ENVIRONMENTAL IMPACT ASSESSMENT

ROYAL BEACH CLUB AT PARADISE ISLAND
NASSAU, THE BAHAMAS

CONDUCTED FOR

PDI PARADISE LTD.

A WHOLLY OWNED SUBSIDIARY OF

ROYAL CARIBBEAN CRUISES LTD.

D/B/A

ROYAL CARIBBEAN GROUP

FOR SUBMITTAL TO

THE MINISTRY OF THE ENVIRONMENT AND HOUSING

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Environmental Impact Assessment
Royal Beach Club at Paradise Island
New Providence, The Bahamas

1.0 EXECUTIVE SUMMARY

This Environmental Impact Assessment summarizes the potential development of the Western portions of Paradise Island. The scope is limited to the project and its area of influence which herein is defined as the 'Site'.

The area to be developed is heavily humanly altered and is revegetated with several pioneer and invasive species.

The proposed project will include the development of Paradise Beach and Colonial Beach to create an arrivals area, family zone, watersports center, food and beverage services, swimming pool and back of house areas in support of a world class beach experience.

2.0 PURPOSE AND SCOPE

The purpose of this report is to assess the environmental impacts associated with the development of proposed marine and terrestrial improvements as depicted on Figure 2.0-1: Conceptual Master Plan, Royal Beach Club Paradise Island, The Bahamas and to recommend measures for minimizing, avoiding, negating, or mitigating of potential impacts when feasible.

This report is to encompass terrestrial and marine areas that could be affected by the proposed Master Plan. Thereby, the scope is limited to the project and its area of influence which herein is defined as the 'Site'. The studies are conducted within the Environmental Impact Assessment (EIA) guidelines provided by the Department of Environmental Planning and Protection (DEPP).

Terrestrial and marine benthic areas were surveyed for the purposes of assisting in the decision-making and impact assessment of the proposed Master Plan inclusive of maritime elements. The terrestrial survey work effort was conducted to identify botanical and avian species to determine recognized land cover classifications within the limits of the investigation site.

Figure 2.0-1: Conceptual Master Plan
(Large scale drawings available upon request)

3.0 GEOGRAPHICAL SETTING

Paradise Island is an island in the Bahamas formerly known as Hog Island. The island, with an area of 685 acres or 1.1 square miles is located just off the shore of the city of Nassau, which is itself located on the northern edge of the island of New Providence. It is best known for the resort Atlantis with its extensive water park rides, pools, beach, restaurants, walk-in aquarium and casinos

Paradise Island is connected to the island of New Providence by two bridges that cross Nassau Harbour. The first was built in 1966 by Resorts International, and the second in the late 1990s.

4.0 PROJECT DESCRIPTION

4.1 PROJECT DETAILS

As RCG (Royal Caribbean Group) is keen to improve the overall experience of cruise passengers, the proposed project will transform underutilized parcels of land into a productive economic and social hub for cruise passengers and Bahamians. The proposed project is an opportunity for RCG and the Government of The Bahamas to foster a mutually beneficial long-term public/private partnership in Nassau.

The proposed project will include the development of Paradise Beach and Colonial Beach to create an arrivals area, family zone, watersports center, food and beverage services, and swimming pool and back of house areas in support of a world class beach experience.

It is anticipated that with the payment of an entrance fee, the experience will include access to the Royal Beach Club, lunch and the rental of a beach chair. For an additional fee, guests will be able

to purchase alcohol and sodas, a cabana, day-bed, clamshell, and participate in watersports and local tours. There will be an array of activities available to guests, including, but not limited to, snorkeling, scuba diving, kayaking, jet skiing, floating mat rentals, inflatable water slides, parasailing, nature hikes, volleyball, and other sand and water related activities. The construction of a family attraction will delight visitors of all ages and may include water fountains and splash zones. While the location is inherently beautiful, RCG will also ensure that additional landscaping is planted throughout the site.

As Paradise Island is close to the Nassau Port, guests will have direct and quick access to the harbor via water taxis. The construction of the water taxi harbor and dock may include dredging, seawalls, wave attenuators, docks and fixtures.

RCG proposes to commence construction in relation to the proposed project in October 2021. It is anticipated that the construction will be completed by May 2023.

4.2 Carrying Capacity Analysis

Preliminary Carrying Capacity Estimates	Gross Area Requirement (Sq.ft.)	Estimated Occupancy Area based on the site plan (Sq.ft.)	Estimated Guests
Pools	40	27,470	687
Pool Decks	70	36,570	522
Water Taxi Landing Areas and piers	15	18,855	1,257
Restrooms	no occupancy rating		0
Cabanas (pool and beach)	25	16,670	667
Bar areas	7	7,360	1,051
Beach	70	150,000	2,143
Beach Pavilion	7	1,380	197
Dining areas	15	25,000	1,667
Retail Areas	60	1,400	23
Tram Stations	7	2,125	304
Back of House	300	51,262	171
Employee Housing	200	6,000	30
		Available Occupancy	**8,719**

Max Guest Capacity (3,500); Workers (250); Total Maximum Planned Capacity (3750)

4.3 PHASING

RCG will not be considering any phasing and the works will be completed without interruption. Once final development and construction drawings are complete a Gant chart for construction will be drafted.

5.0 ALTERNATIVES

The purpose of the discussion of alternatives in an Environmental Impact Assessment (EIA) is to provide a reasonable range of potentially feasible alternatives that are capable of avoiding or

substantially lessening any significant environmental effects of a project, even if these alternatives would impede to some degree the attainment of the project objectives or would be more costly. The range of alternatives describes those that could feasibly accomplish most of the basic objectives of the project and could avoid or substantially lessen one or more of the significant effects.

5.1 ALTERNATIVE PLANS

No alternatives were developed for this location.

5.2 NO ACTION ALTERNATIVE

"The "no-action" alternative would result in no impact to the terrestrial component of this development but would not necessarily prevent any or all future developments for the same area. No action may also limit the long-term growth of the area in comparison with similar places in the Bahamas and elsewhere in the Caribbean which are larger and have a greater range of amenities. Employment levels would likely remain static and may act as a potential deterrent of regional and local development that would certainly take advantage of the Paradise Island improvements and any sufferance facilities offered at the Paradise Island operations. No additional significant impacts to the natural environment are likely to occur, however, the "no action" alternative would not provide the economic stimulus of the further development of Paradise Island. With the significant level of expansion already approved, the "No Action" alternative has not been further considered.

6.0 ENVIRONMENTAL BASELINE

6.1 EXISTING LAND USE AND OWNERSHIP

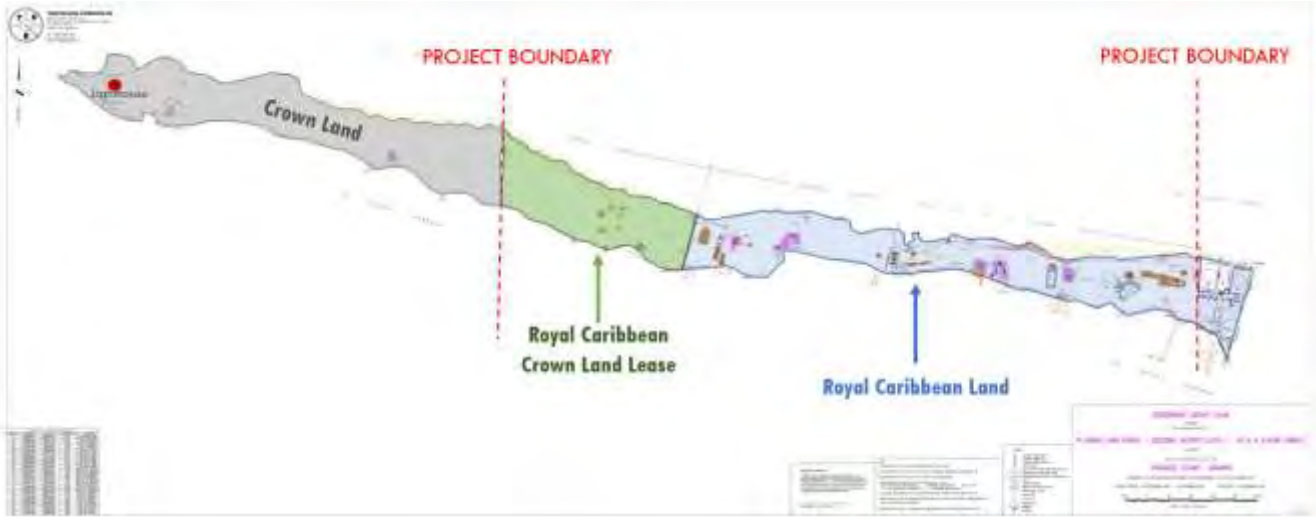


Figure 6.1-1: RCG OWNED PARCELS (SHOWN IN BLUE)

In addition to those parcels shown in blue in Figure 6.1-1 owned by RCG there is a request to lease an additional 7 acres (subject to survey) contiguous with and adjacent to the west of the RCG properties.

6.2 GENERAL CLIMATE OF NEW PROVIDENCE

Nassau Average Temperatures

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min (°C)	17	17	18	19	21	23	24	24	24	22	21	18
Max (°C)	26	26	27	28	30	31	32	32	32	30	28	26
Min (°F)	63	63	64	66	70	73	75	75	75	72	70	64
Max (°F)	79	79	81	82	86	88	90	90	90	86	82	79

Nassau Average Precipitation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Prec.(mm)	35	45	45	80	115	160	150	135	165	165	85	40	1220
Prec.(in)	1.4	1.8	1.8	3.1	4.5	6.3	5.9	5.3	6.5	6.5	3.3	1.6	48
Days	6	6	5	6	11	14	16	16	17	15	9	9	130

Nassau Sea Surface Temperature

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (°C)	25	24	24	25	26	28	29	29	29	28	27	26
Temp (°F)	77	75	75	77	79	82	84	84	84	82	81	79

6.3 CLIMATE CHANGE AND COASTAL RESILIENCY

When considering climate change as it relates to The Bahamas it is important to note that the country is an archipelago of small islands, most of them uninhabited, and that more than 80% of the land surface is only a meter or less above mean sea level. The natural resources of the country are very limited. The economy is built on tourism and services. Bahamians, like other island peoples, have historically had a close personal relationship with the land and the sea. Until the advent of modern tourism and banking industries, most Bahamians relied on the resources of both land and sea for survival.

ADAPTATIONS OPTIONS

Climate change presents new challenges due to the speed of the anticipated changes and the magnitude of the investments needed to adapt to predicted changes. In the case of some small islands the only option may be retreat and abandonment of property. The do-nothing option or no-action strategy is the one against which all other options may be compared. All too often, however, it is the default option because other options are either not available or are not known. Across The Bahamas no one option alone is likely to achieve the desired results of reducing vulnerability to climate change. Zoning practices based on vulnerability assessments, restricting types of development, prohibiting activities that exacerbate the impacts, and replacement and provision of increased security for settlements and infrastructure, are options that need to be considered. Costs associated with planned adaptation will be high but the cost of not acting will be measured directly in loss of life, loss of competitiveness in the tourism sector and often at the expense of the environment.

LOCATION AND POPULATION

The Commonwealth of The Bahamas comprises an archipelago of over 700 islands plus more than 200 cays, islets and rocks, spread over approximately 100,000 mi^2 (260,000 km^2) of the Atlantic Ocean. The Bahamas lies east of Florida (U.S.A.), and extends about 750 mi (1,200 km) southeastwards to within 50 mi (81 km) of Cuba and Haiti. Total land area is approximately 5,380 mi^2 (13,934 km^2). The islands have low relief and the highest point is only 206 ft (63 m) above mean sea level, in Cat Island. The potable freshwater resources of The Bahamas occur as three-dimensional lenses in the rock, overlying brackish and saline waters and most within five feet of the land surface. The 1990 census gave a total of 254,685 persons, with a growth rate of 1.9% per annum since 1980. The projection for 1997 was 288,862, and for 2000, 303,069. Some 60% of the population was under thirty years of age. Over 80% of the population resides on two islands: New Providence (where the capital, Nassau is located), and Grand Bahama.

6.4 HURRICANES & INCLEMENT WEATHER

New Providence Island is located within the Atlantic Tropical Cyclone basin, and as such is subject to be affected by several tropical storms every year, including hurricanes. The hurricane season generally takes place between June and November.

Based on the existing records, 54 tropical systems (26 tropical storms and 28 hurricanes) have passed at less than 60 nautical miles from the island in the period 1851-2010, resulting in an event every 2.9 years and a hurricane every 5.7 years.

The duration of these events affecting the island varies largely with an average of 5 days and a maximum recorded of 17 days.

New Providence has experienced winds of tropical storm force or greater 61 times in the past 147 years as at the end of 2018.

Saffir Simpson Hurricane Intensity Scale

Category One - A Minimal Hurricane
Winds: 74-95 mph, 64-82 kts, 119-153 km/h
Minimum surface pressure: higher than 980 mbar
Storm surge: 3-5 ft, 1.0-1.7 m

Category Two - A Moderate Hurricane
Winds: 96-110 mph, 83-95 kts, 154-177 km/h
Minimum surface pressure: 979-965 mbar
Storm surge: 6-8 ft, 1.8-2.6 m

Category Three - An Extensive Hurricane
Winds: 111-129 mph, 96-112 kts, 178-208 km/h
Minimum surface pressure: 964-945 mbar
Storm surge: 9-12 ft, 2.7-3.8 m

Category Four - An Extreme Hurricane
Winds 130-156 mph, 113-136 kts, 209-251 km/h
Minimum surface pressure: 944-920 mbar
Storm surge: 13-18 ft, 3.9-5.6 m

Category Five - A Catastrophic Hurricane
Winds: equal or greater than 157 mph, 137 kts, 252 km/h
Minimum surface pressure: lower than 920 mbar
Storm surge: higher than 18 ft, 5.6 m

The peak of hurricane season is typically mid-September but the season can extend from June until the end of November.

For the period 1871 through 2018 there have been a total of 61 storms travelling within sixty miles of New Providence.

Nassau was last minimally affected by Hurricane Dorian that passed well to the north with 180mph winds while destroying Great Abaco & Grand Bahama islands as a very slow mover impacting the island for 36 hrs.

6.5 TOPOGRAPHY

A topographic chart has been developed by a licensed Bahamian surveyor; topography rises from the high-water mark (HWM) on the north shore to a central ridge with peak elevations of +17.0 Mean Sea Level (MSL). From the central ridge falls southwardly to an elevation on average of +3.0 MSL on the ironshore at Nassau Harbour.

6.6 HYDROLOGY AND HYDROGEOLOGICAL RESOURCES

New Providence Island is characterized by the absence of permanent rivers or streams. However, with an annual rainfall of approximately 50 inches there are some few small lakes and swamps within its flat territory. The swamps are mainly located within the southern coast of the Island, east of Adelaide and therefore far from the Project location. Lake Killarney is the main terrestrial water feature despite being only 1 m deep. It is located in the center of the Island and surrounded by marshlands. None of these surface water features can be considered as sources of freshwater.

Fresh water is therefore only found underground though always close to the surface (1-2 m below ground level) as in deeper stages it becomes brackish or salty. These resources are however scarce and do not fulfill population requirements resulting in an import of freshwater by barges from North Andros Island and by desalinization of seawater in a reverse osmosis plant.

According to groundwater studies conducted on the Island by the UNDP and the Bahamas government in the proposed location of the development there are no freshwater resources.

Numerous studies have been conducted on the geology and hydrogeology of New Providence Island. In summary, it is part of the Great Bahama Bank, a stable carbonate platform extending to a reported depth of greater than 20,000 feet. The upper portion of the platform is the Pleistocene-age Lucayan Limestone which in the Clifton Pier area (CPA) is approximately 150 ft. (+/-) thick. This formation is also known as the Lucayan Limestone Aquifer (LLA) comprised of poorly stratified oolitic limestone. In the CPA, groundwater within the LLA is predominately saline. However, approximately two (2)-miles east of the Clifton Pier area, the LLA contains a fresh water lens that serves as a source of water for New Providence. The movement of groundwater through the LLA is primarily controlled by secondary permeability features such as fracture systems and solution enlarged bedding planes, cavities and caverns. Groundwater is recharged by precipitation which readily infiltrates through the overlying limestone. The absence of a freshwater lens in the CPA suggests that the secondary permeability features have developed to the point where there is good hydraulic communication both within the LLA and between the LLA and the ocean. Overall, a gradient or slope on the water table towards the ocean would be expected. The groundwater flow system, however, is also influenced by the tidal movements in the adjacent ocean. During a falling or low tide stage, the slope or gradient on the water table towards the ocean would be greater. At the time of a rising or high tide stage, the gradient would be less or even reversed for a brief period of time.

Given the narrow confines of Paradise Island there is no hydrological gradient.

6.7 AIR AND NOISE QUALITY

No information on air quality in the project area at Clifton Pier appears to be available.

Industries located at Clifton Pier (the currently fuel fired power plant, a cement storage area and a spirit's distillery) are currently the main source of air pollution and noise within the geographical area.

In the absence of available data on air quality, it can be assumed that currently the proposed site location air quality levels are mainly influenced by northerly wind patterns. In any case its location in a coastal and flat area exposes the site to a constant flow of winds that contributes keep the air quality in acceptable levels.

6.8 BIOLOGICAL ASPECT

The existing biological baseline is discussed in further detail below.

6.9 BOTANICAL SURVEY

The purpose of the botanical study was to map vegetation types, determine floristic diversity, record protected species abundance and identify the presence of invasive species. Field studies were conducted on 7 October 2019.

6.9.1 Methodology

Vegetation types were mapped by examining aerial photography and verified by walking along the shoreline and within the interior of the vegetation and targeting specific 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 & 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 BEST Commission, National Invasive Species Strategy for The Bahamas, 2013 were noted when encountered. Percentage cover were recorded in the abundance categories Occasional (less than 20%), Moderate abundance (20-50%), Abundant (50-80%) and Dominant (80-100%).

6.9.2 Results

6.9.2.1 Vegetation Types

Four (4) vegetation type classes were encountered on the site - Rocky shore, Beach Strand, Dry Broadleaf Evergreen Formation and Human Altered. Vegetation types observed described in detail in the sections below.

6.9.2.1.1 Coastal

6.9.2.1.1.1 Rocky Shore

Rocky Shore is located along the north eastern, southern and western sections of the coastline. The north eastern section occurred as exposed rock with no vegetation.

Photo 6.9-1: Northern rocky shoreline profile with no vegetation (view facing East)

Along the southern shore it occurs as a band two (2) to three (3) meters wide between the high tide mark and the upland vegetation. The profile varied from exposed rock with no vegetation; to a thin band of vegetation beyond an area of no vegetation and a thin band along a wave cut platform.

Photo 6.9-2: Southern rocky shoreline profile with no vegetation (view facing East)

Photo 6.9-3: Southern rocky shoreline profile with a thin band of vegetation (view facing East)

Photo 6.9-4: Wave cut platform along southern rocky shoreline (view facing East)

The entire western tip of the site is almost exclusively rocky shore with some areas having sand deposits in rock crevices.

Photo 6.9-5: Rocky shoreline along western section of site

Photo 6.9-6: Sand deposits in crevices of rocky shoreline along western section of site

Rhachicallis americana (Sandfly Bush) was the dominant vegetation in all rocky shore types observed. Other vegetation present as occasional species include *Suriana maritima* (Bay cedar), *Conocarpus erectus*, (Buttonwood) and *Coccoloba uvifera* (Sea grape).

6.9.2.1.1.2 Sandy Shoreline

Sandy Shoreline is present along the Northern coast interspersed with Rocky shore. There are no typical dune systems along the sandy shorelines. The Western sandy shore has large sections of *Casuarina equisetifolia* (Australian Pine) and *Scaevola taccada* (White Inkberry) with pockets of other species such as *Uniola paniculata* (Sea oats), *Ipomea pes-caprae* (Railroadvine) and *Tournefortia gnaphalodes* (Bay Lavender).

Photo 6.9-7: Western sandy shoreline profile with Casuarina and White Inkberry (view facing East)

The Easternmost sandy shore is predominantly sand with no vegetation and is separated from uplands by a series of concrete and stone retaining walls (see photo 6.9-8). In some areas vegetation beyond the retaining wall is consistent with what would be expected without human disturbance (see photo 6.9-9). Sandy substrate with vegetation inland to the rocky shoreline is present in some areas in the north eastern section of the site where there is high energy wave action deposited sand (see photos 6.9-10 & 6.9-11).

Photo 6.9-8: Eastern sandy shoreline profile with no vegetation and rock retaining wall (view facing East)

Photo 6.9-9: Sandy substrate vegetation beyond concrete retaining wall (view facing West)

Photos 6.9-10: North-eastern sand substrate vegetation inland to rocky shore (view facing North)

Photos 6.9-11: North-eastern sand substrate vegetation inland to rocky shore (view facing West)

6.9.2.1.2 Interior Upland

6.9.2.1.2.1 Dry Broadleaf Evergreen Formation (DBEF)

The majority of the interior upland areas on the western side of the site is covered with DBEF. This vegetation type consists of shrubland and forest. Shrubland at a height of 3-6 feet is present on the southwestern side of the site beyond the rocky shore. While area in the eastern section further away from the shoreline have heights up to 6-8 feet. Vegetation in the shrubland included, *Conocarpus erectus* (Buttonwood), *Coccoloba uvifera* (Sea grape), *Croton linearis* (Granny bush) and *Cordia sebestena* (Geiger Tree).

Photos 6.9-12: DBEF shrubland 6-8 feet in height

Forest areas occurred in small patches within the southern interior upland areas. Vegetation height ranged from 15 to 25 feet. Plants in the forest sections are similar to the shrubland however, there was greater diversity in the forest.

Photo 6.9-13: Interior of Forest

There was some overlap between forest and human altered areas including areas that were under brushed leaving trees in places and areas with small trails and clearing that revegetated with invasive species.

Photo 6.9-14: Section of DBEF with human disturbance

6.9.2.1.2.2 Human Altered

The easternmost interior upland areas on site is almost exclusively human altered. The area consists of a series of residences with partial or complete clearing of native vegetation. Existing vegetation is a combination of native vegetation left in place which are of a similar composition to DBEF areas on site; and landscape species including grass, palms and ornamentals such as *Stenotaphrum secundatum* (St. Augustine grass), *Archontophoenix alexandrae* (Alexander Palm), *Cocos nucifera* (Coconut Palm), *Ixora coccinea* (Jungle Flame), *Ficus microcarpa* (Green Island Ficus) and *Plumeria sp.* (Frangipani).

Photo 6.9-15: Residential lot on eastern section of site

Photo 6.9-16: Palms, sod and landscape ornamental vegetation on residential lot

6.9.2.1.3 Wetlands

A small depressed area in the western section of the site forms a seasonal fresh water wetland. *Conocarpus erectus* (Buttonwood) and *Sabal palmetto* (Sabal Palm) is the primary species along the periphery of the formation. Other species present include *Coccoloba uvifera* (Sea Grape). Although this formation was identified in the field investigation, it is located outside of RCG's intended project area.

6.9.2.2 Vascular Plant Diversity

A total of eighty-eight (88) vascular plant species were observed during the investigation (See Table 6.9-1). It is highly 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, given that the species abundance list was composed of natural and introduced species the number of plants recorded was relatively low. The small areas of undisturbed interior upland areas are a contributing factor to the low species numbers as the greatest diversity of plants are typically found in these areas.

Table 6.9-1: *List of vascular plant species recorded at RCG Paradise Island Site*

Table Key; Vegetation Types – RS- Rocky Shoreline, BS – Beach Strand, DBEF- Dry Broadleaf Evergreen Formation, HA- Human Altered

Botanical Name	Common Name	Vegetation Type				
		BS	RS	DBEF	HA	W
Acalypha wilkesiana	Match me if you can				✔	
Adenium obesum	Desert Rose				✔	
Aechmea blanchetiana	Bromeliad				✔	
Agave sp.	Agave (variegated)				✔	
Allamanda cathartica	Allamanda				✔	
Aloe vera	Aloe				✔	
Aralia sp.	Aralia					✔
Araucaria heterophylla	Norfolk Island pine				✔	
Archontophoenix alexandrae	Alexander palm				✔	
Asparagus densiflorus	Asparagus fern			✔	✔	
Ateramnus incidus	Crabwood			✔		
Borrichia arborescens	Bay marigold	✔				
Borrichia frutescens	Bay marigold		✔	✔		
Bougainvillea glabra	Bougainvillea				✔	

Brassaia actinophylla	Umbrella tree				✔	
Bumelia americana	Milkberry			✔		
Bursera simaruba	Gum elemi			✔		
Caesalpinia sp.	Knicker Bean			✔		
Cankile lanceolata	Sea Rocket	✔			✔	
Capraria biflora	Goat weed				✔	
Carica papaya	Papaya				✔	
Casasia clusifolia	Seven-year apple			✔		
Casaurina equisetifolia	Casuarina	✔	✔			
Catesbae sp.	Catesbae small			✔		
Chrysobalanus icaco	Cocoplum			✔		
Coccoloba diversifolia	Pigeon plum			✔		
Cocolobba uvifera	Seagrape		✔	✔		
Cocos nucifera	Coconut	✔				
Conocarpus erectus	Buttonwood		✔	✔		✔
Conocarpus erectus L. Var. sericeus	Silver Buttonwood		✔			
Cordia sebestena	Geiger tree			✔		
Croton linearis	Granny bush			✔		
Cyperus planifolus	Flatleaf sedge				✔	
Diospyros crassinervis	Featherbed			✔		
Echites umbelatta	Devil's potato			✔		
Eleusine indica	Fowl foot grass			✔		
Eugenia axillaris	White stopper			✔		
Euphorbia cyathophora	Wild poinsettia				✔	
Euphoria mesembrianthemifolia	Coast spurge	✔				

Ficus aurea	Golden Wild Fig			✔		
Ficus bejamina	Ficus tree				✔	
Ficus citrifolia	Short-leaved Fig			✔		
Ficus elastica	Rubber tree				✔	
Ficus microcarpa	Green Island Ficus				✔	
Hibiscus sp.	Hibiscus				✔	
Hippomane mancinella	Manchineel			✔		
Hymenocallis arenicola	Spider lily	✔				
Ipomea alba	Moon vine			✔		
Ipomea pes-caprae	Railroad vine	✔				
Ixora coccinea	Jungle flame				✔	
Jacquemontia havanensis	Havana Cluster vine			✔		
Jacquinia keyensis	Joewood			✔		
Jasminium fluminese	Jasmine vine			✔		✔
Lantana bahamensis	Wild Sage				✔	
Leucaena leucocephala	Jumbay			✔	✔	
Manilkara jaimiqui subsp. emarginata	Wild dilly			✔		
Myriopus volubilis	Soilder vine			✔		
Oceoclades maculata	Oceoclades orchid			✔		
Pandanus sp.	Pandana (variegated)				✔	
Passiflora sp.	Passion flower			✔		
Philodendron sp.	Philondendron				✔	
Phyllanthus epiphyllanthus	Rock bush			✔		
Pithecellobium keyense	Ram's horn			✔		
Plumeria obtusa	Wild frangipani			✔		

Plumeria sp.	Frangipani				✔	
Reynosia septentrionalis	Darling plum			✔		
Rhachicallis americana	Sandfly bush		✔	✔		
Rivina humilis	Rogue Plant			✔		
Ruellia brittoniana	Mexican Petunia				✔	
Sabal palmetto	Sabal			✔		✔
Salmea petrobioides	Bushy Salmea		✔			
Sansevieria trifasciata	Snake plant				✔	
Scaevola taccada	White Inkberry	✔				
Schefflera arboricola	Dwarf Umbrella tree				✔	
Sesuvium portulacastrum	Sea Purslane	✔				
Sideroxylon foetidissimum	Mastic			✔		
Simarouba glauca	Paradise tree			✔		
Smilax havanensis	China brier			✔		
Sorghum halepense	Johnson grass			✔		
Sporobulus virginicus	Seashore rush grass		✔			
Stenotaphrum secundatum	St. Augustine Grass				✔	
Strumpfia maritima	Mosquito Bush		✔			
Suriana maritima	Bay cedar			✔		
Thespesia populnea	Seaside Mahoe				✔	
Thrinax morrisii	Thatch palm			✔		
Tournefortia gnaphalodes	Sea Lavender	✔				
Uniola paniculata	Sea Oats	✔				
Zanthoxylum fagara	Wild lime			✔		

6.9.2.3 Invasive Species

Five (5) species listed on BEST Commission's National Invasive Species Strategy (2013) were recorded during the investigation (See Table 6.9-2).

Table 6.9-2: Invasive plant species recorded at RCG Paradise Island Site

Botanical Name	Common Name	Presence on site	Recommendations for control*
Asparagus densiflorus	Asparagus fern	Rare occurrence in human altered residential areas.	None listed.
Casuarina equisetifolia	Australian Pine	A common species along the cost forming large stands at several locations.	Control
Leucaena leucocephala	Jumbay	Occasional species in human altered areas.	Control
Scaevola taccada	White Inkberry	A common species along the cost forming large stands at several locations.	Eradication
Brassaia arboricola	Umbrella Tree	Rare occurrence in human altered residential areas.	Control

*Based on BEST Commission's National Invasive Species Strategy (2013)

Photo 6.9-17: Stand of Mature Casuarina trees along northern shoreline

Photo 6.9-18: Patch of Inkberry in foreground with stand of Casuarina in background

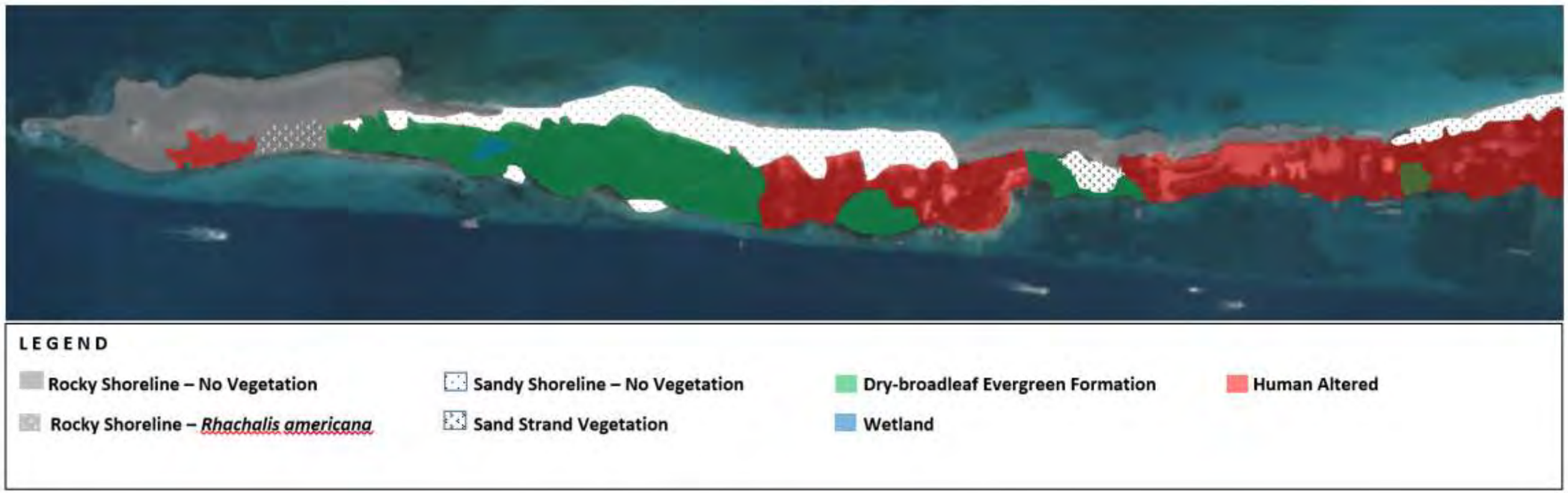
6.9.2.4 Protected Species

No species listed on the Conservation and Protection of the Physical Landscape Act, Protected Trees Order (1997) were observed on the site.

