mangrove formation at two (2) feet below MSL to diminish velocity and reduce disturbance to existing circulation patterns. Moreover, boat basin and channel walls will be constructed using natural ridge sloped with vegetated and boulders. Total build-out of the boat basin is expected to take four and half months (4 ½) months.

Site land-use will change from undeveloped to developed complete with home sites and boat basin for recreational purposes. At present, the privately owned parcel is largely vegetated with utilities installed for existing home sites. Historic aerial surveys indicate past human disturbance on the subject property for agricultural purposes and dredging for infill.

Botanical and Avian Assessment

In terms of vegetation community classification, the site contains ten (10) vegetation types including for which seven (7) are wetlands: Beach Strand, Black Mangrove (*Avicennia germinans)*, Red Mangrove Formation (*Rhizophora mangle)*, Buttonwood Formation *(Conocarpus erectus)*, Sawgrass *(Cladium jamaicense)*, Saltwort *(Salicornia bigelovii)*, Bay Marigold *(Borrchia aerborescens)*, Cattail *(Typha domingensis)*, Dry broadleaf evergreen formation (DBEF), and Human Altered. A total of 84 vascular plant species were observed on during the site field investigation occurring from 2nd to 3rd of November 2018. *Guapira discolor* (Narrow leaf blolly) was the only species observed on site listed on the Protected Tree Order contained within the Conservation and Protection of the Physical Landscape Act. Four (4) invasive species were identified with one (1) white inkberry *(Scaevola taccada)* being recommended for eradication.

Of the seven (7) identified wetland types, the construction of the boat basin will result in the complete loss of two (2) wetland types: Buttonwood Formation and Glasswort formation for the cove and northern flushing channel. Red Mangrove and Black Mangrove communities will be impacted for installation of the northern culverts and channel between the boat basin and cove, respectively. Select individuals of red mangrove formation will be removed for installation of box culverts for northern flushing channels. The boat basin will also result in the unavoidable loss of DBEF. Previous disturbance is noted in the beach stand and black mangrove formation areas.

The Avian Survey identified eleven (11) avifauna during three (3) hours of observation. All species identified are permanent residents with the exception of the Cape May Warbler *(Setophaga tigrine)*, Lesser Yellowlegs *(Tringa flavipes)*, and Blue Wing Teal *(Anas discors)* which are winter non-breeding residents. Also of note is the observance of the White-cheeked Pintail (*Anas bahamnesis)* which is prohibited for hunting.

Overall, species numbers for the site are considered moderate with a majority of the activity occurring within the fresh/brackish wetlands. To note, bird nests were observed in the wetlands and DBEF vegetation.

Marine Assessment

The Marine Benthic Assessment identified benthic habitats and marine flora and fauna within the vicinity of the proposed boat basin. A majority of the substrate can be classified as sand and silt bottom dominated by manatee grass *(Syringodium filiforme)* and various algal types. Thirteen (13) species of marine flora, one (1) coral specie, starlet coral *(Siderastrea radians)*; and three (3) sponge species were observed. In addition, eight (8) other marine species including sea cucumber *(Holothuria Mexicana)* and a juvenile queen conch *(Lobatus gigas)* were observed. Ten (10) species of fish including the commercially important Mutton Snapper *(Lutjanus analis)* were identified. Site investigations also noted Green turtle *(Chelonia mydas)* and Caribbean spiny lobster which are endangered and protected species. Overall, a majority of marine activity occurred within the protection of the mangrove roots close to shore rather than the open flats.

Given the sensitive ecological feature, the mangrove formations comprising a majority of the coastline, the boat basin will not have a fueling station. Furthermore, boat basin design seeks to minimize disturbance to the north coastline water circulation with two box culverts.

Flushing Analysis

Cummins Cederberg was engaged by Windermere Operations, LLC (Client) to prepare an engineering analysis relative to the flushing of the proposed boat basin for the Windermere Island Club Marina in Eleuthera, The Bahamas. A site visit was conducted to observe and measure the coastal processes for the development and calibration of a hydrodynamic model. The following conclusions were obtained based on the analyses results:

- Based on the available published standards for flushing and simulation results, the proposed boat basin configuration results achieves 85% flushing in a 24 hour period.
- Proposed improvements to the north flushing channel include replacing the three (3) creeks with two (2) large culverts, 28.3m (93ft) in length and 4.7m (15.33ft) by 3.15m (10.33ft) in diameter, and corresponding channel of 18.3m (60ft) and 15.3m (50ft).
- Changing the three (3) flushing creeks to two (2) large culverts and a channel resulted in an 82% higher wetted perimeter and a more optimized flushing time for the proposed boat basin.

Mangrove & Wetland Mitigation

Detailed mitigation measures are found within this report under the section titled Mitigation. The proposed 1.36 acre boat basin will result in the loss of wetland habitat including individuals of red and black mangrove. Minimal disturbance to the hydrological regime is recommended. To mitigate this loss it is recommended that:

- Removal of mangrove individuals only where necessary for culvert installation.

- Use of Best Management Practices during construction to limit sediment impacts and hydrological changes.
- Planting of mangrove seedlings immediately following culvert installation.
- Long-term goal for self-recruitment to achieve optimal replanting and resilience.

Recommendations

Recommended Best Management Practices for the boat basin at Windermere Island:

- **Sediment and Erosion Controls**. Land clearing activities require use of best management practices (BMPs) to limit impacts to the environment. BMPS reduce the potential for sediment transport during storm events and entry into subsurface caverns and marine environment. Potential best management practices to consider include a drainage plan, silt fencing and dewatering away from wetland features.
- **Materials Storage and Fuel Storage**. Materials storage should be kept away from sensitive environmental features. Fuel storage and refueling should adhere to best practices, including raised storage with either 110% containment mechanism or doubled walled tanks in the event of spill. While no commercial fueling is anticipated to take place during boat basin operation, construction equipment refueling will require adherence to an Environmental Management Plan (EMP) to minimize spill potential and threats to the ground and surface waters.
- **Sensitive Environmental Features – Mangrove Mitigation**. Two types of mangroves, black and red, fringe the coastline of the peninsula at North Windermere Island. Boat basin design entails two (2) culverts for flushing to mitigate impacts to the mangrove community. Flushing design and employment of best management practices will mitigate adverse impacts. The EMP will document specific constructions for work performed in close proximity to mangroves.
- **Planting with Native Tree species.** Removal of invasive species considered a threat to small island nations will slow the proliferation of unwanted plant species. It is recommended that the developer perform routine removal of saplings to prevent recolonization. A landscaping program that uses a palate of native trees will encourage visits by native fauna.

2 Purpose and Scope

An Environmental Baseline documents existing site conditions and outlines environmental management techniques to manage construction practices. The document serves as a botanical and marine record prior to site clearing and construction. Its purpose is to record existing conditions, highlight potential issues of environmental concern, and to recommend practices for environmental management during construction. The project area and its area of influence shall be known as the 'site'. For this Environmental Baseline, the 'site' is defined as the western peninsula containing the boat basin and the immediate marine benthic environment adjacent to the uplands. It excludes existing homes and home sites outside this area.

An Environmental Baseline shall not be considered an Environmental Impact Assessment.

3 Geographical Setting

The Bahamas is an archipelagic nation comprising 700 islands and cays situated over 100,000 square miles of the Atlantic Ocean. Located east of Florida and north of Cuba, The Bahamas has a population of 351,461 persons of which 70% reside on New Providence. Collectively New Providence, Grand Bahama, and Abaco represent 90% of the population.

Eleuthera is located east of the capital island of New Providence. The narrow island is 110 miles long from the settlement of Current in the North to the Bannerman Town in the south. The boat basin at North Windermere Island is located on Windermere Island which rests directly east of the island of Eleuthera. Windermere Island is connected to mainland Eleuthera via a private access bridge.

According to the 2010 Census, 8,202 persons reside on Eleuthera. The population for area of Savannah Sound Settlement, closest to Windermere Island is 204 persons. Compared to New Providence, the most densely populated with a population density 3,079 persons per square mile, Eleuthera average 43.9 persons per square mile.

Figure 4.1-1 The Bahamas

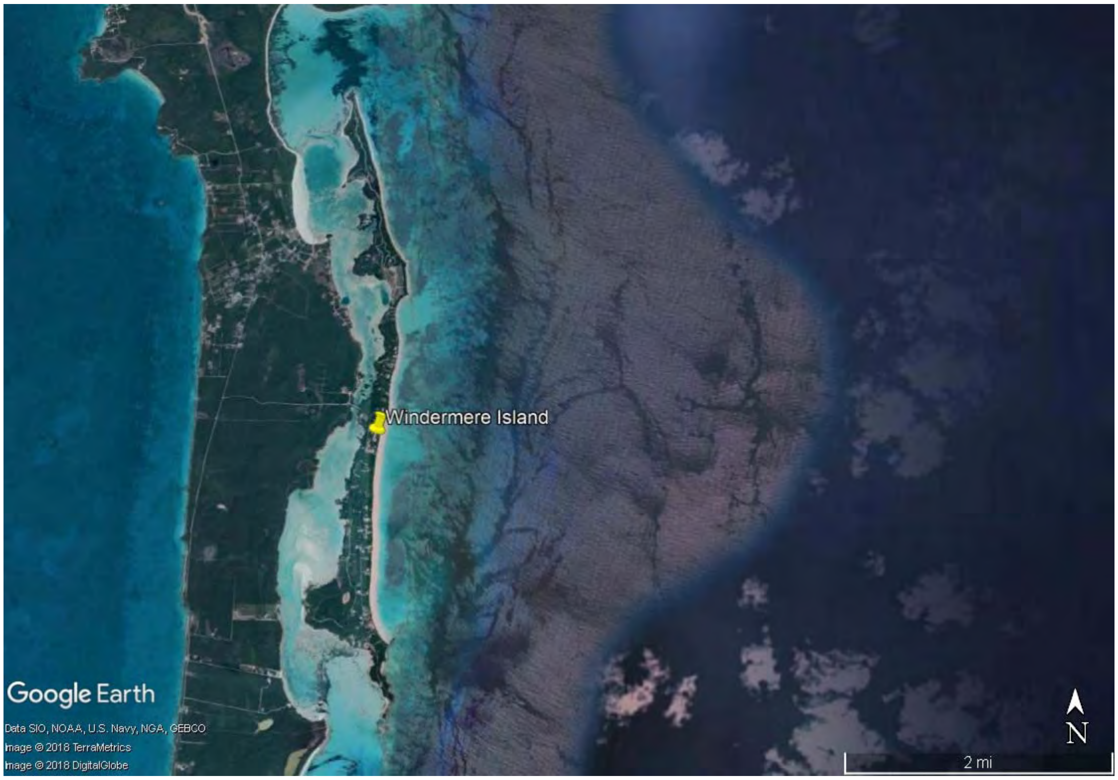

Figure 4.1-2 Windermere Island

Figure 4.1-3 North Windermere Boat basin

4 Existing Land Use, Ownership, & Site History

Final approval for the Windermere Island North Development - Windermere Island was given by the Ministry of the Environment and signed by the Permanent Secretary, Ronald Thompson on March 1, 2009. The letter indicates that the developer 'completed arrangements…for the supply of electricity, water, and telephone through the subdivision…" It further states that "Therefore under section 4(3) of the Private roads and Subdivisions Act, the Minister now grants approval for the sale, conveyance, or demise of lots in Windermere Island North Development." The signed layout plan is attached to the letter.

The Windermere Island Boat basin was initially scheduled to be constructed in 2010. A letter dated 11 March 2010 from The Ministry of the Environment to Turrell, Hall, & Associates approved the proposed boat basin subject to a number of conditions namely involving the preparation of an Environmental Management Plan. The letter and the entirety of its contents are presented in the appendix of this document. Due to the lapse in time, the BEST Commission requested an Environmental Baseline to establish present site conditions.

Current construction includes completion of a residence and establishing utilities throughout the site.

4.1 Historic Aerials

Review of historic aerial photography reveals previous human disturbance on and within the immediate vicinity of the site. In 1958, a roadway allows travel from the northern point to the site's south southern boundary. Then in 1974, a second access road appears at the site's southern boundary. This second road coincides with an area of probable dredging likely used to infill a low-lying area. This area of dredging appears in present day aerial imagery. The boat basin and its associated docks are located primarily in this area of human infilling observed in 1974.

Figure 4.1-1 North Windermere Island 1958

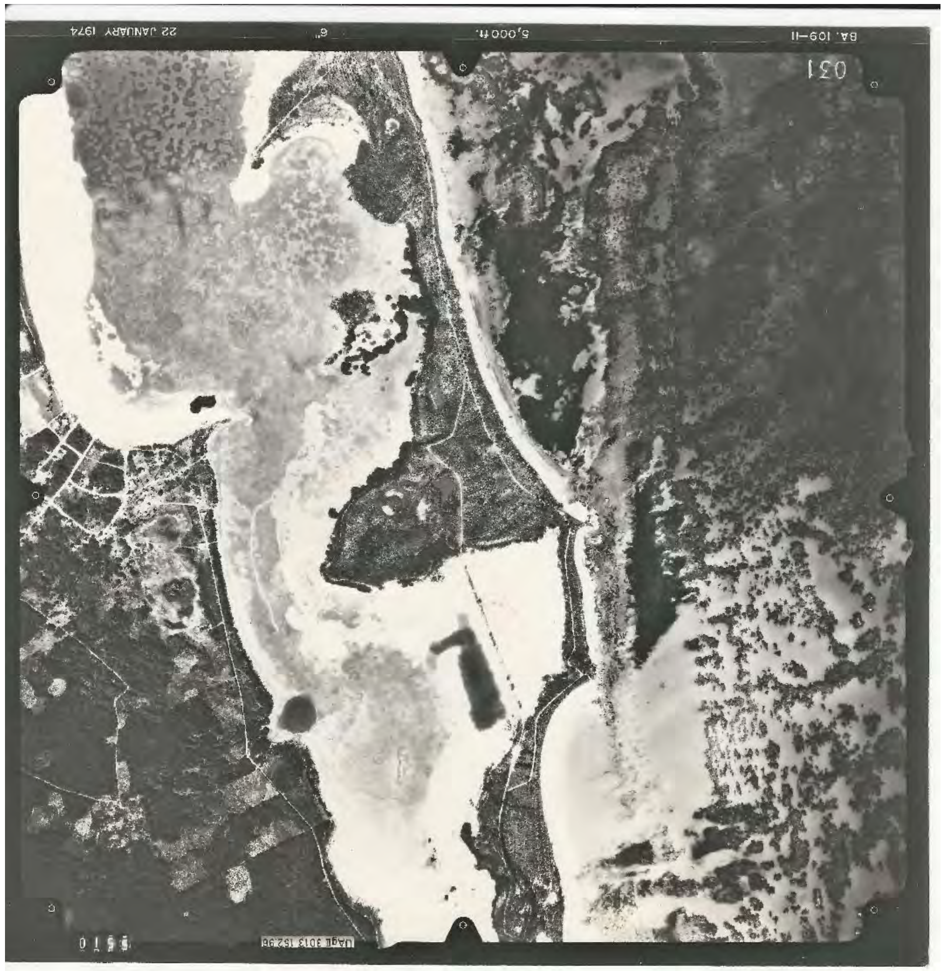

Figure 4.1-2 North Windermere Island 1974

5 Project Description

The 1.36 acre boat basin will be comprised of a timber pile boardwalk capable of berthing 26 vessels across thirteen (13) docks while accommodating a maximum vessel size of 37 and three (3) foot draft. Excavated depth of the boat basin and entrance channel is five (5) feet below mean low sea level. Total volume of excavated materials is estimated at 14,500 cubic yards. This material will be used for land building purposes. A bridge will span the boat basin to allow access to homes on the western portion of the peninsula.

Vessels will access the boat basin from a southern approach. The boat basin is located immediately upon entrance with additional docks beyond the bridge to the north for use by adjacent private homes. Three (3) box culverts are proposed to the north through the mangrove formation at two (2) feet below MSL to diminish velocity and reduce disturbance to existing circulation patterns. Moreover, boat basin and channel walls will be constructed using natural ridge sloped with vegetated and boulders. No pump-out facility at the boat basin is designed as intended to accommodate that type of vessel.

To note, the upland houses will be on a septic tank and the hotel development will have a wastewater treatment plant.

6 Boat Basin Design and Channel Flushing

6.1 Boat Basin Design

Please refer to the Appendix for the boat basin design drawings.

6.2 Boat Basin Flushing Model

Cummins Cederberg was engaged by Windermere Operations, LLC (Client) to prepare an engineering analysis relative to the flushing of the proposed boat basin for the Windermere Island Club Marina in Eleuthera, The Bahamas. A site visit was conducted to observe and measure the coastal processes for the development and calibration of a hydrodynamic model. Published design standards on flushing were reviewed, and a preliminary desktop analysis of the flushing time was conducted. Following the development of the numerical model, a simulation of the hydrodynamics was conducted. The modeled hydrodynamic parameters were compared with the measured parameters and the values were deemed to be within reason to proceed with a numerical flushing analysis. Based on documentation provided by the client, the proposed boat basin was digitized and incorporated into the numerical model. Next, a simulation of the flushing in the boat basin was conducted utilizing the developed numerical model and the outputs were analyzed.

The following conclusions were obtained based on the analyses results:

- Based on the available published standards for flushing and simulation results, the proposed boat basin configuration achieves 85% flushing in a 24 hour period.
- Proposed improvements to the north flushing channel include replacing the three (3) creeks with two (2) large culverts, 28.3m (93ft) in length and 4.7m (15.33ft) by 3.15m (10.33ft) in diameter, and corresponding channel of 18.3m (60ft) and 15.3m (50ft).
- Changing the three (3) flushing creeks to two (2) large culverts and a channel resulted in an 82% higher wetted perimeter and a more optimized flushing time for the proposed boat basin.

7 Alternative Locations

The existing site location was selected because of prior dredging initiated by previous developer. The previous disturbance establishes a boat basin channel entrance for the boat basin. As well, the boat basin is protected from wave action.

8 Physical and Biological Baseline

8.1 General Climate of The Bahamas

The climate of The Bahamas is considered sub-tropical; it lies in a transition zone between the temperate and tropical zone. The archipelago spans 450 miles in longitudinal extent from 21°N to 27.5°N. The northern Bahamas experiences cooler winters and higher amounts of rainfall compared to the southern Bahamas where annual temperatures deviate less and the climate is markedly drier. The climate of The Bahamas is influenced by the sea particularly, the Gulf Stream which lies between Florida and the Great Bahama Bank. (Sealey, 2006)

Average High and Low Air Temperature is given in degrees Fahrenheit for Nassau (Sealey, 2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
High	77.3	77.5	79.7	81.8	84.6	87.3	89.1	89.3	88.4	85.4	81.8	78.7
Low	62.1	62.5	63.8	66.2	69.8	73.3	74.7	74.8	74.4	71.9	68.0	63.8

Rock Sound, Eleuthera can expect 50 inches and 99 rain days compared to New Providence which can expect 57.1 inches and 137 rain days (Sealey, 2006). Rainfall is highest between the months of May and November with peaks during June and October. Generally, prevailing winds are from the northeast with a rotation to the southeast during the summer months, May to September. In winter, wind may shift to the northwest due to cold fronts emanating from North America. According to the Bahamas Department of Meteorology, the average wind speed is eight (8) knots.

8.2 Climate Change

Climate change will contribute to greater climate variability where changes may occur to precipitation patterns, increase in frequency and intensity of storm events, extreme heat, global sea level rise, and alteration of wave patterns leading to shoreline erosion. Given this climate variability, engineering and building designs should plan for a scenario for future high anthropogenic greenhouse gas emissions.

The boat basin design provides for breakaway desks and floating docks to accommodate climate change effects and storm surge.

8.3 Topography

The peninsula ranges in elevation from sea level to nearly fifty (50) ft. A narrow ridgeline extends along the northern site boundary where the land meets the sea; elevations here average ten (10) feet. Overall, the site features diverse topography with numerous changes in elevation from interior depressions to isolated hill top knobs. Please refer to the Appendix for the topographical chart.

8.4 Geology

The Bahamas archipelago exists on a partially exposed carbonate platform between the Atlantic Ocean and the North American Plate. The platform surface geology is comprised mostly of *oolitic limestones.* Pleistocene limestones, Holocene sands and marshland sediments extend to a depth over of four (4) miles below the surface. Fourteen marine banks make up the surface plateaus; the largest being the Great Bahama Bank followed by the Little Bahama Bank. New Providence forms part of the Great Bahama Bank.

Carbonate geology is highly porous and subject to atmospheric erosion leading to the formation of karst solution systems including vast networks of subterranean caverns and Blue Holes. Rainfall and surface discharges quickly infiltrate the permeable limestone. Most surface runoff drains into the porous ground or brackish tidal creeks; The Bahamas has no freshwater rivers.

In general, the landscape of The Bahamas is flat with undulating ridges averaging 30 to 45 meters in height. Cat Island has the highest point of elevation, 206 ft., at Mount Alvernia. Given these physical properties, The Bahamas is subject to storm surge and wave action during tropical cyclone events.

8.4.1 Geology – Site Specific

ETS completed a subsurface investigation for the proposed boat basin at North Windermere Island on October 23, 2018. The subsurface condition encountered consisted of loose fine sand from the surface to a depth of 24 to 30 inches below the surface. A silty sand was observed below this level to the test pit maximum depth of five feet below the surface. It is ETS' understanding that the observed silty sand is generally material deposited in the area during dredging of the existing basin.

Groundwater was encountered in each test pit at an average depth of 38 inches below the existing; however, it should be noted that the groundwater observations only reflect the groundwater conditions at the time of our exploration. Fluctuations of the groundwater table should be expected to occur both seasonally and annually due to variations in rainfall, evaporation, construction activities, and other site-specific factors.

Approximate location of the test pits and photos are available in the full Geotechnical Report found within the Appendix.

8.5 Hydrological and Hydrogeological Resources

In The Bahamas, groundwater comprises the fresh, brackish, saline and hypersaline waters found in the near and deep subsurface and in the lakes and ponds that intercept the surface. The Bahamas has no fresh surface water and therefore, no freshwater lakes, rivers, or creeks.

Freshwater resources in The Bahamas originate from rainfall only and accumulate in Ghyben-Hertzberg lenses. The Ghyben-Hertzberg lens consists of three (3) lateral zones: 1) freshwater where chloride ranges from 90 to 400 ppm; 2) a transition zone (brackish), approximately 1-2m think where chlorides increase rapidly from 400 to 1200 ppm; and 3) a saline zone where chlorides rise above 1200 ppm. Freshwater is less dense than salt water, thus sits above the saline zone separated by a brief mixing layer of brackish water.

On average, the freshwater lens occurs at a depth of two (2) to five feet (5ft.) below the surface. Ninety percent (90%) of freshwater lens resources in The Bahamas are within five feet (5ft.) of the surface. Given the close proximity of fresh water to the surface and the high porosity of limestone, over-extraction and pollution may lead to depletion, saltwater intrusion, and/or contamination, impairing the fragile layer of freshwater over salt.

Threats to groundwater resources:

- **Saltwater Intrusion**. Saltwater intrusion to groundwater may occur due to 1) storm surge generated by tropical disturbances; 2) sea level rise due to climate change; and 3) over-pumping/extraction of freshwater aquifers.
- **Development/Building Features.** Canals and boat basins have the potential to disturb subsurface freshwater lens by allowing the sea to connect at the inland surface.
- **Climate Change.** Based on the IPCC 5th Assessment Report and the Coupled Model Intercomparison Project 5 (CMIP5); climate change will alter existing rainfall patterns in The Bahamas. Climatology data suggest that The Bahamas region will incur a three percent (3%) decrease in monthly rainfall averages with an increase of intensity of rainfall events between October and February. Overall, total rainfall is expected to decrease placing additional pressure on freshwater resources.
- **Contamination.** Groundwater is susceptible to contamination from untreated sewage, industrial wastes, and leaking fuels; this vulnerability is particularly true for New Providence. New Providence is the most populated island and has the highest population density.