6.9.2.5 Vegetation Map

It should be noted that there was significant overlap in the Dry broadleaf evergreen formation and Human Altered vegetation types. For the purposes of mapping the most dominant vegetation type was selected for any given area. Additionally, there are small areas of Rocky shore along the southern boundary that would be indistinguishable by mapping.

Figure 6.9-1: Vegetation Map



6.10 AVIAN ASSESSMENT

An avian survey was conducted on 7 October 2019 to identify the presence, abundance and habitat utilization of avifauna species on the site.

6.10.1 Methodology

The assessment comprised of four (4) hours of active avian and ecological observations on 7 October, 2019 between 7:30 AM and 11:30 AM. Species numbers of visible individuals were recorded in the abundance categories, Single (1), Few (2-10) and Many (11-100). Observations made in the study area on 25 August 2019 are included in this report and contribute to overall species abundance. Physiological evidence such as egg shells are also noted. Species recorded were compiled for final abundance estimates. Taxonomy is based on The Clements Checklist of Birds of the World, August 2019 edition. Status is based on the International Union for Conservation of Nature (IUCN). These results are based on a small sample size of two data points and do not represent the total expected diversity at the site as data collection does not cover a full year of sampling.

6.10.2 Results

6.10.2.1 Species Observations

6.10.2.1.1 Species Abundance

A combined total of twenty-three (23) species were recorded during the surveys, fourteen (14) in October 2019 and twelve (12) in August 2019, with three (3) species observed during both surveys. (See Table 6.10-1).

Table 6.10-1: *Avifauna observed during survey RCG Paradise Island Site, The Bahamas*

TABLE KEY:		
RANGE	STATUS	OBSERVATIONS
PRB = Permanent Resident Breeding	**LC** = Least Concern (Conservation - IUCN)	**S =** Single
SRB = Summer Resident Breeding	**NT** = Near Threatened (Conservation – IUCN)	**F =** Few
WR = Winter Resident	**E =** Endemic	**M =** Many
		PE = Physiological evidence only
		***** August 2019 survey

		** August and October survey	
SCIENTIFIC NAME	COMMON NAME	STATUS/ RANGE/ CONSERVATION STATUS	MASTER OBSERVATION
*Falco sparverius**	American Kestrel	PRB/LC	S
*Haematopus palliatus**	American Oystercatcher	PRB/LC	F
Setophaga ruticilla	American Redstart	WR/LC	F
Nycticorax nycticorax	Black-crowned Night-Heron	PRB/LC	S
Quiscalus major	Boat-tailed Grackle	PRB/LC	F
*Columbina passerine***	Common ground-dove	PRB/LC	F
Dumetella carolinensis	Gray Catbird	WR/LC	S
*Tyrannus dominicensis**	Gray Kingbird	SRB/LC	F
*Charadrius vociferus**	Killdeer	PRB/LC	F
*Leucophaeus atricilla***	Laughing gull	PRB/LC	F
*Zenaida macroura**	Mourning Dove	PRB/LC	F
*Mimus polyglottos***	Northern Mockingbird	PRB/LC	F
Pandion haliaetus	Osprey	PRB/LC	F
Seiurus aurocapilla	Ovenbird	WR/LC	S
Falco peregrinus	Peregrine Falcon	WR/LC	S

Setophaga pinus	Pine Warbler	WR/LC	F
*Charadrius melodus**	Piping Plover	WR/NT	F
*Arenaria interpres**	Ruddy Turnstone	WR/LC	S
*Calidris alba**	Sanderling	WR/LC	F
*Actitus macularius**	Spotted Sandpiper	WR/LC	S
Patagioenas leucocephala	White-crowned pigeon	PRB/NT	M
Nyctanassa violacea	Yellow-crowned Night-Heron	PRB/LC	PE
Setophaga dominica	Yellow-throated Warbler	WR/LC	F

6.10.2.1.2 Species Range

The range of a species is the geographic areas where the birds can be consistently found e.g. migrant birds have seasonal ranges while restricted range species remain on same island or in same region year-round.

6.10.2.1.2.1 Permanent Resident

Permanent Resident Breeding species refers to the resident species that live and breed year-round throughout the Bahama Islands. A total of twelve (12) species were found in this category during the surveys.

Photo 6.10-1: Juvenile Black-crowned Night-Heron

Photo 6.10-2: Osprey eating a Stoplight Parrotfish

6.10.2.1.2.2 Summer Resident Breeding

Summer Resident Breeding refers to migrants that breed in The Bahamas during summer months from April to October and spend the rest of the year in other regions. Gray Kingbird (*Tyrannus dominicensis*) is the only species in this category that was recorded within the site. The Gray Kingbird is a species of flycatcher, it travels north from the southern Caribbean in April and return in October. This species was observed during the August 2019 survey.

Photo 6.10-3: Gray Kingbird (*Tyrannus dominicensis)*

6.10.2.1.2.3 Winter Resident Non-breeding

Winter Resident Non-breeding species refers to the annual non-breeding fall/winter migrants to the Bahama Islands from North America. Ten (10) species in this category were recorded within the study area during the surveys.

6.10.2.1.2.4 Endemic Species

Endemic Species have a restricted range with a geographically limited area of distribution. No endemic species were recorded.

6.10.2.1.3 Conservation Status

6.10.2.1.3.1 Protected Species

All of the species observed are protected under the Wild Birds Protection Act (Statute Law of The Bahamas, Chapter 249). In addition, all species with the exception of permanent breeding residents, are protected under international law such as the Migratory Bird Treaty.

6.10.2.1.3.2 Species of Concern

"Near Threatened" (NT) by the IUCN classifies a species that may be considered threatened with extinction in the near future, although it does not currently qualify for the threatened status.

White-crowned Pigeon (*Patagioenas leucocephala*), recorded during the October 2019 site visit and Piping Plovers (*Charadrius melodus*) recorded in August 2019 are designated as Near-threatened species by ICUN.

6.10.2.1.3.3 Endangered Species

None of the species recorded are classified as endangered locally or internationally.

6.10.2.1.4 Habitat Utilization

The majority of birds were detected within the coastal and interior dry broadleaf evergreen vegetation. The three (3) falcons were found in the rocky coastal area and used Casuarina trees as perches. The Gray Kingbird use tall dry branches as perches to look-out for flying insects; their primary food source. The majority of White-crowned pigeons were detected in the residential areas. Piping Plovers were only found in the sandy area.

6.11 BENTHIC SURVEY

On 18 October 2019, benthic surveys were conducted immediately off the southern shoreline of Paradise Island, Bahamas (See Figure 6.11-1: Survey Site Area). The purpose of the investigation was to assess the benthic types, identify fauna and flora species, within areas of proposed works.

Figure 6.11-1: Survey Site A & B

6.11.1 Methodology

The Roving Diver method was utilized at sites A & B. Benthic cover and species identification were recorded, along within species abundance. The abundance scale used were single (1), few (2-10) and many (+ 10). Other general observations were made for the entire survey area.

6.11.2 Results

6.11.2.1 General Observations

The assessed sites were located along a rocky shore ecosystem. The weather conditions were clear with slight cloud cover. Winds were less than 10 knots. Visibility was seven (7) based on a range of

one to ten (1-10) with one (1) being zero visibility and ten (10) being transparent. Depth ranged between approximately zero and fifteen (0-15) feet.

6.11.2.2 Benthic Description

6.11.2.2.1 Sandy Bottom

Sandy bottom was present at both Site A and B. Site A consisted of seagrass beds with areas of calcareous algae growth. Site B was mainly sandy bottom, seagrass with patches of hardbottom. The seagrass beds at both sites included patches of Turtle Grass (*Thalassia testudinum*) that varied from sparse to dense at different locations. At Site B Manatee Grass (*Syringodium filiforme*) was mixed in with the Turtle Grass. Mixed patches of seagrass and algae were also observed in sandy bottom substrate. A significant amount of trash was observed in the sandy bottom amongst the seagrasses.

Photo 6.11-1: Mixture of Turtle Grass (*Thalassia testudinum*), Manatee Grass (*Syringodium filiforme*) and Three finger leaf algae (*Halimeda incrassata)*.

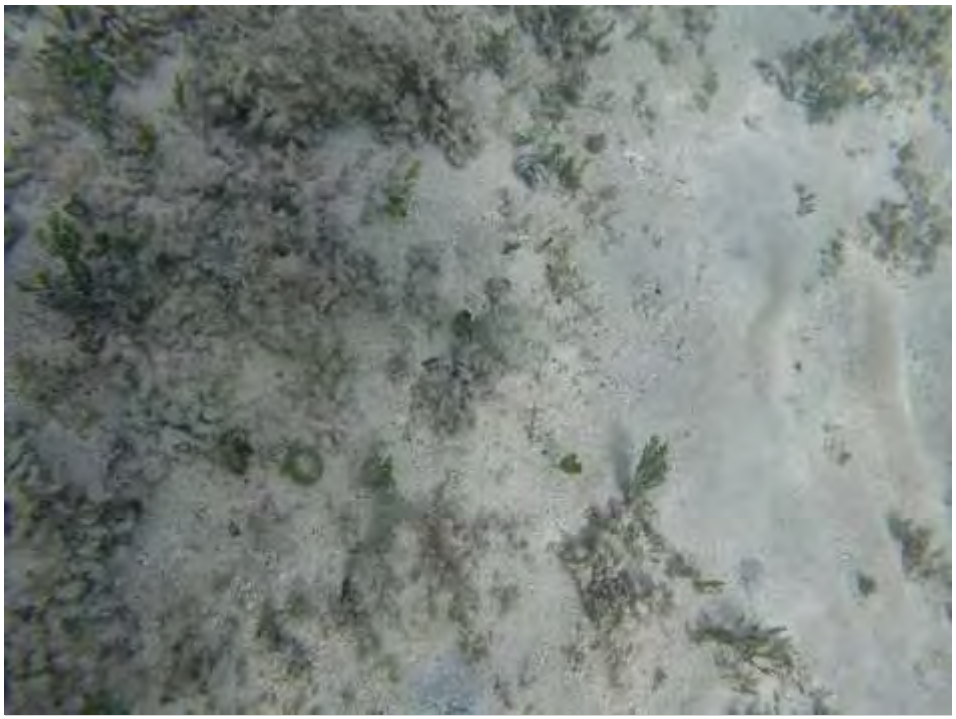


Photo 6.11-2: Sandy bottom with some algae

Photo 6.11-3: Seagrass bed with trash

6.11.2.2.2 Hard Bottom

The hard bottom observed was an extension of the shoreline and rock revetment. The area extends to the sandy bottoms and seagrass beds. Several algae species were observed within this area such as Fuzzy finger algae (*Dasycladus vermicularis*), Merman's Shaving brush (*Penicillus sp.*) Three finger leaf alga (*Halimeda incrassata*) and Mermaid's Fans (*Udotea sp*.).

Photo 6.11-4: Rocks with Three finger leaf algae (*Halimeda incrassata)* and Fuzzy finger algae (*Dasycladus vermicularis*)

6.11.2.2.3 Other

Several existing dock structures were observed at both sites. However, some structures have collapsed and are acting as artificial reefs. The highest density and abundance of fish species were seen near and around these collapse structures.

Photo 6.11-5: Showing collapsed structure

Conch Shell substrate were seen at both sites, where a significant amount of conch shells were discarded after conch harvest.

Photo 6.11-6: Showing discarded conch shells.

6.11.2.3 Species Diversity

6.11.2.3.1 Flora Observed

Twelve (12) floral species was observed include ten (10) Algae and (2) Seagrasses (see Table 6.11-1 below).

Table 6.11-1: Algae and seagrass (species no. 12) observed during assessment.

Scientific Name	Common Name
Algae	
Neomeris annulata	Fuzzy Tip Algae
Penicillus sp.	Merman's Shaving Brushes
Udotea sp.	Mermaid's Fans
Halimeda incrassata	Three finger leaf alga
Cyanobacteria	Cyanobacteria
Dasycladus vermicularis	Fuzzy Finger Algae
Laurencia Sp.	Red Algae
Acetabularia crenulata	Mermaid's wineglass
Halimeda opuntia	Disk algae
Rhipocephalus sp.	Ripweed
Seagrass	
Syringodium filiforme	Manatee Grass
Thalassia testudinum	Turtle Grass

Photo 6.11-7: Showing a variety of algae: Merman's Shaving Brushes (*Penicillus sp*.), Three finger leaf (*Halimeda incrassata)* and Disk algae (*Halimeda opuntia)* in sandy bottom

6.11.2.3.2 Fauna Observed

6.11.2.3.2.1 Epifauna

Seventeen (17) epifaunal species were observed that includes ten (10) Corals (see Table 6.11-2 below).

Table 6.11-2: Epifauna observed throughout the survey site

Scientific Name	Common Name	Abundance
	Corals	
Diploria clivosa	Knobby Brain Coral	Few
Obicella faveolata	Mountainous Star Coral	Few
Millepora alicicornis	Branching Fire Coral	Many
Porites astreoides	Mustard Hill Coral	Many
Siderastrea radians	Lesser Starlet Coral	Few
Agaricia humilis	Lettuce Coral	Few
Porites porites	Finger Coral	Many

Diploria labyrinthiformis	Grooved brain coral	Single
Eunicea fusca	Doughnut Sea Rod	Single
Siderastrea siderea	Starlet Coral	Few
Other		
Condylactis gigantean	Giant Caribbean Anemone	Many
Diadema antillarum	Black Spiny Urchin	Few
Anamobaea oerstedi	Split-Crown Feather Duster	Many
Holothuria floridana	Sea Cucumber	Few
Spirobranchus giganteus	Christmas Tree Worm	Few
Cliona zooxanthellate	Sponge	Few
Ircinia felix	Stinker Sponge	Few

Photo 6.11-8: Showing Social Feather Duster Worm

Photo 6.11-9: Showing Sea Cucumber

Photo 6.11-10: Showing Giant Caribbean Anemone

Photo 6.11-11: Showing multiple coral colonies of *Obicella favaolata* (Mountainous Star Coral)

6.11.2.3.2.2 Other Fauna Observed

Nineteen (19) fish species was observed (see Table 6.11-3 below).

Table 6.11-3: Fish Species observed throughout the survey site

Scientific Name	Common Name	Abundances
Abudefduf saxatilis	Sergeant Major	Few
Acanthurus chirurgus	Doctor Fish	Single
Acanthurus coeruleus	Blue Tang	Single
Caranx ruber	Bar Jack	Single
Chartodon ocellatus	Spotfin Butterflyfish	Few
Chromis multilineata	Brown Chromis	Few
Gramma loreto	Fairy Basslet	Few
Haemulon flavolineatum	French Grunt	Many
Halichoeres bivittatus	Slippery Dick	Many

Holocentrus sp.	Squirrelfish	Few
Hypanus americanus	Southern Stingray	Single
Lutjanus analis	Mutton Snapper	Single
Lutjanus apodus	Schoolmaster Snapper	Few
Pomacanthus paru	French Angelfish	Single
Thalassoma bifasciatum	Blueheaded wrasse	Few
Stegastes leucostictus	Beaugregory	Few
Sparisoma viride	Stoplight parrotfish	Single
Epinephelus guttatus	Red Hind	Single
Haemulon sciurus	Blue Stripe Grunt	Few

6.11.2.4 Commercially Important Species

There were no commercially important species observed.

6.11.2.5 Endangered and Protected Species

There were no endangered or protected species observed.

6.11.2.6 Invasive Species

There were no invasive species observed.

6.11.2.7 Habitat Utilization

6.11.2.7.1 Sandy Bottom/ Seagrass Beds

There was very little activity in areas of the sandy bottom. No activity was recorded in the seagrass beds. A small number of fish were observed swimming in these areas.

6.11.2.7.2 Hard Bottom and Artificial Reef

The majority of the fauna and epifauna species recorded were observed in and around hard bottoms and dock structures. These habitats also had the highest abundance and diversity of algae and coral species.

6.11.3 Discussion

6.11.3.1 Coral

Boulder and branching hard coral recruitment were observed at both sites. The overall abundance and diversity of corals was low. Coral colonies were sparsely dispersed with an exception of a small area within site A containing multiple colonies of *Obicella favaolata* (Mountainous Star Coral).

Some colonies observed were in good health, others were partially dead, diseased or in competition for space by aggressive invertebrate (e.g encrusting sponge).

6.11.3.2 Human Influence

There is significant boat traffic in this area. It is directly across the habour from a cruise ship port and the downtown area of New Providence. Also, it is in close proximity to Nassau Container Port and Porter's Cay Dock.

A significant amount of trash was seen at both sites. Building structures on properties associated with assessed areas were either under renovation or abandoned. There are no public road access to these properties, so solid waste management may have been managed and preform by previous owners. The sites are located in a high tourist and marine traffic area. Thus, there are many factors that could have potentially contributed to the abundance of trash observed.

6.12 NATIONAL PARKS

New Providence houses the capital city of the Bahamas, Nassau. It currently holds approximately 70% of the entire Bahamian population. The island is a major tourist attraction with a rich history spanning over 300 years. The native forests that remain are just remnants of a biologically rich island. New Providence has blue holes, caves and lakes but the remaining forests are fragmented and mostly scheduled for development. At one time there was a five-foot-long iguana that roamed the island; now extinct, like the many other possible species from a once diverse island. (*https://bnt.bs/parks/new-providence/)*

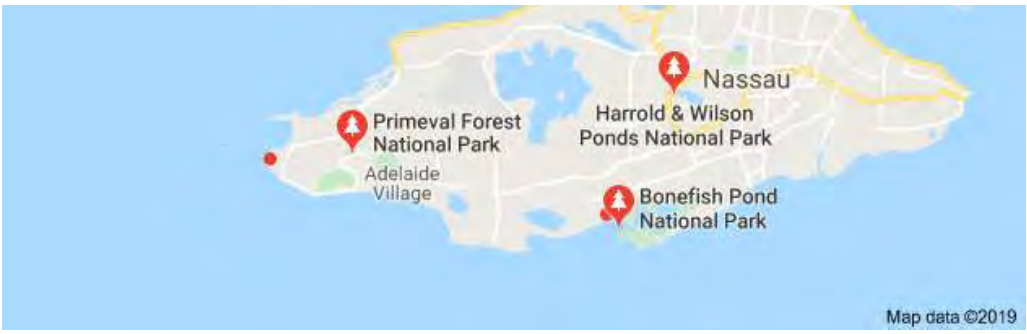


Figure 6.12-1 Location of National Parks on New Providence

New Providence has a total of four (4) National Parks;

The Retreat located in east central New Providence formerly a private residence was the first National Park on the island.

Harrold and Wilson Ponds National Park - Located in South Central New Providence, Harrold and Wilson Ponds provides natural wetland habitat for more than 100 bird species.

Bonefish Pond National Park - Bonefish Pond is 1235 acres of coastal wetland area.

Primeval Forest National Park - Located in southwestern New Providence, this old-growth undisturbed, woodland is representative of the early evergreen tropical hardwood forests of the Bahamas.

6.13 SOCIO-ECONOMIC

The Commonwealth of The Bahamas consists of 29 islands, 661 cays, and 2,387 islets. As a result of this insularity the country has more than 3,500 km of coastline and an Exclusive Economic Zone of approximately 654,715 km^2.

The Bahamas has a Gross Domestic Product (GDP) of $ 8.845 Billion and a per capita Gross National Income (GNI) of about US$ 20,740 in 2015 (World Bank, 2017). The capital is Nassau, located in the Island of New Providence.

New Providence Island, with a surface of 207 km^2 is the 11th largest island of the country.

This section outlines the existing socio-economic conditions that may be influenced by the project's activities.

According to the World Bank, The Bahamas has a population of 388,019 people (data from 2015) with an annual growth rate around 1.29% (World Bank, 2015). The age group of population between 0 and 14 years old comprises 29.4% of the population while is the age group between 15 and 64 years comprises 65.3%.

The main characteristic of its population distribution is that, according to the results of the 2010 census, 95% of the population is concentrated in only seven islands with 70% living in New Providence Island, where the project is envisaged.

The Bahamas is one of the wealthiest Caribbean countries with an economy heavily dependent on tourism and offshore banking.

According to the World Bank (2017), the Gross Domestic Product (GDP) in The Bahamas in 2015 was 8.845 Billion US dollars. Estimates for 2016 indicate a GDP of 9.066 billion US Dollars (CIA, 2017). This places The Bahamas as the 161th country out of 230 in terms of GDP.

Tourism, together with tourism-driven construction and manufacturing, accounts for nearly 60% of GDP and directly or indirectly employs half of the country's labor force (World Bank, 2017).

After tourism, financial services constitute the second-most important sector of the Bahamian economy and, when combined with business services, account for 37% of GDP. However, the financial sector is smaller than it has been in the past because of the enactment of new financial regulations in 2000 that caused many international businesses to relocate elsewhere.

The Economy of The Bahamas

The main crops and agricultural products cultivated on the islands include citrus, vegetables and poultry (CIA, 2017). In 2015, Bahamas' exports were led by crawfish, aragonite, crude salt and polystyrene products. In addition to tourism and banking, main industries in the archipelago are oil bunkering, maritime industries, transshipment, salt, rum, aragonite and pharmaceuticals (CIA, 2017).

The authorities projected a growth rate of 1.5% in 2017, with an increase to 1.8% in 2018, driven by the scaling up of investments in infrastructure, as well as growth in tourism and agriculture (World Bank, 2017).

The labor force is mainly engaged in tourism and other services, and only 3% is dedicated to the agriculture. The unemployment rate was estimated at 15% in 2014 (CIA, 2017).

6.14 TRANSPORTATION

Air arrivals to New Providence are via Nassau's Lynden Pindling International Airport (LPIA) which is the fourth busiest airport in the Caribbean and the main international gateway to The Bahamas. Most major carriers and a number of smaller and private aircraft are accommodated at an FBO at the same location.

Nassau is also accessed through the Nassau Harbour which services most major cruise lines.

Nassau Container Port is a strategically located port facility for container and general cargo shipping located on Arawak Cay, just two miles west of Downtown Nassau at the mouth of Nassau Harbor.

The island is serviced with taxis, buses and private vehicles.

6.15 UTILITY PROVISIONS

The back of House Utility site will be located on East end of property with aesthetics comparable to other buildings and surrounded by heavy landscape.

Water

A 150 000 gallon Reverse Osmosis Plant to be installed inside a closed building with 2- 150,000 gallon storage tanks, to ensure continuous supply.

Electricity

Electricity utility service in the entire Bahamas is by statute, the sole prerogative of the Bahamas Power & Light Company Limited, whose performance in recent years has been anything but reliable. Therefore, while a service connection to that utility is a legal requirement, it is essential that a stand-by power supply, equivalent to the full load demand of the development be provided against the possibility of supply failure.

BPL will be requested to install two 500kW transformers as a primary service.

Full site will include low-voltage installations to support CCTV and Wi-Fi connectivity for the safety and enjoyment of RCG guests.

Waste Water Handling

Although the public utilities systems in New Providence Island, and the near-by Paradise Island have improved dramatically over the past decade, service availability is still limited. The Water & Sewerage Corporation do not provide service on Paradise Island, where the main waste treatment services provider is Paradise Islands Utilities. While it would be possible to establish a service connection to this provider, the geographical separation between the two locations may preclude this as being a viable option, leaving self-provision of treatment services as being the only available viable option.

Wastewater therefore will be treated locally at the site through a wastewater treatment plant.

Wastewater Treatment Plant to treat 110,000 gallons per day with above grade membrane bioreactor treatment system.

7.0 REGULATORY AND LEGAL

7.1 DOMESTIC REGULATION

Introduction

All development projects are carried out within a framework of national regulations, international conventions, corporate policies, and procedures and recognized third party guidelines, all of which have different applications, remits, requirements, and implications.

The Developer will comply with the legal requirements of The Government of The Bahamas, and The Developer's own internal standards and topic-specific conventions to which The Bahamas is a signatory. The Developer will also consider, when relevant, to the establishment of mitigation measures, the application of relevant international standards including International Finance Corporation (IFC) guidelines and World Bank Environmental, Health and Safety (EHS) Guidelines.

Institutional Framework

The sections below present a summary of the key government policies and statutory instruments and laws relevant to the Project as well as the government departments and national governing bodies and authorities that will have an interest in the EIA.

The Bahamas is organized into a parliamentary constitutional monarchy headed by Queen Elizabeth II. As a member of the Commonwealth, its political and legal traditions are considered to be close to those of the United Kingdom. The country is divided into 32 districts that provide a system of local government, with the exception of Grand Bahama Island, whose affairs are handled directly by the Grand Bahama Port Authority.

Local government in the Bahamas exists in two forms, namely second-schedule and third-schedule district councils. There are a total of 32 local government districts: 13 second-schedule districts, which are further sub-divided into town areas, and 19 third-schedule districts, which are all unitary authorities.

The Government of The Bahamas executive branch consists of, The Prime Minister and his Cabinet of Ministers, which are elected members of Parliament appointed by the Prime Minister.

The Ministry that has direct responsibility for managing environmental affairs in The Bahamas is the Ministry of the Environment.

Bahamas Investment Authority

The Bahamian government's proactive economic growth and development policies are guided by the Bahamas Investment Authority (BIA), established to reduce bureaucratic delays for domestic and international investors.

Operating from the Office of the Prime Minister, the BIA has been designated a "one-stop shop" designed to simplify investing in The Bahamas. The BIA serves as the administrative arm of the National Economic Council and Investment's Board.

The BIA has the following areas of responsibility:

- Develop investment policies
- Promote investment
- Evaluate project proposals
- Monitor and co-ordinate project implementation
- Administer the government's investment concessionary legislation

All non-Bahamians or Permanent Residents seeking to do business in The Bahamas must obtain prior approval from the Bahamas Investment Authority (BIA). The application for BIA approval must be in the form of a comprehensive Project Proposal. The application must include all of the requirements set forth in the Project Proposal Guidelines issued by the BIA. Bahamian legal counsel usually submits the formal application to the BIA along with the required supporting documents.

The application process is as follows:

1. Submit the Project Proposal, along with supporting documents to the BIA.
2. The BIA will process the application and submit the same to the National Economic Council for a determination. The NEC is comprised of a group of Government ministers including the Prime Minister and the Minister of Finance.
3. Depending on the nature of the proposed business activity, the relevant Government Ministry or Agency would be consulted for input:
    a. Ministry of the Environment.
    b. Ministry of Works and Transport.
    c. Ministry of Housing.
    d. Respective Family Island Local Government
    e. Department of Environmental Planning and Protection
4. Once a determination has been made, the BIA will communicate to the applicant in writing. If the determination is favorable, the BIA will issue a "project approval in principle", subject to any stipulated conditions and to satisfying the requirements of the relevant government agencies.

The Ministry of the Environment (MoE)

The MOE's area of responsibility includes:

i. to manage, protect and conserve all land, water, air and living resources of The Bahamas, having regard to the environmental, economic and social benefits they may confer on The Bahamas;

ii. to undertake, commission and coordinate environmental studies and research relating to the environment of The Bahamas;

iii. advising as to public or private sector proposals that would significantly affect the environment of The Bahamas; and

iv. providing advice as to procedures for the assessment and monitoring of environmental impacts;

The departments, agencies and authorities under the responsibility of the MoE are:

a. the department responsible for environmental health services;

b. the agency responsible for national geographic information services;

c. the authority responsible for public parks and public beaches;

d. the body responsible for forestry; and

e. the body responsible for scientific research, reviewing Environmental Impact Assessments, advising on environmental projects and administering multilateral environmental agreements.

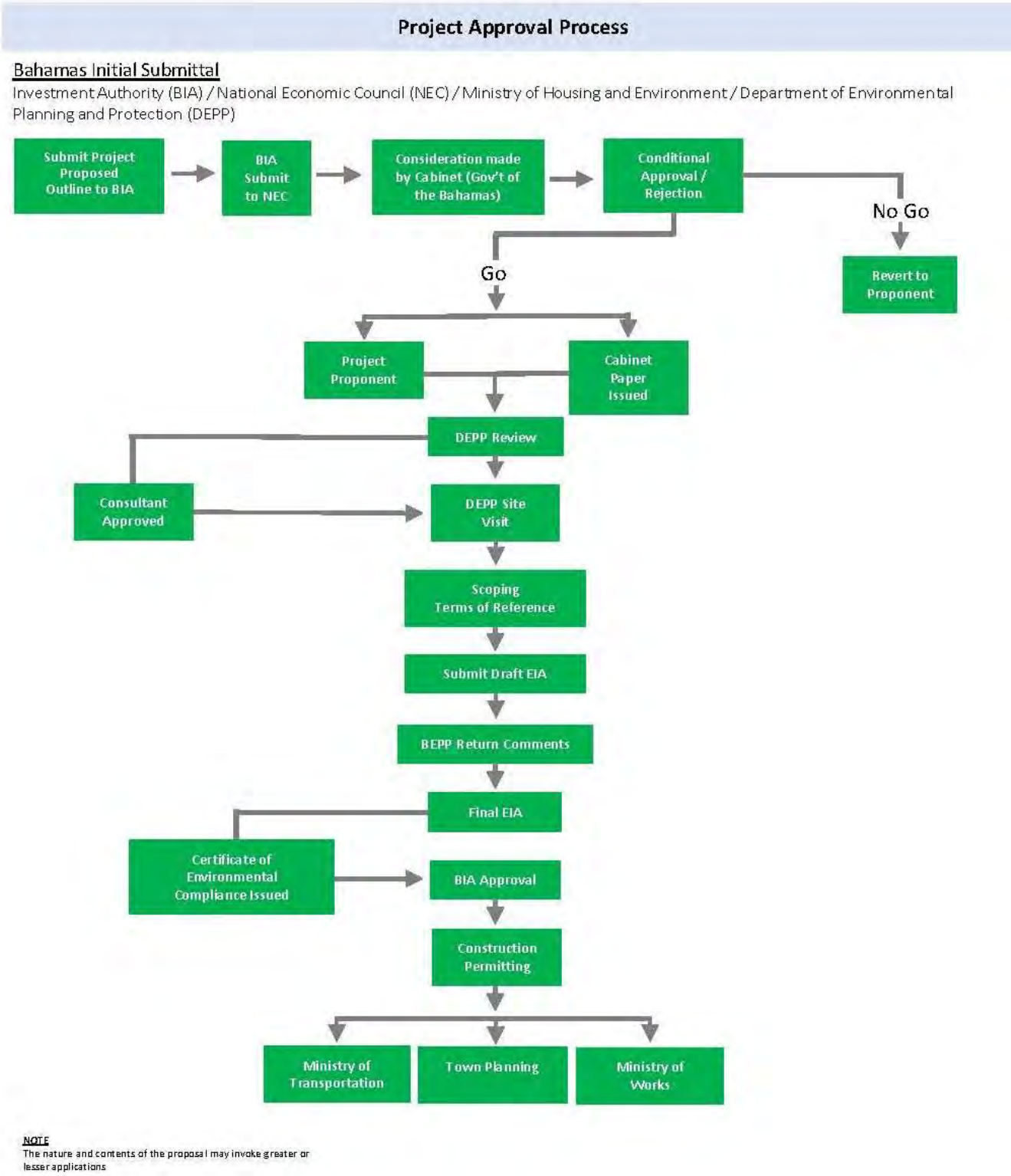
The Department of Environmental Planning and Protection ("the Department")

The Department of Environmental Planning and Protection is under the responsibility of the Ministry of the Environment. The duty of the Department is to promote best practices in environmental management and to minimize harm to the environment. The Department is comprised of the Director, Deputy Director, Assistant Directors, and appointed environmental officers. The Department is subject to the general control and direction of the Director. The functions of the Department include the regulation, oversight and review of Environmental Management Plans and Environmental Impact Assessments, promoting and enforcing compliance with the Environmental Planning and Protection Act, 2019 ("the Act") and any regulations made under that Act. The Act makes it a requirement to obtain a Certificate of Environmental Clearance in accordance with prescribed regulations prior to commencing work on a project and it provides that any person who commences work on a project without first obtaining a Certificate of Environmental Clearance commits an offence.

The Act provides for regulations relating to Environmental Management Plans and Environmental Impact Assessments to be issued. The Regulations have not yet been passed, but it is expected that the Regulations, when passed, will address the types of projects, developments and activities which shall require the preparation of an Environmental Management Plan or Environmental Impact

Assessment and the procedures for the assessment of Environmental Management Plans and Environmental Impact Assessments as well as the requirements for public consultation.

Figure 7.1-1: Project Approval Process



Source: *Islands By Design, 2020*

The Department of Environmental Health Services (DEHS)

The DEHS is the environmental regulatory department of The Bahamas Government. It is responsible for environmental control, solid waste collection, and disposal. It is also the responsible for enforcing industrial regulation, public health guidelines, for regulating and enforcing public sanitation. The oil spill contingency plans are also responsibility of this Department.

The Bahamas National Trust

The Bahamas National Trust is a non-profit organization established through The Bahamas National Trust Act in 1959. It is responsible for establishing and managing national parks and protected areas, historic preservation, public awareness and outreach on environmental issues.

Other Government Agencies

Other government agencies in The Bahamas share specific environmental responsibilities that may be relevant for the proposed Project, which during the approval process may require the procurement of additional information and/or permits. These include the following:

- Department of Fisheries: responsible for enforcing fisheries regulations and establishing marine reserves;
- Department of Agriculture: responsible for the conservation of birds and plants;
- Department of Lands & Surveys, Forestry Unit: responsible for managing forest resources;
- Ministry of Tourism and Aviation: responsible for Road Traffic, Postal Department, Department of Civil Aviation, Department of Meteorology, and Port Department;
- National Emergency Management Agency (NEMA): Mission is, "To reduce the loss of life and property within the Commonwealth of The Bahamas, by ensuring that adequate preparedness and mitigation measures and response and recovery mechanisms are established to counteract the impact of natural, man-made and technological hazards" and
- National Oil Spill Advisory Committee: Purpose is to ensure that The Bahamas is in a state of readiness, as it pertains to oils spills in the territorial and archipelagic waters of The Bahamas.

Other governmental organizations of interest are:

- Bahamas Maritime Authority;
- The Bahamas Electricity Corporation (BPL);
- Water and Sewerage Corporation;
- Ministry of Public Works & Urban Development - Civil Engineering Department;
- Ministry of Public Works & Urban Development - Building Control Division;

- Department of Physical Planning;
- The Royal Bahamas Police Force;
- The Royal Bahamas Defense Force;
- Bahamas Customs;
- Bahamas Immigration;
- Ministry of Tourism;
- Antiquities, Monuments and Museums and
- Bahamas Telecommunications Company (BTC)

National Policy and Legislation

The fundamental objective of Bahamas' environmental policy is to improve the quality of life of population through the reasonable use of natural resources, especially water, and with the aim of achieving sustainable economic development to meet the needs of present and future generations.

The Commonwealth of The Bahamas has established a comprehensive institutional and legal framework for environmental protection and natural resources management. Three key organizations, The Department of Environmental Planning and Protection, the Department of Environmental Health Services (DEHS) and The Bahamas National Trust (BNT), together with specific governmental resource management agencies, provide the institutional direction for environmental protection and management. Environmental protection is supported by a number of laws and regulations that control activities in the physical and biological environment. Recent modifications to long-established natural resources laws, and new laws and regulations dealing with the physical environment, have enhanced the existing legal framework. Additional laws are currently under development to update the existing legal structure.

The project will be designed, constructed, operated, and maintained in accordance with applicable Bahamian environmental laws and regulations.

Bahamian legislation which pertains to the physical and natural environment and which may pertain to the proposed development is listed in Table 7.1-1 (specific legislation marked in bold are directly applicable to the project and are described in more detail afterwards).

Table 7.1-1: Overview of applicable Bahamian legislation by Title and Chapter

Title IV	
Ch. 18	Consular Relations and Commonwealth Officers Act, 1969
Ch. 26	Public Works Act, 1964
Ch. 28	Out Islands Utilities Act, 1965
Ch. 37	Local Government Act, 1996
Ch. 51	**Antiquities, Monuments, and Museum Act, 1998;** Antiquities, Monuments, and Museum Regulations, 1999
Title XIV	
Ch. 140	International Persons Landholding Act, 1994
Ch. 194	Electricity Act, 1956
Title XIX	
Ch. 195	Out Islands Electricity Act, 1965
Title XX	
Ch. 196	**Water and Sewerage Corporation Act, 1976;** Water Supply Rules, 1953
Ch. 197	Water Supplies (Out Islands) Act, 1953; Water Supplies (Out Islands) Rules
Title XXI	
Ch. 199	Housing Act, 1968; Housing Regulations, 1983
Ch. 200	Buildings Regulation Act, 1971 Buildings Regulation (General) Rules, 1971

	Building Regulation (Extension to the Out Islands) Order, 1975
Ch. 201	Roads Act, 1968
Ch. 204	Coast Protection Act, 1968
Title XXV	
Ch. 215	Explosives Act, 1970 Explosives Regulations, 1970
Ch. 216	Explosive Substances (Illegal Use and Possession) Act, 1958
Ch. 217	Inflammable Liquids Act, 1958
Ch. 218	Liquefied Petroleum Gas, Act 1988 Liquefied Petroleum Gas Regulations, 1988
Ch. 219	Petroleum Act, 1978 Petroleum Regulations, 1978
Title XXVI	
Ch. 223	Derelict Motor Vehicles (Disposal) Act, 1967
Ch. 232	**Environmental Health Services Act, 1987**
Title XXX	
Ch. 248	Wild Animals (Protection) Act, 1968
Ch. 249	Wild Birds Protection Act, 1952 Wild Birds Protection (Reserves)
Ch. 250	Plants Protection Act, 1916 Plants Protection Order 1918 Prohibition of the Importation of Plants Order, 1971 Prohibition of the Importation of Plants (State of California) Order, 1982

	Plants Protection (Import of Citrus Fruits, Plants and Other Propagative Material from Florida) Order, 1993 Plants Protection (Restriction on Imports of Fruits, Vegetables, Flowers, Plants and other Propagative Materials) Pink Mealybug) Order, 1997 Plant Protection Rules, 1916
Title XXXI	
Ch. 251	Land Surveyors Act, 1975 Bye-laws of The Bahamas Association of Land Surveyors 1993 Land Surveyors Regulations, 1975
Ch. 252	Acquisition of Land Act, 1913
Ch. 253	Out Islands Dilapidated Buildings Act, 1952
Ch. 257	Private Roads and Subdivisions (Out Islands) Act, 1965
Ch. 258	Subdivisions (Local Improvement Associations) Act, 1965
Ch. 259	Reclamation and Drainage Act, 1937
Ch. 260	**Conservation and Protection of the Physical Landscape of The Bahamas Act, 1997** **Declaration of Protected Trees Order, 1997** **Conservation and Protection of the Physical Landscape of The Bahamas Regulations, 1997**
Ch. 269	**Port Authorities Act, 2006**
Ch. 270	Abutments Act, 1864
Ch. 271	Abutments (Out Islands) Act, 1883
Ch. 274	Abandoned Wreck Act, 1965
Ch. 275	Merchant Shipping (Oil Pollution) Act, 1989

	Merchant Shipping (Oil Pollution) (Indemnification of Ship Owners) Regulations 1978
Ch. 278	Water Skiing and Motor Boat Control, 1971 Water Skiing and Motor Boat Control Regulations. 1971
Ch. 282	Archipelagic Waters and Maritime Jurisdiction, 1996
Ch. 283	The Bahamas Maritime Authority Act, 1995
Title XLVIII	
Ch. 391	The Bahamas National Trust Act, 1959 The Bahamas National Trust (Amendment) Act 2010
Ch. 328A	Family Islands Development Encouragement Act, No. 14, 1997 Forestry Act, 2010 **Planning and Subdivision Act, 2010**[1]
Ch. 39 of 2019	**Ministry of the Environment Act, 2019**
Ch. 40 of 2019	**Environmental Planning and Protection Act, 2019**

[1] The Bahamian court has held in the case of Simmons and BIRD v The Town Planning Committee and 4M Harbour Island 2019/Pub/ JRV/0018 that The Planning and Subdivision Act does not apply to Harbour Island, as the legislation that extended this Act to the family Islands referred to Eleuthera and not Harbour Island. Therefore, projects on Harbour Island are governed by the old law, which is the Town Planning Act ch. 255

7.2 INTERNATIONAL

The Commonwealth of Bahamas is signatory to the international conventions and protocols listed in Table 7.2-1.

Table 7.2-1: International Conventions and Protocols in force in The Bahamas

Convention/Protocol	Entry in force / accession	Detail/Objectives
Convention on Wetlands of International Importance (Ramsar Convention), 1971	June 1997 (entry in force)	The Convention aims to maintain the ecological characteristics of wetlands of international importance and to plan the "wise use", or sustainable use, of all wetlands on the territory of the countries which have ratified the Convention. Its aim is to protect wetlands, in order to stem the progressive encroachment on and loss of wetlands now and in the future.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	March 1979 (entry in force)	This convention regulates international trade in certain animal and plant species. Depending on the annex in which they are listed, the species are subject to export conditions (with systems of permits and special authorizations). The States must set up the necessary institutions for controlling trade in the species and issue export permits.
Convention of Biological Diversity	September 1993 (entry in force)	This convention has three main objectives: the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Implementation of this convention entails drafting national strategies for conservation and sustainable utilization of biological diversity. It is considered to be the key document for sustainable development.
United Nations Framework Convention on Climate Change; 1992	June 1992 (entry in force)	The United Nations Framework Convention on Climate Change was adopted in Rio de Janeiro in 1992 by 154 States, in addition to the European Community. It entered into force on 21 March 1994 and in 2004 had been ratified by 189 countries. This convention is the first attempt by the UN to more clearly identify what climate change actually is and how to remedy it.

Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks	January 1997 (entry in force)	To encourage cooperation between States to ensure conservation and promote the objective of optimum utilization of fisheries resources both within and beyond the exclusive economic zone.
Kyoto Protocol, 1997	April 1999 (entry in force)	The protocol stipulates legally binding commitments on industrialized countries obliging these countries to reduce the annual average emissions of greenhouse gases by about 5.2% over the period 2008-2012.
United Nations Convention to Combat Desertification; 1994	February 2001 (entry in force)	This convention aims to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies. *Not directly relevant to this project.*
Stockholm Convention on Persistent Organic Pollutants	January 2006 (entry in force)	To protect human health and the environment from persistent organic pollutants.
Basel Convention Controlling Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), 1989	August 1992 (accession)	Conscious of the damage that could be caused to human health and the environment by hazardous and other wastes and the trans-boundary movements of these wastes, the States undertake to employ strict controls to protect human health and the environment against the harmful effects of the production and management of hazardous and other wastes.
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	May 1993 (accession)	The Montreal Protocol on Substances that Deplete the Ozone Layer was designed to reduce the production and consumption of ozone depleting substances in order to reduce their abundance in the atmosphere, and thereby protect the earth's ozone Layer.
Vienna Convention for the Protection of the Ozone Layer, 1985 (Vienna Convention)	April 1993 (accession)	This convention served as a framework for efforts to protect the globe's ozone layer. The objectives of the Convention were for Parties to promote cooperation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.

International Convention for the Prevention of Pollution from Ships (MARPOL), 1973	May 2011	The purpose of this convention is to regulate pollution by hydrocarbons, chemical products, packaging, garbage, sewage and atmospheric emissions. It is the reference text in the field of marine pollution prevention. The convention is primarily based on the specification of and compliance with technical rules, e.g. requirement for double-hulled oil tankers and tankers carrying chemical products, requirement for oil-water separators and to maintain documentation. The Wider Caribbean Region (WCR) (Caribbean Sea and Gulf of Mexico) became a designated Special Area under Annex V of the MARPOL Convention, which prohibits the discharge of all garbage by ship.
International Convention on Civil Liability for Oil Pollution Damage, 1969 and 1992	October 1976 (accession)	International maritime treaty adopted to ensure adequate compensation where oil pollution damage is caused by maritime accidents.
Convention for the Unification of Certain Rules of Law Relating to Assistance and Salvage at Sea	February 1913 (accession)	To provide a uniform set of rules governing assistance and salvage at sea.
International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992 (1992 Fund Convention)	July 1976 (accession)	To supplement the International Convention on Civil Liability for Oil Pollution Damage, 1969; to ensure that adequate compensation is available to persons who suffer damage caused by pollution resulting from the escape or the discharge of oil from ships; and to ensure that the oil cargo interests bear a part of the economic consequences of such oil pollution damage, to the relief of the shipping industry.
Convention on Facilitation of International Maritime Traffic, as amended (FAL)	May 1998 (accession)	To prevent unnecessary delays in maritime traffic, to aid co-operation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures.
Convention on the International Regulations for Preventing Collisions at Sea (COLREGS)	July 1997 (entry in force)	To update and replace the International Regulations for Preventing Collisions at Sea, 1960; to maintain a high level of safety at sea.
International Convention for the Safety of Life at Sea (SOLAS), 1974	February 2000 (entry in	The convention aims to ensure that ships of signatory countries comply with a series of safety standards and practices.

Caribbean Challenge Initiative, 2013.	May 2013	An agreement made between 9 Caribbean government and territories committing them to accelerate and expand efforts to safeguard the Caribbean region's marine and coastal environment, further promote the sustainable use of natural resources through new commitments to conservation.
The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (WCR) or Cartagena Convention. 1983	June 2010	Focused on the protection of the marine environment from pollution within the Caribbean, it includes a series of specific protocols on oil spills, specially protected areas and wildlife and land based sources of marine pollution
United Nations Convention on the Law of the Sea (UNCLOS) (Montego Bay Convention), 1982	July 1983 (entry in force)	This convention defines the powers of enforcement available to the states affected by an illegal act of marine pollution.
International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) 1990	January 2002 (accession)	Article 3 of this convention requires that ships and installations at sea have an oil pollution emergency plan. The Developer must develop an Oil Spill Response Plan.
ILO Conventions	May 197 (entry in force)	International labor standards are legal instruments drawn up by the ILO's constituents (governments, employers, and workers) and setting out basic principles and rights at work. They are either conventions, which are legally binding international treaties that may be ratified by member states, or recommendations, which serve as non-binding guidelines.

8.0 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 METHODOLOGY

The EIA process constitutes a systematic approach to the evaluation of a project and its associated activities throughout the project lifecycle. The process includes:

- Screening and Scoping;
- Project Alternatives and Base Case Design;
- Existing Environmental and Socio-Economic Conditions;
- Impact Assessment;
- Residual Impact Identification;
- Disclosure and Stakeholder Consultation; and
- Mitigation and Monitoring;

Screening is the first step in the assessment process. It confirms the need (or otherwise) for an EIA by appraising the type of project and its associated activities throughout the project lifecycle in the context of its biophysical, socio-economic, policy and regulatory environments given the location, scale and planned activities associated with the Project, it was agreed with the Ministry of Housing and the Environment / BEST Commission (now DEPP) that the project should be subject to an EIA, and the EIA should take account of applicable national and international legislation.

Scoping is a high-level assessment of anticipated "interactions" between project activities and environmental "receptors". Its purpose is to focus the assessment on key issues and eliminate certain activities from the full impact assessment process based on their limited potential to result in discernable impacts. To arrive at a conclusion to 'scope out' an activity/event, a mixture of expert scientific judgement based on prior experience of similar activities and events.

8.2 LAND USE IMPACTS

Land use change will be minimal, given the extent of previous human disturbance. The Western end of Paradise Island will undergo a modest transition to a larger facility providing similar experiences to those for which Paradise Island has become developed for.

8.3 AESTHETIC IMPACT

The physical setting of Paradise Island may be considered moderately aesthetic due in part to its existing land use.

Whilst the visual aesthetics of shoreline development is an individual assessment, the proposed further development of the western end of Paradise Island will be in keeping with existing land use and will not detract from or introduce adverse impacts to the existing current aesthetics.

8.4 IMPACTS TO THE PHYSICAL ENVIRONMENTAL

Cumulative physical impacts are not considered significant given the existing terrestrial physical disturbance and moderate expansion anticipated.

The existing site is developed with a number of residences in varying states following Hurricane Mathew. Most structures are scheduled to be demolished and all construction demolition debris is to be removed from site.

A complete demolition plan is to be included in the Environmental Management Plan.

Construction and expansion of pathways and buildings may require additional steps to create a solid and durable foundation including localized penetration of subsurface limestone in order to properly support the new facilities.

Weather and climate are environmental factors that will persist throughout the development period, and as such the developer shall take into consideration the impacts from anticipated and unexpected weather events that may naturally alter the physical environment.

The proposed development seeks to avoid undue environmental harm where possible. Mitigation techniques and best management practices to mitigate and alleviate adverse impacts will be further addressed in an Environmental management Plan (EMP).

8.4.1 Erosion and Sediment Impacts

Erosion and sediment impacts are limited to activities associated with preparation for construction and supporting infrastructure, i.e. lay-down area and pathway improvements, and site clearance. Other potential erosion and sediment impacts such as storm-water management, and protection of sensitive environments will fall under the auspice of an Environmental Management Plan.

8.4.2 Hydrology & Hydrogeological Resource Impacts

Excluding the salt water table, no significant subterranean fresh water lens is known to exist at the Site that would be otherwise affected by the project expansion.

No site-specific hydrological studies have been conducted nor is it presumed that they will be required as the minimal land mass of the Site would not accumulate nor develop any fresh water lens of any magnitude. Hydrologic impacts refer to harmful substances released into surface or ground waters either directly or indirectly and these cause change to surface and sub-surface water flows.

8.4.3 Noise and Air Impacts

By definition, noise pollution takes place when there is either excessive amount of noise or an unpleasant sound that causes temporary disruption in the natural balance. This definition is usually applicable to sounds or noises that are unnatural in either their volume or their production. Our

environment is such that it has become difficult to escape noise. Even electrical appliances at home have a constant hum or beeping sound. By and large, lack of urban planning increases the exposure to unwanted sounds.

The increased use of Paradise Island as a destination is unlikely to result in any appreciable increases in sound or noise pollution.

8.4.4 Navigational Impacts During Construction

There is no land-based access to the site, therefore requiring that all construction materials and equipment be mobilized through the use of construction barges and boats. An existing provision ramp is located at the site which will be utilized for equipment access and egress, fill disposal, and waste removal. There is no recreational, commercial or residential marine traffic that transits the southern portion of the site near shore, as this land is all unoccupied and vacant. The marine structures and loading sites are located well beyond the boundaries of the main shipping channel so that any boats or barges that are working at the site will be well clear of any and all commercial marine traffic.

Operational marine traffic will see an increase in traffic but there is an existing base of marine traffic and visitation to this area.

8.5 BIOLOGICAL IMPACTS

8.5.1 Habitat Fragmentation

For the most part, habitat fragmentation impacts are not anticipated due the significant amount of existing human disturbance and introduced vegetation.

8.5.2 Habitat Degradation

Habitat degradation impacts are considered negligible. Some habitat degradation is unavoidable due to loss of habitat necessary for construction clearing and building. These impacts are considered minimal given the extent of human altered areas over the entire island.

The greatest biological threat posed to biodiversity, particularly on small Cays, is localized impacts as a result of alteration of habitat through the introduction of aggressive opportunistic species such as those recommended for removal or eradication.

An Environmental Management to be developed will discuss invasive species systematic removal.

8.5.3 Wildlife Impacts

All of the focal species of conservation concern has a small population size and limited geographic distribution, all of the focal and with species are avifaunal relative dearth of localized life history information for each of these birds, species-specific management is not likely practical or efficient. Instead the preservation to the extent possible of suitable foraging and roosting habitat is key to preservation and conservation.

8.5.4 Impacts on Special Ecological Features and Biodiversity

No areas of special or sensitive ecological or notable diversity were observed Biodiversity on Paradise Island is limited due to its small land mass as smaller land masses tend to support fewer numbers of species than larger ones.

8.6 SOLID WASTE & HAZARDOUS WASTE IMPACTS

No solid waste issues are anticipated as all solid waste streams will be disposed of.

8.7 WATER AND WASTEWATER IMPACTS

It is recommended that water supply is a self-provision from an RCG owned and operated reverse osmosis plant, thereby ensuring a safe and consistent potable water supply.

Self-provision of waste water treatment is considered as being the only viable option. One advantage of this option is the intrinsic availability of tertiary treated effluent for irrigation and flush water, if this option is selected.

Direct control by RCG will ensure that the requirements of the Water and Sewerage specifications for waste streams are adhered to.

8.8 FIRE AND HURRICANE RISKS

Fire presents a significant risk to businesses. It can kill or seriously injure employees or visitors and can also damage or destroy buildings, equipment or stock. Fire management will further be discussed in an Environmental Management Plan to be developed.

Extreme coastal storm events, such as hurricanes, are of particular concern for the Project due to the frequency of occurrence in the Caribbean. The long fetch of open Atlantic Ocean allows for storms to develop and mature into categorically classified hurricane systems by the time they reach the warmer waters of the Caribbean.

8.9 SOCIO-ECONOMIC IMPACTS

After completion of the Project, Nassau Harbour will continue to operate as a cruise ship destination, and no increase in population would be for staff employed by RCG. Long-term employment for continuing operations at the new facility includes retention and expansion of job opportunities. RCG plans to involve local musicians, entertainers, and other professions and incorporate and use local culture and artists in the continuing destination operations. Furthermore, RCG will make reasonable efforts to employ Bahamians to provide landscaping services.

The National Retail and Investment Policy of the Bahamas requires that the retail operations are conducted by Bahamians with the exception of logo shops. The Project will provide additional retail opportunities for Bahamians.

RCG brings over 2Mpassengers to the Bahamas annually, and completion of this Project will increase the passenger count dramatically. In addition, all twenty-five (25) RCG ships are currently registered in the Bahamas. The Project will improve the cruise guest experience, and to promote future passenger traffic growth to the Project, site improvements are essential. The Project will provide an economic benefit to the Government of the Bahamas and its residents from the various islands within the Bahamas. The increase in cruise ship passengers will provide additional revenue to the Government in the form of head taxes and customs. In addition, the Project will create additional employment opportunities for Bahamians both in design and construction jobs as well as permanent operational positions as discussed in previous sections.

9.0 REGISTER OF SIGNIFICANT ENVIRONMENTAL ASPECTS

No significant environmental impacts are anticipated and no register is compiled.

10.0 ENVIRONMENTAL MANAGEMENT

A site-specific environmental management plan will be developed and will ensure that project implementation and operation will be carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle.

11.0 RECOMMENDATIONS

It is recommended that the EMP to be developed contain site specific invasive specie removal and replacement with indigenous species.

12.0 CONCLUSION

This Environmental Impact Assessment for the proposed terrestrial expansion of existing facilities on Paradise Island recommends moving forward with the proposed development and finds no significant negative impact. The site will experience an insignificant loss of vegetation; however, implementation of mitigation techniques such as native landscaping and close construction footprint shall lessen overall impacts.

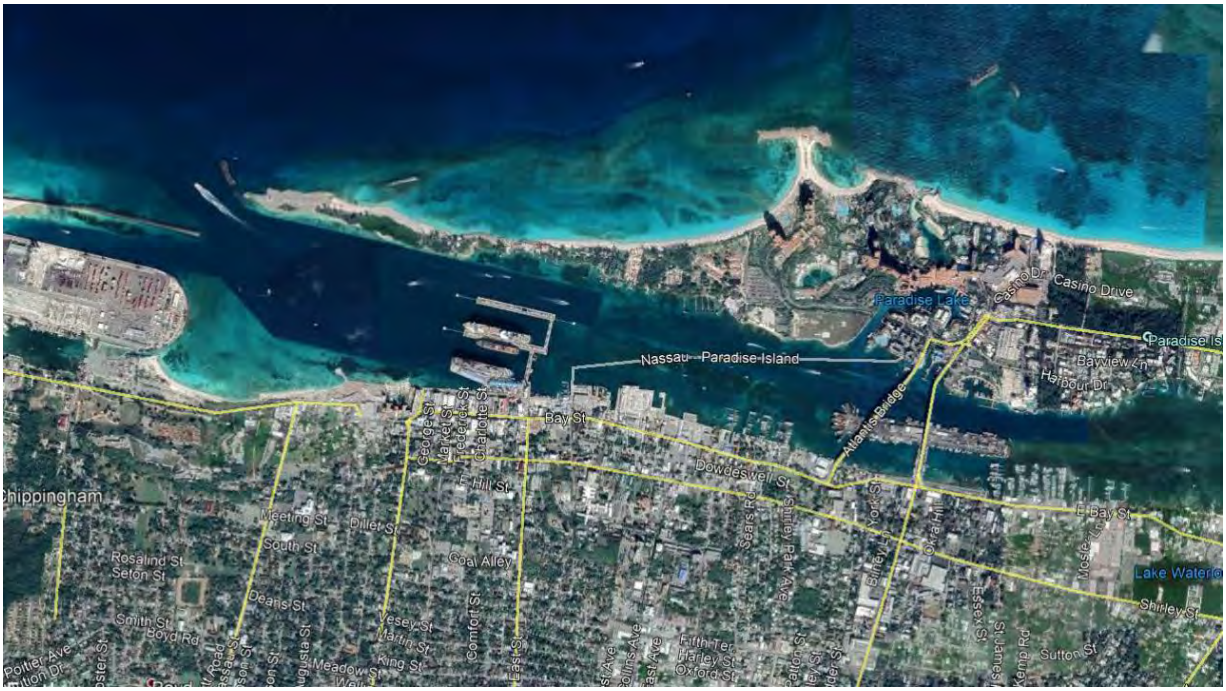
Additionally, the capital investment will positively impact the local community by providing employment and occupational transfer of skills while expanding the touristic offerings of the area. The developer emphasizes a local Bahamian workforce with minimal environmental impacts through the use of smart energy technology, smart building design, and high efficiency products.

13.0 REFERENCES

- https://www.climatestotravel.com/climate/bahamas
- https://www.adaptation-undp.org/explore/caribbean/bahamas

14.0 APPENDIX

A. COASTAL ASSESSMENT



Coastal Processes Study
Royal Paradise Island, Bahamas

Presented to:

Islands by Design, Ltd.

Attn: Keith A. Bishop

December 14, 2020

Prepared by:

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1. Introduction

Moffatt & Nichol (M&N) was retained by the Islands by Design, Ltd (Client) to conduct a coastal processes study for the planned cruise guest destination project on Royal Paradise Island (Project) located just north of Nassau (on New Providence Island), Bahamas (see Figure 1-1). The objective of the coastal processes study is to assist the Client with the compilation of a comprehensive Environmental Impact Assessment (EIA) for the planned cruise guest destination project.

Figure 1-1: Project Site

M&N collected, compiled and reviewed existing available data sets regarding winds, waves, water levels, historical hurricanes and storm surges in the project vicinity. A statistical analysis for the winds and waves was performed. The monthly and annually wind and wave roses were developed. Winds and waves for normal conditions as well as extreme conditions were evaluated. The extreme wind and wave conditions were determined through an extreme probability analysis. M&N utilized the state-of -the-art DHI MIKE 21 spectral wave model to transform the waves from offshore to the Project region.