Deep-well injection

The Bahamas has a subsurface inverted geothermal gradient indicative of a high degree of exchange with the surrounding ocean. Subsurface water temperatures decrease with depth due to massive amounts of seawater than move in and out of the carbonate banks in response to tidal currents. Due to these traits, deep well injection is a viable means for stormwater and effluent discharge. The Water and Sewerage Corporation sets the requirements and specifications for all disposal wells with the reject zone at 400 feet and below.

8.6 Excavation and Fill

Total volume of excavated materials is estimated at 14,500 cubic yards. This material will be used on site.

8.7 Hurricanes

New Providence is situated in the hurricane zone. Hurricane season begins June 1st and ends November 30th though tropical cyclones may form outside this period. According to the coastal dataset of the Coastal Service Center, National Oceanic and Atmospheric Administration, seventy-seven (77) tropical disturbances (tropical storms and hurricanes) have come within 50 nautical miles of Windermere Island, Eleuthera between 1859 and 2016. Hurricane history tracker and database can be found at this link: http://coast.noaa.gov/hurricanes/ .

In 2004, Hurricane Frances, a strong Category 2 storm passed to the immediate northeast of Windermere Island.

8.8 Air and Noise Quality

Air and noise quality at the site is anticipated to be good as no heavy industry takes place in close proximity. No testing was performed or is anticipated to be required during the development process.

8.9 Botanical Survey

Botanical field studies were conducted on 2-3 November 2018 for terrestrial communities within a survey site approximately 50 acres (See Figure 1: Survey Area). The purpose of the study was to map vegetation types, determine floristic diversity and identify the presence of protected and invasive species.

Figure 8.9-1 Survey Area

8.9.1 Methodology

Vegetation types were mapped by examining aerial photography and verified by walking along the survey lines and the interior of site at various locations. Vegetation type taxonomy is based on Areces et al. (1999). Vascular plant species occurring in each vegetation type were recorded and used to compile an overall floral list. Plant taxonomy is based on Corell and Corell (1982). The presence, location and abundance of vascular species listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order (1997) and the Department of Marine Resources, National Invasive Species Strategy for The Bahamas, 2013 were noted when encountered. Percentage cover were recorded in the abundance categories - Rare (less than 5%), Occasional (5- 20%), Moderate abundance (20-50%), Abundant (50-80%) and Dominant (80-100%).

8.9.2 Vegetation Types - Human Altered

Ten (10) vegetation type classes were encountered on the island - Beach strand, Black Mangrove (*Avicennia germinans*) Formation, Red Mangrove (*Rhizophora mangle*) Formation, Buttonwood (*Conocarpus erectus*) Formation, Sawgrass (*Cladium jamaicense*) Formation, Saltwort (*Salicornia bigelovii*) Formation, Bay Marigold (*Borrichia aerborescens*) Formation, Cattail (*Thypha domingensis*) Formation, Dry broadleaf evergreen formation (DBEF) and Human Altered. The various vegetation types observed are described in the sections below and their location on site illustrated on Figure 2 – section 2.5.5 vegetation map.

8.9.3 Coastal

8.9.3.1 Beach Strand

Beach Strand is present at one (1) location along the southern section of the coastline. The vegetation strip is four (4) to five (5) meters wide between the high-water mark and the upland areas. Vegetation height is less than two (2) meters. Species present include Sea Oats (*Uniola paniculata*) ground cover and shrubs such as Bay cedar (*Suriana maritima*), Bay lavender (*Argusia gnaphalodes*), Sea Grape (*Coccoloba uvifera*) and Black Inkberry (*Scaevola plumieri*) along the northern sections. The substrate is a combination of mostly sand with some silt.

Vegetation in this area does not appear to be naturally occurring as the species composition and substrate are not typically associated in the configuration present on site. Based on examination of historical aerial photograph that do not show a beach strand at this location, it is likely that the natural vegetation in this area was removed some time ago by a prior developer along with the clearing of the surrounding upland vegetation. It is highly probably that the vegetation along this strip was naturally an extension of the Black Mangrove (*Avicennia germinans*) formation immediately to the North. This probability is further supported by the presence of patches of Black Mangrove along the shore and in the water on the southern section of the Beach Strand. The s beach strand also has species such as Saltwort (*Salicornia bigelovii*) and Seashore rush grass (*Sporobolus virginicus*) that area commonly associated with Black Mangrove formations.

Figure 8.9-2 Beach Strand (view facing East)

Figure 8.9-3: Beach Strand (view facing West)

8.9.3.2 Black Mangrove (*Avicennia germinans)*

A Black Mangrove (*Avicennia germinans*) formation is present along the shoreline and extends a significant distance inland. This area is almost exclusively Black Mangrove with an occasional Red Mangrove (*Rhizophora mangle*) and Buttonwood (*Conocarpus erectus*). There is surface water or saturated soils present throughout the entire system.

Figure 8.9-4 Black Mangrove (Avicennia germinans) Formation

8.9.3.3 Red Mangrove Formation (*Rhizophora mangle)*

The entire northern coastline of the survey area is Red Mangrove Formation ranging from less than one (1) meter to more than five (5) meters in height.

Figure 8.9-5 Red Mangrove (Rhizophora mangle) Formation

8.9.4 Wetlands

8.9.4.1 Buttonwood Formation (Conocarpus erectus)

Buttonwood formations are present at two (2) locations within the interior of the survey site. Both areas have Buttonwood (*Conocarpus erectus*) along the periphery of a body of standing water less that one (1) meter in depth. Bay Marigold (*Borrichia arborescens*) is a common associated species at both locations. The formations differ in that one is considerably larger than the next, with the larger formation having stands of dead buttonwood trucks throughout while the smaller one has an open body of water.

Figure 8.9-6Large Buttonwood (Conocarpus erectus) Formation

Figure 8.9-7 Smaller Buttonwood (Conocarpus erectus) Formation

8.9.4.2 Sawgrass (*Cladium jamaicense)*

Sawgrass (*Cladium jamaicense*) is present around the periphery of an open body of water in the interior of the site. The vegetation height is approximately two (2) meters. Other species present include Buttonwood (*Conocarpus erectus*), Nicker (*Caesilpinia sp.*) and Saltbush (*Baccharis angustifolia*).

8.9.4.3 Saltwort (Salicornia bigelovii) Formation

A saline pond is located in the interior of the site. Saltwort (*Salicornia bigelovii*) is present along the periphery of the water followed by a larger band of Bay Marigold (*Borrichia arborescens*) on the outside perimeter.

8.9.4.4 Bay Marigold (Borrichia arborescens) Formation

A small section in the interior of the site is exclusively Bay Marigold (*Borrichia arborescens*). This formation is in close proximity to several other wetland features. At the time of the investigation the substrate was dry however, there is evidence of periods of inundation and saturated soils.

8.9.4.5 Cattail (Thypha domingensis) Formation

Cattail (*Thypha domingensis*) is the dominant species in a depressed area within the interior of the site. Bay Marigold (*Borrichia arborescens*) and Saltbush (*Baccharis angustifolia*) are present on the periphery of the formation.

Figure 8.9-8 Saw grass (Cladium jamaicense) Formation

Figure 8.9-9 Saltwort (Salicornia bigelovii) Formation

Figure 8.9-10 Bay Marigold (Borrichia arborescens) Formation

Figure 8.9-11 Cattail (Thypha domingensis) Formation

8.9.5 *Interior Upland*

8.9.5.1 Dry Broadleaf Evergreen Formation

The majority of the island is covered with dry broadleaf evergreen formation (DBEF). Common species include Silver top Palm (*Coccothrinax argentata*), Trema (*Trema lamarckianum*), Beefwood (*Guapira discolour*) and Granny bush (*Croton linearis*).

Figure 8.9-12Dry Broadleaf Evergreen Formation

The majority of the DBEF areas on the site has Silver top palm (*Coccothrinax argentata*) as a dominant species.

Figure 8.9-13 Silver top palm (Coccothrinax argentata) dominated DBEF

Figure 8.9-14 Interior of DBEF on site

8.9.6 Human Alerted

Human Altered areas on the island included roads and cleared areas that revegetated with weed species such as *Stachytarpheta jamaicensis*(Blue Flower) and *Bidens alba* (Shepherd's Needle); and grasses including *Cenchrus incertus* (Coast Sand Spur) and *Andropogon glomeratus* (Bushy beard grass).

Figure 8.9-15 Human Altered Herbland

8.9.7 Vegetation Map

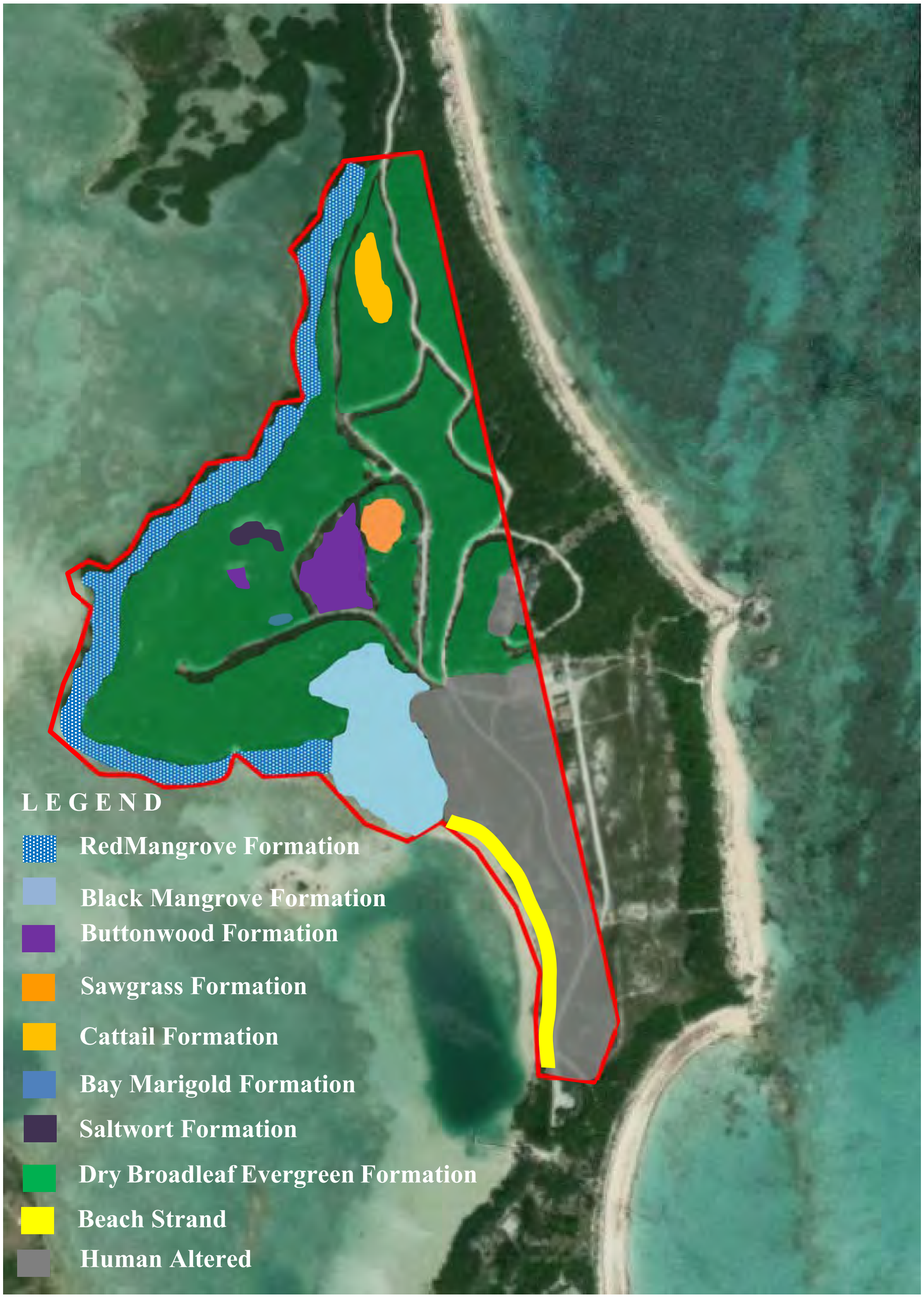

Figure 8.9-16 Vegetation Map North Windermere Island Survey

8.9.8 Invasive Species

Four (4) species listed on BEST Commission's National Invasive Species Strategy (2013) were recorded during the investigation (See Table 8.10.8-1)

Table 8.9-1 Invasive plant species recorded on North Windermere Island

Botanical Name	Common Name	Presence on site	Recommendations for control*
Casuarina equisetifolia	Australian Pine	A few individuals at various location on the site.	Control
Leucaena leucocephala	*Jumbay*	Occasional species in human altered areas.	Control
Scaevola taccada	White Inkberry	A few individuals at various location on the site.	Eradication
Weldia trilobata	*Wedelia*	Confined to Human Altered areas on the site.	Control

* Based on BEST Commission's National Invasive Species Strategy (2013) list of species for control

8.9.9 Protected Species

Guapira discolor (Narrow leaf Blolly) was the only species listed on the Conservation and Protection of the Physical Landscape Act, Protected Trees Order (1997) that was observed on the site. It was present as a common species in the DBEF areas of the site.

8.9.10 Vascular Plant Diversity

A total of eighty-four (84) vascular plant species were observed during the investigation. It is unlikely that this number represents all of the plant species present within the vegetative communities on the site as data collection was limited to a single field session however, it is a fair representation of the species typically observed in these areas throughout The Bahamas.

8.10 Avian Assessment

The purpose of the avian study was to identify the presence, abundance and habitat utilization of avifauna species on the site.

8.10.1 Methodology

The assessment comprised of three (3) hours of active avian and ecological observation. The avifauna of the site was assessed and recorded by walking along existing roads and trails and targeting specific areas noted by examining aerial imagery. Species numbers were recorded in the abundance categories, Single, Few (2-10) and Many (11-100). Species recorded were compiled for final abundance estimates.

8.10.2 Avian Species Observed

A total of eleven (11) species were recorded during the investigation.

8.10.2.1 Species Range – Permanent Residents

The majority of the species recorded live and breed throughout the islands of The Bahamas. The exceptions include the Cape May Warbler (*Setophaga* tigrine), Lesser Yellowlegs (*Tringa flavipes*) and Blue wing teal (*Anas discors*) which are winter non-breeding residents. ##

8.10.2.2 Species Range - Endemic Species

No endemic species were recorded.

8.10.2.3 Conservation Status - Protected Species

All of the species observed are protected under the Wild Birds Protection Act Chapter 249, Statue Law of The Bahamas (1952). It is prohibited to hunt the White-cheeked Pintail (*Anas bahamensis*) in The Bahamas.

8.10.2.4 Conservation Status - Endangered Species

There were no endangered species recorded.

8.10.3 Habitat Utilization

Significant bird activity was observed in the fresh / brackish wetlands where an abundance of waterfowl was observed. The number of species recorded for the DBEF area was moderate however, there was significant activity in these areas and it is highly likely that there were other species present that were not recorded as the dominance of silver top palm leaves in some areas provided large areas for the birds to take cover and remain out of sight.
A number of bird nest were observed in the wetland and DBEF vegetation indicating that the site is utilized for breeding.

*Figure 8.10-1 Cape May Warbler (*Setophaga tigrine*) in Human Altered area on site*

Figure 8.10-2 Nest in Red Mangrove Formation

8.11 Benthic Assessment

A benthic survey was conducted around the Northern section of Windermere Island, Eleuthera to provide biological baseline data for areas in the vicinity of proposed marine works. The investigation was focused on identifying and describing benthic habitats and the presence and abundance of marine flora and fauna.

8.11.1 Methodology

The benthic ecosystem of the proposed area for the marine development was assessed using the roving method. A record was taken of all flora and fauna species as well as substrate type. Species abundance was recorded as Single, Few (2-10) and Many (10 +).

8.11.2 Findings – General Observations

The assessed site is located in a creek system between Windermere Island and Savannah Sound. Mangrove ecosystem is the domain habitat type located along the shoreline and extending into the creek, followed by seagrass beds towards the center of the creek. The weather conditions were slightly overcast, with winds less than ten (10) knots. Visibility was five (5) based on a range of one to ten (1-10) with one (1) being zero visibility and ten (10) being transparent.

8.11.2.1 Benthic Description

The majority of the substrate in the survey areas was sand and silt bottom dominated by Manatee Grass (*Syringodium filiforme*) and various alga type. Manatee Grass (*Syringodium filiforme*) and algae substrate composition was recorded for approximately ten to twelve (10-12) meters from the shore.

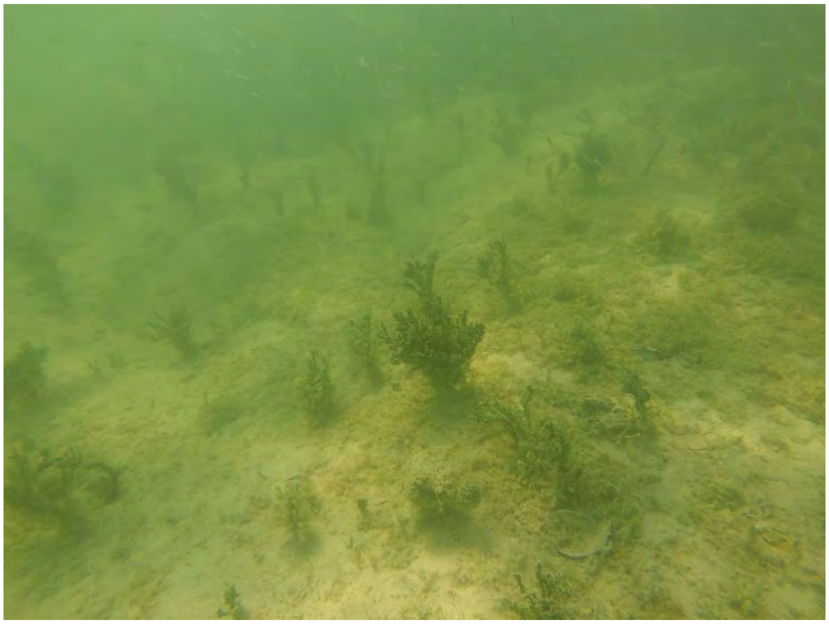

Figure 8.11-1 Sand and silt bottom substrate with Halimeda sp.

8.11.2.2 Benthic Flora Observed

Table 8.11-1 Algae and seagrasses (species no. 13) observed during assessment.

Scientific Name	Common Name
Acetabularia crenulate	Mermaid's Wine Glass
Caulerpa cupressoides	Cactus Tree Algae
Caulerpa sertularioides	Feather Algae
Dasycladus vermicularis	Fuzzy Finger
Dictyota spp.	Dictyota
Halimeda spp.	Green Algae
Laurencia sp.	Red Algae
Penicillus spp.	Mermaid's Shaving Brushes
Phaeophyta	Turf Algae
Rhipocephalus phoenix	Pinecone Algae

Scientific Name	Common Name
Sargassum natans	Sargassum Seaweed
Syringodium filiforme	Manatee Grass
Ulva lactuca	Sea Lettuce

Figure 8.11-2 Halimeda sp. *and Manatee Grass (*Syringodium filiforme).

*Figure 8.11-3 Silt covered substrate with Feather Algae (*Caulerpa sertularioides*)*

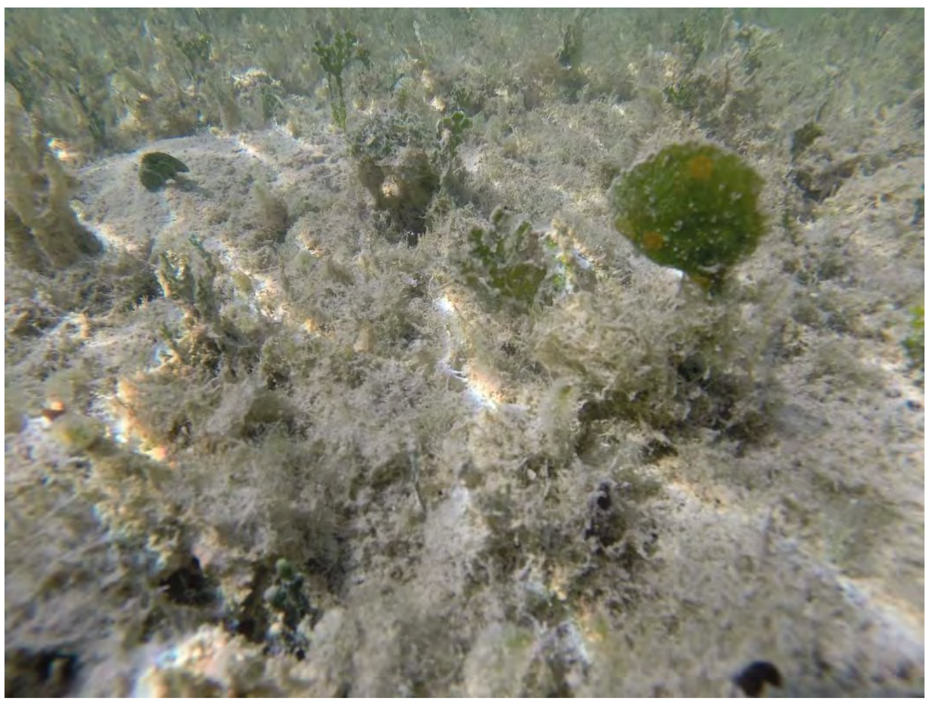

Figure 8.11-4 Substrate covered in Silt, Distyota spp. *and* Halimeda spp.

8.11.2.3 Benthic Fauna Observed

8.11.2.3.1 Coral

Coral (species no. 1) observed during assessment.

Table 8.11-2 Coral Species Observed

Scientific Name	Common Name	Abundance
Siderastrea radians	Starlet Coral	Few

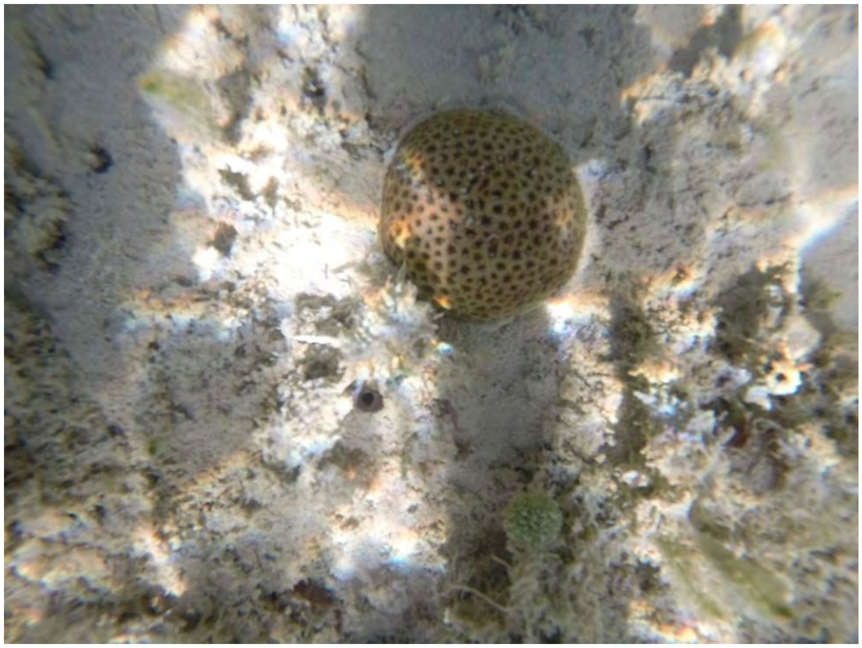

*Figure 8.11-5 Silt covered substrate with Starlet Coral (*Siderastrea radians*)*

8.11.2.3.2 Sponge Species

Table 8.11-3 Sponge (species no. 3) observed during assessment.