2. Project Description

The Project site is located on Paradise Island on the northeast coast of New Providence Island, Bahamas. The site is adjacent to the Nassau cruise ship terminal to the south and located approximately 2.5 kilometers from Nassau proper, as presented in Figure 2-1.

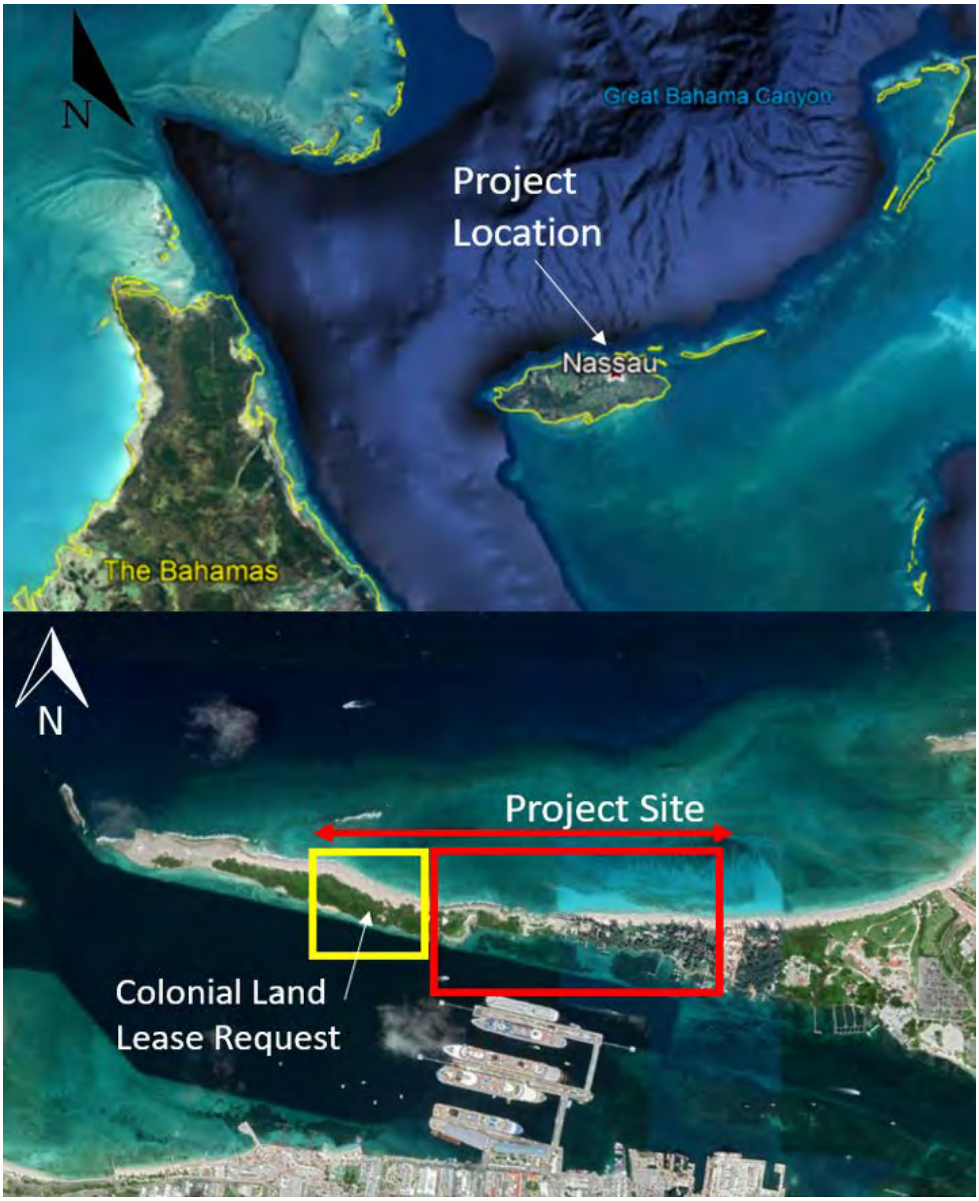


Figure 2-1: Project Location

The conceptual design marine elements as part of the master plan for the proposed renovations to Royal Paradise Island are listed as follows and presented in Figure 2-2:

- Paradise Cove Beach and Swim Area
- Secondary Provisions Ramp
- Piers and dock structures (Arrivals, Water Sports, Back of House)
- Boardwalks
- Existing Seawall
- North Beach

Concept schematic design drawings for the marine elements are presented in Appendix D.

Figure 2-2: Master Plan (CRTKL, 2020)

3. Site Observations

A site visit to the project location was conducted on November 15, 2019, to review the existing shoreline and metocean conditions. The following graphic illustrates the observed conditions and summarizes coastal concept design considerations.

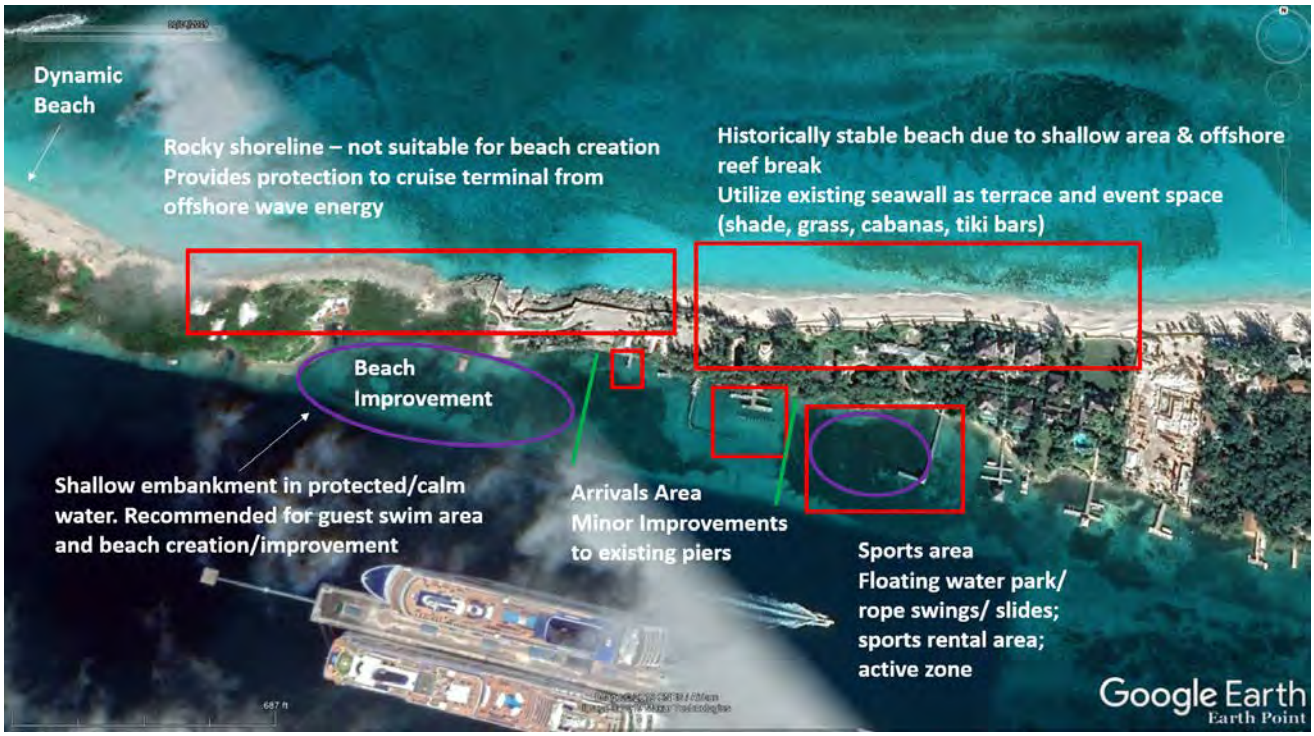


Figure 3-1: Site Observations & Opportunities

<u>Northern Shoreline</u>

The north side of Paradise Island exhibits an energetic wave environment, with dynamic shorelines to the west and a more stable beach to the east. The offshore reef and bathymetric shoal formations help stabilize east beach.

- Recommend separating into three zones: west beach (dynamic), rocky shore, east beach (more stable
- West beach – dynamic wave and current environment. Suitable for guest chairs/access, but not recommended for permanent structures or infrastructure investments.
- Rocky shore – stable, narrow, existing seawall structures provide privacy to shoreline and pocket beaches. Suitable for cabanas and tiki huts on stilts. Existing pocket beaches and tide pools can be improved for guest safety and experience.
- East beach – historically stable due to shallow offshore bathymetry. Recommend utilizing the existing seawall for terrace-style guest experience to provided vegetated, grassy area, shade experience and event space.

Photos illustrating the Northern Shoreline conditions are presented in the following pages.

Photo 1 - Dynamic west beach (looking east)

Photo 2 - Rocky Shoreline private pocket beach access

Photo 3 – Pocket beach on north shoreline

Photo 4 – Rocky shoreline existing seawall and deck

Photo 5 – Rocky shoreline existing seawall protection and lower tidepools

Photo 6 - Existing seawall and pathway elevation on east beach

Photo 6 - Existing stairway to east beach

Photo 7 - Existing seawall and beach on north shoreline (looking east)

Photo 8 - Existing seawall for proposed terrace

Photo 9 - Existing rock protection and east beach (looking west)

Southern Shoreline

The south side of Paradise Island is protected from the offshore wave energy that primarily approaches the site from the northeast direction. This side of the island is in close proximity to the cruise terminal and navigation channels. The coastal and marine opportunities on this shoreline of the project are recommended as follows:

- Creating bounded swim zones, creation of shallow pocket beaches and snorkel trails for guest experience and recreation.
- Opportunity to create a sports zone area with recreational vessel access to the adjacent shallow harbor channel to the east.
- Recommended placing desired utilities and the more “permanent” facilities on this side of the island.
- Utilize the existing rocky shore to create nature boardwalk opportunities and swim or snorkel trails.
- Recommend delineating a no-swim, Arrivals Area for vessel traffic to allow tender access for guests and required cargo. Recommend improving and utilizing existing piers, as able to incorporate into the master plan aesthetics.

Photos illustrating the Southern Shoreline conditions are presented in the following pages.

Photo 10 – Shallow, calm swim area on southern shoreline (looking west)

Photo 11 – Shoreline opportunities for guest recreation

Photo 12 – Beach opportunity and shallow, calm swim area on southern shoreline (looking west)

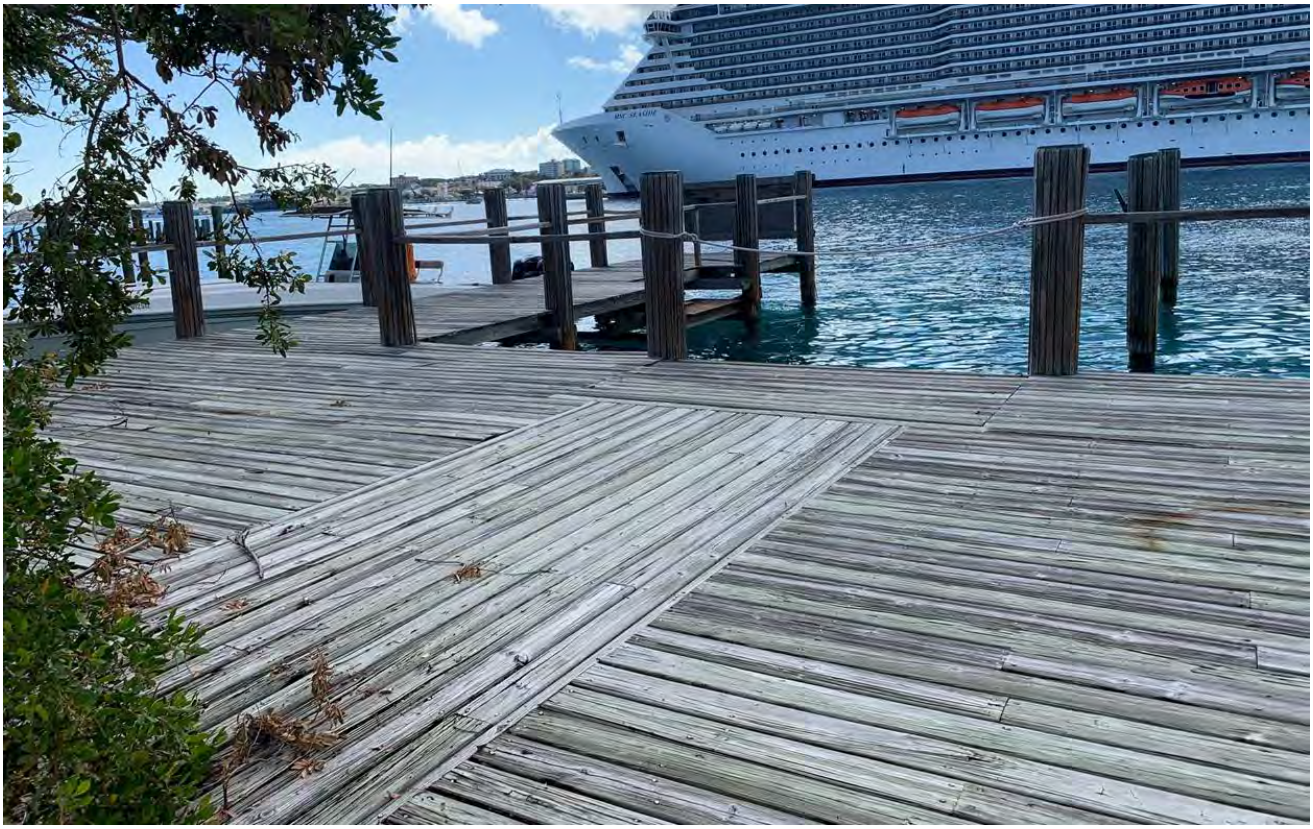


Photo 13 – Existing pier for proposed arrivals area (looking south)

Photo 14 – Existing pier for proposed arrivals area requiring repairs (looking west)

Photo 15 – Existing pier for proposed arrivals area for guest dismount (looking east)

Photo 16 – Existing pier for proposed arrivals area requiring minor repairs (looking south)

4. Coastal Processes

This section presents the review and analysis to the natural coastal processes including hurricanes, winds, waves, water levels and storm surges at Royal Paradise Island, Bahamas.

4.1. Hurricanes

A hurricane is defined as a severe tropical, cyclonic storm with sustained wind speed above 119 km/hr. Hurricanes impact coastal areas by increasing water levels (storm surge) and developing large storm waves that can cause severe damage to coastal communities. In the Northern Hemisphere, hurricanes typically develop in north of the equator in the tropical and subtropical latitudes of the Atlantic Ocean. Characteristics of hurricanes include: low barometric pressure, high winds, heavy rainfall, large waves, and storm surges. The hurricane season for project vicinity generally lasts from the middle of May through November.

The National Hurricane Center (NHC) tropical storm and hurricane database (HURDAT) provides tropical storm and hurricane data including a time series of center locations, maximum sustained wind speeds, and central pressures at 6-hour intervals. Examination of the HURDAT records between 1918 and 2018 revealed that 48 storms passed within the 105-kilometer radius of the Project site (see Figure 4-1). A list of the extracted historical hurricanes showing date, name and maximum wind speed (1-minute) is presented in Table 4-1. The largest wind speed recorded between 1918 and 2018 is 69 m/sec caused by the hurricane in September 1932.

Figure 4-1: Historical Storm Tracks

Table 4-1: Historical Storms (1918 – 2018) within 105-kilometer Radius

No.	Date	Storm Name	Wind Speed (m/sec)	Category
1	Sep. 5, 1932	UNNAMED	69	H4
2	Aug. 24, 1992	ANDREW	64	H4
3	Sep. 18, 1926	UNNAMED	64	H4
4	Oct. 6, 2016	MATTHEW	62	H4
5	Sep. 3, 1933	UNNAMED	62	H4
6	Sep. 26, 1929	UNNAMED	62	H4
7	Sep. 7, 1965	BETSY	57	H3
8	Aug. 26, 1949	UNNAMED	57	H3
9	Jul. 26, 1926	UNNAMED	57	H3
10	Sep. 14, 1999	FLOYD	54	H3
11	Sep. 3, 2004	FRANCES	49	H2
12	Oct. 6, 1941	UNNAMED	49	H2
13	Aug. 25, 2011	IRENE	46	H2
14	Nov. 5, 2001	MICHELLE	41	H1
15	Sep. 3, 1979	DAVID	41	H1
16	Oct. 13, 1945	UNNAMED	41	H1
17	Aug. 1, 1995	ERIN	39	H1
18	Oct. 3, 1966	INEZ	36	H1
19	Aug. 6, 1928	UNNAMED	36	H1
20	Oct. 7, 1958	FOX	33	H1

The effects of Hurricane Andrew in the Bahamas included three direct fatalities and $250 million (1992 USD) in damage. The hurricane made its first landfall in The Bahamas on Eleuthera as a Category 5 hurricane.

More recently, Hurricane Matthew raked across the main northern islands of the Bahamas with its full Category 4 force. It was the first major hurricane to strike Nassau and New Providence, home to the bulk of the Bahamas' population of 375,000, since 1932. Experiencing a direct hit from the eyewall of Matthew, Grand Bahama also suffered extensive damage. An estimated 95 percent of homes in Eight Mile Rock and Holmes Rock sustained severe damage. Numerous trees and power lines were toppled by the storm's high winds, rendering roads impassable. Flooding-induced by the backside of the storm affected much of the western half of the island. Total losses from Matthew in the Bahamas are estimated to be approximately $580 million (2016 USD).

4.2. Water Levels and Storm Surges

In order to establish the tide datums on site, the Oregon State University (OSU) tidal database which is based on TOPEX/Poseidon satellite altimetry data (Egbert et al., 1994; Egbert and Erofeeva, 2002) was used to extract astronomical tides at the same location of the data point.

Table 4-2 shows tidal datums according to a tidal constituents analysis performed on water levels extracted from the Global TPXO8 1/6 + Coastal (2016) model for the 1983-01-01 to 2001-12-31 Epoch. The elevations are shown in reference to MSL. The tides at the Project site are semi-diurnal with a mean range of 0.78 m and a great range of 0.9 m.

Table 4-2: Predicted Water Levels

Datum	Elevation (m)	Elevation (ft)
Mean Higher High Water Level (MHHW)	0.48	1.58
Mean High Water Level (MHW)	0.39	1.27
Mean Sea Water Level (MSL)	0.00	0.00
Mean Low Water Level (MLW)	-0.39	-1.27
Mean Lower Low Water Level (MLLW)	-0.42	-1.37

Storm surge occurs due to the onshore movement of water from onshore wind, and from the rise in the mean sea level as a result of low pressures in the center of a storm. In Nassau, storm surge is typically related to the passage of a tropical storm or hurricane.

In 2008, Baird performed comprehensive storm surge simulations as part of the Nassau Port deepening project. The model results indicate that the 100-year storm surge level would be in the order of 1.2 m above a mean high tide level.

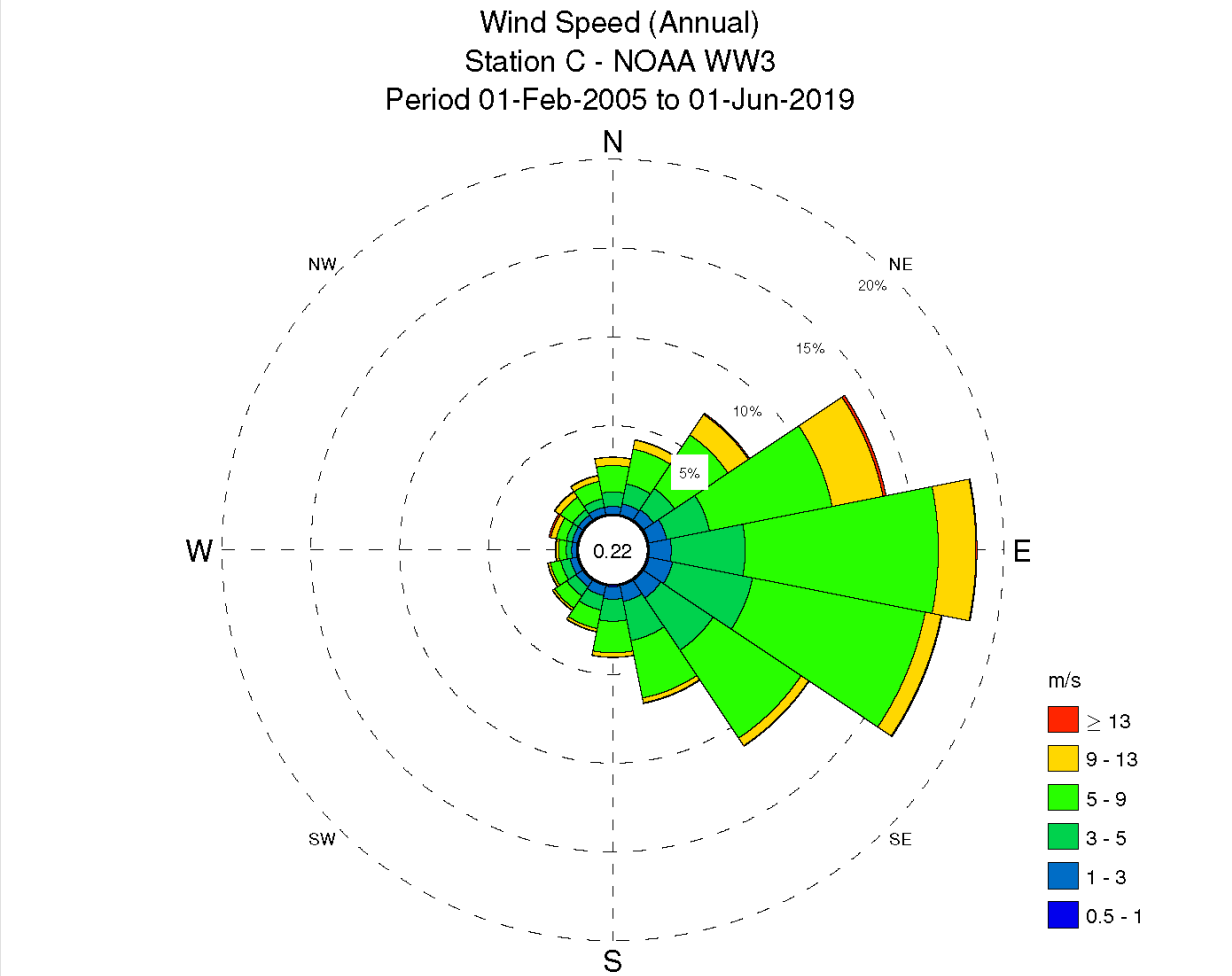
4.3. Winds and Waves

The wind and wave data were extracted from the NOAA WAVEWATCH III model. The wind data is from the Global Forecast System (GFS). The acquired data includes a time series of approximately fourteen years of wind and wave information at a 3-hour interval. The wind speeds and directions were extracted at project site. The offshore waves were extracted at two offshore locations (see Figure 4-2).

Figure 4-2: Wind and Wave Data Locations

Normal Wind and Wave Conditions

Figure 4-3 illustrates the annual wind rose at the Project site. The wind rose indicates that the prevailing winds were from east-northeast, east and east-southeast directions. The monthly wind roses are presented in Appendix A. The percent exceedance of wind speeds is illustrated in Figure 4-4. Table 4-3 presents the analyzed normal wind conditions.



Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 41865, calms 92
No missing observations

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.24	4.34	7.26	13.67	18.49	16.90	11.28	6.81	4.05	2.70	2.10	1.75	1.25	1.67	1.97	2.30	99.78
13				0.17										0.11			0.80
9	0.46	0.52	1.39	2.92	2.12	0.91	0.51	0.28	0.25	0.17	0.14	0.13	0.15	0.32	0.37	0.32	10.94
5	1.49	2.00	3.62	7.04	10.87	9.91	5.95	3.30	1.78	1.07	0.82	0.60	0.43	0.57	0.85	1.00	51.29
3	0.81	1.15	1.43	2.46	4.17	4.60	3.55	2.25	1.24	0.83	0.63	0.54	0.30	0.34	0.37	0.49	25.17
1	0.43	0.62	0.68	1.02	1.24	1.34	1.18	0.91	0.70	0.56	0.44	0.40	0.28	0.29	0.31	0.41	10.82
0.5																	0.76

Figure 4-3: Annual Wind Rose at Project Site

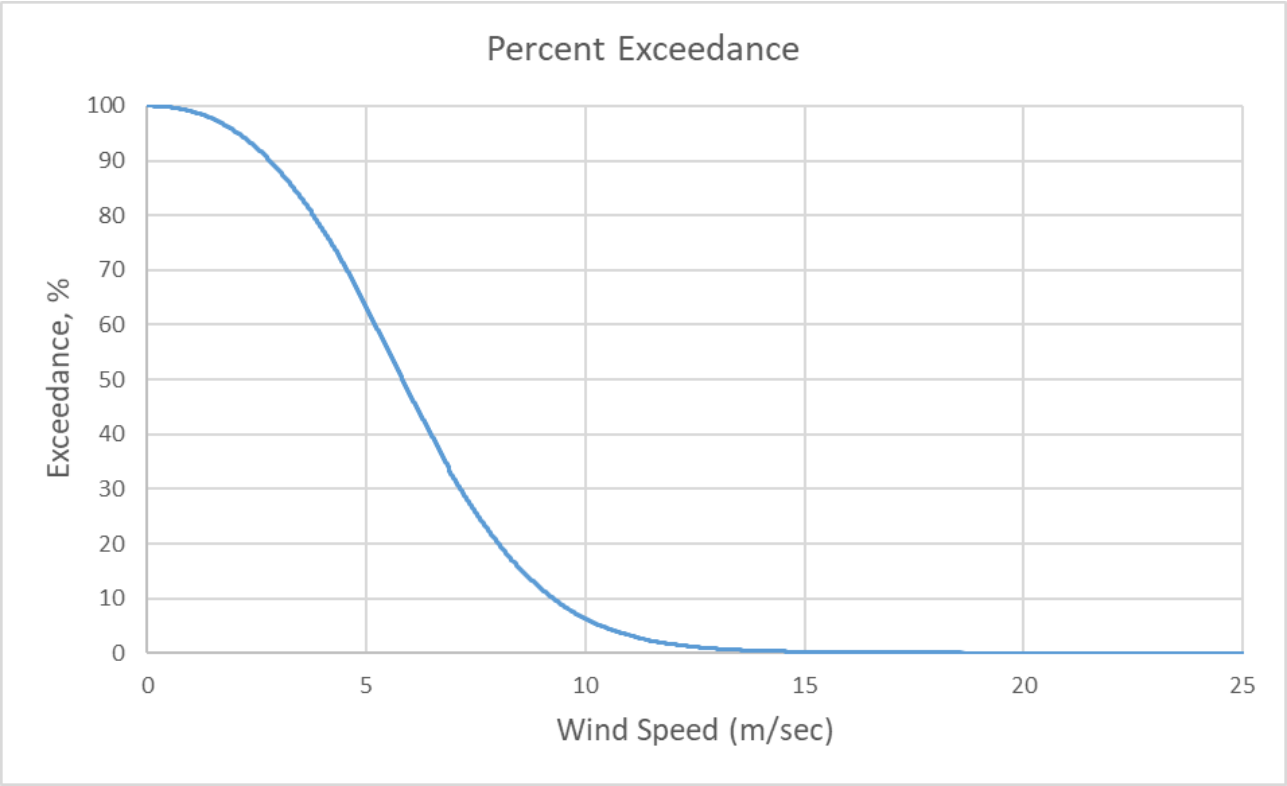


Figure 4-4: Annual Wind Speed Percent Exceedance

Table 4-3: Normal Wind Conditions

Exceedance, %	Wind Speed (m/s)
1	12.7
5	10.4
10	9.3

Appendix B and Appendix C present the annual and monthly wave roses at north offshore area and east offshore area, respectively. The annual wave rose at north offshore indicates that the prevailing waves were from northeast. The annual wave rose at east offshore indicates that the prevailing waves were from east and east-southeast. The percent exceedance of wave heights is illustrated in Figure 4-5 and Figure 4-6. Table 4-4 presents the normal wave conditions.