Scientific Name	Common Name
Ircinia felix	Stinker Sponge
Ircinia strobilina	Black Ball Sponge
Svenzea zeai	Volcano Sponge

8.11.2.3.3 Other Fauna

Table 8.11-4 Other Fauna (species no. 8) observed during assessment.

Scientific Name	Common Name
Anamobaea oerstedi	Split-Crown Feather Duster
Bartholomea annulata	Corkscrew Anemone
Cassiopeia xamachana	Upside-down Jellyfish
Crassostrea rhizophorae	Mangrove Oyster
Dasyatis americana	Stingray
Holothuria mexicana	Sea Cucumber
Lobatus gigas	Queen Conch (Juvenile)
Panulirus argus	Caribbean Spiny Lobster

*Figure 8.11-6 Various biota including Corkscrew Anemone (*Bartholomea annulate*) and Volcano Sponge (*Svenzea zeai*)*

*Figure 8.11-7 Alga covered substrate with Sea Cucumber (*Holothuria mexicana*).*

*Figure 8.11-8 Red Mangrove root with Mangrove Oysters (*Crassostrea rhizophorae*).*

8.11.2.4 Fish Species

Table 8.11-5Fish (species no. 10) observed during assessment.

Scientific Name	Common Name	Abundances
Ablennes hians	Flat Needlefish	Few
Abudefduf saxatilis	Sergeant Major	Few
Diodon hystrix	Porcupinefish	Single
Haemulon flavolineatum	French Grunt	Many
Holocentrus sp.	Squirrelfish	Few
Lutjanus analis	Mutton Snapper	Few
Lutjanus apodus	Schoolmaster Snapper	Many
Sphyraena barracuda	Great Barracuda	Few
Stegastes adustus	Dusky Damselfish	Few
Stegastes leucostictus	Beaugregory	Few

*Figure 8.11-9 Red Mangrove root with Porcupinefish (*Diodon hystrix*)*

8.11.2.4.1 Commercial Endangered and Protected Species

Table 8.11-6 Commercially Important, Endangered and Protected species observed during assessment.

Table key: CI = Commercially Important, **ES** = Endangered Species, **PS =** Protected Species

Scientific Name	Common Name	Status
Chelonia mydas	Green Turtle	ES/PS
Lobatus gigas	Queen Conch	ES/PS/CI
Lutjanus analis	Mutton Snapper	CI
Panulirus argus	Caribbean Spiny Lobster	ES/PS/CI

8.11.3 Discussion

The flats observed were of silt, sand, seagrass and algae substrate. Portions within the site were previously altered but the majority is intact. The site acts as a nursery and feeding ground for various organisms.

Activity in the flats were relatively low, with the majority of movement observed within the Red Mangrove root system. The fauna species diversity and abundance observation may have been low due to the changing tide, which may have influenced the migration of activity deeper within the roots for protection from predation. Low density within the open flats also suggests that the extensive width of the channel/creek does not provides optimum protection for fish species.

Observation showed that the site is important for commercially important species such as Spiny Lobster (*Panulirus argus*). The high abundance of Spiny Lobster suggests food source availability at the site is high. On the other hand, there were low abundance of queen conch (*Lobatus gigas*) which may be due to the low density of turtle grass (*Thalassia testudinum*).

8.12 National Parks & Protected Areas

At present, there are no National Parks or Protected Areas in the vicinity of the proposed boat basin. However, under the Bahamas Protected Project, the Bahamas National Trust proposes expanding the existing marine protected area network. This expansion would include the proposed Savannah Sound and Plantation Reef marine protected area encompassing 3,469 acres immediately adjacent to the boat basin.

A Rapid Ecological Assessment was conducted in August 2017 and identified the mangroves within Savannah Sound to be highly productive. This area has a high species diversity and fish density, and supports a number of juvenile species including Nassau Grouper, queen conch, snappers, grunts, and parrotfish. While it is noted that reef systems off-shore show degradation, Plantation Reef is in superior condition.

Figure 8.12-1 Savannah Sound & Plantation Reef Proposed MPA

8.13 Utility Provisions

The boat basin is a basin that will have limited utilities. There will be no fuel station. Electricity to the development is provided by the Bahamas Power & Light Corporation. Potable water is supplied by a reverse osmosis plant on site.

8.13.1 Stormwater Management

Stormwater will be collected by use of swales and a detention pond to collect run-off.

8.13.2 Boat basin Fueling

There will be no fueling at the boat basin.

9 Environmental Laws, National Environmental Policies and International Conventions

The boat basin at North Windermere Island is within the constituency of Central and South Eleuthera which is represented by Member of Parliament Hank Johnson.

9.1 Environmental Laws of The Bahamas

Environmental Law, Regulation, Policy	Subject	Summary
Conservation and Protection of the Physical Landscape of The Bahamas, 1997 Chapter 260	Excavation, Landfill, Quarrying, Mining, Protected Trees Listing	This Act makes provisions for the regulation of activities including excavation, landfill, quarrying, mining, and harvesting of protected trees in The Bahamas for the purpose of conservation of maintenance of the environment. The Regulations include a list of protected tree species in The Bahamas.
Environmental Health Services (Collection and Disposal of Wastes) Regulations 2004	To administer and outline waste collection and management facilities	Environmental Health Services (Collection and Disposal of Wastes) Regulations 2004 establish the collection and control of waste including waste facilities and other matters relating to wastes.
Environmental Health Services (Fees and Services) Regulations 2000	To establish fees and services performed by the Department of Environmental Health Services	The Fees and Services regulations outline services and associated fee rates performed by the Department of Environmental Health Services. The Department may provide testing for air quality, water quality, and radioactive materials.
Environmental Health Services Act 1987	To promote and protect the public health and to provide for the conservation and maintenance of the environment	An Act to promote the conservation and maintenance of the environment in the interest of health for proper sanitation in matters of food and drinks, and generally for the provision and control of services, activities, and other matters connected therewith or incidental thereto.
Health and Safety at Work Act 2002 Health and Safety at Work Amendment, 2015	To protect human health and safety at work	The purpose of the Act is to secure the health, safety and welfare of persons at work- protect persons other than persons at work against risks to health or safety arising out of or in connection with the activities of persons at work- control the storage and use of explosive or highly flammable or otherwise dangerous substances, and generally preventing the unlawful acquisition, possession and use of such substances.
Planning and Subdivision Act, 2010 Planning and Subdivision Regulations (Application Requirements), 2011	To regulate the built environment	This Act regulates the development of the built environment though physical planning protocols across the archipelago of The Bahamas. The Act stipulates the process for subdivision approval subject to specific conditions with respect to the features of the proposed development or project including the preparation of an Environmental Impact Assessment/Statement.
Public Works Act 1963	To provide for the physical development of The Bahamas	An Act to provide for the construction, management and development of public works, buildings, and road.
Water and Sewerage Act 1976	To establish the Water and Sewerage Corporation and to control water resources	An Act to establish a Water and Sewerage Corporation for the grant and control of water rights, the protection of water resources, regulating the extraction, use and supply of water, the disposal of sewage and for connected purposes

Wild Animals Protection Act 1968	To protect wild animals of The Bahamas	The Act provides a listing of protected animal species in The Bahamas
Wild Birds Protection Act 1987 Wild Bird Protection Act (Reserves)	To protect wild birds of The Bahamas	The Act protects the wild birds of The Bahamas and makes provision for the dedication of time periods for the hunting of specific species.

9.2 National Environmental Policies

9.3 International Conventions of Relevance

Relevant National Policies	Subject	Summary
National Policy for the Adaptation to Climate Change 2005	Climate change assessment for the immediate and project adaptation techniques for The Bahamas	The National Policy for the Adaptation to Climate Change outlines a national framework to meet the goals and objectives of the United Nations Framework Convention on Climate Change (UNFCC). The Bahamas is committed to reduce greenhouse gases and address climate change impacts.
National Invasive Species Strategy for The Bahamas, 2013	Identifies and recommends a management framework for the control and eradication of invasive species.	The National Invasive Species Strategy for The Bahamas originally published in 2003, was updated in 2013 as part of the Global Environment Facility funded project, Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MITIASIC). It sets forth a management framework for the control and eradication of invasive species.
National Biodiversity Strategy and Action Plan, 1999	A plan to maintain biodiversity through sustainable development for a small island developing nation.	The Bahamas Government is committed to conserve biodiversity and to pursue sustainable development. This document highlights the role of biodiversity in the Bahamian social and environmental context and recommends measures to ensure its compatibility with future development.
International Convention/Organization	**Subject**	**Summary**
Cartagena Convention Ratified: June 24, 2010	An agreement for the protection and development of the marine environment in the wider-Caribbean region	The Convention provides a legal framework for cooperation in the wider Caribbean region. Three technical agreements support the Convention which include: - Protocol for Co-Operation in Combating Oil Spills - Protocol for Specially Protected Areas and Wildlife (SPAW) - Protocol Concerning Pollution from Land-based Sources and Activities (LBS)
Convention on Biological Diversity	To preserve species diversity	The Bahamas is a signatory to the Convention on Biological Diversity which came into force December 1993. It has three main goals: a) The conservation of biological diversityb) The sustainable use of components of biological diversityc) The fair

Signed: June 12, 1992		and equitable sharing of the benefits arising out of the utilization of genetic resources
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) Signed: June 7, 1997	This convention provides a framework for the international protection of wetlands as contributors for human resources and moreover, for avifauna which do not adhere to international boundaries.	The Bahamas is a signatory to the Convention on Wetlands of International Importance, also known as the Ramsar Convention. This convention provides a framework for the international protection of wetlands as contributors for human resources and moreover, for avifauna which do not adhere to international boundaries. Ramsar defines wetlands as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters'.
Convention to Combat Desertification & Drought Signed: Nov. 10, 2000	To combat desertification and to mitigate the effects of drought	The Convention is a proponent for sustainable development by addressing social and economic issues that directly impact land degradation.
United Nations Framework on Climate Change Signed: June 1992 Kyoto Protocol Signed: April 9, 1999 Paris Agreement Ratified: August 22, 2016	To stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with climate systems	The Bahamas is a signatory to UNFCC which entered into force in March 1994. The UNFCC was the culmination of climate negotiation at the Rio Earth Summit in 1992. This summit established a framework with an aim to stabilize atmospheric greenhouse gas. The Kyoto Protocol was developed under the UNFCC to provide emissions targets and timetables for developed countries. The Paris Agreement as put forth at the Conference of the Parties (COP21) in December 2015. The agreement has not yet come into force as it requires at least 55 parties to have ratified the agreement.

9.4 Government Departments and Local Non-Governmental Organizations

- Ministry of Public Works
- Ministry of the Environment and Housing
- BEST Commission
- Port Department
- Department of Physical Planning
- Department of Environmental Health
- Water and Sewerage Corporation
- Bahamas Power and Light

10 Register of Environmental Issues

Register of Environmental Issues: Boat basin at North Windermere Island			
Aspect	Ecological Value	Impacts	Recommendations for Mitigation & Management
Botanical	Ten (10) vegetation types were identified including: - Beach Strand - Black Mangrove - Red Mangrove - Buttonwood - Sawgrass - Saltwort - Bay Marigold - Cattail - Dry Broadleaf Evergreen Formation - Human Altered Of note, the site has seven (7) wetland communities. Red and black mangroves fringe the coastline and the other wetland types are present inland. One (1) protected species, narrow leaf blolly and four (4) invasive species were observed.	The boat basin design has a primary entrance to the south with additional but non-navigable flushing channels to the north. Construction of the boat basin will result in the loss of the interior wetland communities' sawgrass formation, saltwort formation, and buttonwood formation. The majority of the peninsula and immediate areas are covered by DBEF. Red mangrove communities are not expected to incur long-term adverse impacts. The black mangrove community fringes the area of the southern boat basin entrance with select species removed for basin construction. Coastal vegetation along the southern perimeter as noted in the botanical study and confirmed by historic aerial imagery was previously disturbed. Land clearing and site preparation activities should focus on the avoidance and minimization of sediment and erosion, pollution prevention, waste management, materials storage, refueling, and BMPs included in the EMP.	- Erosion and Sediment BMPs - Prevention of Pollution of Waterbodies - Mangrove and Wetland Mitigation - Removal of Invasive Species - Landscaping with Native Species - Waste Management Program
Avian	Eleven (11) avian species were observed. The white-crowned pigeon is listed as a near threatened (NT) species on the IUCN red list. Avifauna activity was greatest in the fresh/brackish wetlands and in the DBEF with a moderate number of species observed. Breeding on site is likely with	Removal of wetland features, sawgrass formation, saltwort formation, and buttonwood formation for the basin will result in the loss of some waterfowl avifauna due to the loss of habitat. Planting with native species and a natural shoreline may encourage visits by shorebirds.	- Mangrove and Wetland Mitigation - Removal of Invasive Species - Landscaping with Native Species - Air and Noise Quality BMPs

	observance of nests in wetlands and DBEF.		
Marine	Benthic substrate can be described as sand and silt bottom dominated by manatee grass and various alga types. The manatee grass and alga substrate extended ten (10) to twelve (12) meters from shore. One (1) coral species and three (3) sponge species were identified. Other notable fauna included sea cucumber, juvenile conch, Caribbean spiny lobster, and string ray. Ten (10) fish species were observed included commercially important Queen Conch, Mutton Snapper, and Caribbean Spiny Lobster. Green turtle was also observed.	A previously dredged area exists to the immediate south of the site. A majority of the activity occurred within the mangrove roots. Disturbance to red mangroves is anticipated to be limited to the area of the northern flushing channels and basin entrance. Greatest impacts will occur at the southern boat basin entrance. Placement and construction of northern flushing channels will employ BMPs to limit removal of individuals trees. Once flushing channels are in place, it is expected that mangroves will naturally recolonize the area. Activity was limited in the open flats.	- Erosion and Sediment BMPs - Prevention of Pollution of Waterbodies - Mangrove and Wetland Mitigation - Landscaping with Native Species - Waste Management Program - Educational signage in boat basin on species using mangroves

11 Environmental Management

Environmental management is a systematic approach that integrates environmental policy and planning with continuous monitoring of implementation techniques to improve environmental compliance in order to achieve the goals of sustainable development. Hazards to human health and safety and the environment can be managed through careful planning, vigilance and strong communication during works, and continual improvement to the overall environmental management program.

The preferred management approach is to avoid, minimize, and control adverse impacts to human health, safety, and the environment. Where adverse impacts cannot be avoided, best management practices should be employed to mitigate human and environmental harm. An Environmental Management Plan is recommended for construction of the boat basin at North Windermere Island with attention given to erosion and sediment control and prevention of pollution of water resources.

12 Environmental Mitigation for Wetlands

This section documents techniques to mitigate wetland loss at North Windermere Island resulting from construction of the boat basin.

12.1 Definition of a Wetland

Wetlands exist in a transition zone between the aquatic and terrestrial environments. Neither terrestrial nor aquatic, wetlands have unique characteristics that allow for a distinct classification. The Bahamas is a signatory to the Convention on Wetlands of International Importance for Waterfowl Habitat, also known as the Ramsar Convention. Ramsar defines wetlands as ‘areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters’.

At the core of every wetland definition is hydrology; the precarious balance in a transition zone is contingent on the reigning hydrologic regime. The underlying hydrology of a wetland system determines its physio-chemical properties in turn influencing the biota, terrestrial and marine, present in a wetland. Importantly, too little or too much water results in a complete transition to either a terrestrial or marine environment, respectively.

Ecosystem services provided by wetlands include: storm surge and flood protection, water quality improvement, nursery and feeding habitat, waterfowl habitat, inherent aesthetic and cultural values, and recently discovered, mangroves are prolific natural carbon sinks. Anthropogenic alterations to existing marine and vegetation communities are threatening coastal ecosystems; in the case of the Bahamas mangroves are particularly affected. Threats to wetland communities include: coastal development, aquaculture, nutrient loads, ecosystem change, and climate change.

12.2 The Bahamas

The coastal wetland ecosystem of The Bahamas is typically considered to be mangrove. Mangroves or mangal are defined as ‘Subtropical and tropical coastal ecosystem dominated by halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters’ Mitsch 2007). To note, this definition includes dozens of tree and shrub species that exist in a mangrove system but are not necessarily classified as a species of mangrove such as the prevalent *Conocarpus erectus* (green buttonwood).

Beyond the hydrologic regime and salinity, mangroves exist only where there is protection from high-energy wave action.

12.3 Overview of Wetlands and Impacts at North Windermere Island

Seven (7) distinct wetland vegetation types are present on site including: including red mangrove, black mangrove, buttonwood formation, sawgrass formation, saltwort formation, bay marigold formation, and cattail formation. With the exception of the mangrove wetland types, the wetlands are located inland.

Construction of the boat basin will result in the loss of several interior wetland communities including sawgrass formation, glasswort formation, and buttonwood formation. The majority of the peninsula and immediate areas are covered by DBEF.

Red mangrove communities are not expected to incur long-term adverse impacts. The black mangrove community fringes the area of the southern boat basin with select species removed for construction. As confirmed in aerial imagery, the coastal vegetation along the southern peninsula perimeter was previously disturbed given the present atypical species composition.

12.4 Mangrove Restoration and Creation - Mitigation Techniques

Wetland mitigation techniques generally fall within the categories of wetland creation, restoration, and enhancement. Recommended techniques for North Windermere include wetland creation and restoration.

Generally, The Bahamas employs a mitigation ratio of 2:1 meaning that for every acre of mangrove lost to development, two (2) acres of restored or created. On-site mitigation is encouraged, however given constraints of land-use and spatial availability, off-site mitigation may be considered where warranted.

Important considerations for wetland creation and restoration (Mitsch 2007):

1. **Local Wetland Ecology**. Mangroves will flourish in environments with suitable hydrology, biochemical, and wave energy conditions.
2. **Self-Design to Avoid Over-Engineering**. Self-design means that the ecosystem created or restored contains the properties that will allow mangroves and the wetland system to grow naturally. Whether through human or natural seeding a successful self-designed mangrove habitat will adjust and change over time. The system should be self-sustaining. Mangrove success should not be determined solely on the number of plants or animals present.
3. **Mangal Planting**. Where a mangal formation has been decimated completely, the physical planting of trees may be required to reintroduce the species into the greater ecosystem. A December 2016 article in Smithsonian notes the excessive costs associated with planting as in the case of the Philippines where the World Bank spent $35 Million to plant three (3) million mangrove seedlings between 1984 and 1992. By 1996, less than twenty (20) survived. Natural colonization is a cost-efficient mechanism if mangroves are present within the area of restoration and the biophysical and biochemical properties remain the same.

Mangal planting while a popular mitigation technique may not yield satisfactory results. Research indicates that natural recolonization of mangroves is the preferred approach for effective mangrove restoration. According to Wetlands International, when the enabling biophysical and socio-economic conditions are in place, nature will do rest resulting in optimal placement, better survival, and a more resilient mangrove forest. Planting efforts fail due to poor understanding of the hydrological and biochemical needs for mangrove survival. However, planting can assist or enrich the natural regeneration process.

In a 2011 study Boizard and Mitchell tested the mechanical resistance of seedlings growing at five (5) locations with different substrate and canopy conditions (Boizard, 2011). Overall, Boizard and Mitchell concluded that seedling anchorage success varied among locations with different overstory and substrate conditions likely due to differences in competition and acclimation to wind and wave energy along with differences in rooting in substrates.

Wetland Mitigation Techniques for North Windermere Island

The objective for the wetland mitigation program for North Windermere Island is to enable self-recruitment of mangrove individuals following installation of the culverts and initial mangal planting. With adequate biophysical conditions, self-recruitment is the long-term goal for North Windermere Island. Substantial alteration of water flow to achieve perceived optimal flushing time may impede self-recruitment due to changes in the critical hydrological regime.

1. **Boat basin Design.** The boat basin design incorporates natural walls and slopes to encourage recolonization of shoreline vegetation and use by local marine benthic species. Given the shallow depths of Savannah Sound, the boat basin will be excavated to a depth of five (5) ft below mean low.
2. **Flushing Channels.** Access to the boat basin is via the southern basin entrance channel. The two (2) northern culverts will allow for water circulation while eliminating high velocity water flow associated with tide changes to encourage natural recolonization of the existing mangrove community.
3. **Natural Coastline.** Homeowners will be discouraged from removing existing coastal vegetation around the boat basin and peninsula. Invasive species will be removed and replaced with native vegetation.
4. **Mangrove Planting.** Individual mangroves to be affected by construction will be removed and allocated for revegetation following construction completion. Where needed, additional mangroves will be planted as propagules to supplement natural recolonization.
5. **Waste Management.**
    a. Solid Waste Management. Trash will be collected, stored, and sorted at a designated location. Covered waste bins may be provided on and around the property to prevent litter.
    b. Liquid Waste Controls. All homes and facilities will be connected to the wastewater treatment plant to avoid excess nutrient inputs to the ground and adjacent coastal waters. Boats will must use pump out services if required.
    c. Pesticides, Fertilizers, and Herbicide Use. The community will discourage the application of pesticides, fertilizers, and herbicides to limit pollution into the waterbodies.
    d. Fuel. No fueling services will be provided at the boat basin.

12.5 Environmental Management

The United States National Ocean and Atmospheric Administration (NOAA) published guidance for planning and response considerations for oil spills in mangrove systems. It is recommended that the developer use this guide during construction and operation. While no fueling operations are anticipated, equipment refueling will occur on site during construction operations. This manual combined with an Environmental Management Plan and the above wetland mitigation techniques should facilitate a functional wetland habitat in association with the proposed boat basin.

12.6 Recommendations

- **Environmental Management Plan.** An Environmental Management Plan (EMP) is recommend prior to construction of the basin. An EMP will guide the workforce on best management practices (BMPs) for excavation activities in close proximity to sensitive environmental features.
- **Sediment and Erosion Controls**. Land clearing activities require use of best management practices (BMPs) to limit impacts to the environment. BMPS reduce the potential for sediment transport during storm events and entry into subsurface caverns and marine environment. Potential best management practices to consider include a drainage plan, geotechnical investigations, silt fencing and dewatering away from wetland features.
- **Materials Storage and Fuel Storage**. Materials storage should be kept away from sensitive environmental features. Fuel storage and refueling should adhere to best practices, including raised storage with either 110% containment mechanism or doubled walled tanks in the event of spill.

- **Invasive Species Removal.** Removal of invasive species considered a threat to small island nations will slow the proliferation of unwanted plant species. It is recommended that the developer perform routine removal of saplings to prevent recolonization.
- **Planting with native tree species.** A landscaping program that uses a palate of native trees will encourage visits by native fauna.

13 References

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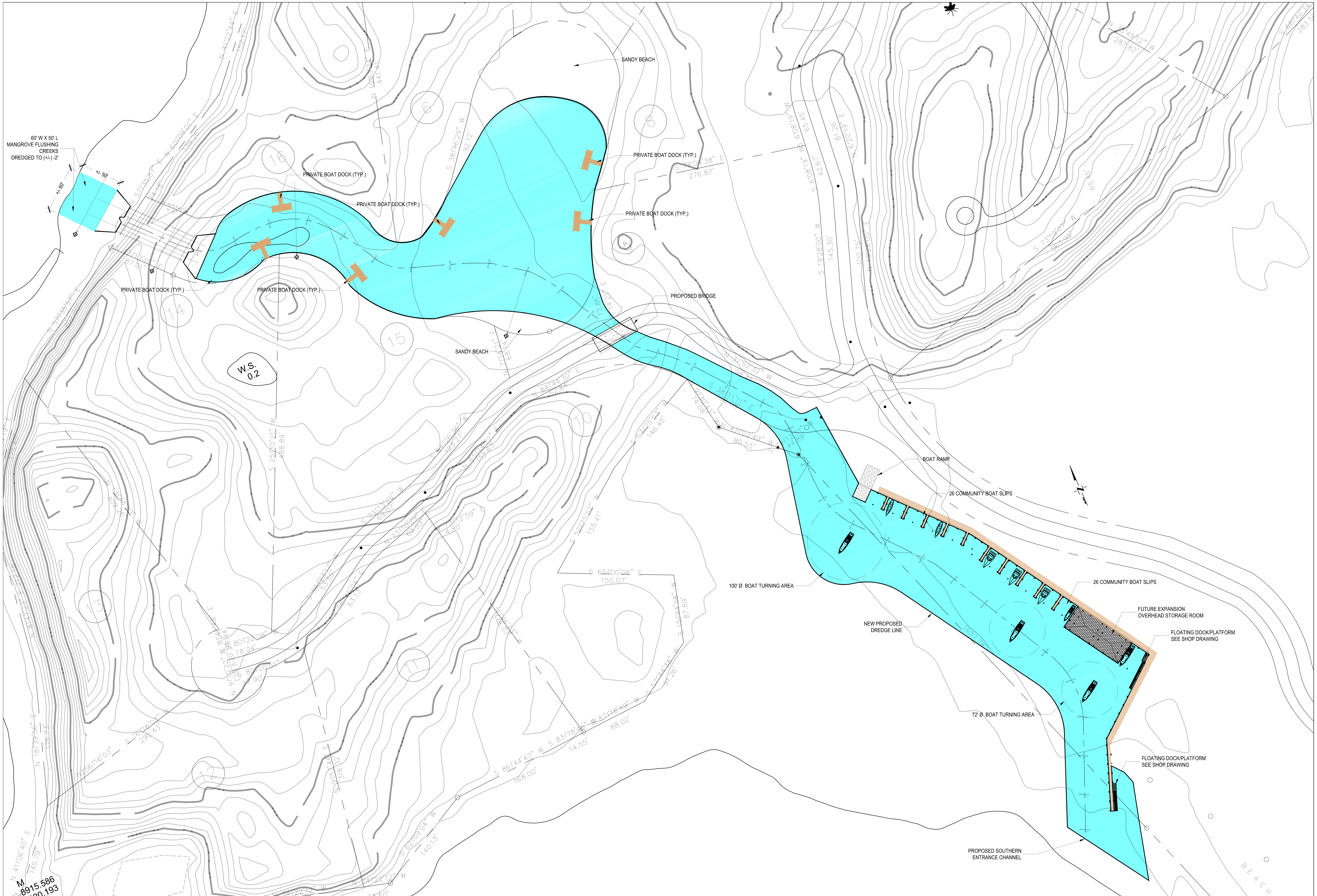
14 Appendix

14.1 Master Plan Including Topography, Dredge & Excavation Plan



LAGOON LAYOUT PLAN

SCALE: 1:600

REVISIONS	BY

ENGINEERING & TECHNICAL SERVICES
P.O.BOX SS 5589 NASSAU, N.P. BAHAMAS.
Tel: (242) 394-3219 Fax: (242) 394-4488

PROPOSED BOAT BASIN
WINDERMERE ISLAND, BAHAMAS

SHEET NAME:
LAGOON OVERVIEW PLAN

DRAWN :	CHECKED :
J.V.	L.K.

DATE : MAY 2019

SCALE : AS NOTED

JOB NO. :

SHEET

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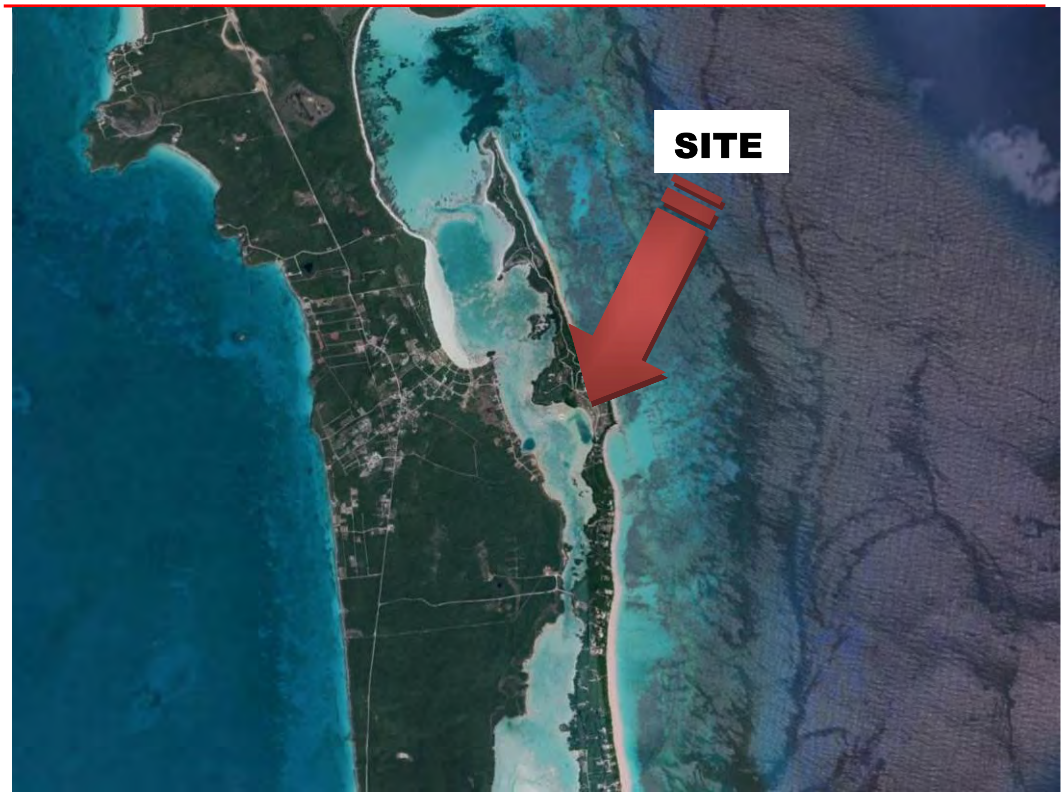
14.2 ETS Geotechnical Report

North Windermere Island Development

Proposed Boat BAsin

GEOTECHNICAL INVESTIGATION

Windermere Island, Eleuthera



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Issued February 07, 2019

1.0 Introduction and Scope

As requested by Mr. Eric Christensen, ETS completed a subsurface investigation for the proposed boat basin at North Windermere Island, Eleuthera. The site of the planned boat basin located west of the proposed hotel site.

Based on the information provided to it is our understanding that it is proposed to install a 40 slip boat basin with a depth of -4.0 below mean low water level. The bulkhead of the boat basin will consist of steel sheet piles and timber finger piers.

The scope of the subsurface investigation included site exploration, and an evaluation of the samples recovered to determine appropriate foundation design and construction parameters. The site exploration was carried out on October 23, 2018. The soil investigation consisted of completing four test pits within the proposed excavated areas.

The existing site surface elevation appears to range between three to five feet above mean sea level (MSL) based on the ground water level observed in the test pits.

2.0 Observations and Assessment

2.1 Region Geology

The general surface geology in the Bahama Islands is a mildly karst weathered limestone, with minor cavities along the surface. Generally, the Bahamas geology is predominately Lucayan limestone with a variable percentage of calcareous sands and coral. The limestone in the Bahamas is irregularly cemented with local areas of coral laminated between periods of sedimentation from the changes in the sea level.

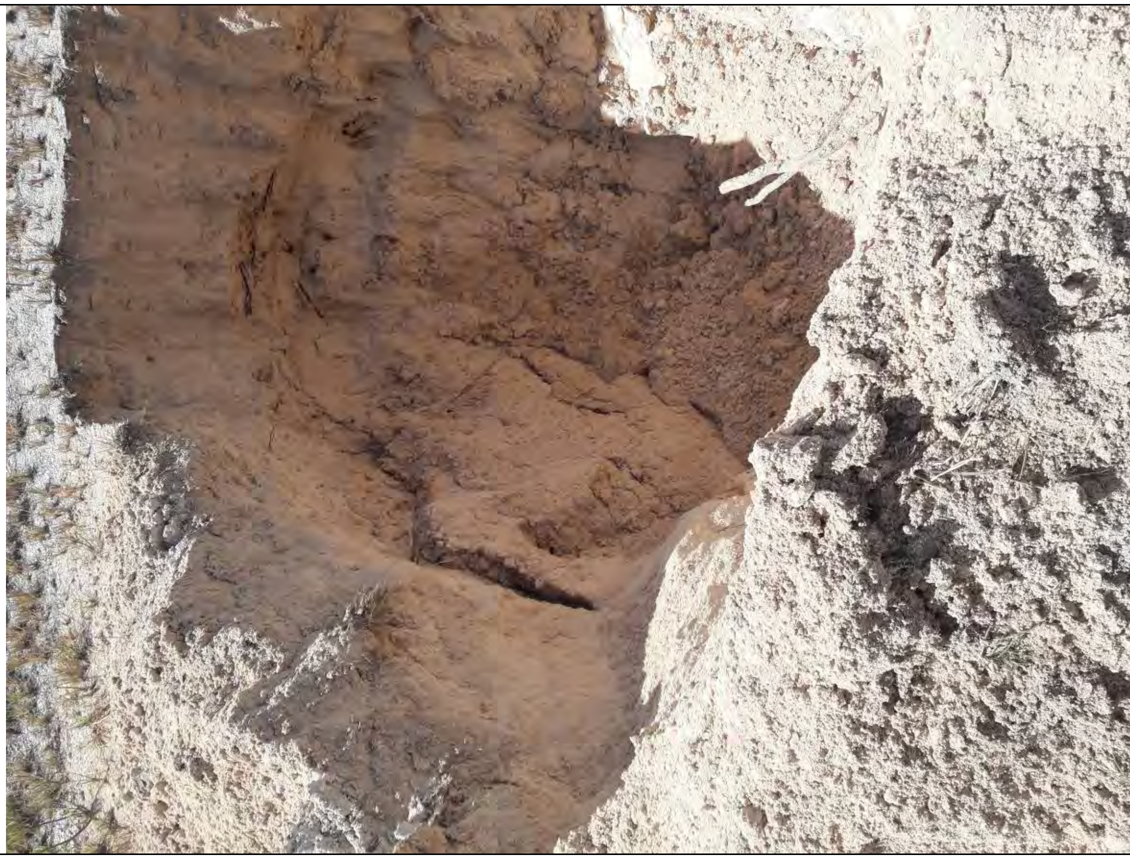
2.2 General Observations

Generally, the subsurface condition encountered consisted of loose fine sand from the surface to a depth of 24 to 30 inches below the surface. A silty sand was observed below this level to the test pit maximum depth of five feet below the surface. It is our understanding the observed silty sand is generally material deposited in the area during dredging of the existing basin. See Figure 1 for the approximate location of the test pits. See Figure 2 for gradation curve for representative sand and silt material samples.

Groundwater was encountered in each test pit at an average depth of 38 inches below the existing; however, it should be noted that the groundwater observations only reflect the groundwater conditions at the time of our exploration. Fluctuations of the groundwater table should be expected to occur both seasonally and annually due to variations in rainfall, evaporation, construction activities, and other site-specific factors.

FIGURE 1.0 – TEST PIT LOCATIONS

Cont………



TEST PIT #1

TEST PIT #1

Cont………

TEST PIT #2

TEST PIT #2

Cont………

TEST PIT #3

TEST PIT #3

Cont………

3.0 Foundation Design Parameters

Based on the site observations and anticipated design loads, it is our opinion that, from a geotechnical standpoint, the site is suitable for the proposed boat basin. Based on the preliminary design drawings the following is our recommended bulkhead design parameters:

Considering the ease of construction and performance on similar projects, it is our recommendation that a sheet pile walls be used for the bulkhead design. Our analysis indicate that a sheet pile wall installed to a depth of 28 feet below the existing grade for a cantilever wall or 20 feet below grade for a anchor wall. ***It is recommended that cantilever AZ14-770 A 572 Gr. 60 sheet pile be installed to a depth of no less than 25 feet below the existing grade for total pile length of 30 feet.***

Based on the test pit observations and sample testing the following table is a summary of the recommended design parameters.

TABLE 1.0 DESIGN PARAMETERS

DEPTH (FEET)	LOCATION / DESCRIPTION	EFFECTIVE UNIT WEIGHT (PCF)	ANGLE OF FRICTION	ALLOWABLE BEARING CAPACITY (PSF)
0 to 2	SAND	90	30	2500
2 to 10	SILTY SAND	125	28	1500
10 to 30	SANDY LIMESTONE (ASSUMED)	95	32	3000

4.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations in this report are based on soil conditions encountered during the soil investigation; however, if the soil conditions encountered during construction should differ significantly from those reported we should be contacted to provide supplemental recommendations.

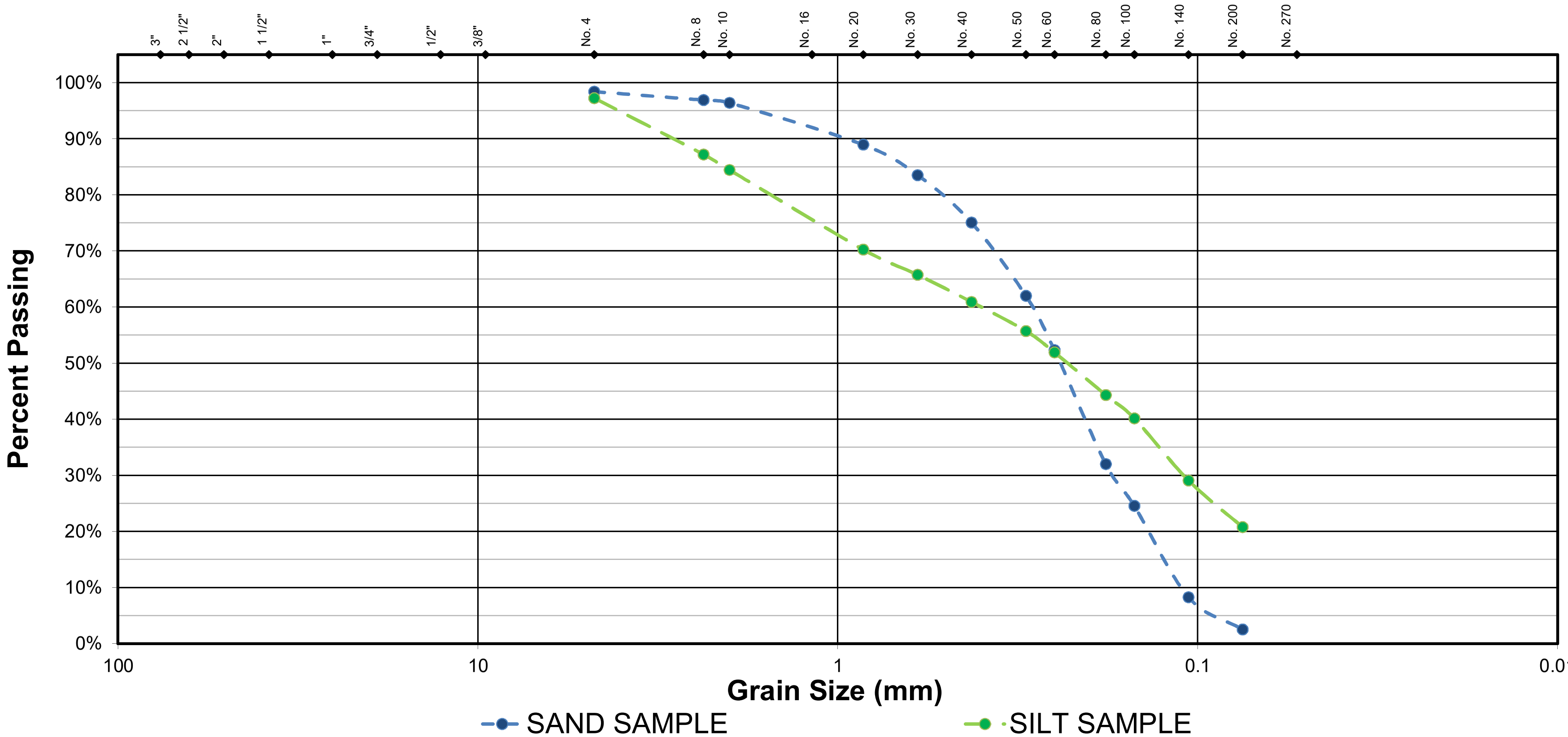
We appreciate the opportunity to be of service in preparing this report. If you have any questions on the above or require additional assistance, please do not hesitate to contact the undersigned.

LAMBERT KNOWLES, P.E.
ENGINEERING & TECHNICAL SERVICES
CONSULTING ENGINEERS

ets
ENGINEERING AND TECHNICAL SERVICES

FIGURE 2.0 - GRAIN SIZE DISTRIBUTIOM

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL	SAND		SILT	CLAY
	Coarse to Medium	Fine		

Project Name:	NORTH WINDERMERE ISLAND	ETS File Number:	
Project Location:	PROPOSED BOAT BASIN		
Client Name:	NW DEVELOPMENT	TEST DATE	DEC. 4, 2018
Sample No.:	1 AND 2	USCS CLASSIFICATION	SM
Sample Description:	SAND AND SILT SAMPLE		
Percent Passing No. 200 Sieve =	SAND: 10.7%, SILT: 67.1%	% Mass Loss During Test =	

ENGINEERING & TECHNICAL SERVICES

14.3 Cummins Flushing Report

Flushing Analysis

Windermere Island Club Marina
Eleuthera, The Bahamas

Revision 2, July 2019

Prepared for:
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TABLE OF CONTENTS

1 Executive Summary

Cummins Cederberg was engaged by Windermere Operations, LLC (Client) to prepare an engineering analysis relative to the flushing of the proposed marina basin for the Windermere Island Club Marina in Eleuthera, The Bahamas. A site visit was conducted to observe and measure the coastal processes for the development and calibration of a hydrodynamic model. Published design standards on flushing were reviewed, and a preliminary desktop analysis of the flushing time was conducted. Following the development of the numerical model, a simulation of the hydrodynamics was conducted. The modeled hydrodynamic parameters were compared with the measured parameters and the values were deemed to be within reason to proceed with a numerical flushing analysis. Based on documentation provided by the client, the proposed marina basin was digitized and incorporated into the numerical model. Next, a simulation of the flushing in the marina basin was conducted utilizing the developed numerical model and the outputs were analyzed. Further, design improvements to the original master plan to include two large culverts and corresponding channel versus the original proposed three flushing creeks. A flushing analysis was conducted on the new basin layout and compared against the original master plan.

The following conclusions were obtained based on the analyses results:

- The modeled flushing time for the proposed marina basin based on a 50% dilution factor is approximately 2 days and 6 hours.
- The modeled flushing time for the marina basin based on a 10% dilution factor is approximately 4 days.
- Based on the available published standards for flushing and simulation results, the proposed marina basin configuration exhibits an acceptable flushing time.
- Proposed improvements to the north flushing channel include replacing the three creeks with two large culverts, 28.3 m (93ft) in length and 4.7 m (15.33 ft) by 3.15 m (10.33 ft) in diameter, and a corresponding channel of 18.3 m (60 ft) and 15.3 m (50 ft).
- The proposed improvements resulted in a 15% dilution factor after 1 day and a 2.7% dilution factor after 2 days.
- The modeled flushing time of the proposed improvements based on a 50% dilution factor is approximately 13 hours
- The modeled flushing time of the proposed improvements based on a 10% dilution factor is approximately 27 hours (1 day and 3 hours)
- The modeled dilution factor at 12 hours, 24 hours, 36 hours, and 48 hours for the proposed improvements is 72.7%, 15.1%, 5.7%, and 2.66% respectively.
- Changing the three flushing creeks to two large culverts and a channel resulted in an 82% higher wetted perimeter and a more optimized flushing time for the proposed marina basin.

2 INTRODUCTION

2.1 Background

Cummins Cederberg, Inc. (Cummins Cederberg) was engaged by Windermere Operations LLC (Client) to prepare an engineering analysis relative to the flushing of the marina basin proposed Windermere Island Club Marina development project (Project) located in Eleuthera, The Bahamas.

2.2 Objective

The proposed Project includes the creation of an internal basin with a docking facility and individual dock structures, along with small flushing 'creeks' through an existing mangrove shoreline to connect back out to the bay. The objective of the present engineering analysis is to evaluate the flushing characteristics of the proposed internal basin and the efficacy of the proposed additional 'creeks' to the overall flushing. This objective was updated to present an engineering analysis of proposed enhancements to the original design to replace the flushing 'creeks' with two large culverts and a corresponding channel.

2.3 Scope

The scope of work included the following components:

Site Visit and Current Measurements: Cummins Cederberg visually evaluated the coastal processes within the vicinity of the Project site, specifically of the existing topography and bathymetry, shoreline configuration, sediment transport, and wind and wave characteristics. Two tide gauges were deployed to record water levels throughout the duration of the visit, and current measurements were obtained in strategic locations for subsequent use in calibrating the numerical model.

Hydrodynamic and Transport Modeling: Cummins Cederberg developed a detailed model domain utilizing existing available bathymetric survey data for the site and the proposed lagoon layout, along with available and measure tidal data. The MIKE21 HD FM numerical model was utilized to perform numerical model simulations of the tidal hydrodynamics in the vicinity for the proposed conditions in order to analyze the flow characteristics. The MIKE 21 HD FM Transport numerical model was utilized to visually simulate the exchange of water throughout the proposed marina basin. Dispersion of an artificial dye was simulated to identify potential areas of stagnant water. The flushing time to exchange the majority of the water was evaluated and compared to industry standards for water quality.

The report presented herein was developed to document the above-described analyses.

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3 Site Conditions

The Project site is located in Eleuthera, The Bahamas (refer to Figures 3.1). Specifically, the Project site is located on the northern half of Windermere Island. Windermere Island faces the Atlantic Ocean to the east and faces mainland Eleuthera to the west. The eastern portion of Windermere Island is lined with sandy beaches, while the western portion is lined with both beaches and vegetation.