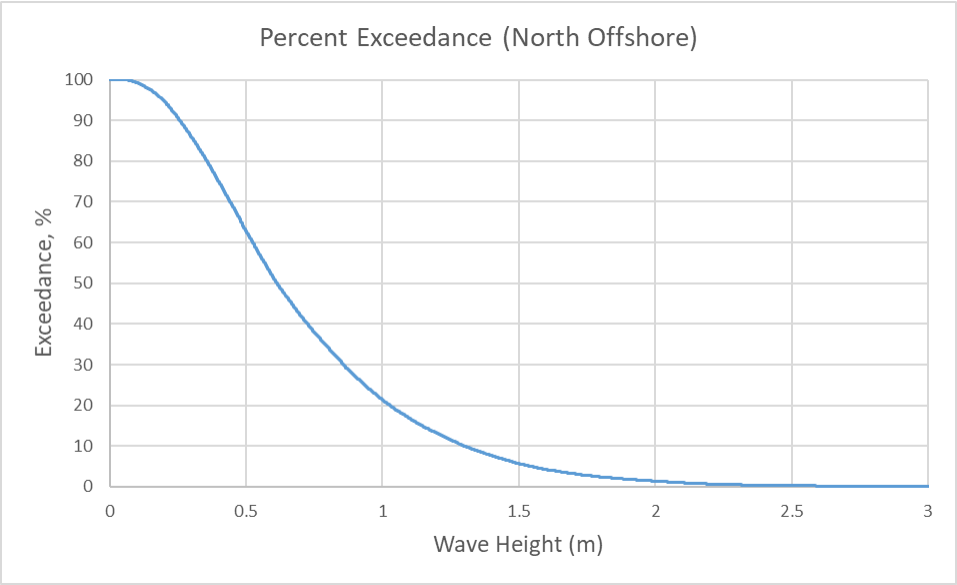


Figure 4-5: Annual Wave Height Percent Exceedance (North Offshore)

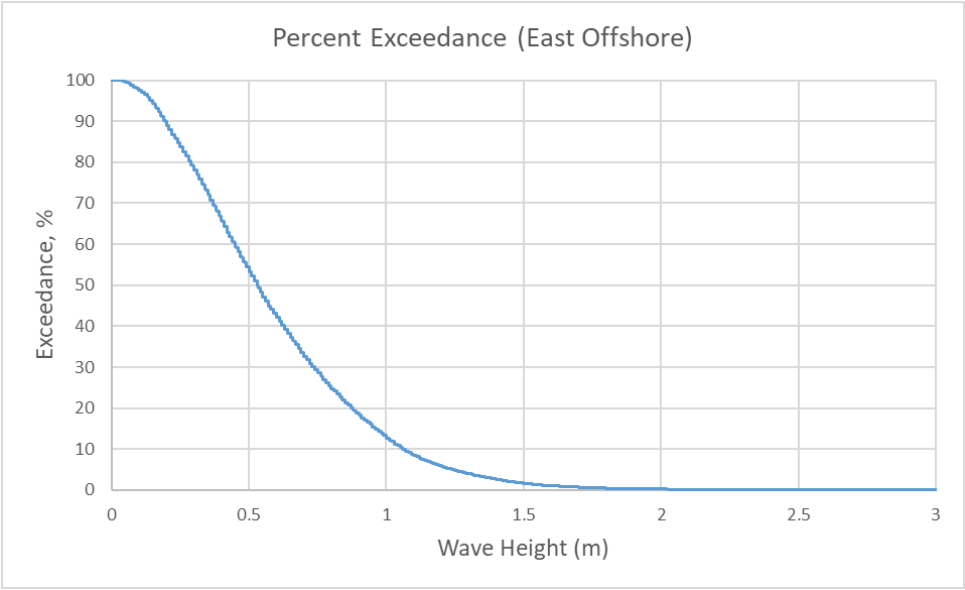


Figure 4-6: Annual Wave Height Percent Exceedance (East Offshore)

Table 4-4: Normal Wave Conditions

Exceedance, %	Wave Height (m)	
	North Offshore	East Offshore
1	2.10	1.62
5	1.55	1.24
10	1.30	1.06

Extreme Wind and Wave Conditions

An extreme probability analysis was conducted to determine the extreme design wind conditions for the 50- and 100-year return periods. The fitted Weibull distribution of wind speeds on the historical extreme events is illustrated in Figure 4-7. Table 4-5 presents the design extreme wind speeds for 50- and 100-year return periods.

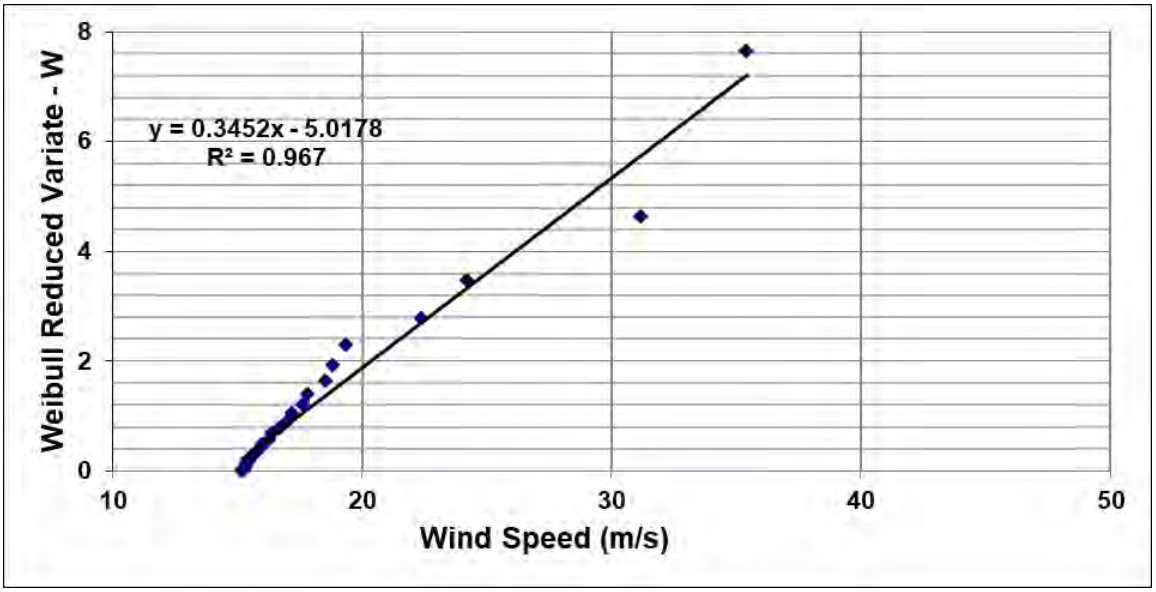


Figure 4-7: Weibull Distribution of Wind Speeds

Table 4-5: Extreme Wind Conditions

Return Period (year)	Wind Speed (m/sec)
50	39.4
100	45.1

An extreme probability analysis was conducted to determine the extreme design wave conditions for the 50- and 100-year return periods. The fitted Weibull distribution of wave heights on the historical extreme events is illustrated in Figure 4-8 and Figure 4-9. Table 4-6 presents the design extreme wind speeds for 50- and 100-year return periods.

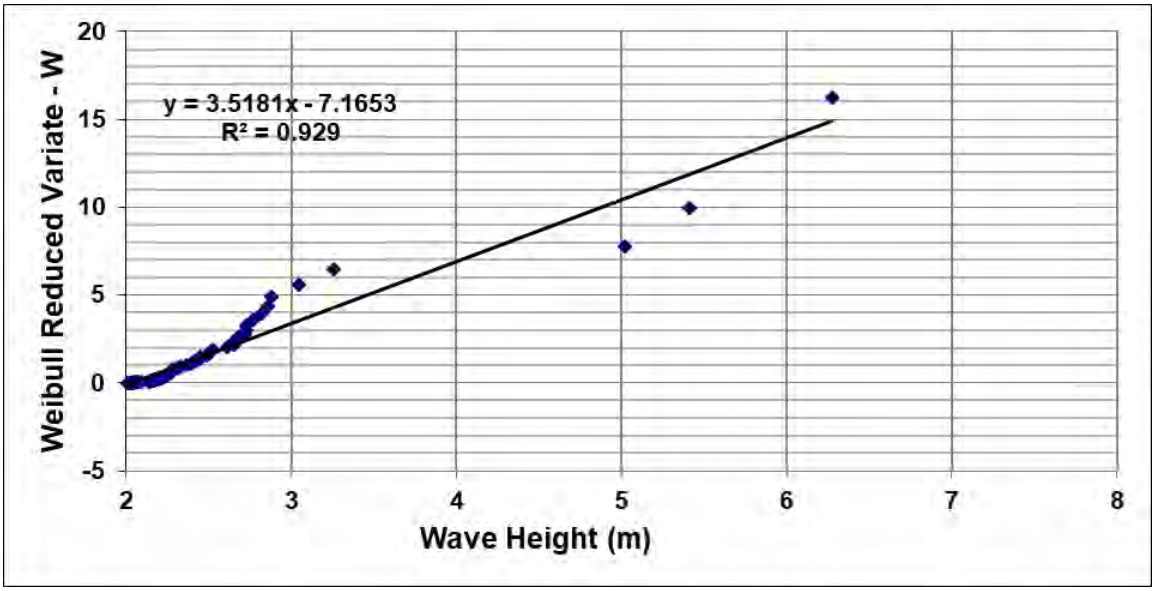


Figure 4-8: Weibull Distribution of Wave Height (North Offshore)

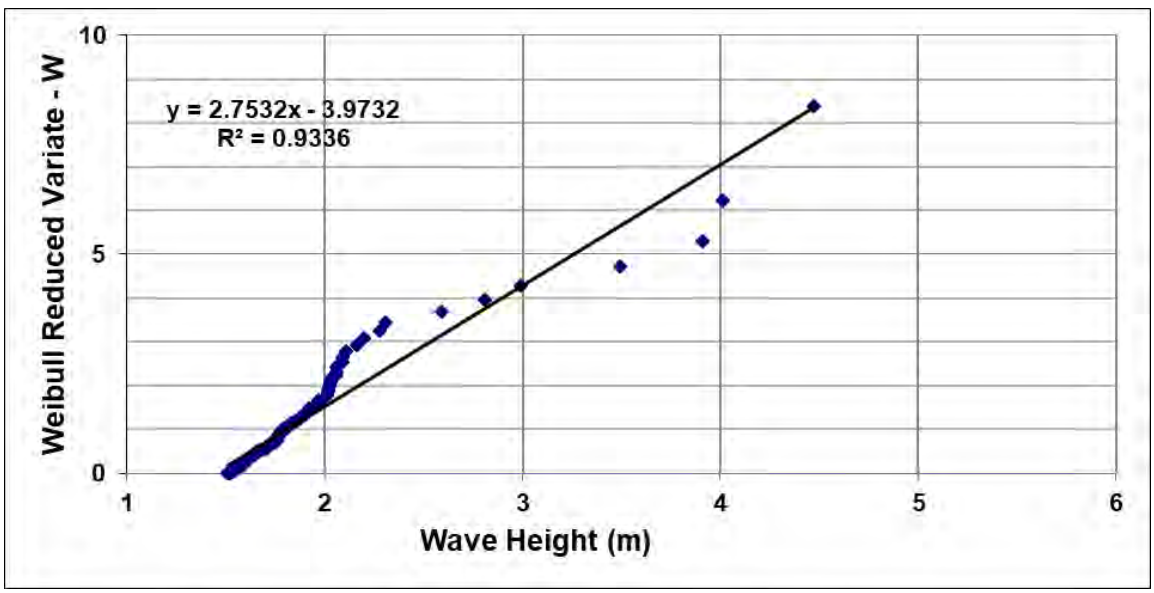


Figure 4-9: Weibull Distribution of Wave Height (East Offshore)

Table 4-6: Extreme Wave Conditions

Return Period (year)	Wave Height (m)	
	North Offshore	East Offshore
50	6.9	4.8
100	8.0	5.3

5. Nearshore Wave Transformation Modeling

A regional nearshore spectral wave transformation model was developed for the Royal Paradise Island project. The wave transformation study was performed utilizing a third-generation, two-dimensional spectral wave model. The DHI MIKE 21 Spectral Waves (SW) software was used to calculate wave conditions approaching the project area, using winds and offshore wave boundary conditions. MIKE 21 SW simulates the growth, decay and transformation of wind-generated waves and swells in offshore and nearshore coastal areas.

The existing bathymetric survey data, winds, and offshore wave climates were used for the spectral wave model development. The bathymetric survey data includes the latest survey conducted by Caribbean Coastal Services (CCS) dated on October 25, 2019, and NOAA charts. The model domain computational mesh resolution and model bathymetry are illustrated in Figure 5-1 and Figure 5-2. The horizontal mesh resolution varies between 1,500 m offshore and 10.0 m at project site.

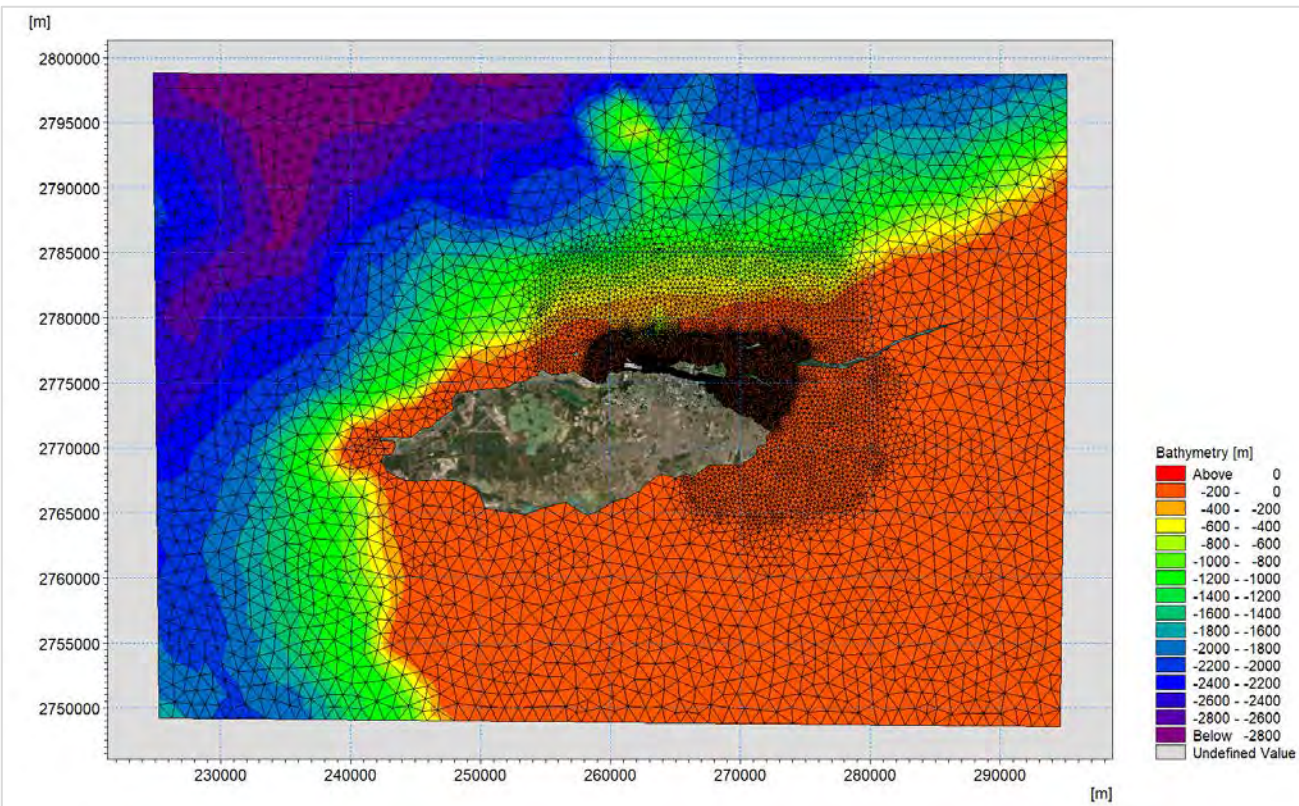


Figure 5-1: Wave Model Domain and Mesh (Entire Area)

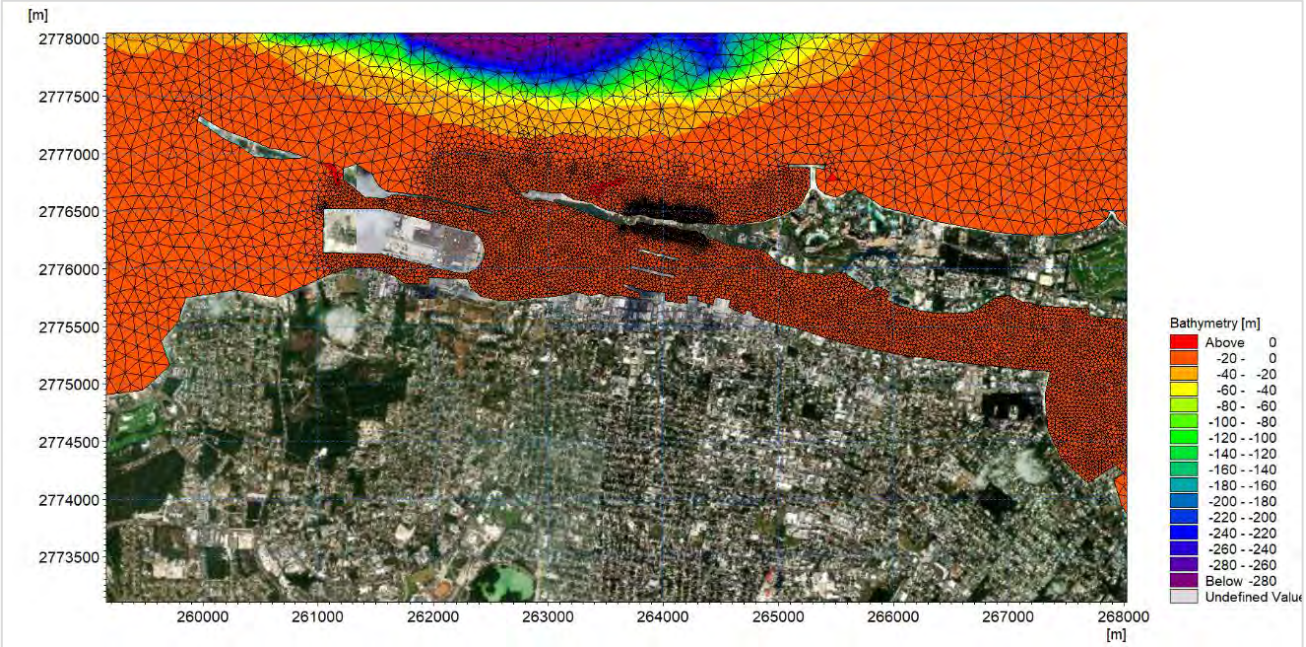


Figure 5-2: Wave Model Domain and Mesh (Project Site)

The spectral wave model was used to transform the wave climates from the offshore to the nearshore area. The analyzed extreme offshore wave conditions and extreme wind conditions in Table 4-5 and Table 4-6 were used as wind and wave open boundary conditions. The wave model results were extracted from six typical locations (see Figure 5-3). Table 5-1 presents the extreme wave conditions at the Project site for the 100-year return period.

Figure 5-3: Wave Data Locations

Table 5-1: Extreme Wave Conditions at Project Site (100-year Return Period)

Location	Hs, m	Tp, sec
O#1	1.21	11.7
O#2	1.65	11.7
O#3	1.89	11.7
B#1	1.47	3.5
B#2	1.57	3.5
B#3	1.52	3.5

For the normal wave condition, one-year time-series of wave climates in 2018 were simulated using the spectral wave model. Table 5-2 presents the normal wave conditions at project site for 1 percent exceedance wave height.

Table 5-2: Normal Wave Conditions at Project Site (1% Exceedance)

Location	Hs, m	Tp, sec
O#1	0.76	7.0
O#2	1.03	7.1
O#3	1.20	7.1
B#1	0.32	2.1
B#2	0.33	2.1
B#3	0.29	2.0

6. Conclusions and Recommendations

6.1. Conclusions

A coastal processes study was performed for the planned cruise guest destination project located on Royal Paradise Island, just north of Nassau of New Providence Island, Bahamas.

The following conclusions were obtained from the coastal processes study:

- During 1918 and 2018, there were 48 storms that passed within the 105-kilometer radius of the Project site. The largest wind speed recorded was 69 m/sec caused by the hurricane in September 1932.
- The predicted MHW level is approximately 0.39, MSL, and the predicted MLW level is approximately -0.39 m, MSL.
- The storm surge for 100-year return period is approximately 1.2 m above the mean high tide level.
- The prevailing winds were from east-northeast, east and east-southeast directions. The 1 percent exceedance normal wind speed is approximately 12.7 m/sec at the project site. The extreme wind speed for 100-year return period is approximately 45.1 m/sec.
- At the north side water area of Paradise Island, the estimated normal significant wave heights are approximately between 0.76 m and 1.20 m for 1 percent exceedance wave height. The estimated extreme significant wave heights are approximately between 1.21 m and 1.89 m for a 100-year return period.
- At the bay side water area of Paradise Island, the estimated normal significant wave height is approximately 0.33 m for a 1 percent exceedance wave height. The estimated extreme significant wave height is approximately 1.57 m for 100-year return period.

6.2. Recommendations

- Upland improvements, specifically infrastructure and related structures, should be designed for the 100-year storm event to include storm surge and wave crest elevations.
- Improvements below this elevation should be designed with break-away structures or with other improvements that facilitate flood waters and surge with minimal post-storm event damage.
- Shorelines along the bay side should be designed with appropriate shore stabilization that could include seawalls, revetments, or appropriate living shoreline configurations.
- Consideration should be provided for filling low-lying areas of the Project site to raise the grades and minimize damage from future storm impacts.
- Coastal improvements should be designed to account for coastal processes outlined in this report.

- Resiliency – the Project architectural/engineering design should account for resiliency. Current guidance on Sea Level Rise and adaptation to climate change can be found here: https://unfccc.int/sites/default/files/resource/bhsnc2.pdf
- Evaluating storm surge and coastal storm impacts accounting for resiliency was beyond the scope of services for this study.

7. References

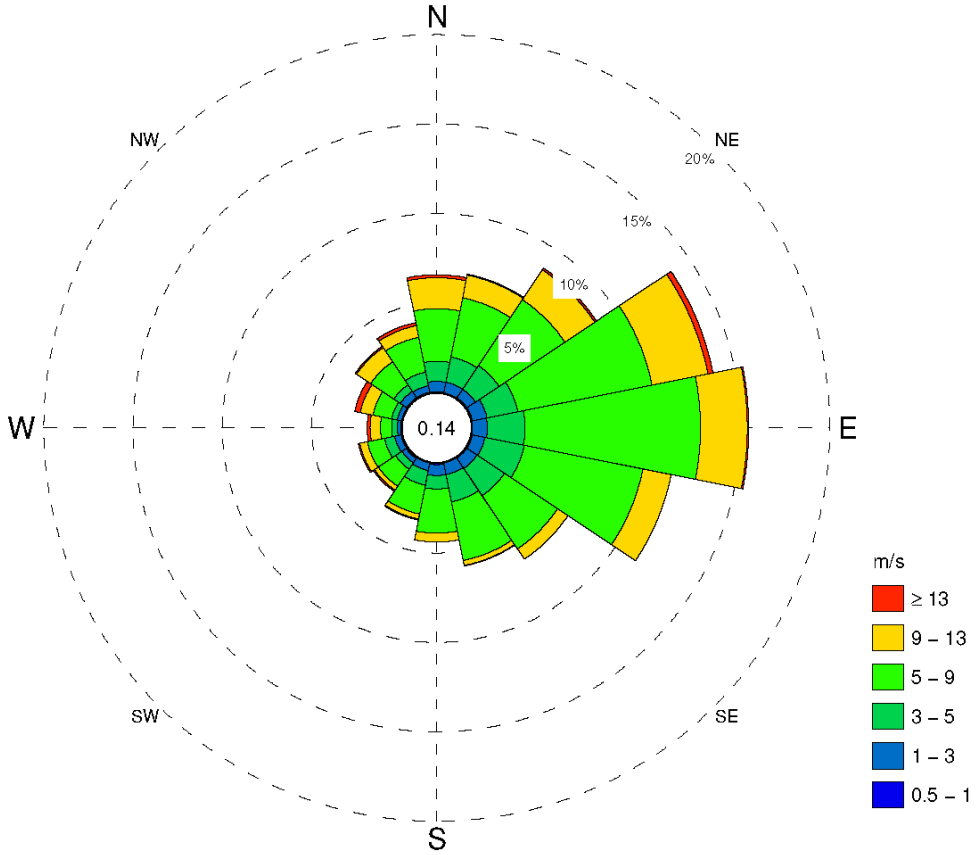
Baird, 2008. *Wave Climate and Dredging Impacts, Nassau harbor Port Improvement Project.* AW.F. Baird & Associates Ltd.

DHI, 2014. *MIKE 21 Spectral Wave Module, Scientific Documentation*, MIKE by DHI software series, Horsholm, Denmark.

USACE, 2006. *Coastal Engineering Manual*, U.S. Army Corps of Engineers, Washington, D.C

Appendix A: Monthly Wind Roses at Project Site

Wind Speed (January)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

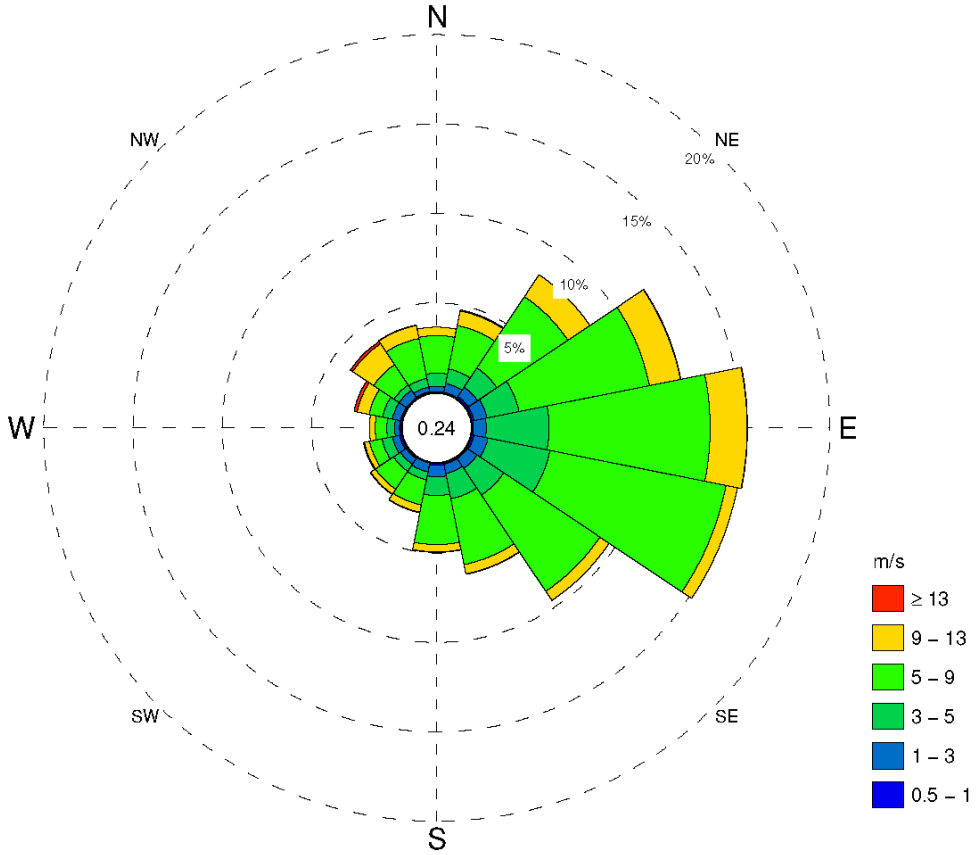


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3472, calms 5
About 0.375% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	6.57	6.77	8.76	13.77	15.47	11.38	6.83	5.88	4.38	3.25	2.28	2.48	1.90	2.68	3.49	4.00	99.86
13	0.17		0.12	0.29									0.17	0.32		0.17	1.73
9	1.73	1.30	2.02	3.20	2.62	1.61	0.69	0.29	0.49	0.29	0.26	0.43	0.58	0.72	0.95	0.66	17.83
5	2.94	3.37	4.44	7.66	9.82	6.77	3.57	3.34	2.48	1.64	1.15	0.98	0.63	1.07	1.56	1.99	53.40
3	1.12	1.44	1.58	1.76	2.10	2.25	1.84	1.56	0.75	0.84	0.43	0.58	0.32	0.32	0.43	0.78	18.09
1	0.58	0.60	0.58	0.84	0.84	0.72	0.69	0.66	0.60	0.43	0.29	0.37	0.17	0.26	0.43	0.37	8.44
0.5																	0.37

Wind Speed (February)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

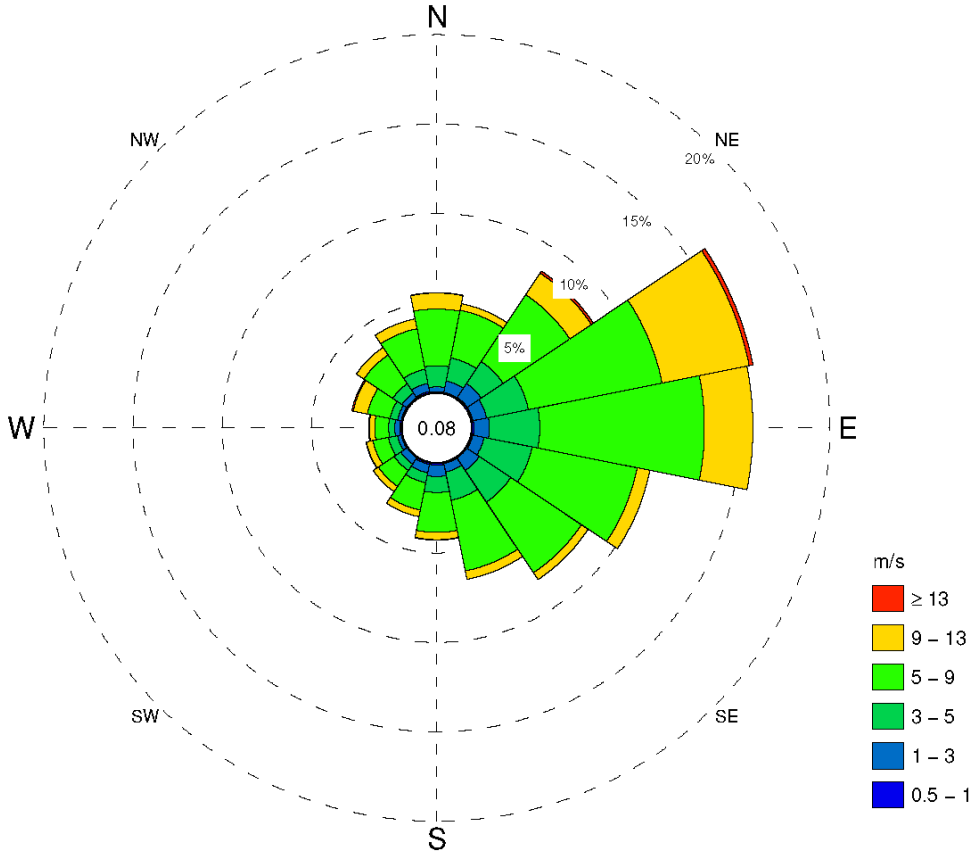


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3384, calms 8
About 0.414% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.63	4.73	8.30	11.94	15.40	15.16	9.60	6.35	4.96	2.84	2.48	2.19	1.77	2.72	3.81	3.87	99.76
13														0.18	0.15		0.65
9	0.47	0.83	1.48	1.77	2.07	0.65	0.62	0.53	0.41	0.41	0.33	0.30	0.33	0.68	1.42	0.74	13.03
5	2.10	2.48	4.79	7.45	9.01	10.05	6.47	3.75	2.75	1.45	1.21	0.71	0.65	0.77	1.36	2.28	57.27
3	0.74	0.83	1.30	1.83	3.52	3.55	1.80	1.45	1.03	0.44	0.47	0.59	0.44	0.56	0.35	0.50	19.41
1	0.30	0.50	0.62	0.74	0.74	0.80	0.65	0.53	0.65	0.50	0.38	0.41	0.27	0.47	0.50	0.27	8.33
0.5			0.12	0.12		0.12						0.12					1.06