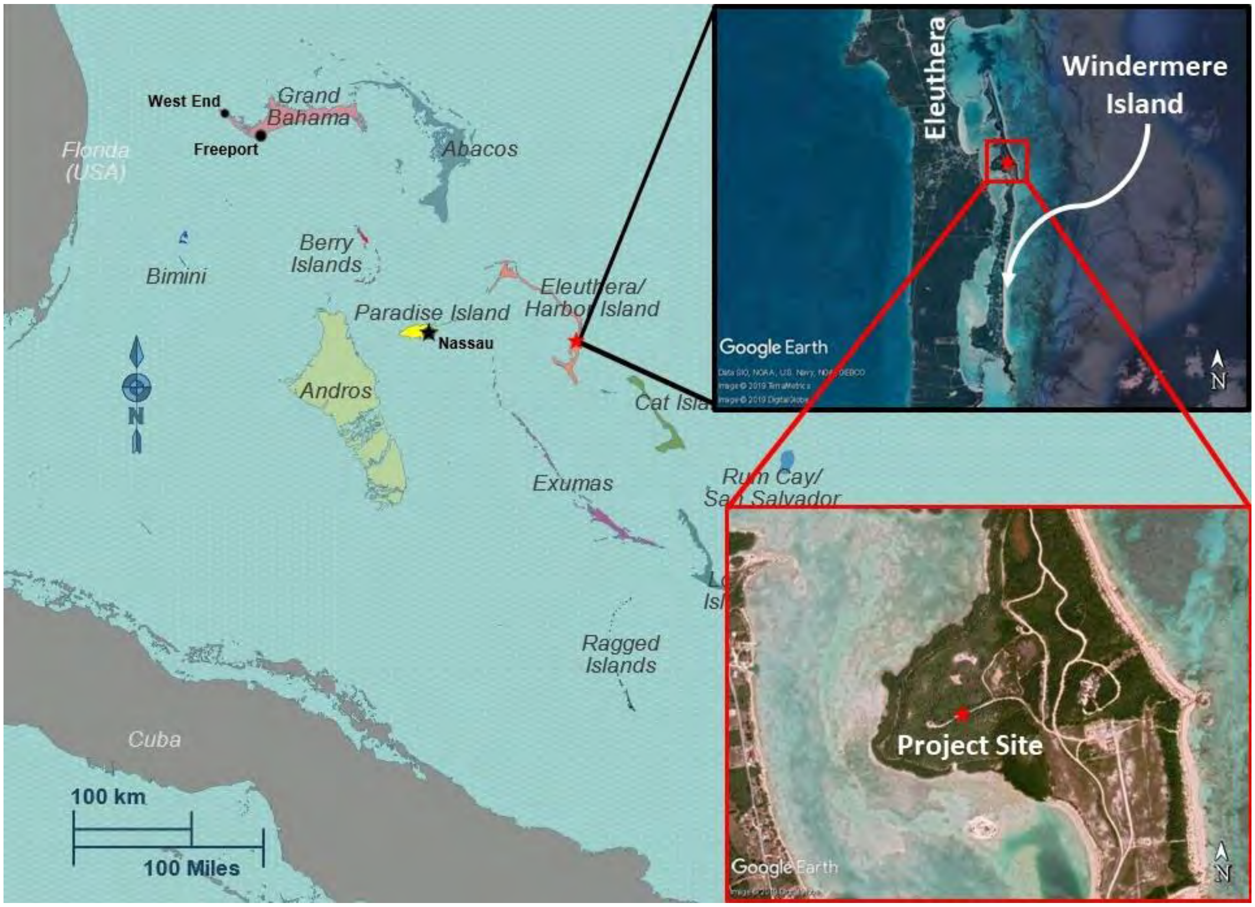


Figure 3.1 Location Map

A bay is formed between Windermere Island and mainland Eleuthera, with an opening (facing east) measuring approximately 1 km on the north, and an opening on the south (facing south) measuring approximately 0.7 km. The bay varies in width, with wide portions measuring approximately 1 km on both the north and south end, while the narrowest point within the bay is located at the bridge which connects Windermere Island with mainland Eleuthera, with a width of approximately 30 m. The bay includes features such as grass flats, sand shoals, mangrove clusters, and ironshore islands. Water depths vary greatly within the bay, with multiple sandy shoals being exposed during low tide, and a relatively deep blue-hole.

3.1 Tides

The National Oceanic and Atmospheric Administration (NOAA) provides Tidal predictions for both the eastern (Atlantic Ocean) and the western (Bahamas Bank) sides of Eleuthera. The tidal water level predictions for station TEC4627 (Eleuthera Island, East Coast) provided by NOAA compare well with the peak measurements recorded by tide gages installed by Cummins Cederberg (refer to section 4). The peak water levels measured are summarized in Table 2.1.

TABLE 2.1

Measured Tidal Water Levels, Eleuthera Island, East Coast

Water Level	Elevation (m, Lowest Measured Water Level on 1/21/2019)
High Water Level	1.2 m (4 ft)
Low Water Level	0.0 m (0 ft)

3.2 Winds

Winds are predominantly from the east with stronger easterly-northeasterly winds in the winter and milder easterly-southeasterly winds in the summer. Extreme wind speeds can occur at the Project Site since it is located in the Caribbean region, which is a hurricane prone area.

3.3 Waves

The Project Site is mainly exposed to wind generated waves generated within the previously described bay between Windermere Island and mainland Eleuthera. As such, during predominantly easterly wind direction, waves at the project site are limited. During periods of northerly winds, typically during the winter months, wave activity is experienced at the site, as waves can build up, spread, and refract into the project area. However, due to the limited fetch and relatively shallow water depths the waves are generally not large in magnitude, as compared to the Atlantic Ocean side.

4 FIELD INVESTIGATIONS

On January 22nd, a team of Cummins Cederberg coastal engineers conducted both water level measurements and current measurements at strategic locations near the project site to aid in the development and calibration of a hydrodynamic model for the Project.

4.1 Water Levels

Water levels were recorded in two locations near the Project site using two separate tide gages. The locations of the tide gages are shown in Figure 4.3. The tide gages were set to sample water levels at 2-minute intervals. The tidal range at both locations was approximately 4 feet. NOAA's predicted tide levels for the day of the water level recordings agrees with the 4 ft range recorded by the tide gages. A comparison is shown in Figures 4.1 and 4.2.

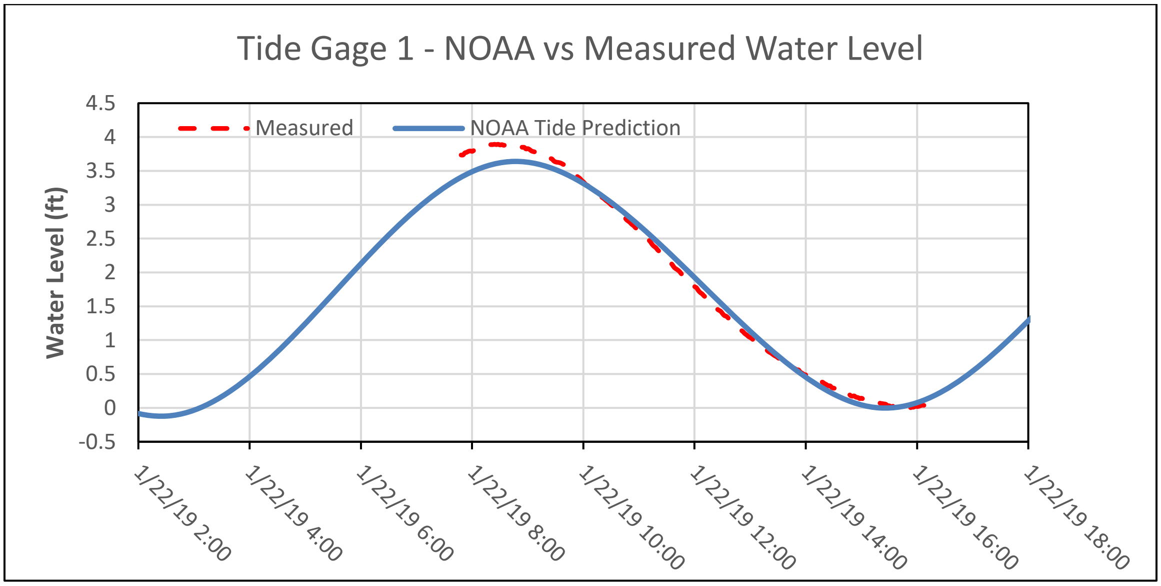


Figure 4.1 Tide Gage 1 Measurements vs NOAA Prediction

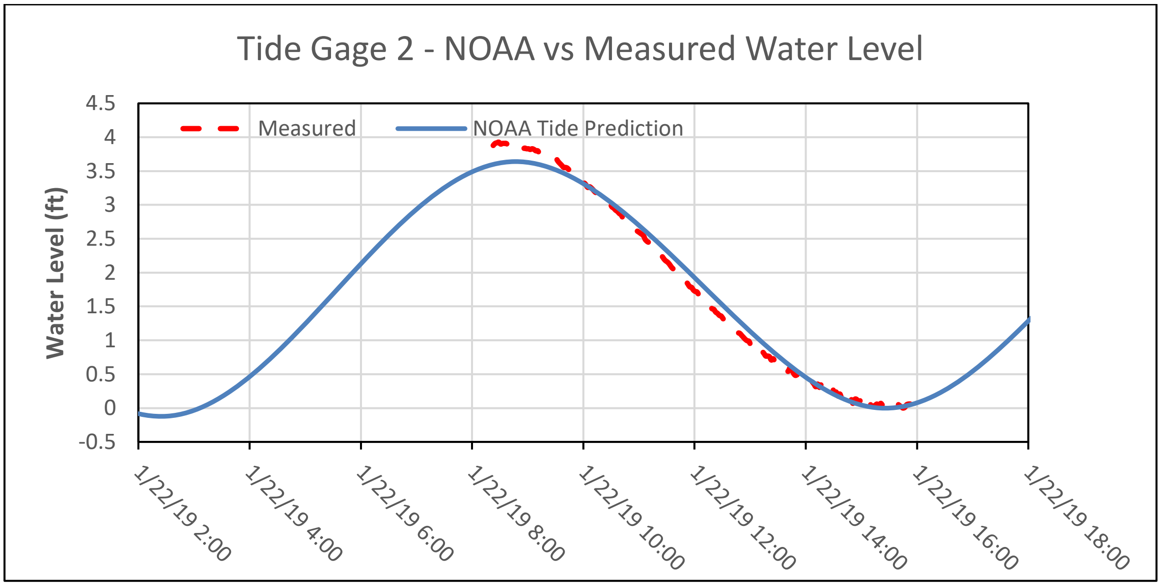


Figure 4.2 Tide Gage 2 Measurements vs NOAA Prediction

4.2 Current Measurements

The current measurements were conducted at the location of the bridge connecting Windermere Island with mainland Eleuthera, as shown in Figure 4.3. The location of this measurement was selected as the flow through this location was expected to induce a clear signal of directionality and flow. A peak southerly current was measured at 0.6 m/s (2 ft/s).

Figure 4.3 Measurement Locations

5 FLUSHING

Flushing is an important characteristic of natural and artificial tidal lagoons. Appropriate flushing promotes water quality as well as improves the lagoon's environmental and recreational aspects. For tidal lagoons, the potential for good water quality is typically assessed through the evaluation of the flushing time. The flushing time is the time required to exchange a percentage of water from the lagoon with the ambient area based on mixing, water circulation, tidal variations and other mechanisms. Short flushing times are desirable in the lagoon since it reduces the potential for stagnant water and the concentrations of contaminants that might enter the lagoon via stormwater runoff or other avenues, thus improving the water quality of the lagoon.

5.1 Proposed Master Plan

A master plan along with schematic drawings of the proposed marina basin were provided by the Client, illustrating geometry and features (refer to Attachment A). The proposed marina basin consists of a southern entrance channel measuring approximately 38 m (125 ft) in width. On the northern end, three creeks are proposed within mangroves to aid in the flushing of the basin, which would otherwise be a dead end. Small docks are located through the length of the basin. The water depths throughout the entire marina basin are proposed at 1.2 m (4 ft), except for the flushing creeks between the mangroves, where the water depth is proposed at 0.6 m (2 ft), relative to mean low water.

5.2 Flushing Time

Values for the recommended flushing time vary based on the defining entity. The U.S. Environmental Protection Agency defines the flushing time as the time to reduce a concentration to 10% of its original concentration. In Florida a flushing time of less than 4 days relative to a 10% level is typically required by environmental agencies. Mangor defines the flushing time as the time to reduce a concentration to 50% of its original concentration and states a flushing time of 5-7 days is generally acceptable for swimming in artificial lagoons.

5.3 Tidal Prism Analysis

As a precursor to the more complex numerical model a desktop analysis in the form of a Tidal Prism Analysis (TPA) was conducted to understand the potential upper and lower limits of the analysis.

The TPA considers the average basin depth at low tide and high tide, the surface area of the marina, and the tidal cycle. Utilizing these basin characteristics, it is possible to estimate the flushing time based on a dilution factor (i.e. reduction percentage of original concentration). The flushing time can be estimated with the following equation, assuming nonvertical sides and nontidal freshwater inflow:

$$T_f = \frac{T_c \log D}{\log\left(\frac{V_L + b \times V_p}{V_H}\right)}$$

Where:

T_f = Flushing time
D = Dilution factor
V_L = Volume of basin at low tide
V_p = Volume of basin tidal prism $(V_H - V_L)$
T_c = Tidal cycle time
b = Return flow factor
V_H = Volume of basin at high tide

The tidal cycle was selected as 12.4 hours, which is consistent with semi-diurnal tide observed in Eleuthera and the associated tidal predictions. The volume of the basin during low and high tide was calculated using the tidal water levels shown in Table 2.1 and using the geometric characteristics of the marina basin lagoon shown in the documents provided by the Client (refer to Attachment A). The return flow factor is based on the percentage of the water previously 'flushed' from the marina on the outgoing tide and expressed as a decimal fraction. This value was utilized as a sensitivity parameter to evaluate the flushing time, with values of 0.1 and 0.5.

Using a dilution factor of 50%, the flushing time required ranges from 17 hours to 35 hours based on the sensitivity parameter (return flow factor), which is considered more than adequate for swimming conditions. With a dilution factor of 10%, the flushing time required ranges from 2.5 day to 4.9 days. The lower end of the calculated range is below the US EPA time, while the upper end is above the US EPA time. A return flow factor of 0.1 is aggressive, as it assumes a large fraction of the water exiting the marina basin does not return to the basin. Based on the hydrodynamic characteristics of the project site, the flow factor is expected to be closer to 0.5 due to the north-south orientation of the entrance and flushing channels and the cyclical southerly-northerly flow of water observed during the site visit. The desktop analysis suggests the flushing characteristics of the proposed marina basin are favorable.

5.4 Hydrodynamic Modeling

To thoroughly analyze the flushing time, a hydrodynamic numerical model was developed utilizing the MIKE21 Hydrodynamic Model (HD) engineering software package. The MIKE21 HD numerical model simulates two-dimensional water level variations and flows in response to a variety of forcing mechanisms in canals, lakes, estuaries and coastal areas. In the aforementioned hydrodynamic model, the water levels and flows are resolved on a flexible triangular grid covering the area of interest when provided with the bathymetry, bed resistance coefficients, wind field, and hydrographic boundary conditions. The output of the numerical model includes a time series of water surface elevation, flux, current velocity, and directions at specified grid points.

The Transport module of the MIKE21 HD FM model simulates the transport of suspended substances based on the flow conditions from the hydrodynamic calculations. In the two-dimensional simulation, described herein, the dispersion coefficient is calculated as the eddy viscosity, used in the solution of the flow equations, multiplied by a scaling factor. In a typical MIKE21 HD FM simulation with the Transport module, the substance concentrations are resolved on a flexible triangular grid covering the area of interest, when provided with the inputs to the hydrodynamic model, initial concentration and decay characteristics, along with boundary conditions. The output of the Transport module includes a time series of substance concentrations and current velocities at all specified grid points.

Other model parameters in the MIKE21 HD FM model include bed resistance and eddy viscosity. Bed resistance is the resistance of the seabed to the water flow and can be used for model calibration. In the simulations performed for this study, the bed resistance formulation implemented the Manning Equation, in which the Manning number was set to the constant value of 32 $m^{1/3}/s$. Eddy viscosity is used to model the turbulence encountered within the simulation. Specifically, the Smagorinsky formulation, (which calculates the eddy viscosity as a time-varying function of the local velocity gradients multiplied by a constant value) was applied with a constant value of 0.28.

5.4.1 Model Setup

The numerical model domain, shown in Figure 5.1 measures approximately 1500 km in the east-west direction and 1100 km in the north-south direction. The bathymetric data outside the Project Site area was derived from an in-house database of global water depths. The domain of the model within the extents of the Project Site was digitized using varying triangle sizes incorporating bathymetric data obtained from observations during the site visit and available chart data.

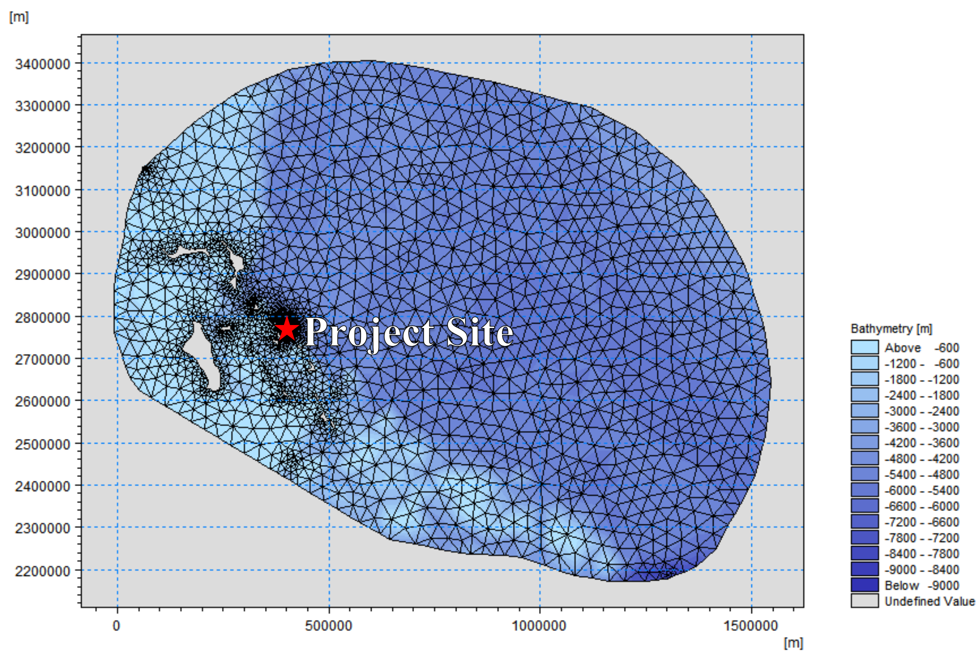


Figure 5.1 Modeling Domain

Figure 5.2 shows a zoomed-in view of the area near the Project Site, showcasing the refined numerical mesh used near the site. Tidal water levels for the numerical model were imported from MIKE 21’s Global Tide Model (GTM). The GTM provides tidal data from derived from 17 years of multi-mission satellite altimeter data, validated with coastal tide gauges located around the globe.

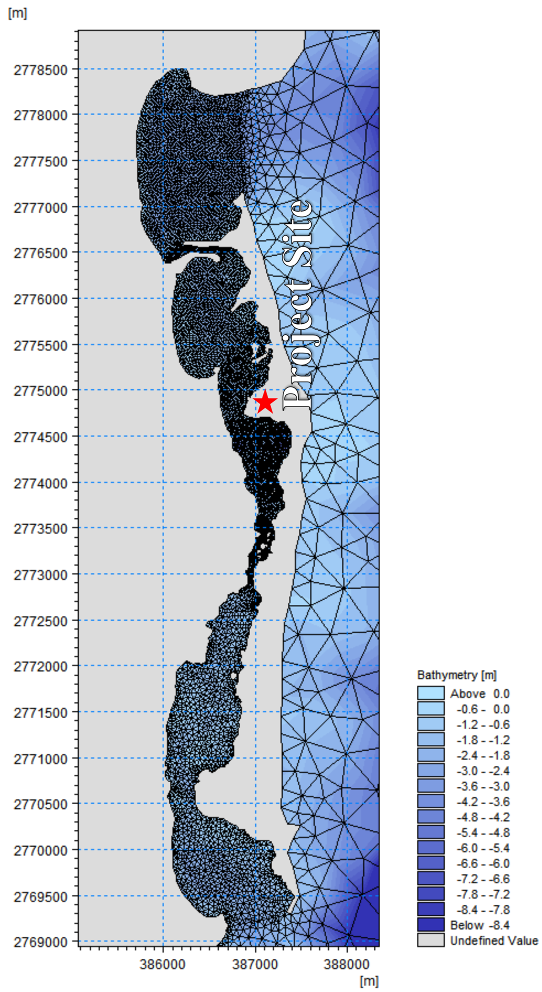


Figure 5.2 Refined Meshed Near Project Area

5.4.2 Existing Conditions and Calibration

Prior to the analysis of the flushing time using the numerical model, a comparison between the measured, observed, and predicted elements at the project site were conducted to compare the numerical model output with observations. The water flow in the project area was simulated utilizing the tidal water level variations derived from the GTM, thereby simulating the ebb and flood tide experienced in the bay. Using the created numerical mesh and the tide input conditions, the hydrodynamic calculations were performed.

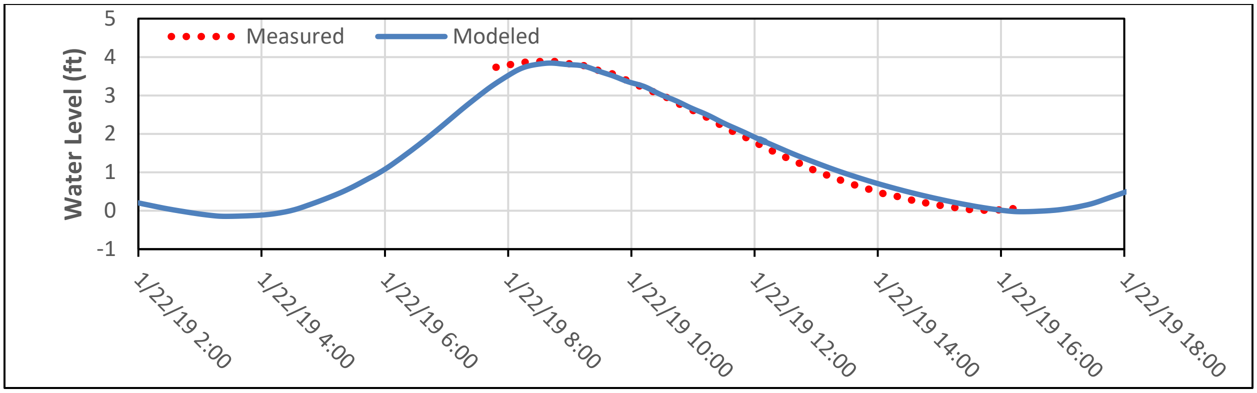


Figure 5.3 Measured and Modeled Water Levels at Tide Gage Location 1

Surface water level outputs of the numerical model were extracted at the location of the tide gages to compare the modeled water level to the water level measured by the tide gages. Figure 5.3 and A5.4 illustrates the comparison between the modeled water levels and measured water levels by both tide gages. The data also matches well with the prediction from NOAA's tide station TEC4627. Based on the graphs of the modeled and measured tidal water levels, it appears there is a difference in the timing of nearly 0.5 to 1 hour between the recorded low and high water peaks. The offset is consistent, meaning the tidal period is consistent with measurements and the modeled tidal amplitude matches the measured amplitude.

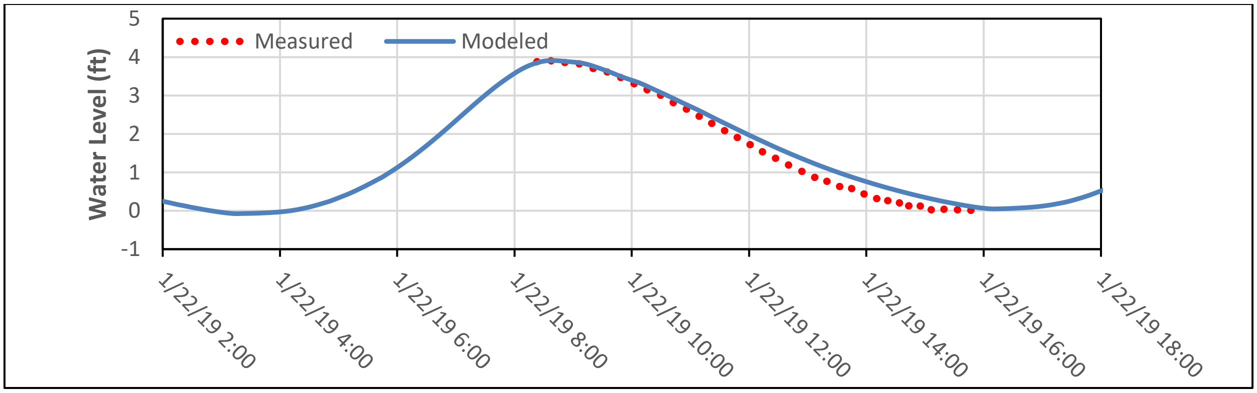


Figure 5.4 Measured and Modeled Water Levels at Tide Gage Location 2

Current speeds were extracted from the numerical model at the bridge location where the field current measurements were performed. Figure 5.5 illustrates the comparison between the modeled current speeds and the measured current speeds. It is noted there is a tidal lag of approximately 2 hours between the modeled current speeds and the measured current speeds, which could arise from the lag in the water levels from the measured and modeled water levels. The magnitude of the measured current speeds and modeled current speeds are in agreement. In general, the outputs of the numerical model are comparable with observed, predicted, and measured elements at the project site.

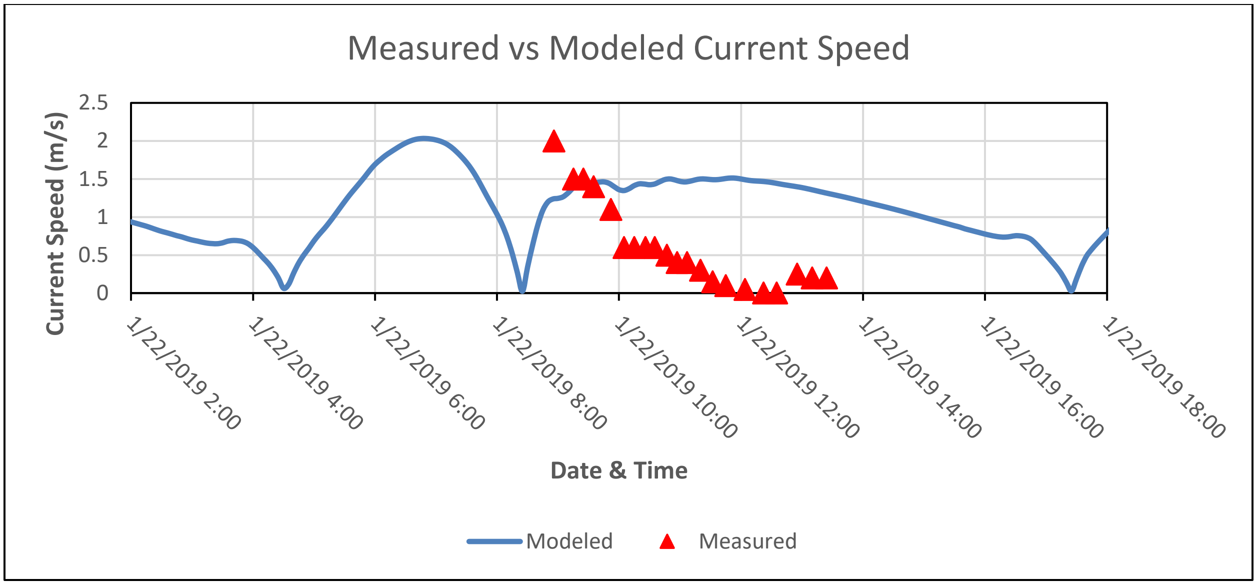


Figure 5.5 Modeled and Measured Current Speeds 1

5.4.3 Flushing Simulation

Utilizing the proposed marina basin schematics provided by the client, the marina basin was digitized and integrated into the previously developed numerical model. A fine resolution mesh was created to accurately model the shape of the basin, and the water depths were input as described in the proposed plans. A snapshot of the proposed marina basin numerical mesh is shown in Figure 5.6.

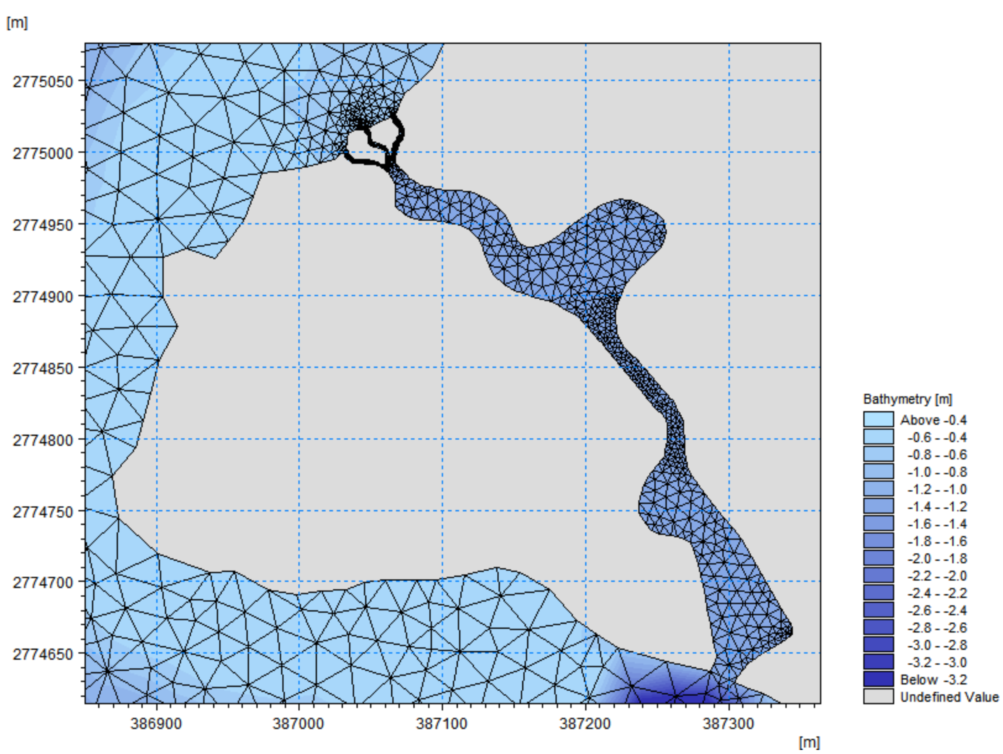


Figure 5.6 Proposed Marina Basin in Numerical Model

To carry out the simulation, an initial condition with a concentration of 100% was placed into the extents of the marina basin, as shown in Figure 5.7. To obtain an upper value of the flushing time, no wind was added to the flushing simulation. Including the wind will improve flushing and further reduce the flushing time. The simulated flushing characteristics are then compared with the previously described published guidelines.

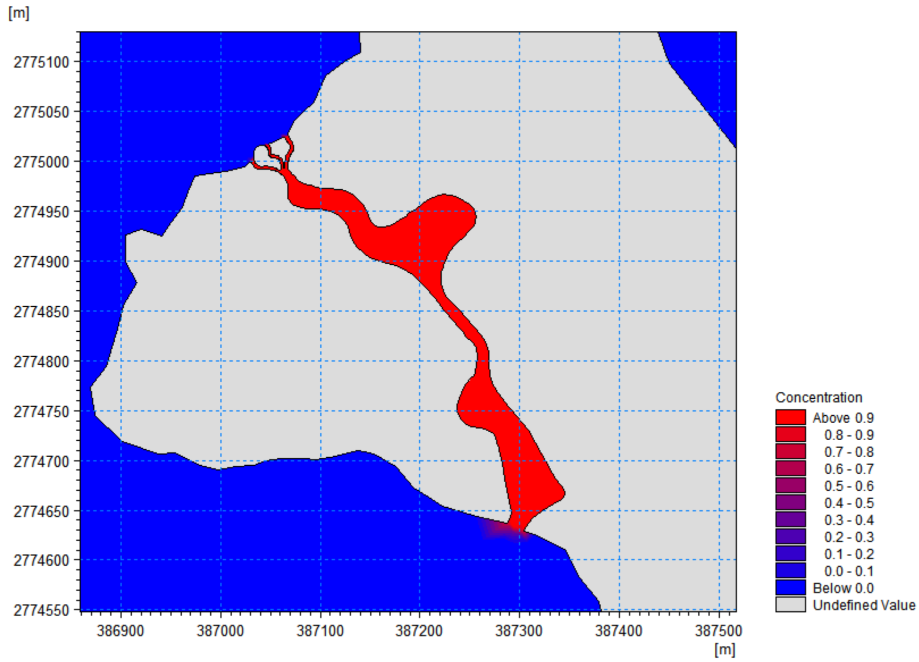


Figure 5.7 Proposed Marina Basin in Numerical Model

5.4.4 Results

Figure 5.9 shows the concentration percentage after selected elapsed times (i.e. 6, 12, 18, …, 96 hours) for the different lagoon concentrations. The results of the numerical modeling show the flushing time to be approximately 2 days and 6 hours for a 50% dilution factor, and approximately 4 days for a 10% dilution factor, values which are acceptable within published standards by both Mangor and the EPA. Furthermore, the values are similar and within the range of the values calculated utilizing the TPA desktop analysis. Therefore, the configuration of the proposed marina basin provides adequate flushing conditions.

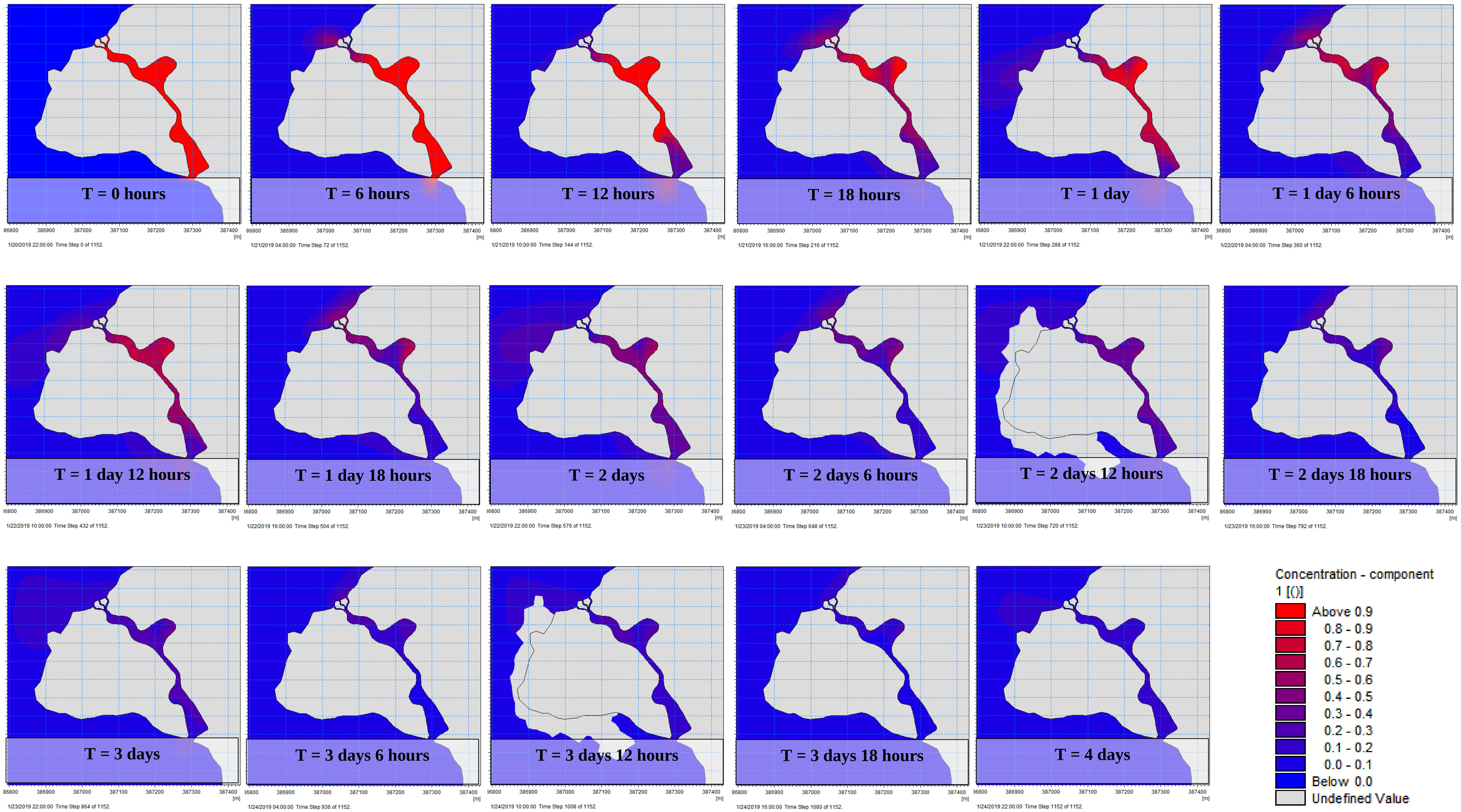


Figure 5.9 Flushing Numerical Model Results

5.5 Revised Master Plan

5.5.1 Flushing Channel Improvements

Design improvements were proposed for the north flushing channel in order to improve flushing of the basin. The three proposed creeks were replaced with two large culverts, of 28.3 m (93 ft) in length and 4.67 m (15.33 ft) by 3.15 m (10.33 ft) diameter and a corresponding channel of 18.3 m (60 ft) by 15.3 m (50 ft). The culverts have an approximate wetted perimeter of 8.4 m (28 ft) and the channel an approximate wetted perimeter of 11.6 m (38 ft) and the water depth is proposed at -0.6 m (-2 ft) relative to mean sea level. The total wetted perimeter in the proposed improvements is 37.8 m (124 ft), which is a 17.1 m (56 ft), 82%, increase from the original proposed master plan.

5.5.2 Flushing Simulation

The digital model was updated based on the schematics of the culverts and northern channel entrance provided by the client. The fine resolution mesh was created to accurately model these changes to determine if this new layout will further optimize the flushing of the channel. A snapshot of the modified marina basin numerical mesh is shown below in Figure 5.10

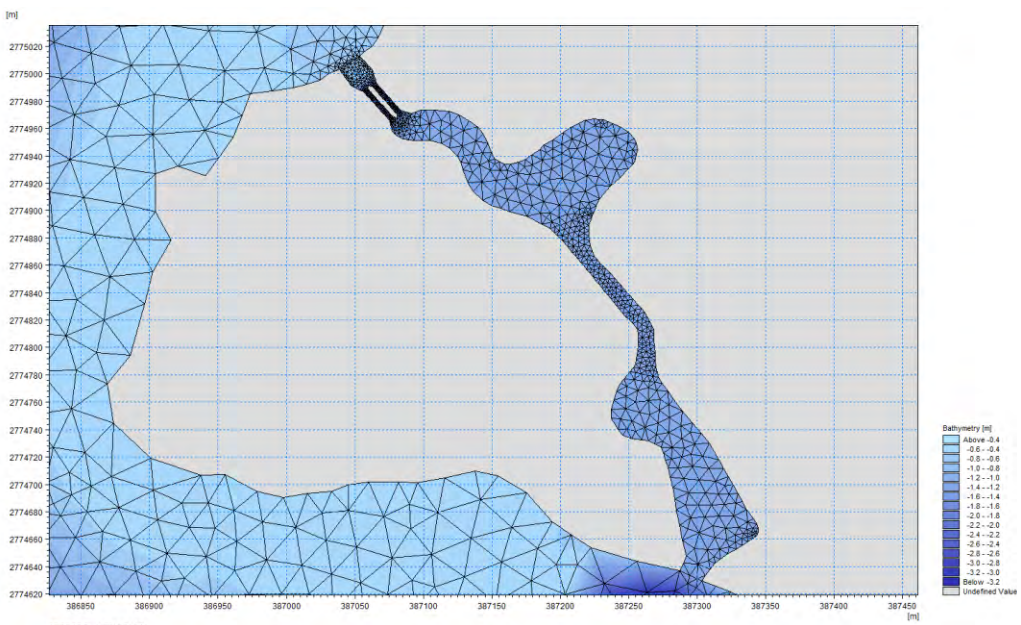


Figure 5.10 Modified Marina Basin in Numerical Model

To carry out the simulation, an initial condition with a concentration of 100% was placed into the extents of the marina basin, as shown in Figure 5.11. In additional, an easterly wind of 6 m/s was adopted for the simulation to reflect representative conditions at the site. The simulated flushing characteristics were then compared with the previous model results and published guidelines.

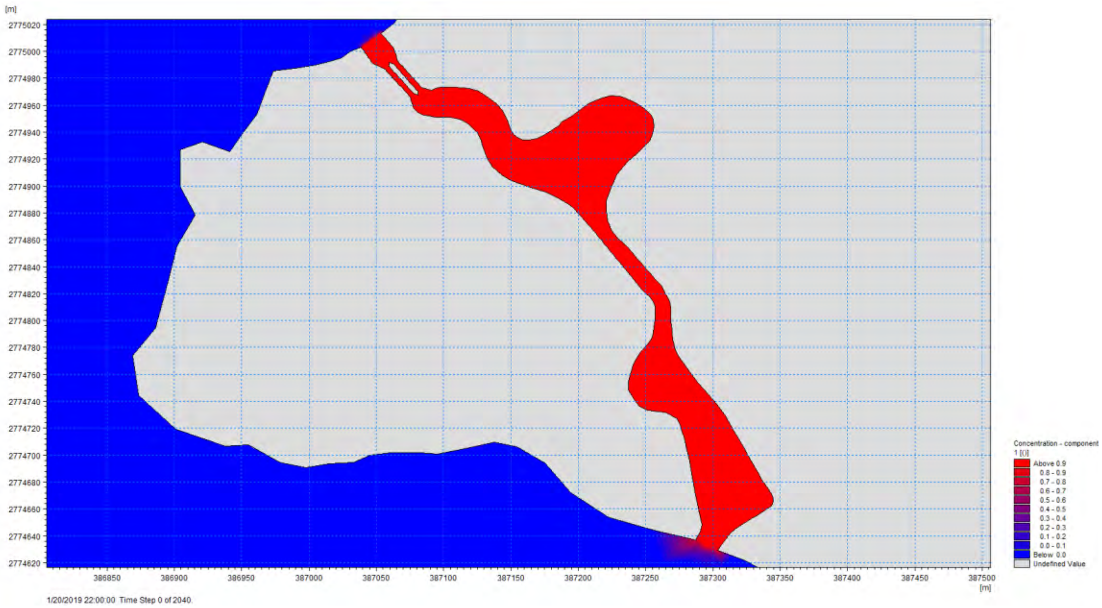


Figure 5.11 Modified Marina Basin Initial Condition

5.5.3 Results

Figure 5.12 shows the concentration percentage after selected elapsed times (i.e. 6, 12, 18, …, 48 hours) for the different basin concentrations. The results of the numerical modeling show that after one day the average concentration remaining in the basin is approximately 15%, and after two days the average concentration remaining in the basin is approximately 2.7%. Additionally, the modeled dilution factor at 12 hours, 24 hours, 36 hours, and 48 hours for the proposed improvements is 72.7%, 15.1%, 5.7%, and 2.66% respectively.

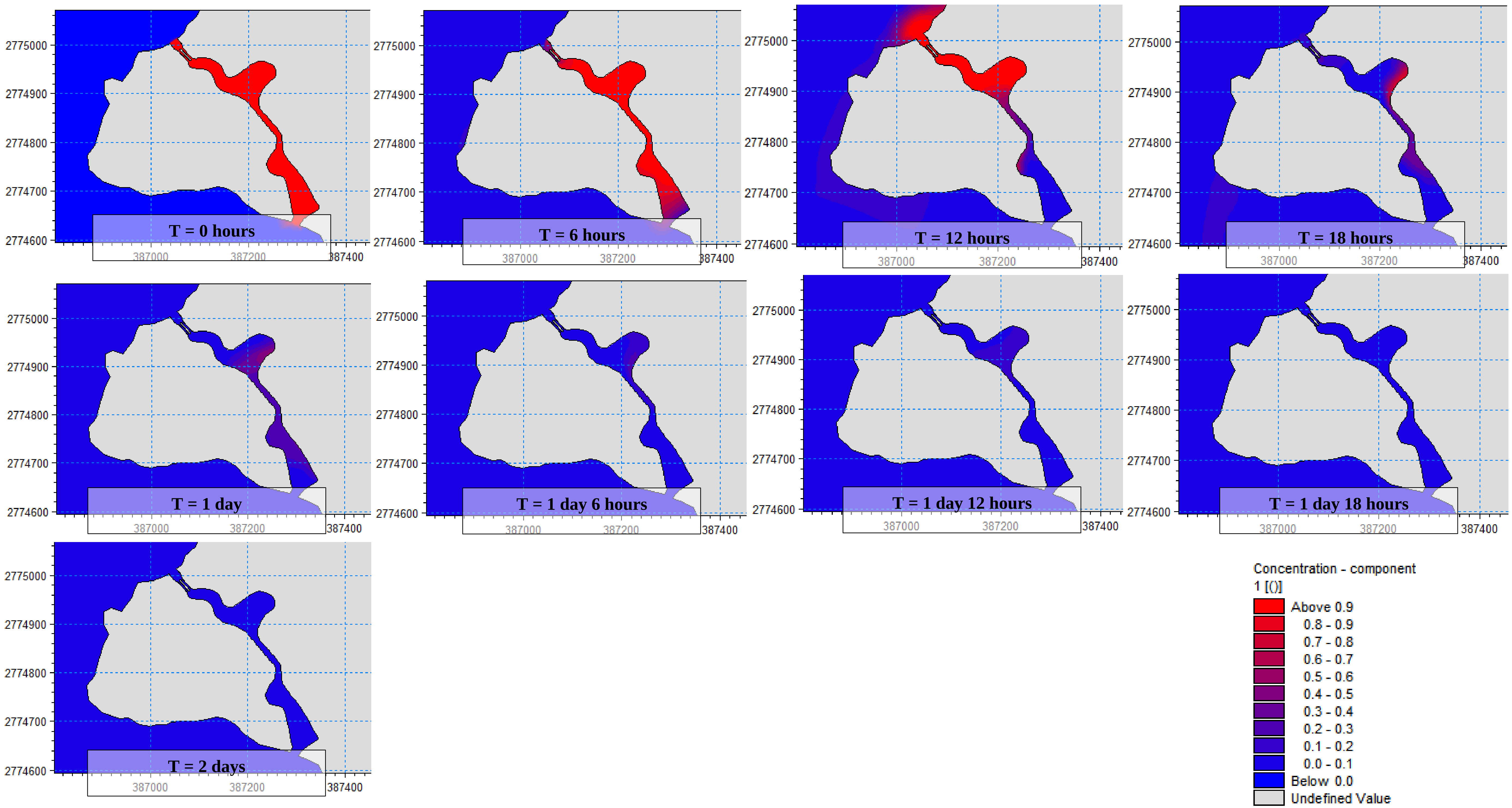


Figure 5.12 Modified Plan Flushing Numerical Model Results

6 CONCLUSIONS

A site visit was conducted to measure and observe the coastal processes involving the flushing for a proposed marina basin at Windermere Island, Eleuthera The Bahamas. The site visit consisted of a team of Cummins Cederberg engineers who measure tidal water level variations near the project site using tide gages, and measured currents at a strategic location for the development and calibration of a numerical hydrodynamic model. The layout of the marina basin included three flushing creeks on the north side of the Project Site and an entrance channel to the marina basin on the south side. Both a desktop and numerical flushing analysis was conducted to evaluate the flushing conditions of the proposed marina basin. In order to improve flushing of the basin, design improvements were proposed for the north flushing channel.