Wind Speed (March)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

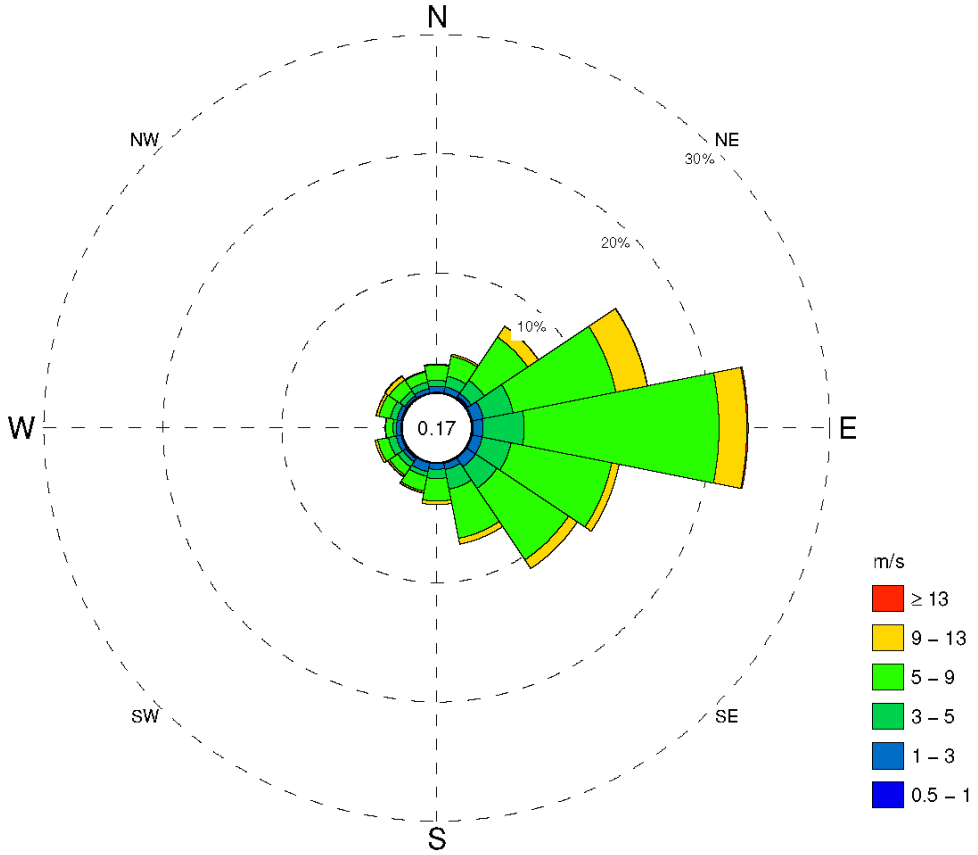


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3720, calms 3
About 0.376% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	5.56	5.08	8.55	16.05	15.70	10.16	8.20	6.64	4.27	3.06	2.28	2.04	1.83	2.85	3.41	4.22	99.92
13			0.13	0.22													0.56
9	0.89	0.38	1.45	4.97	2.72	0.73	0.46	0.48	0.40	0.38	0.35	0.38	0.30	0.81	0.51	0.56	15.75
5	3.17	2.72	4.49	7.63	9.22	5.99	4.76	4.03	2.23	1.56	1.08	0.89	0.78	1.29	1.94	2.31	54.09
3	1.18	1.32	1.48	2.39	2.82	2.74	2.12	1.61	0.89	0.56	0.43	0.51	0.35	0.43	0.62	0.81	20.27
1	0.27	0.65	0.94	0.78	0.86	0.65	0.83	0.48	0.65	0.48	0.43	0.22	0.27	0.22	0.32	0.46	8.49
0.5																	0.75

Wind Speed (April)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

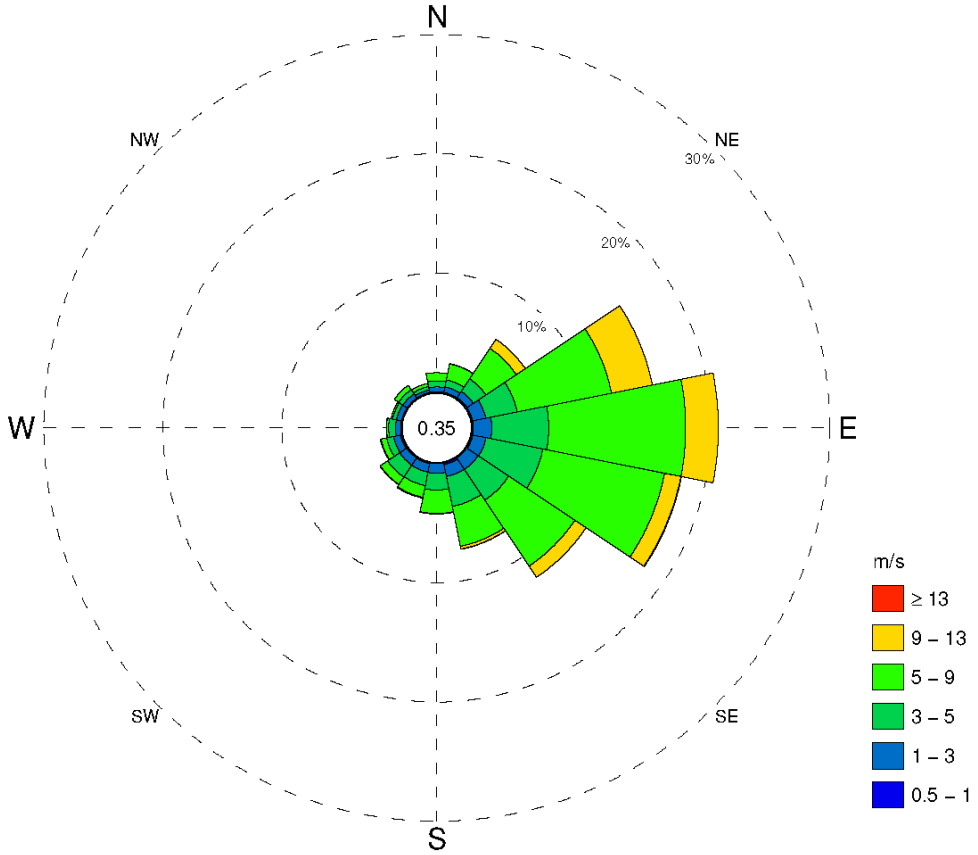


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3600, calms 6
About 0.389% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	2.36	3.31	7.28	15.06	23.14	12.61	11.19	6.94	3.44	2.58	1.97	2.28	1.33	2.19	2.28	1.86	99.83
13					0.11												0.31
9		0.17	1.08	2.69	2.33	0.64	0.89	0.50	0.31	0.14	0.17	0.22		0.22	0.39		9.97
5	1.28	1.72	4.36	8.81	16.36	8.61	7.22	4.19	1.89	1.28	0.83	0.92	0.61	0.97	1.11	0.86	61.03
3	0.50	0.92	1.33	2.56	3.44	2.47	2.17	1.69	0.78	0.39	0.53	0.67	0.28	0.56	0.50	0.56	19.33
1	0.50	0.50	0.33	0.94	0.81	0.86	0.89	0.53	0.47	0.75	0.31	0.42	0.39	0.36	0.19	0.36	8.61
0.5			0.14								0.11						0.58

Wind Speed (May)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

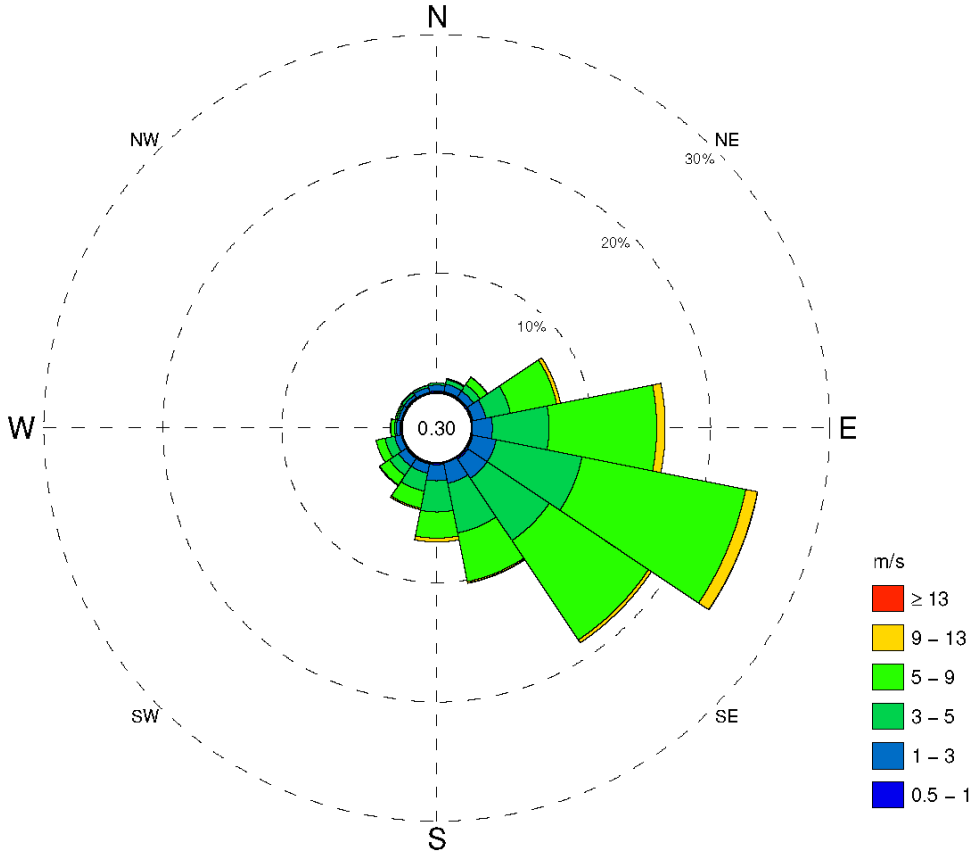


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3720, calms 13
About 0.376% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.64	2.50	5.94	15.46	20.65	17.96	12.07	7.39	4.22	3.01	2.74	1.83	1.24	0.91	1.29	0.81	99.65
13																	
9			0.91	3.49	2.74	1.40	1.13	0.24									10.19
5	0.70	1.37	3.06	8.09	11.51	10.43	6.67	3.41	1.96	0.99	0.75	0.48	0.16	0.13	0.43	0.27	50.43
3	0.51	0.59	1.26	2.69	4.78	4.87	3.09	2.55	1.40	1.16	1.21	0.59	0.59	0.32	0.43	0.30	26.34
1	0.40	0.48	0.65	1.13	1.53	1.13	1.16	1.02	0.81	0.73	0.73	0.59	0.40	0.46	0.43	0.22	11.85
0.5								0.13				0.11					0.75

Wind Speed (June)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

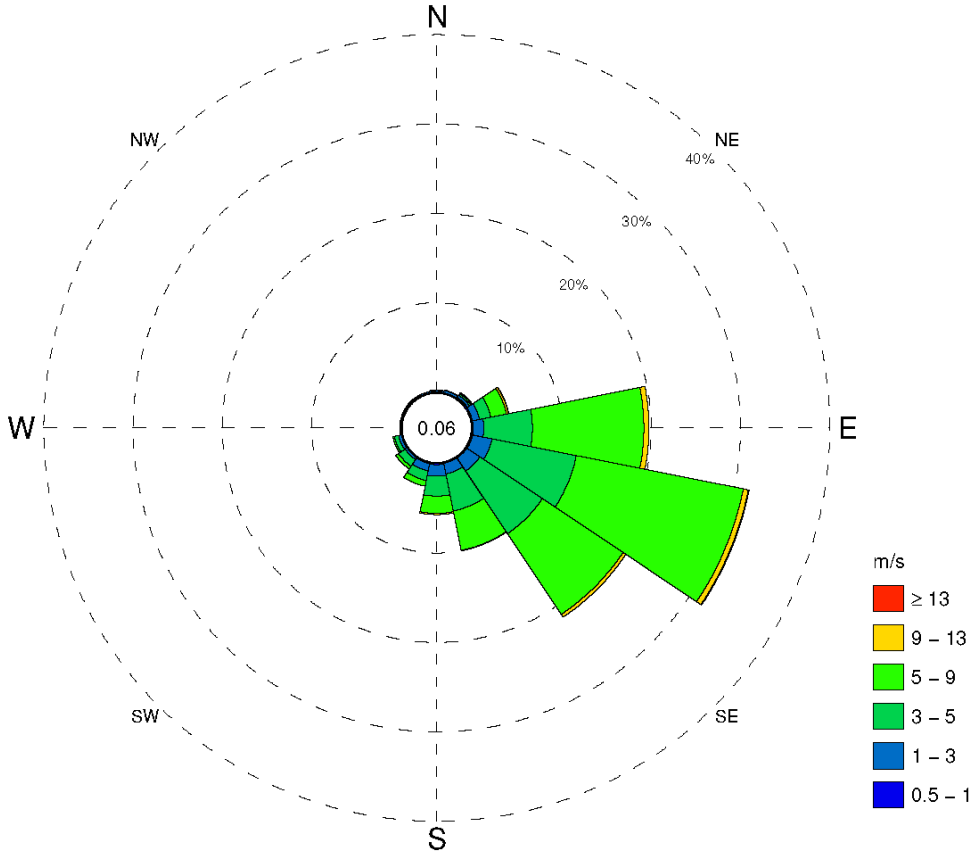


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3361, calms 10
About 0.417% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.77	1.22	2.14	7.59	16.19	24.49	18.68	10.29	6.58	3.99	2.83	2.20	0.89	0.57	0.62	0.65	99.70
13				0.33	0.71	1.01	0.30	0.12	0.33	0.12							3.03
9			0.74	3.96	9.04	14.01	10.03	4.17	2.20	1.46	0.98	0.77	0.33	0.12			47.99
5	0.18	0.39	0.65	2.11	4.76	7.35	6.28	4.25	2.62	1.55	0.92	0.83	0.15	0.15	0.24	0.18	32.61
3	0.51	0.65	0.65	1.10	1.67	1.99	1.93	1.73	1.34	0.77	0.77	0.57	0.30	0.27	0.27	0.42	14.94
1							0.15										1.07
0.5																	

Wind Speed (July)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

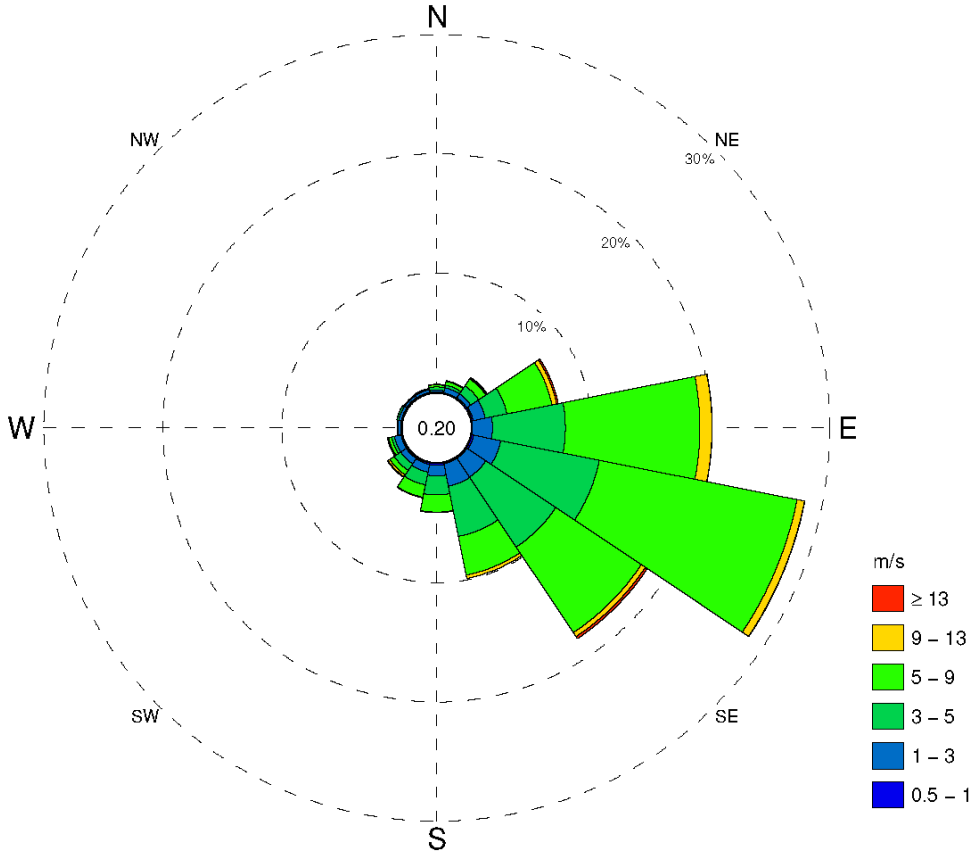


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3472, calms 2
About 0.375% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.23	0.32	0.78	4.21	19.76	31.65	21.46	10.02	5.70	2.65	1.53	1.01	0.17	0.14	0.17	0.14	99.94
13																	0.12
9				0.23	0.58	0.58	0.37		0.14								1.99
5			0.14	1.79	12.47	19.07	10.86	4.49	1.93	0.66	0.37	0.17					51.96
3			0.20	1.30	5.44	9.62	8.41	4.23	2.22	1.09	0.89	0.49	0.12				34.27
1	0.14	0.26	0.29	0.81	1.21	2.22	1.76	1.21	1.30	0.84	0.26	0.32				0.14	10.92
0.5			0.12						0.12								0.69

Wind Speed (August)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

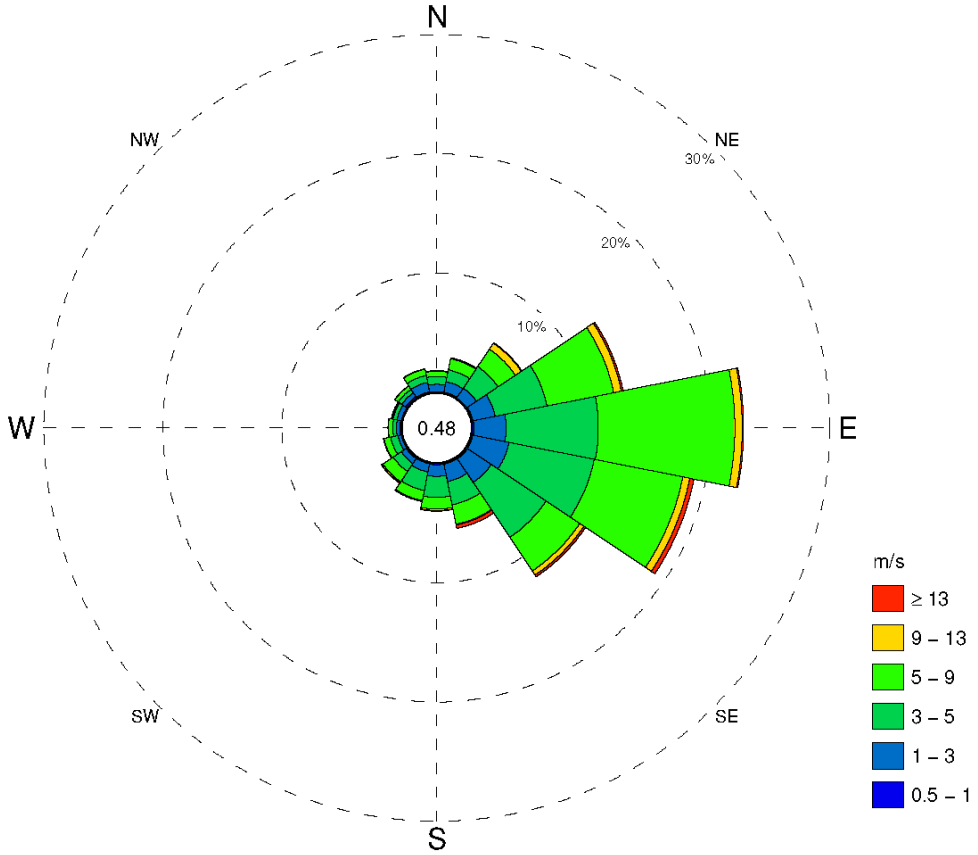


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3472, calms 7
About 0.375% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.66	1.04	2.10	7.40	20.13	28.51	18.26	9.88	4.12	3.00	1.99	1.24	0.35	0.43	0.32	0.37	99.80
13				0.14			0.20										0.75
9				0.40	1.01	0.63	0.40	0.29			0.17						3.20
5	0.17	0.32	0.72	3.86	11.29	16.94	8.64	3.31	1.44	1.07	0.46	0.26					48.47
3	0.26	0.23	0.81	1.84	6.13	8.44	7.06	4.29	1.58	1.09	0.66	0.23		0.14			33.01
1	0.14	0.43	0.40	1.04	1.67	2.33	1.90	1.93	0.89	0.66	0.55	0.58	0.23	0.23	0.17	0.23	13.39
0.5				0.12		0.14			0.14	0.12							0.98

Wind Speed (September)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

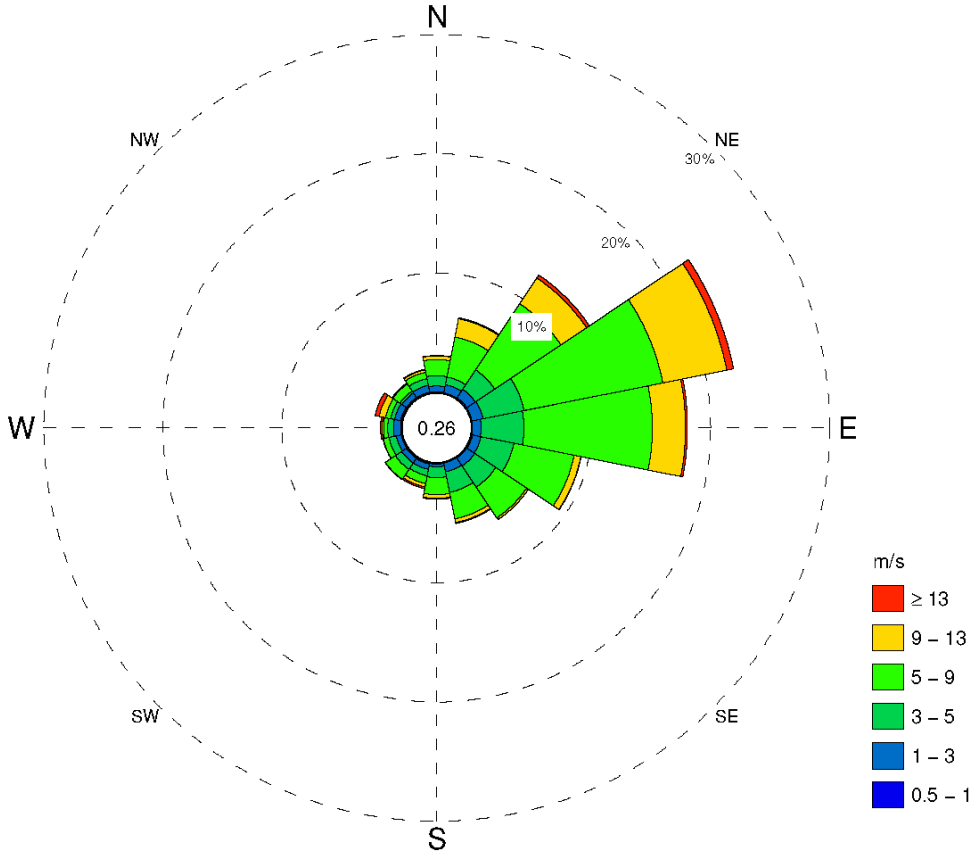


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3360, calms 16
About 0.387% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.82	3.01	5.60	12.95	22.77	19.02	12.02	5.60	3.99	3.30	2.59	1.58	1.10	0.89	1.25	2.05	99.52
13				0.15	0.12	0.36	0.18	0.30									1.34
9			0.60	0.65	0.63	0.60	0.42		0.12		0.12						3.54
5	0.45	0.95	1.76	5.71	11.46	7.59	3.39	1.67	0.98	0.86	1.04	0.57	0.39		0.33	0.54	37.77
3	0.65	1.01	2.17	4.43	7.74	7.29	5.54	1.99	1.76	1.58	0.80	0.63	0.30	0.33	0.36	0.60	37.17
1	0.63	0.89	1.01	1.90	2.71	3.10	2.38	1.49	0.98	0.71	0.51	0.30	0.30	0.39	0.39	0.80	18.48
0.5					0.12		0.12								0.15		1.22

Wind Speed (October)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

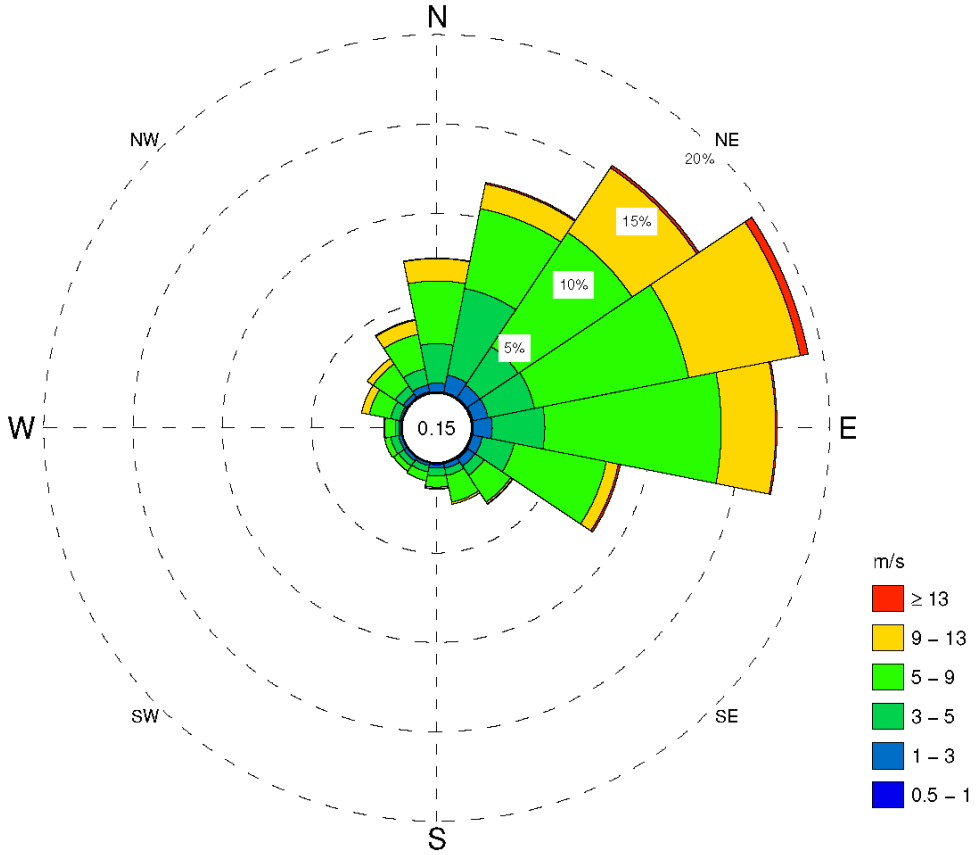


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3472, calms 9
About 0.375% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.08	6.42	12.41	22.41	18.06	9.36	6.25	5.18	3.00	2.19	2.22	1.61	1.73	2.28	1.53	2.02	99.74
13			0.29	0.58	0.17					0.14			0.14	0.35			2.13
9	0.32	1.56	2.59	5.47	2.79	0.58	0.17	0.32	0.32	0.29			0.12	0.55		0.20	15.32
5	1.35	3.43	6.68	11.90	10.77	5.16	3.11	2.28	1.41	0.66	1.01	0.49	0.35	0.43	0.72	0.55	50.29
3	0.86	0.66	1.96	3.51	3.60	2.82	2.13	1.76	0.92	0.55	0.63	0.63	0.49	0.35	0.20	0.58	21.66
1	0.49	0.69	0.86	0.95	0.72	0.72	0.81	0.75	0.23	0.46	0.49	0.43	0.60	0.52	0.46	0.58	9.76
0.5																	0.58

Wind Speed (November)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019

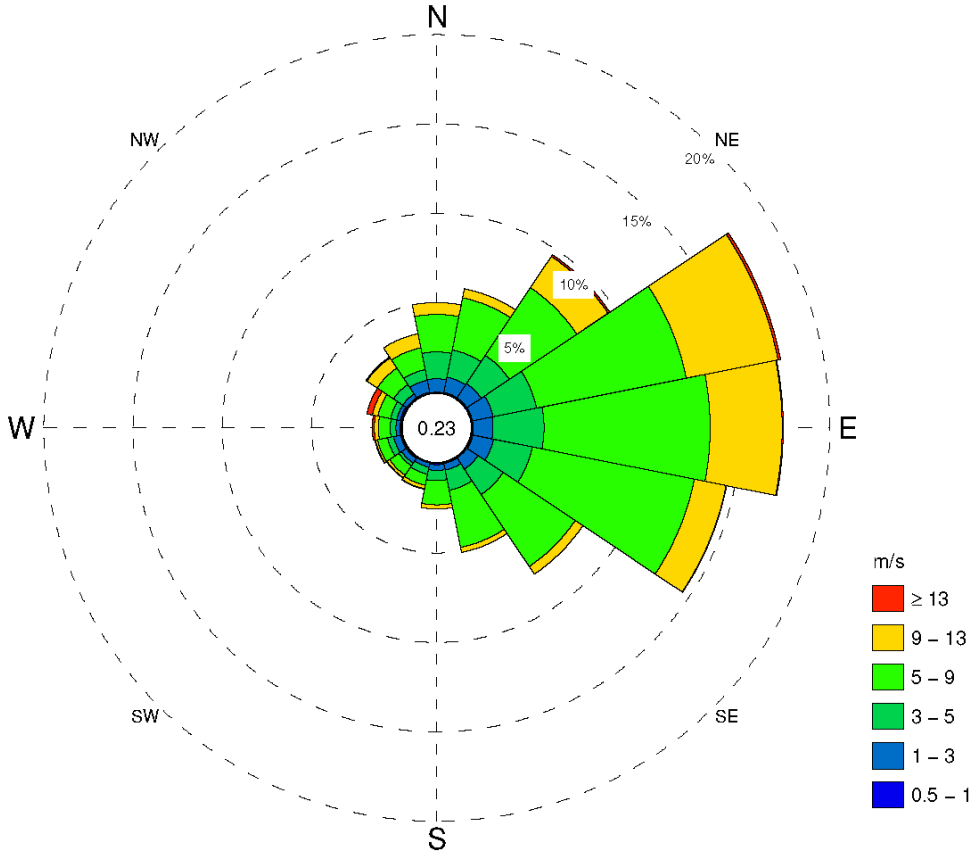


Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3360, calms 5
About 0.387% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	7.50	11.99	15.65	19.20	17.05	8.48	3.12	2.35	1.43	1.01	0.92	0.98	0.98	2.29	2.68	4.20	99.85
13			0.15	0.45		0.12											1.04
9	1.25	1.40	4.35	6.37	3.04	0.68	0.12	0.12						0.45	0.39	0.80	19.11
5	3.51	4.55	7.68	8.81	9.88	5.27	1.79	1.52	0.63	0.51	0.36	0.36	0.60	1.22	1.49	1.96	50.12
3	2.20	4.94	2.59	2.65	2.95	1.82	0.63	0.42	0.45	0.36	0.36	0.45	0.21	0.51	0.54	0.92	21.96
1	0.48	0.98	0.86	0.86	1.07	0.57	0.48	0.27	0.18	0.15	0.21	0.18		0.12	0.24	0.39	7.11
0.5																	0.51