The following conclusions were obtained based on the analyses results:

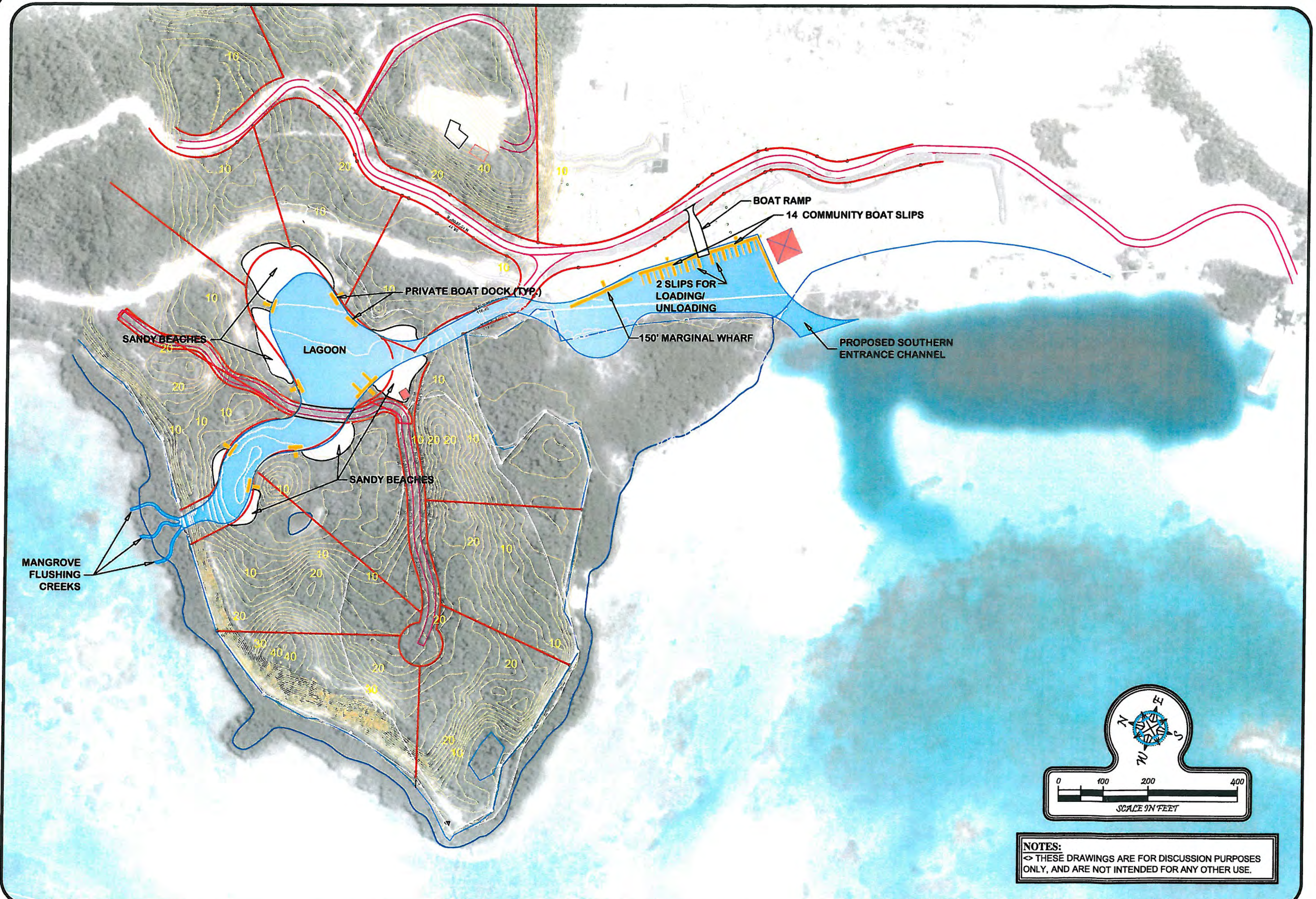
- The modeled flushing time for the proposed marina basin based on a 50% dilution factor is approximately 2 days and 6 hours.
- The modeled flushing time for the marina basin based on a 10% dilution factor is approximately 4 days.
- Based on the available published standards for flushing and simulation results, the proposed marina basin configuration exhibits an acceptable flushing time.
- Proposed improvements to the north flushing channel include replacing the three creeks with two large culverts, 28.3 m (93ft) in length and 4.7 m (15.33 ft) by 3.15 m (10.33 ft) in diameter, and a corresponding channel of 18.3 m (60 ft) and 15.3 m (50 ft).
- The proposed improvements resulted in a 15% dilution factor after 1 day and a 2.7% dilution factor after 2 days.
- The proposed improvements resulted in a 50% dilution factor after 13 hours and a 10% dilution factor after 27 hours (1 day and 3 hours).
- The modeled dilution factor at 12 hours, 24 hours, 36 hours, and 48 hours for the proposed improvements is 72.7%, 15.1%, 5.7%, and 2.66% respectively.
- Changing the three flushing creeks to two large culverts and a channel resulted in an 82% higher wetted perimeter and a more optimized flushing time for the proposed marina basin.

This report was prepared in accordance with industry standards and practice for the exclusive use in the documentation required for the proposed Windermere Island Club Marina Project located in Eleuthera, The Bahamas. No other warranty, expressed or implied, is herewith made.

7 REFERENCES

1. DHI Water & Environment, MIKE 21 Flow Model FM Hydrodynamic, User Guide (2017)
2. DHI Water & Environment, MIKE 21 Flow Model FM Transport Module, User Guide (2017)
3. Mangor, Karsten, "General Guidelines for Good Quality Artificial Beaches and Lagoons, and Case Stories" (2007)
4. United States Environmental Protection Agency, "Coastal Marinas Assessment Handbook" (1985)

ATTACHMENT A – SCHEMATIC DRAWINGS OF MARINA BASIN



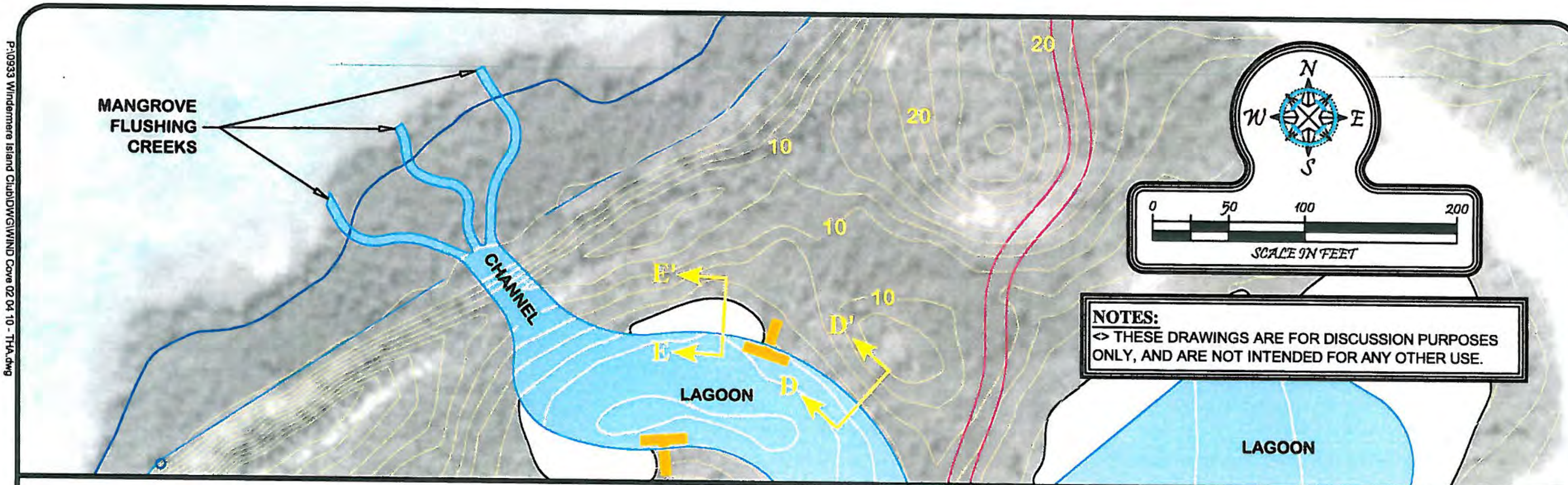
WINDERMERE

AERIAL VIEW OF SUBJECT PROPERTY

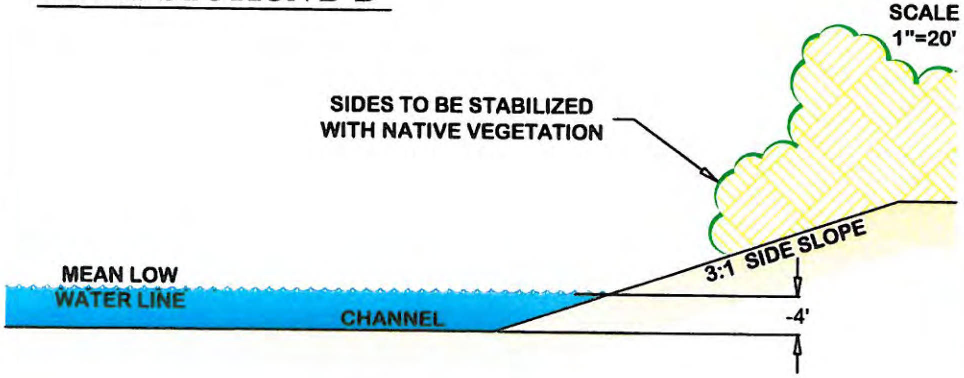
TURRELL, HALL & ASSOCIATES, INC.
Marine & Environmental Consulting
3584 Exchange Ave. Suite B,
Naples, Fl. 34104-3732
Phone: (239) 643-0166
Fax: (239) 643-6632
email: tuna@turrell-associates.com

DRAWN BY: SS	REVIEWED BY: TTT	TAB NAME: Planview	REVISIONS:
PROJECT #:	SHEET: 1 OF 3		N/A
DATE: 11-03-09			N/A
SCALE: 1"=200'		FILE NAME: P:\0933 Windermere Island Club\DWG\WIND Cove 02 04 10-THA.dwg	

P:\0933 Windermere Island Club\DWG\WIND Cove 02 04 10 - THA.dwg

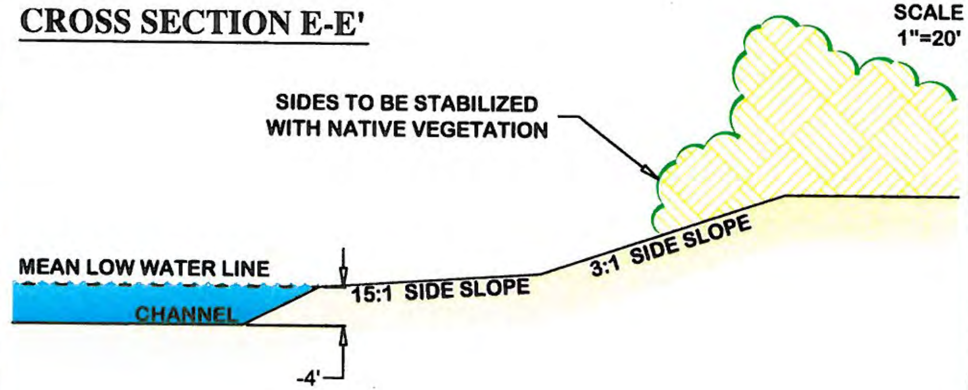


CROSS SECTION D-D'



NATURAL RIDGE

CROSS SECTION E-E'



SANDY BEACH

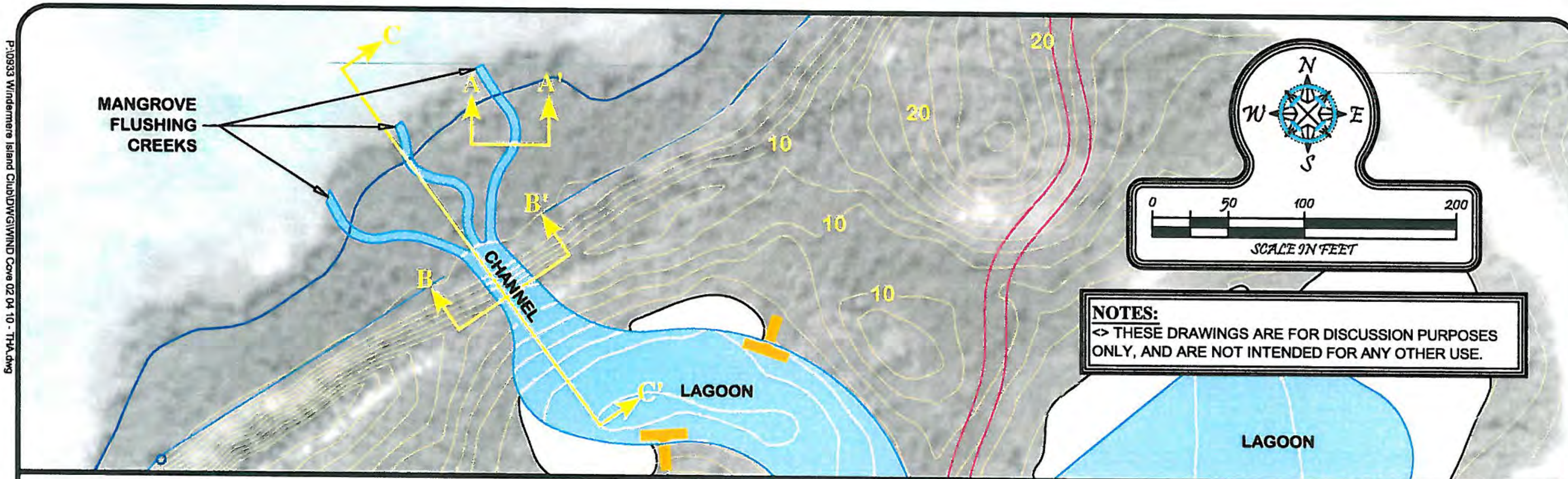
Turrell, Hall & Associates, Inc.
Marine & Environmental Consulting
3584 Exchange Ave. Suite B. Naples, FL 34104-3732
Email: tuna@turrell-associates.com Phone: (239) 643-0166 Fax: (239) 643-6632

WINDERMERE

DRAFT - CONCEPTUAL LAYOUT

DESIGNED:	T.T.T.	REVISION:	TAB NAME:	Details2
DRAWN BY:	BCB	N/A	SHEET:	3 OF 3
CREATED:	02-04-10	N/A	SCALE:	1"=100'
JOB NO.:	TTT	N/A		
SECTION-		TOWNSHIP-	RANGE-	

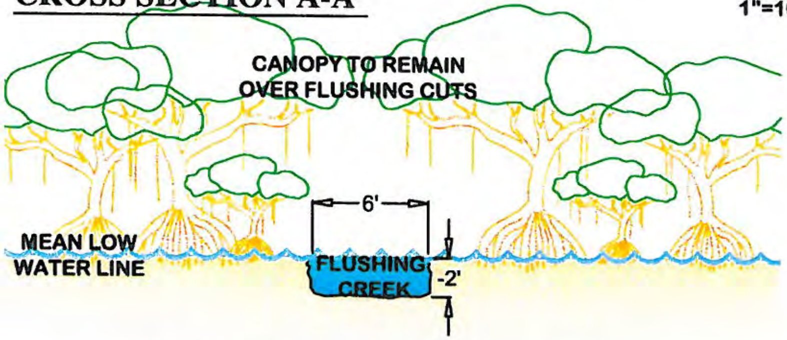
P:\0933 Windermere Island Club\DWG\WIND Cove 02 04 10 - THA.dwg



NOTES:
<> THESE DRAWINGS ARE FOR DISCUSSION PURPOSES ONLY, AND ARE NOT INTENDED FOR ANY OTHER USE.

CROSS SECTION A-A'

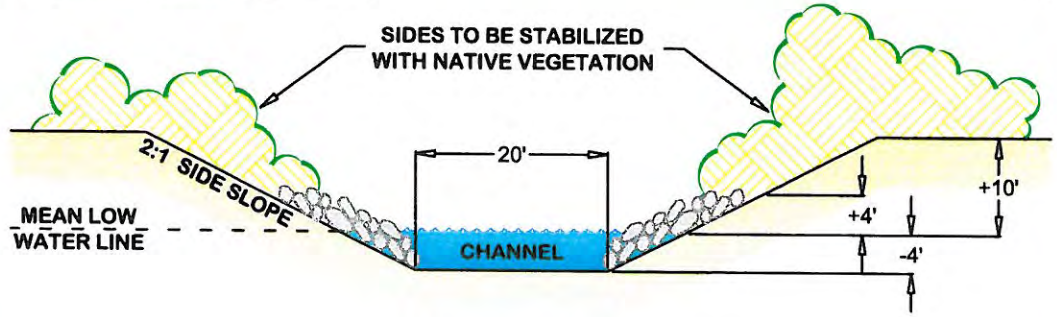
SCALE 1"=10'



MANGROVE FLUSHING CREEK

CROSS SECTION B-B'

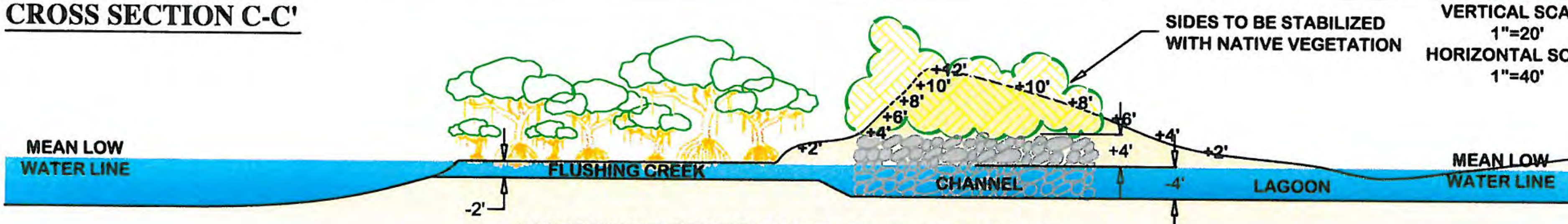
SCALE 1"=20'



CHANNEL CUT IN RIDGE

CROSS SECTION C-C'

VERTICAL SCALE 1"=20'
HORIZONTAL SCALE 1"=40'



MANGROVE CREEK TO CHANNEL TO LAGOON

Turrell, Hall & Associates, Inc.
Marine & Environmental Consulting
3584 Exchange Ave. Suite B. Naples, FL 34104-3732
Email: tuna@turrell-associates.com Phone: (239) 643-0166 Fax: (239) 643-6632

WINDERMERE

DRAFT - CONCEPTUAL LAYOUT

DESIGNED:	T.T.T.	REVISION:	TAB NAME:	Details
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CREATED:	09-11-09	N/A	SCALE:	1"=100'
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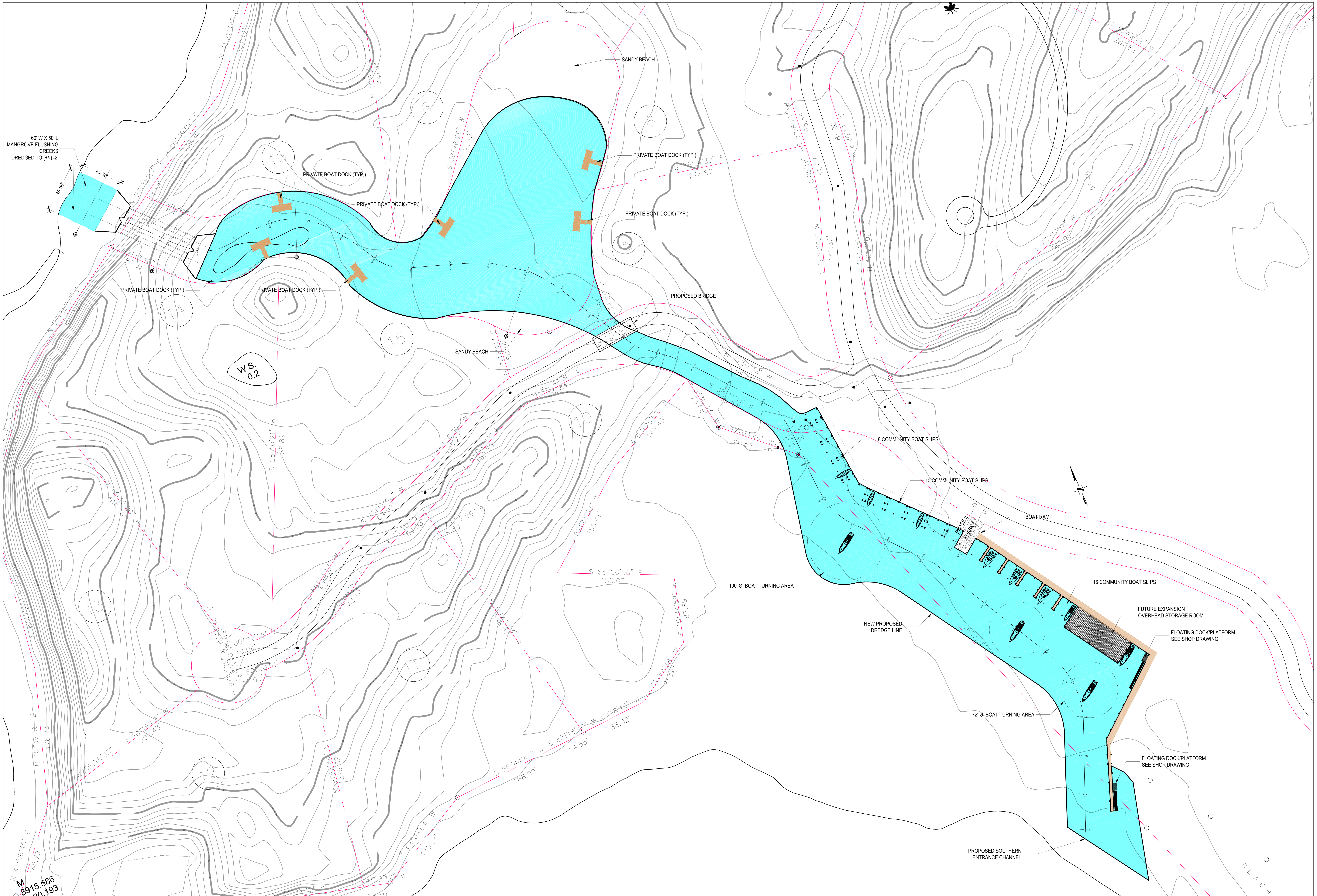
SECTION-		TOWNSHIP-	RANGE-	

ATTACHMENT B – SCHEMATIC DRAWINGS OF MODIFIED MARINA BASIN



LAGOON LAYOUT PLAN

SCALE: 1:600

REVISIONS	BY

ENGINEERING & TECHNICAL SERVICES
P.O.BOX SS 5589 NASSAU, N.P. BAHAMAS.
Tel: (242) 394-3219 Fax: (242) 394-4488

PROPOSED BOAT BASIN
WINDERMERE ISLAND, BAHAMAS

LAGOON OVERVIEW PLAN

SHEET NAME:

DRAWN :	CHECKED :
J.V.	L.K.

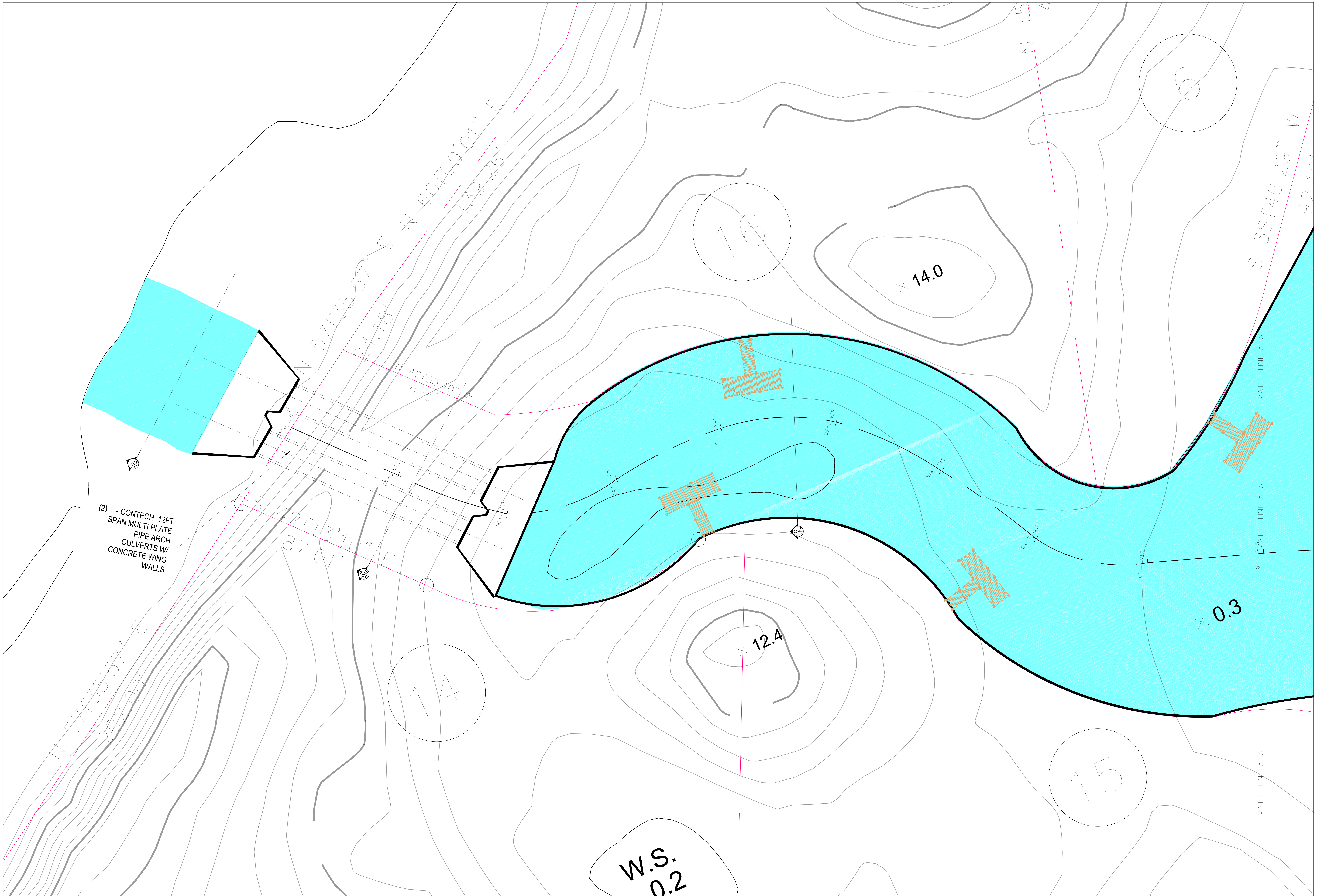
DATE : JAN. 2019

SCALE : AS NOTED

JOB NO. :

SHEET

S - 9



LAGOON LAYOUT PLAN

SCALE: 1:200

REVISIONS	BY

ENGINEERING & TECHNICAL SERVICES
P.O.BOX SS 5589 NASSAU, N.P. BAHAMAS.
Tel: (242) 394-3219 Fax: (242) 394-4488

PROPOSED BOAT BASIN
WINDERMERE ISLAND, BAHAMAS
SITE PLAN- STA 0+00 TO 4+50

SHEET NAME:

DRAWN :	CHECKED :
J.V.	L.K.

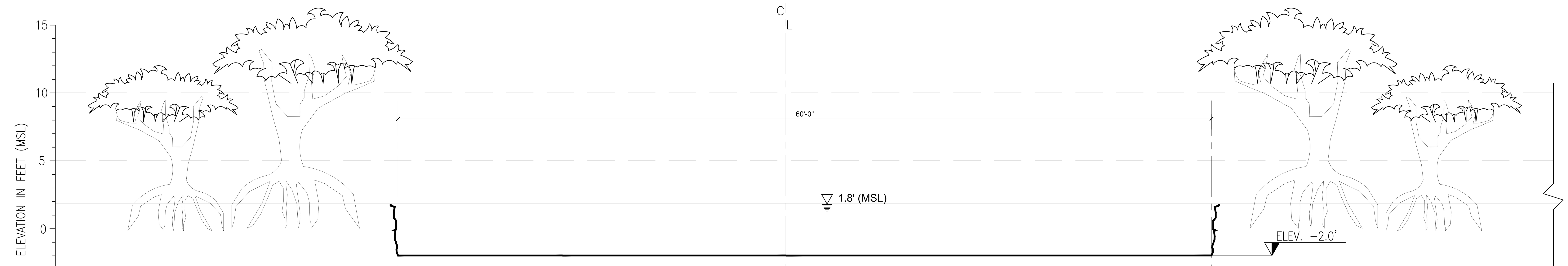
DATE : JAN. 2019

SCALE : AS NOTED

JOB NO. :

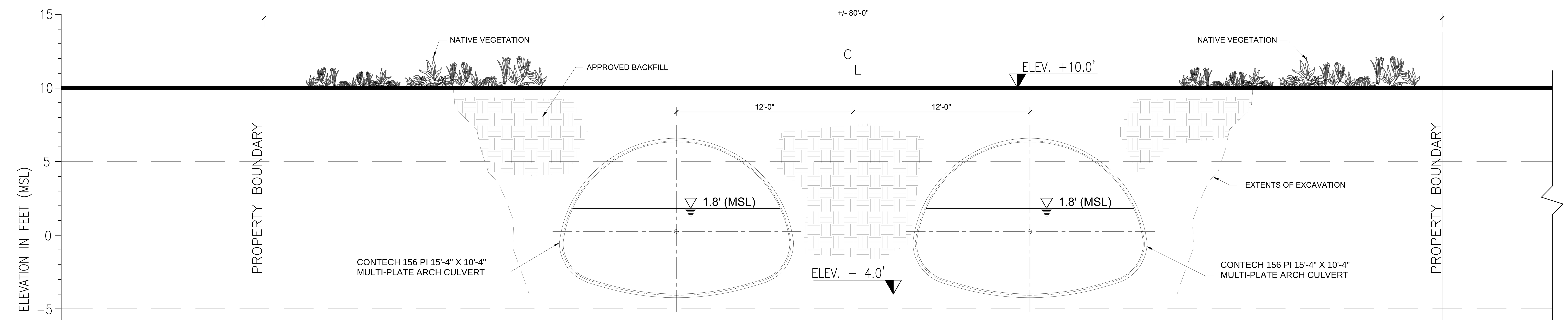
SHEET

S - 10



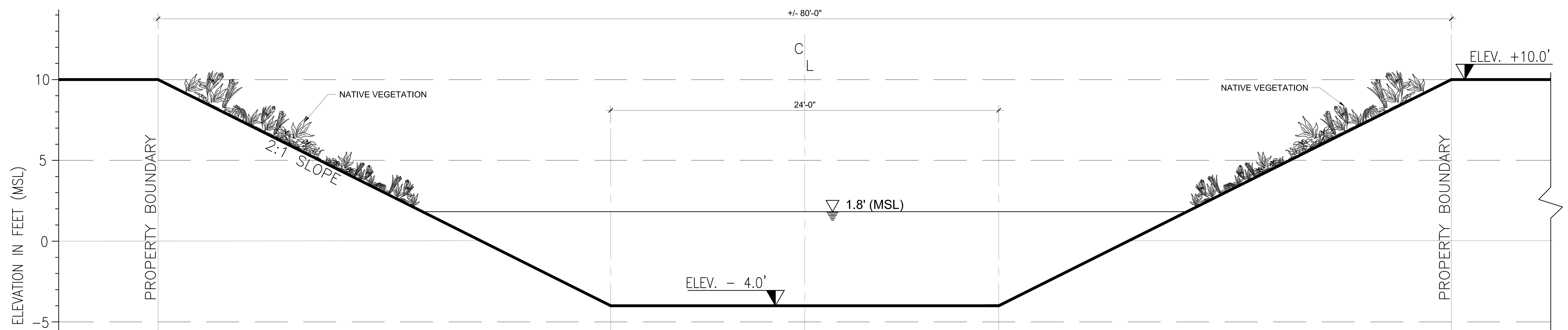
SECTION A - MANGROVE FLUSHING CREEK

SCALE: 1/4"= 1' - 0"



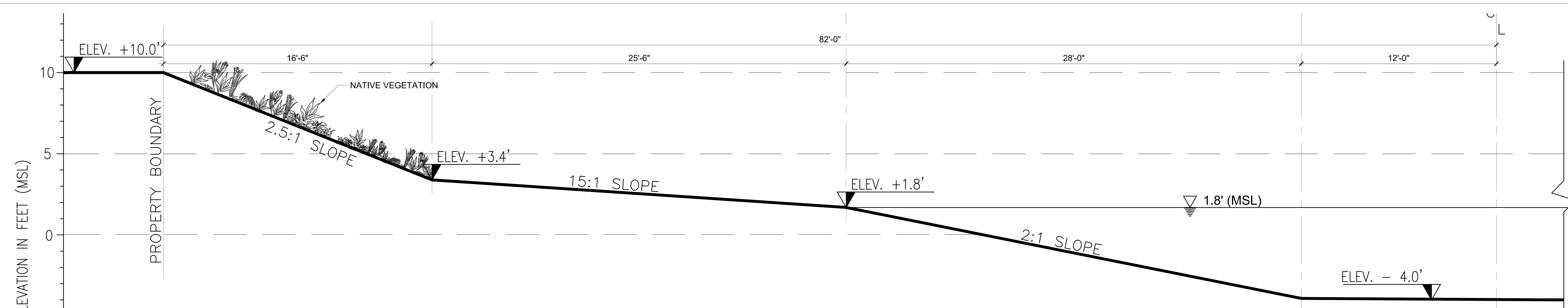
SECTION B - RIDGE CULVERT

SCALE: 1/4"= 1' - 0"



SECTION C - NATURAL RIDGE

SCALE: 1/4"= 1' - 0"



SECTION D - SANDY BEACH

SCALE: 1/4"= 1' - 0"

TYP. SECTIONS

SCALE: 1/4"=1'-0"

REVISIONS	BY

ENGINEERING & TECHNICAL SERVICES
P.O.BOX SS 5589 NASSAU, N.P. BAHAMAS.
Tel: (242) 394-3219 Fax: (242) 394-4488

PROPOSED BOAT BASIN
WINDERMERE ISLAND, BAHAMAS

SHEET NAME:
TYPICAL SECTIONS

DRAWN :	CHECKED :
J.V.	L.K.
DATE :	JAN. 2019
SCALE :	AS NOTED
JOB NO. :	
SHEET	

S - 14

14.4 List of Vascular Plant Species Observed

Table Key: B= Beach Strand**, W=**Wetland, **DBEF**= Dry Broadleaf Evergreen Formation, **HA** = Human Altered.

Botanical Name	Common Name	Location			
		W	DBEF	HA	BS
Acacia choriophylla	Cinnecord		√		
Amyris elemifolia	Torchwood		√		
Andropogon glomeratus	Bushy beard grass			√	
Angadenia sagraei	Lice root	√	√		
Argusia gnaphalodes	Sea Lavender				√
Ateramnus lucidus	Crabwood		√		
Avicennia germinans	Black Mangrove	√			
Baccharis angustifolia	Saltbush	√			
Bidens alba	Shepherd's needle			√	
Borrichia arborescens	Bay marigold	√			
Bourreria ovata	Strongback		√		
Bursera simaruba	Gum elemi		√		
Caesilpinia sp.	Nicker Bean	√			
Canavalia nitida	Bay bean	√			
Casasia clusifolia	Seven-year apple		√		
Casaurina equisetifolia	Casuarina	√	√	√	
Cassia sp.	Cassia		√		
Cassytha filiformis	Love Vine		√		
Cenchrus incertus	Coast Sandbur		√	√	
Centrosema angustifolium	Butterfly pea	√	√		
Chiococca alba	Snowberry		√		
Chrysobalanus icaco	Coco plum	√			
Coccothrinax argentata	Silver thatch palm		√		
Cocolobba uvifera	Seagrape	√	√		
Cocos nucifera	Coconut			√	
Conocarpus erectus	Buttonwood	√			
Conocarpus erectus var. sericeus	Silver Buttonwood	√			
Corchorus hirsutus	Wooly booger		√		
Cordia bahamensis	Blood berry		√		
Crossopetalum ilicifolium	Ground holly		√		
Croton linearis	Granny bush		√		
Cyperus planifolius	Coastal sedge	√		√	
Echites umbelatta	Devil's potato		√		
Erithalis fruticosa	Black torch		√		
Ernodea littoralis	Beach creeper		√		√
Eugenia axillaris	White stopper		√		
Eugenia foetida	Spanish stopper		√		
Euphoria mesembrianthemifolia	Coast spurge			√	√
Eustoma exaltum	Marsh Gentian			√	√
Fimbristylis cymosa	Spike rush			√	
Guapira discolor	Beefwood		√		
Hymenocallis arenicola	Spider lily		√		
Ipomoea pes-caprae	Beach Morning Glory	√	√	√	
Jacquemontia havanensis	Jacquemontia		√		

Botanical Name	Common Name	Location			
		W	DBEF	HA	BS
Jacquinia keyensis	Joewood		√		
Koanophyllon villosum	Jackmada		√		
Lantana involucrata	Wild Sage			√	
Lasiacis divarcata	Wild bamboo		√		
Leucaena leucocephala	Jumbay		√	√	
Lysiloma latisiliquum	Wild Tamarind		√		
Malpighia polytricha	Touch me not		√		
Metopium toxiferum	Poison wood				
Myrica ceifera	Wax Myrtle	√			
Myriopus volubilis	Solider vine	√	√		
Myrsine floridana	Myrsine	√			
Oceoclades maculata	Oceoclades orchid		√		
Passiflora sp.	Passion fruit		√		
Phyllanthus epiphyllanthus	Rock bush		√		
Pithecellobium keyense	Ram's horn		√		
Pluchea odorata	Marsh fleabane			√	
Psychotria nervosa	Wild Coffee		√		
Randia aculeata	Randia		√		
Reynosia septentrionalis	Darling Plum		√		
Rhizophora mangle	Red Mangrove	√			
Salicornia bigelovii	Glasswort	√			
Salmea petrobioides	Bushy salmea	√			
Scaevola plumieri	Black Inkberry				√
Scaevola tacadda	White Inkberry			√	√
Sesuvium portulacastrum	Sea Purslane	√		√	√
Smilax havanensis	China brier		√	√	
Solanum bahamensis	Canker Berry			√	
Solanum erianthum	Salve Bush			√	
Sporobulus virginicus	Seashore rush grass	√			
Stachytarpheta jamaicensis	Blue flower			√	
Suriana maritima	Bay Cedar	√			√
Thespesia populnea	Cork tree	√			
Trema lamarckianum	Trema		√		
Turnera ulmifolia	Buttercup		√	√	
Uniola paniculata	Sea oats				√
Uniola virgata	Limestone grass		√		
Urechites lutea	Wild Alamanda		√		
Waltheria indica	Sleeping Morning			√	
Weldia trilobata	Wedelia			√	
Zanthoxylum fagara	Wild lime		√		

14.6 Avian Species Observed

TABLE KEY:

RANGE

PR = Permanent Resident

PBR = Permanent Breeding Resident

WNR = Winter Non-breeding Resident

STATUS

LC = Least Concern (Conservation - IUCN)

NT = Near Threatened (Conservation – IUCN)

SCIENTIFIC NAME	COMMON NAME	MASTER OBSERVATION	STATUS/RANGE/ CONSERVATION
Anas discors	Blue wing teal	Few	WNR/ LC
Anas bahamensis	White-cheeked Pintail	Many	PR / LC
Coereba flaveola	Bananaquit	Many	PR /LC
Columbina passerina	Common ground dove	Many	PR /LC
Egretta tricolor	Tricolored Heron	Few	PR / LC
Loxigilla violacea	Greater Antillean Bullfinch	Few	PR / LC
Mimus polyglottos	Northern Mockingbird	Few	PR / LC
Nyctanassa violacea	Yellow-crowned Night-Heron	Few	PR / LC
Patagioenas leucocephala	White-crowned pigeon	Many	NT/PR
Setophaga tigrina	Cape May Warbler	Few	WNR/ LC
Tringa flavipes	Lesser Yellowlegs	Few	WNR/LC

14.7 Ministry of the Environment Letter 11 March 2010

MINISTRY OF THE ENVIRONMENT
Dockendale House, West Bay Street
P.O. Box N-7132, Nassau The Bahamas
Tel: 1(242) 328-2701; Fax: 1(242) 328-1324

REF: MTE/BEST/EIA/W/1

SENT VIA FACSIMILE

11 March 2010

Mr. Todd T. Turrell, P.E.
Turrell, Hall & Associates, Inc.
Naples, FL
FAX: (239) 643-6632

RE: Windermere Island Club Marina

Dear Mr. Turrell:

The Ministry of the Environment approves the proposed marina for the Winderemere Island Club, subject to the following:

- No fueling takes place;
- Provisions are made for vessel sewage disposal in accordance with the requirements of the relevant government agencies;
- No clear-cutting, instead transplant native species to other areas of the project site as much as possible;
- Blasting is not used;
- Connection to the open water shall remain as the last area for excavation;
- Forty-foot setback (landward) from the peak of the beach slope is maintained, at a minimum;
- Stormwater and run-off are managed to prevent direct discharge into the creeks, channel, lagoon and marina;
- An environmental management plan is submitted to the Ministry, prior to construction. The plan shall include a construction schedule and provide the procedures and plans to address shoreline stabilization, sediment/soil erosion control, spoil stockpiling and dewatering, site run-off/drainage control, sewage management, solid waste management, vegetation transplanting, land clearing, equipment maintenance/service area, spill response, turbidity control.

As the anticipated marine traffic includes both non-motorised and motorised watercraft, the Winderemere Island Club should also implement a marina safety programme, inclusive of markers and signage, to assist in guarding public safety.

Sincerely,

Ronald Thompson
PERMANENT SECRETARY

cc. Commander Patrick McNeil
Port Controller
Port Department

Mr. Michael Major
Director
Department of Physical Planning

Ms. Melony McKenzie
Director
Department of Environmental Health Services

14.8 Bahamas Investment Authority Letter October 22, 2018

BAHAMAS INVESTMENT AUTHORITY

Cecil Wallace Whitfield Centre, Cable Beach
P. O. Box CB - 10980
Nassau, N.P., The Bahamas
Tel: (242) 702-5500 Fax: (242) 327-5806

October 22, 2018

OPM/PRJ/EX/09

Glinton | Sweeting | O'Brien
Counsel & Attorneys-at-Law
P. O. Box N 492
Nassau, N.P.
The Bahamas

GLINTON I SWEETING I O'BRIEN
OCT 24 2018
RECEIVED

Attn: Andrew G. S. O'Brien

Via Facsimile: 328-8008

Dear Sir:

Re: CH WINDERMERE LENDING LLC & WINDERMERE OPERATIONS LLC
Continuation of the development of the Windermere Island North subdivision Windermere Island, Eleuthera, The Bahamas

Thank you for your letter dated October 9, 2018 in which you advised that Mr. Lambert Knowles of Bahamas Engineering and Technical Services is the Engineer of Record for the captioned project and the environmental engineer doing the EMP for the Boat Basin, is Melissa Alexiou of WayPoint Consulting.

In this regard, please be advised that The Bahamas Environment and Science Technology (BEST) Commission has determined that an Environmental Baseline study (EBS) will be required for the marina component as the pre-existing study was carried out in 2009, approximately 10 years ago.

The details for the TOR's for the Baseline (EBS) are as follows:

- ***Basic History***
- ***Present status of terrestrial works***
- ***Marina design (climate change resilience) and channel flushing***
- ***Alternative locations with explanations for the site locations***
- ***Bathometry survey***
- ***Dredge Plan/Excavation Plan for Marina Channel***
- ***Fill Plan for material from the proposed channel (Geo-Tech survey)***
- ***Confirmation on Dock fuel station***
- ***Mitigation plan for lost wetlands***

Please contact the undersigned should you require further assistance.

Yours sincerely,

MMBaillou
Mona Lisa M. Baillou (Miss)
For/Director of Investment

/mmb

14.9 Ministry of the Environment and Housing Letter March 1, 2009

MINISTRY OF THE ENVIRONMENT
P. O. BOX N-8156
TELEPHONE NOS: 322-4830/9 323-7240
FAX: 302-9587 – TELEX:20572 WORKS

FILE NO: MOE/SUB/136/8/70 March 1st 2009

Wind Development Ltd.
225 Main Street
Wenham, MA 01984

Attention: Mr. Carry Rich

Dear Sir:

RE: **FINAL APPROVAL**
WINDERMERE ISLAND NORTH DEVELOPMENT – WINDERMERE ISLAND

The Minister of The Environment is satisfied that you have completed arrangements for all such works as may be necessary for the supply of electricity, water and telephone throughout the subdivision and for construction of the roads as required under the terms of the Acceptance in Principle.

Therefore under section 4(3) of the Private Roads and Subdivisions Act, the Minister now grants approval for the sale, conveyance, or demise of lots in Windermere Island North Development.

Please be advised that:-

1. Each lot must be marked out on ground with 5/8" diameter steel rods embedded in concrete.

2. Street Names must be submitted to this Ministry for approval, and street nameplates to an approved specification must be erected at a position to be agreed.

3. You shall be responsible for the construction, maintenance and hold the Minister of Works harmless against any costs with the preparation, upkeep or repair of the roads in the subdivision and covenants. If at any time the Government is required to take over the roadways in the said subdivision for use by the public, you will at your expense make good the roads to the standards normally required by the Government, including a minimum width of 40ft. Right-of-Way.

A copy of the layout plan stamped and signed is attached for your records.

Congratulations on the successful completion of your subdivision.

Yours faithfully,

Ronald Thompson
PERMANENT SECRETARY

CBZ/jsn

CC: Director, Department of Physical Planning
President, Bahamas Telecommunications Company Ltd.
General Manager - Bahamas Electricity Corporation
Water & Sewerage Corporation
Director, Department of Environmental Health Services
Building Control Officer-Ministry of Works & Immigration