Wind Speed (December)
Station C – NOAA WW3
Period 01–Feb–2005 to 01–Jun–2019



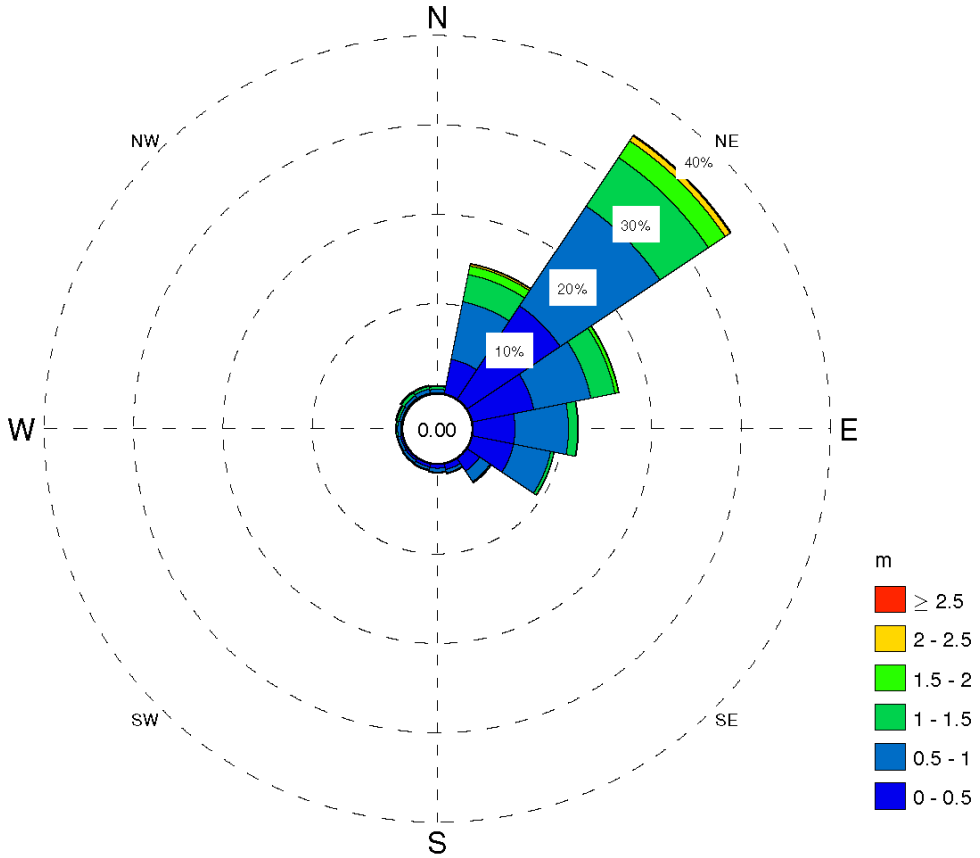
Direction FROM is shown
Center value indicates calms below 0.5 m/s
Total observations 3472, calms 8
About 0.375% of observations missing

Percentage of Occurrence

Wind Speed, m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	5.01	5.93	9.65	17.63	17.40	14.54	7.83	5.10	2.53	1.50	1.38	1.53	1.61	1.99	2.76	3.37	99.77
13			0.12	0.14									0.12	0.32			0.92
9	0.66	0.52	2.10	5.24	4.03	1.81	0.52	0.29	0.23	0.20	0.17	0.12	0.23	0.32	0.69	0.81	17.94
5	2.10	2.97	4.55	8.55	9.30	9.25	4.84	3.25	1.35	0.63	0.63	0.58	0.66	0.72	1.09	1.24	51.73
3	1.50	1.56	1.90	2.48	2.85	2.22	1.70	1.15	0.58	0.40	0.17	0.35	0.32	0.35	0.63	0.60	18.75
1	0.75	0.86	0.95	1.18	1.12	1.18	0.75	0.37	0.32	0.23	0.32	0.40	0.23	0.20	0.26	0.69	9.82
0.5																	0.60

Appendix B: Wave Roses at North Offshore

Significant Wave Height (Annual)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

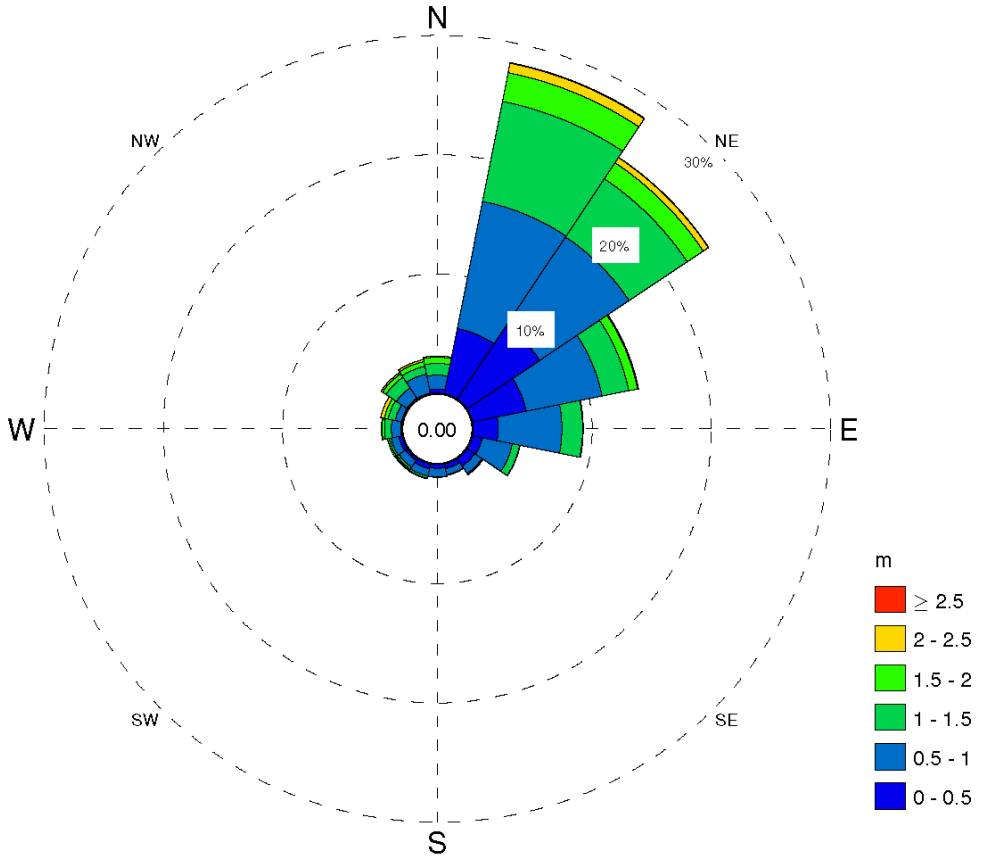


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 41579, calms 1
No missing observations

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.86	14.86	35.54	16.74	11.79	9.34	3.26	1.14	0.94	0.77	0.71	0.62	0.67	0.77	1.01	0.97	100.00
2.5			0.14														0.30
2		0.22	0.67														1.12
1.5	0.12	0.98	2.25	0.41											0.13	0.11	4.34
1	0.29	3.10	6.52	2.75	1.03	0.36	0.14			0.10			0.15	0.26	0.40	0.31	15.77
0.5	0.37	6.56	13.42	6.51	5.99	4.25	1.41	0.39	0.42	0.30	0.33	0.31	0.35	0.28	0.36	0.45	41.71
0		3.93	12.54	7.00	4.69	4.68	1.69	0.63	0.41	0.35	0.25	0.19					36.76

Significant Wave Height (January)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

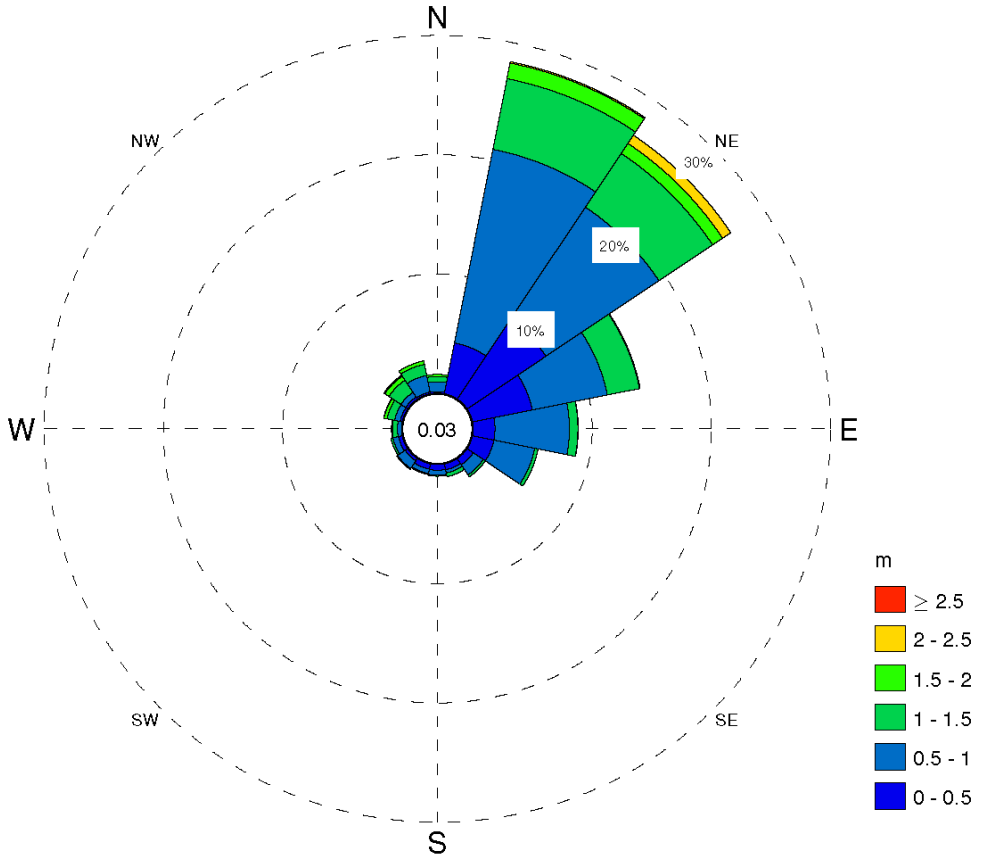


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3460, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.12	28.32	24.39	14.22	9.25	4.08	1.62	0.98	1.07	1.27	1.24	1.27	1.71	1.85	2.69	2.92	100.00
2.5																	
2	0.12	0.81	0.52											0.32	0.14	0.17	2.31
1.5	0.52	2.46	1.62	0.75							0.12	0.14	0.20	0.32	0.35	0.40	7.05
1	0.98	8.55	5.87	2.28	1.73	0.64				0.17	0.20	0.17	0.58	0.61	1.07	0.66	23.67
0.5	1.16	10.87	9.02	6.50	5.35	2.57	0.75	0.52	0.72	0.64	0.66	0.66	0.78	0.55	1.04	1.62	43.41
0	0.35	5.58	7.34	4.60	2.11	0.84	0.75	0.40	0.32	0.40	0.20	0.29					23.47

Significant Wave Height (February)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

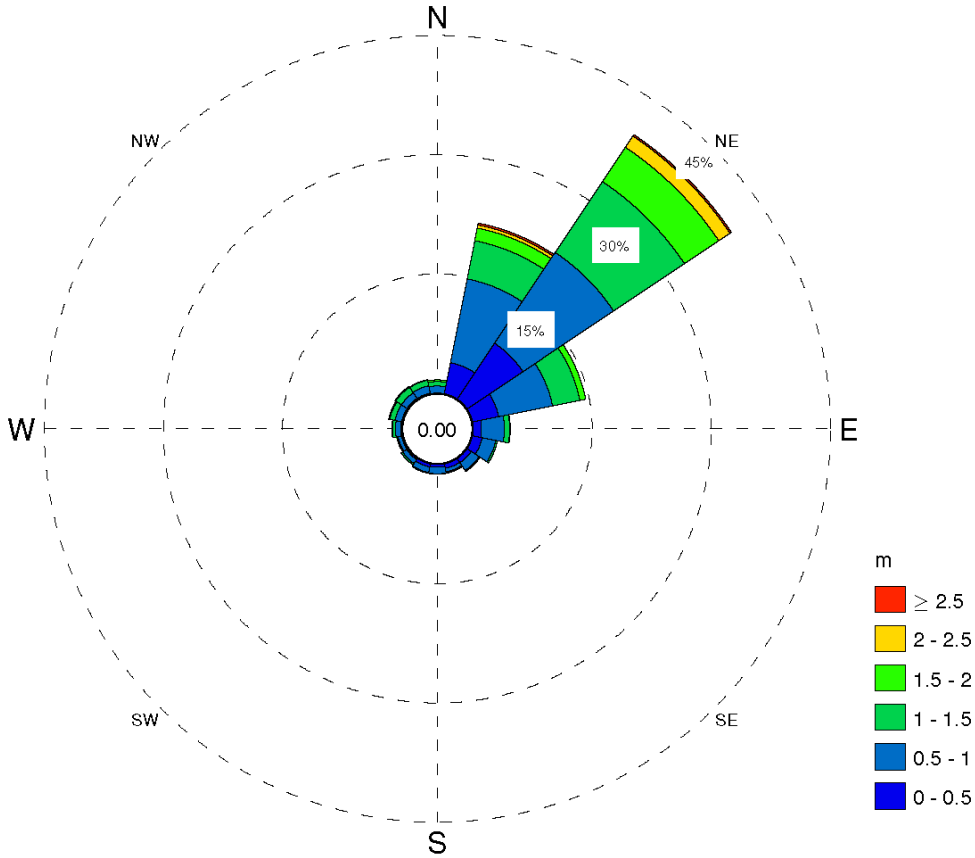


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3377, calms 1
About 0.414% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.57	28.40	26.62	14.36	8.82	5.63	1.84	1.10	0.98	0.92	1.10	0.98	0.86	1.60	2.40	2.81	99.97
2.5																	
2		0.12	0.83														1.10
1.5	0.18	1.33	1.01											0.27	0.41	0.30	3.70
1	0.44	6.04	5.42	2.75	0.71	0.30	0.21	0.33				0.18	0.41	0.65	1.21	0.95	19.81
0.5	0.83	16.55	11.40	6.43	6.25	3.49	1.01	0.27	0.41	0.38	0.77	0.47	0.36	0.47	0.47	1.42	50.99
0	0.12	4.35	7.97	5.12	1.84	1.84	0.62	0.50	0.47	0.44	0.24	0.33		0.18	0.21	0.15	24.37

Significant Wave Height (March)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

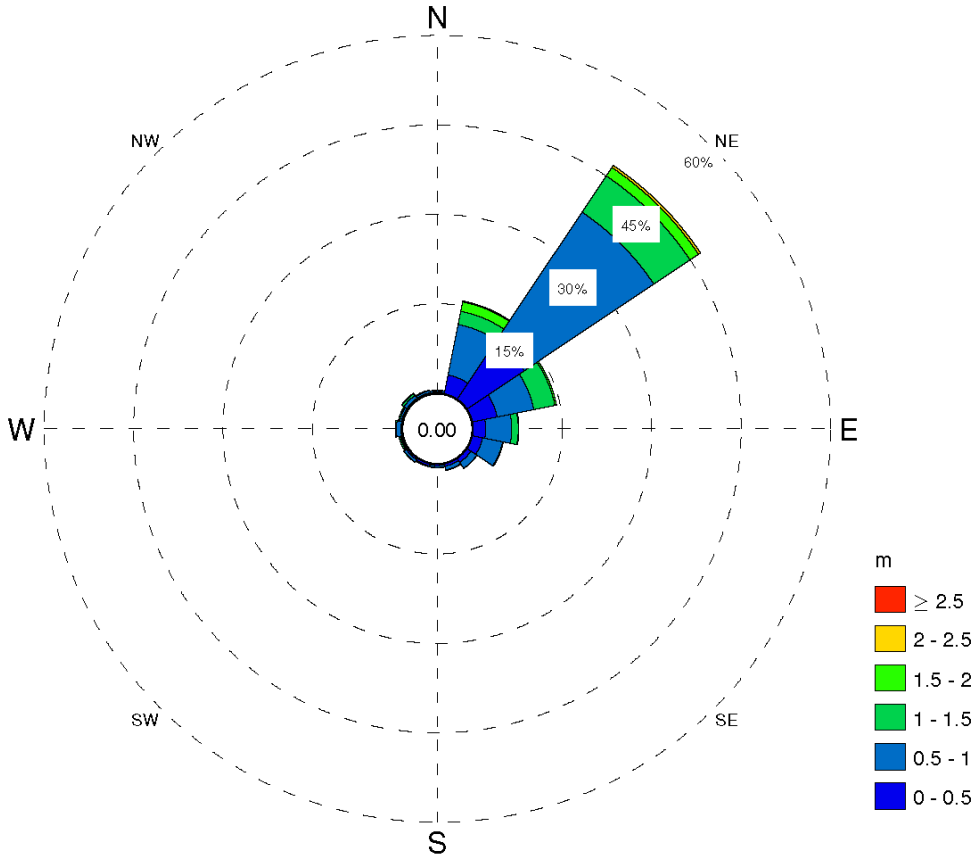


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3713, calms 0
About 0.376% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.67	21.90	40.02	14.54	4.69	3.20	1.94	1.21	1.21	1.21	0.97	0.73	1.24	1.75	1.91	1.80	100.00
2.5		0.24	0.22														0.46
2		0.40	1.70														2.18
1.5	0.22	1.62	5.20	0.75											0.11		8.27
1	0.57	4.90	10.72	3.50	0.67	0.22	0.13	0.11		0.11	0.22	0.16	0.38	0.67	0.86	0.73	24.00
0.5	0.89	10.75	13.74	6.92	2.88	1.75	1.19	0.46	0.83	0.73	0.59	0.46	0.67	0.86	0.83	0.94	44.49
0		3.99	8.46	3.37	1.05	1.24	0.62	0.57	0.32	0.38	0.16		0.11		0.11		20.60

Significant Wave Height (April)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

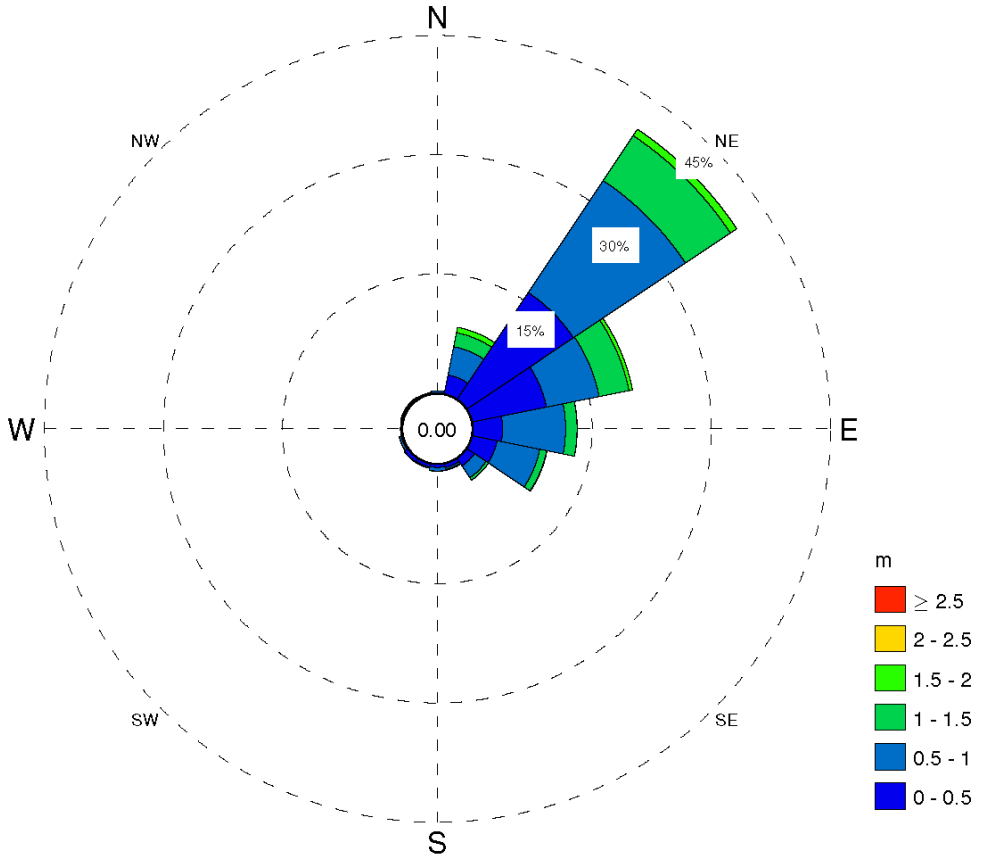


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3585, calms 0
About 0.389% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.47	15.87	47.14	14.39	7.70	5.30	1.98	1.14	0.53	0.50	0.75	0.59	1.09	0.70	1.20	0.64	100.00
2.5																	
2		0.17	0.42														0.59
1.5		1.59	1.70	0.28	0.11												3.82
1		2.26	7.31	3.60	1.12	0.14		0.11				0.22	0.20	0.22	0.39	0.11	15.84
0.5	0.25	8.65	26.16	6.28	4.35	3.43	1.20	0.64	0.31	0.20	0.47	0.22	0.78	0.31	0.59	0.33	54.17
0	0.17	3.21	11.55	4.24	2.12	1.73	0.75	0.39	0.17	0.31	0.25	0.14	0.11	0.14	0.14	0.17	25.58

Significant Wave Height (May)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

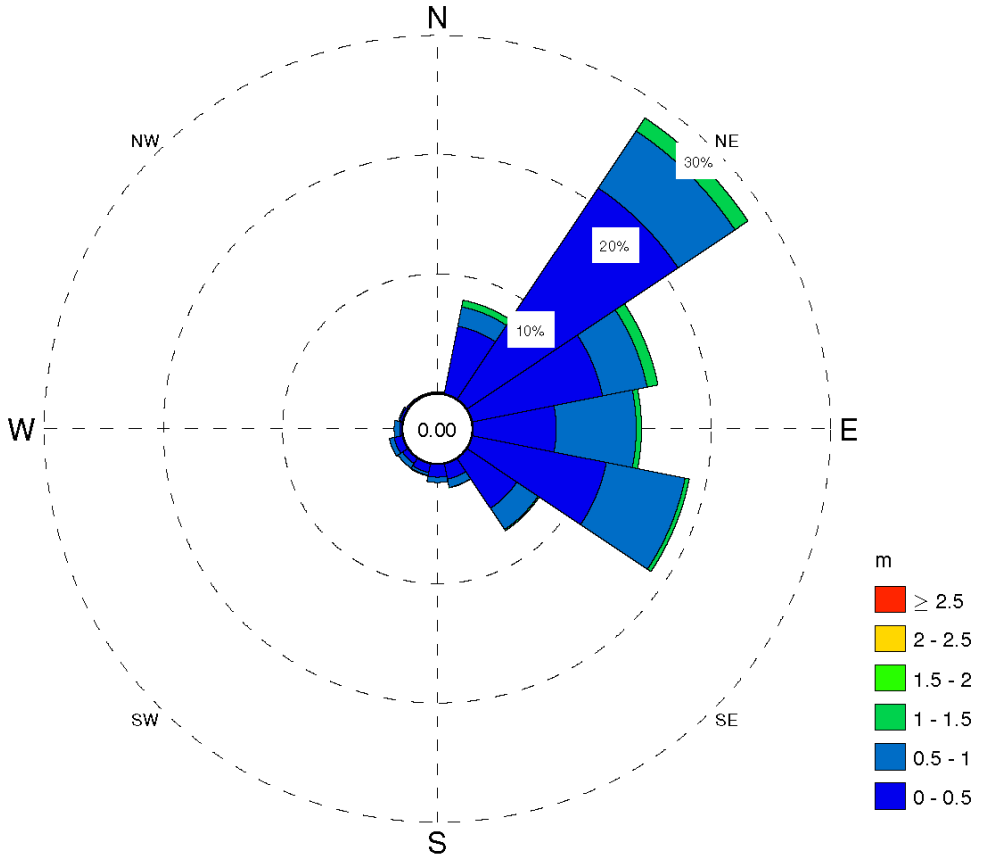


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3692, calms 0
About 0.376% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.27	8.53	40.85	20.56	13.11	9.59	3.25	0.81	0.84	0.54	0.54	0.41		0.24	0.24	0.14	100.00
2.5																	
2		0.70	0.98	0.46													2.22
1.5		1.79	6.80	3.82	1.44	0.89	0.38	0.11									15.33
1	0.19	3.63	16.96	6.77	7.94	5.47	1.76	0.24	0.46	0.16		0.27		0.14	0.11		44.20
0.5		2.41	16.12	9.51	3.71	3.17	1.11	0.46	0.35	0.38	0.49	0.11			0.14	0.14	38.24
0																	

Significant Wave Height (June)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

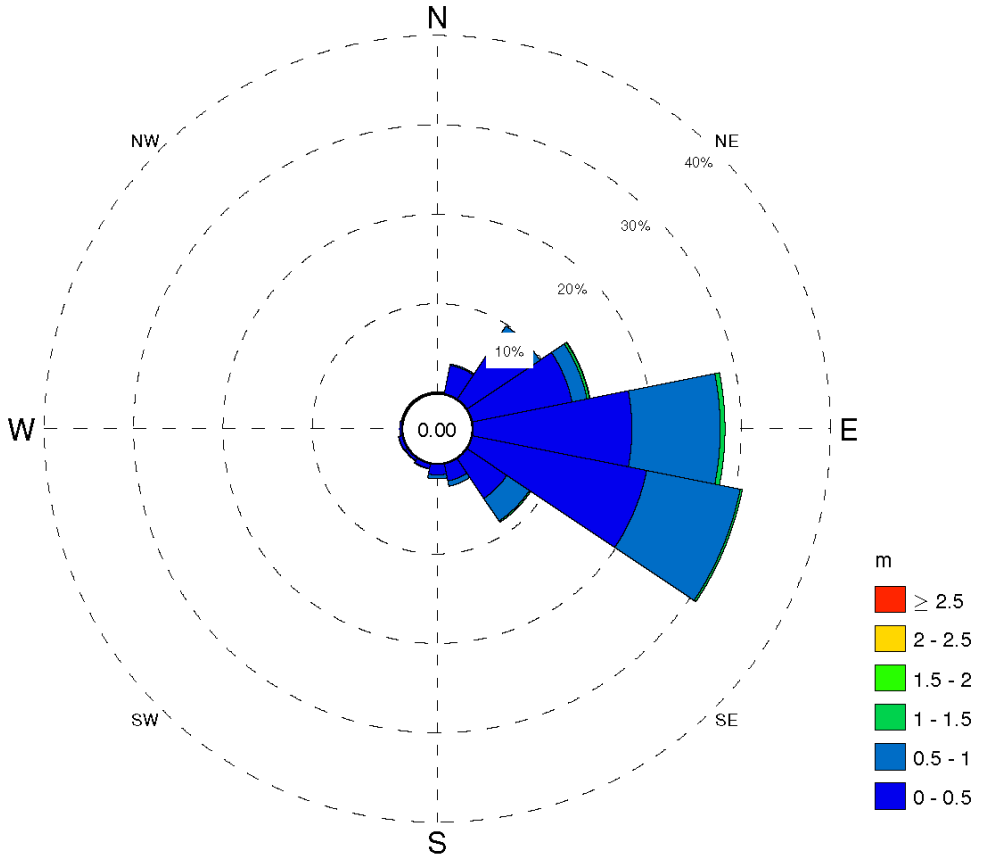


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3324, calms 0
About 0.476% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total		8.00	28.37	15.88	14.14	18.56	7.28	2.05	1.50	1.02	0.96	1.11	0.63	0.30	0.12		100.00
2.5																	
2																	
1.5		0.57	1.32	0.93	0.45	0.36	0.12										3.85
1		1.65	5.75	3.82	6.71	6.74	2.14	0.72	0.45	0.24	0.45	0.42	0.48	0.12			29.69
0.5		5.78	21.30	11.13	6.98	11.46	5.02	1.29	1.05	0.72	0.51	0.69	0.15	0.18	0.12		66.46
0																	

Significant Wave Height (July)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

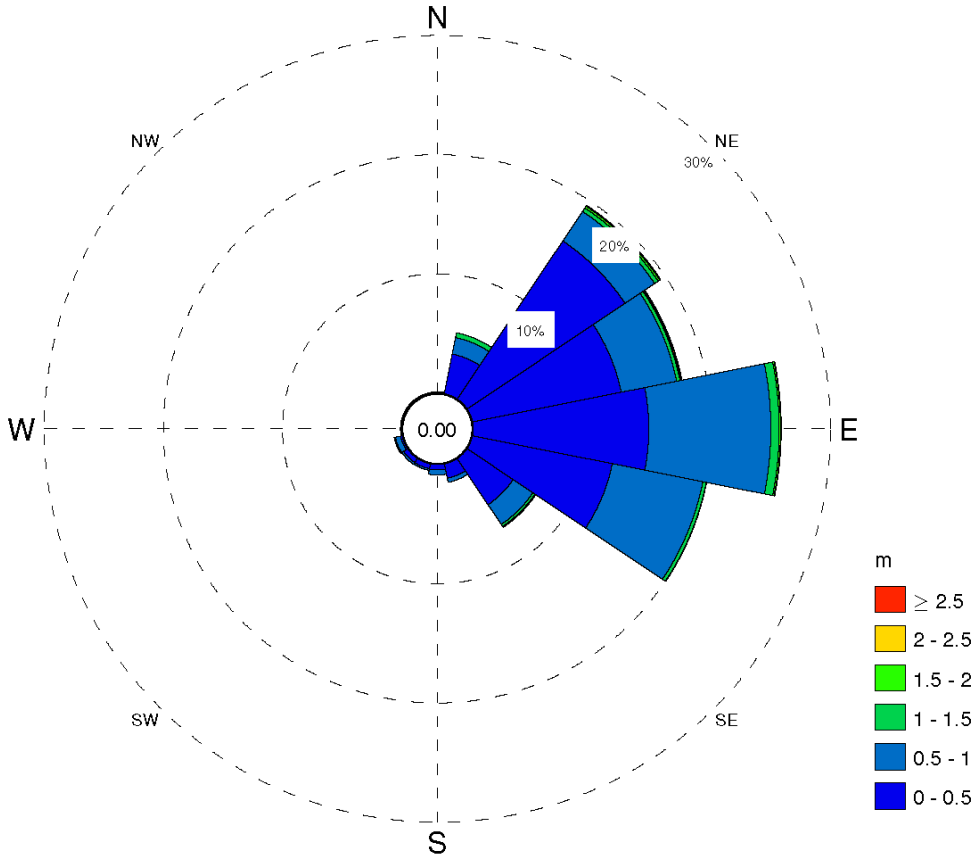


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3380, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total		3.40	9.82	13.43	28.20	30.80	8.58	2.54	1.60	0.59	0.36	0.44	0.24				100.00
2.5																	
2																	
1.5				0.30	0.53	0.24	0.18										1.24
1		0.15	1.12	1.72	9.88	10.68	3.05	0.59	0.44								27.81
0.5		3.25	8.70	11.36	17.78	19.88	5.36	1.95	1.15	0.53	0.30	0.38	0.24				70.89
0																	

Significant Wave Height (August)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

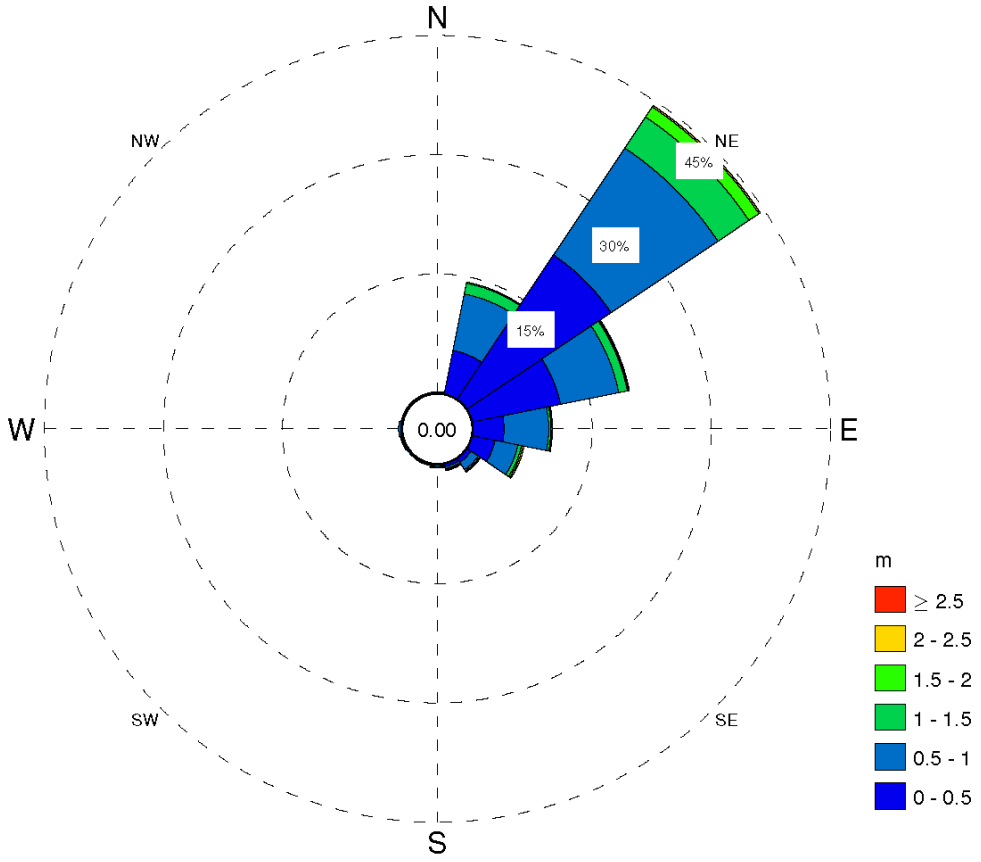


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3417, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total		5.21	19.55	17.94	25.87	20.05	6.94	1.58	0.88	0.56	0.59	0.70					100.00
2.5																	0.26
2																	0.18
1.5			0.18		0.12												0.50
1		0.41	0.35	0.29	0.70	0.29	0.20										2.31
0.5		1.40	2.99	4.74	10.24	7.76	1.99	0.35	0.44	0.15	0.18	0.44					30.67
0		3.39	15.95	12.73	14.75	11.97	4.65	1.23	0.44	0.41	0.41	0.15					66.08

Significant Wave Height (September)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

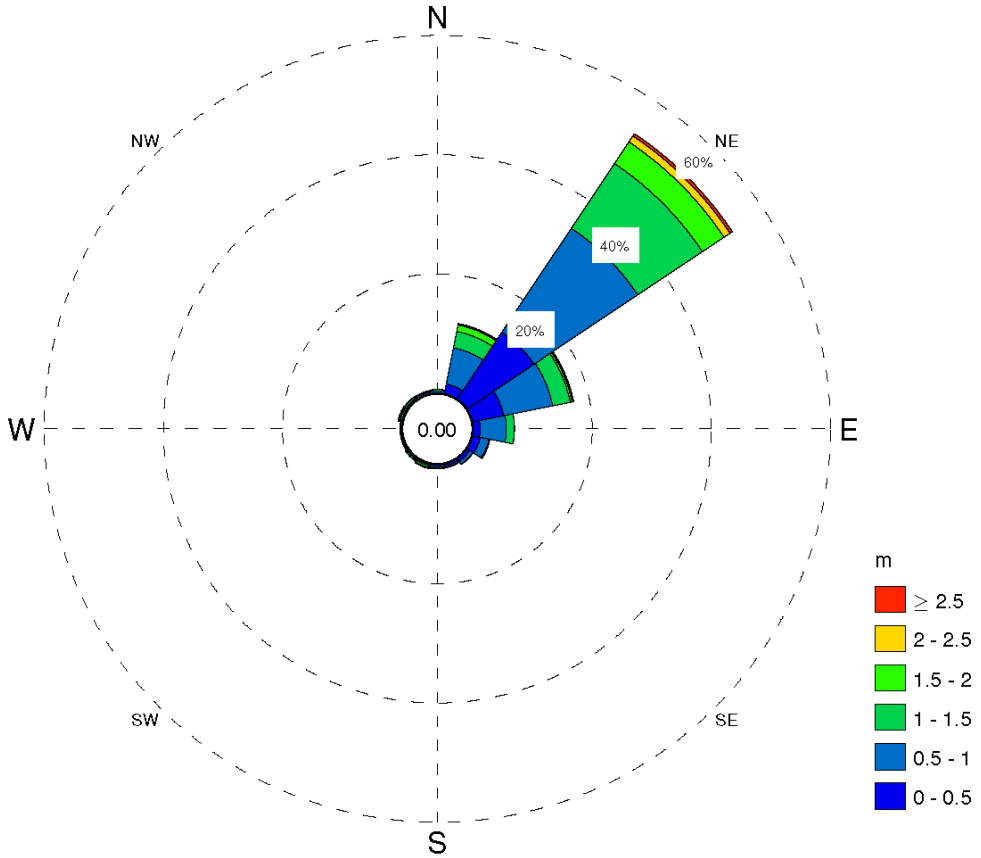


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3343, calms 0
About 0.387% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total		14.33	44.42	20.16	9.99	6.64	2.03	0.87	0.42	0.21		0.27	0.39				100.00
2.5																	0.12
2			0.21			0.18		0.12									0.78
1.5		0.15	1.53	0.12		0.18	0.15	0.12									2.39
1		1.38	4.70	1.11	0.27	0.45	0.18		0.12								8.32
0.5		7.24	16.18	7.48	5.62	2.93	1.11	0.27	0.15			0.12	0.24				41.64
0		5.56	21.81	11.31	3.89	2.90	0.57	0.33					0.15				46.75

Significant Wave Height (October)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

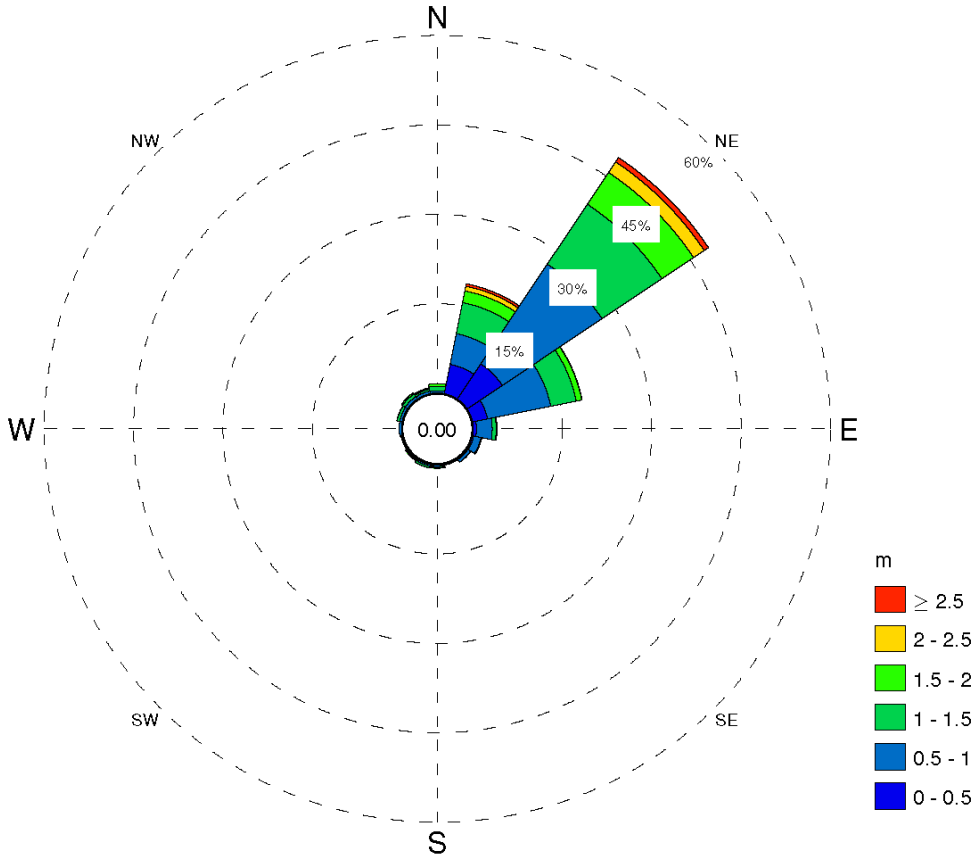


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3462, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.64	12.02	53.55	17.33	6.96	3.00	1.21	0.69	0.72	0.81	0.52	0.32	0.29	0.75	0.64	0.55	100.00
2.5			0.46	0.20										0.20			1.33
2		0.17	1.21														1.62
1.5		1.10	4.36	0.29										0.12			6.27
1	0.23	2.80	13.06	3.00	1.36	0.17			0.17	0.32	0.23			0.26	0.29	0.17	22.27
0.5	0.35	6.18	20.94	8.41	4.39	1.47	0.61	0.26	0.29	0.23	0.12	0.14	0.12	0.12	0.23	0.26	44.11
0		1.68	13.52	5.34	1.18	1.33	0.55	0.32	0.17								24.41

Significant Wave Height (November)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

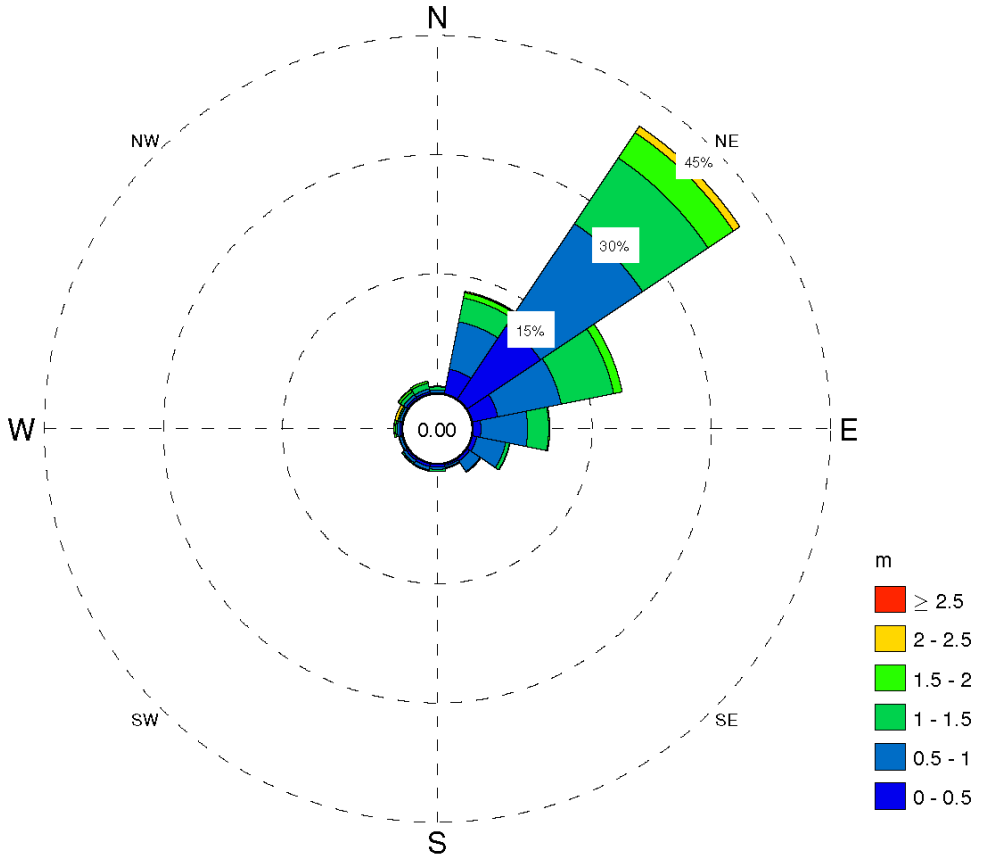


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3359, calms 0
About 0.387% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.58	18.82	48.73	18.79	4.02	1.61	0.74	0.12	0.63	0.71	0.45	0.15	0.42	0.95	1.28	1.01	100.00
2.5		0.42	0.86														1.28
2		0.80	2.14														3.13
1.5	0.42	1.99	6.40	0.95					0.12						0.24	0.18	10.54
1	0.77	5.33	12.09	4.38	0.65	0.15			0.18	0.36	0.15			0.45	0.54	0.33	25.45
0.5	0.36	5.24	20.13	10.81	2.65	1.25	0.54		0.24	0.24	0.15		0.39	0.42	0.48	0.45	43.50
0		5.03	7.12	2.59	0.57	0.21	0.18			0.12							16.11

Significant Wave Height (December)
Station A - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019



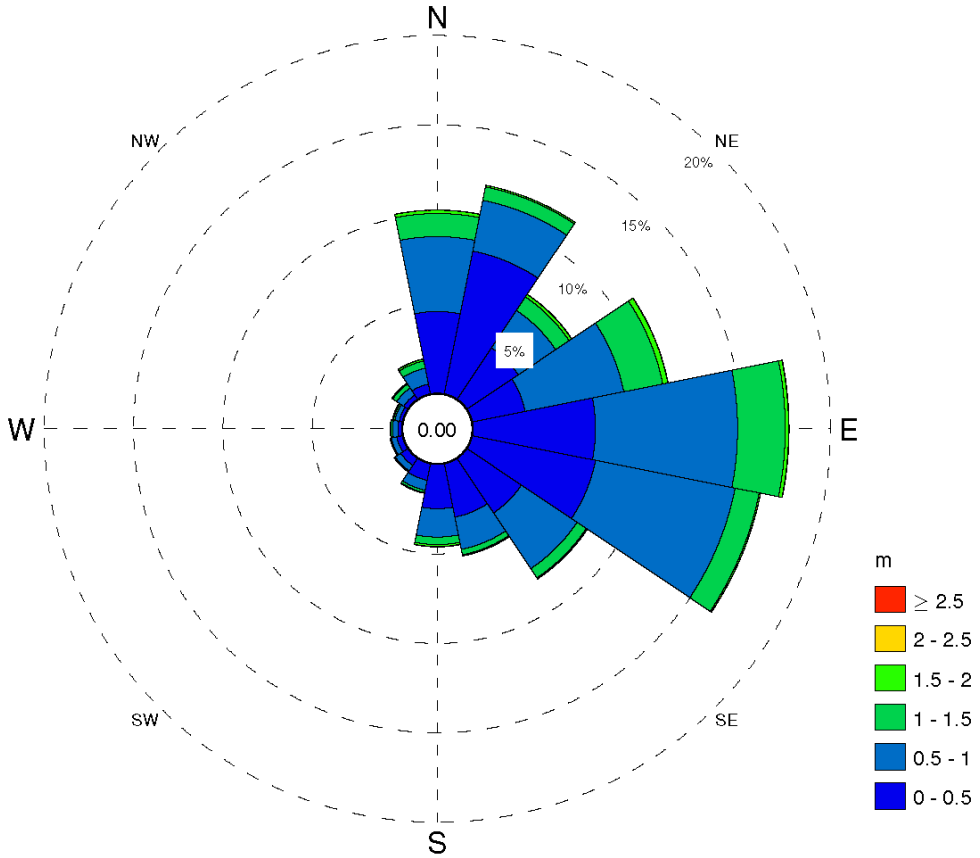
Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3467, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	0.89	13.15	41.30	19.24	9.66	4.82	2.08	0.61	0.89	0.92	0.89	0.46	0.98	0.95	1.50	1.64	100.00
2.5																	
2		0.14	0.98											0.37			1.59
1.5	0.12	0.69	3.84	1.10	0.14								0.20		0.32	0.29	6.89
1	0.37	3.06	9.92	6.75	2.65	0.49		0.14	0.29	0.12	0.20		0.20	0.20	0.46	0.72	25.73
0.5	0.32	6.09	15.46	8.13	5.88	3.72	1.59	0.26	0.29	0.43	0.40	0.32	0.32	0.32	0.40	0.37	44.30
0		3.14	11.10	3.26	0.98	0.55	0.37	0.20	0.32	0.35	0.26		0.23		0.26	0.26	21.46

Appendix C: Wave Roses at East Offshore

Significant Wave Height (Annual)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

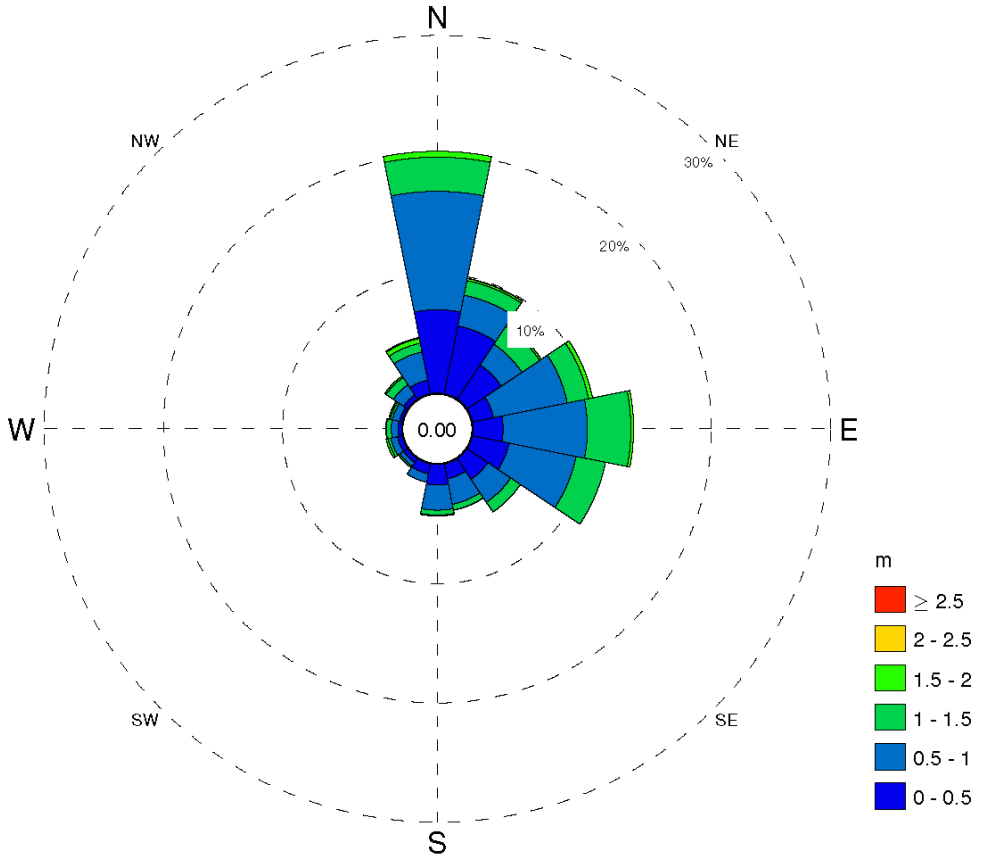


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 41432, calms 1
No missing observations

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	10.24	11.89	7.05	11.17	17.69	16.45	8.10	5.25	4.61	1.68	0.91	0.70	0.64	0.57	1.06	1.99	100.00
2.5																	0.10
2																	0.14
1.5	0.18		0.17	0.29	0.20				0.11							0.10	1.51
1	1.30	0.77	0.91	2.23	2.66	1.37	0.62	0.31	0.42	0.13					0.26	0.41	11.68
0.5	4.19	2.89	2.52	5.63	7.96	7.97	3.75	1.84	1.58	0.57	0.37	0.30	0.30	0.26	0.47	0.91	41.49
0	4.56	8.14	3.44	3.01	6.85	7.03	3.65	3.03	2.47	0.93	0.46	0.32	0.20	0.17	0.27	0.55	45.08

Significant Wave Height (January)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

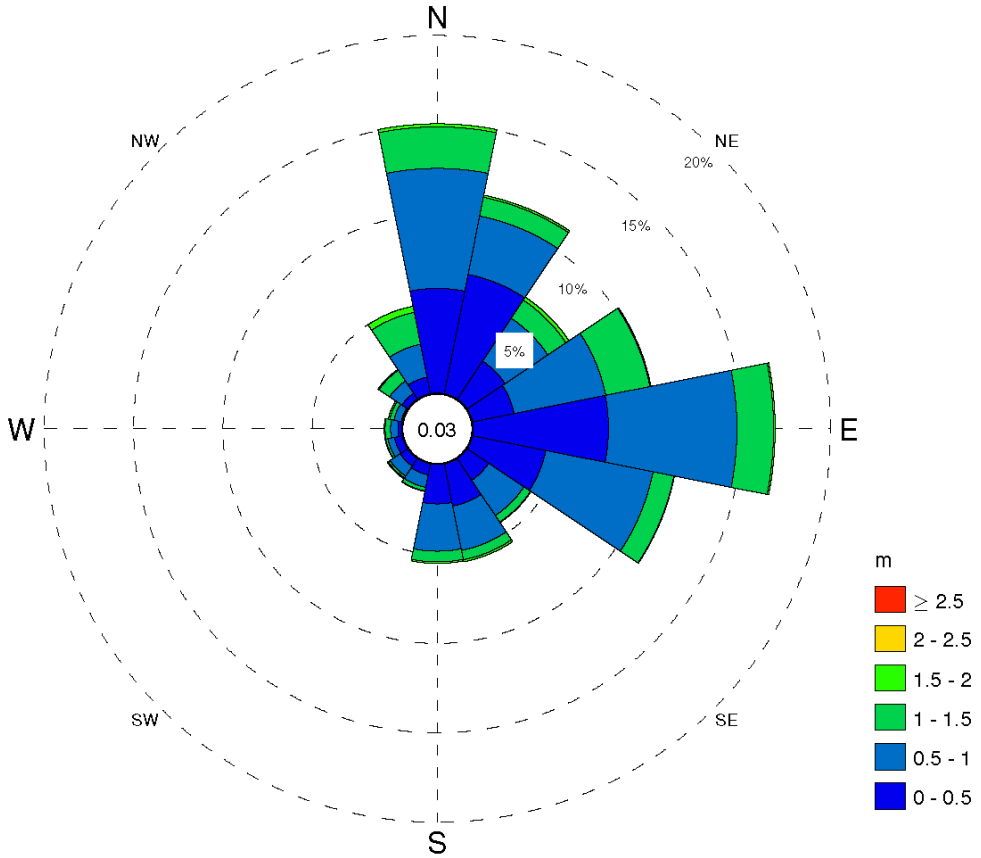


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3451, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	20.28	9.88	7.51	10.29	13.47	11.39	5.39	3.97	4.32	1.56	0.93	1.39	1.33	1.16	2.32	4.81	100.00
2.5																	0.20
2	0.49	0.17	0.17	0.35	0.23							0.17		0.12	0.14	0.41	2.38
1.5	2.87	1.25	1.80	1.83	3.65	2.52	0.99	0.49	0.41		0.14	0.23	0.41	0.17	0.72	0.75	18.23
1	9.94	2.64	2.09	6.32	7.07	5.74	2.32	2.17	2.12	0.72	0.38	0.58	0.58	0.61	1.04	2.41	46.71
0.5	6.98	5.80	3.45	1.80	2.52	3.13	2.09	1.27	1.71	0.84	0.41	0.41	0.29	0.23	0.41	1.16	32.48
0																	

Significant Wave Height (February)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

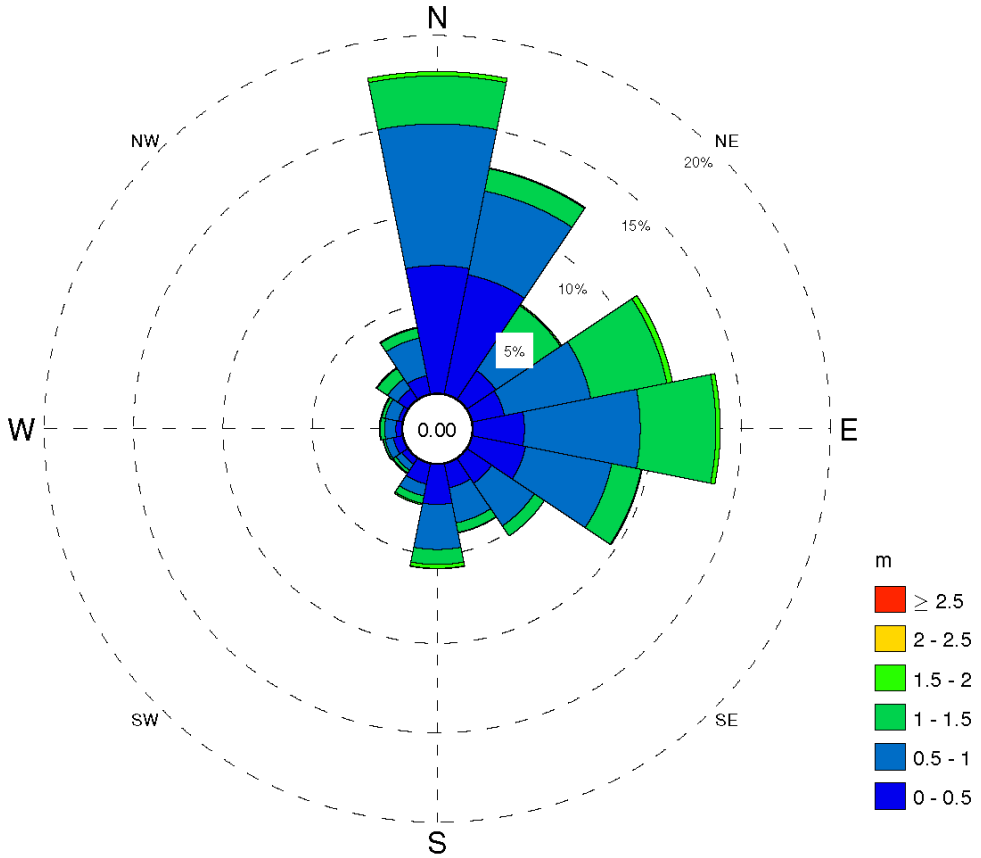


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3366, calms 1
About 0.414% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	15.06	11.32	6.86	10.19	16.90	11.53	4.31	5.59	5.53	1.57	1.37	0.98	0.98	0.80	1.99	4.99	99.97
2.5																	
2	0.18	0.12	0.21					0.12								0.36	1.57
1.5	2.32	1.07	1.22	2.53	2.05	1.19	0.45	0.53	0.59	0.21	0.12	0.12	0.30	0.24	0.71	1.81	15.45
1	6.71	3.33	2.88	5.23	7.19	6.12	2.38	2.53	2.64	0.71	0.68	0.39	0.42	0.42	0.83	1.87	44.33
0.5	5.85	6.80	2.55	2.38	7.58	4.19	1.46	2.41	2.20	0.62	0.51	0.45	0.21		0.39	0.95	38.59
0																	

Significant Wave Height (March)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

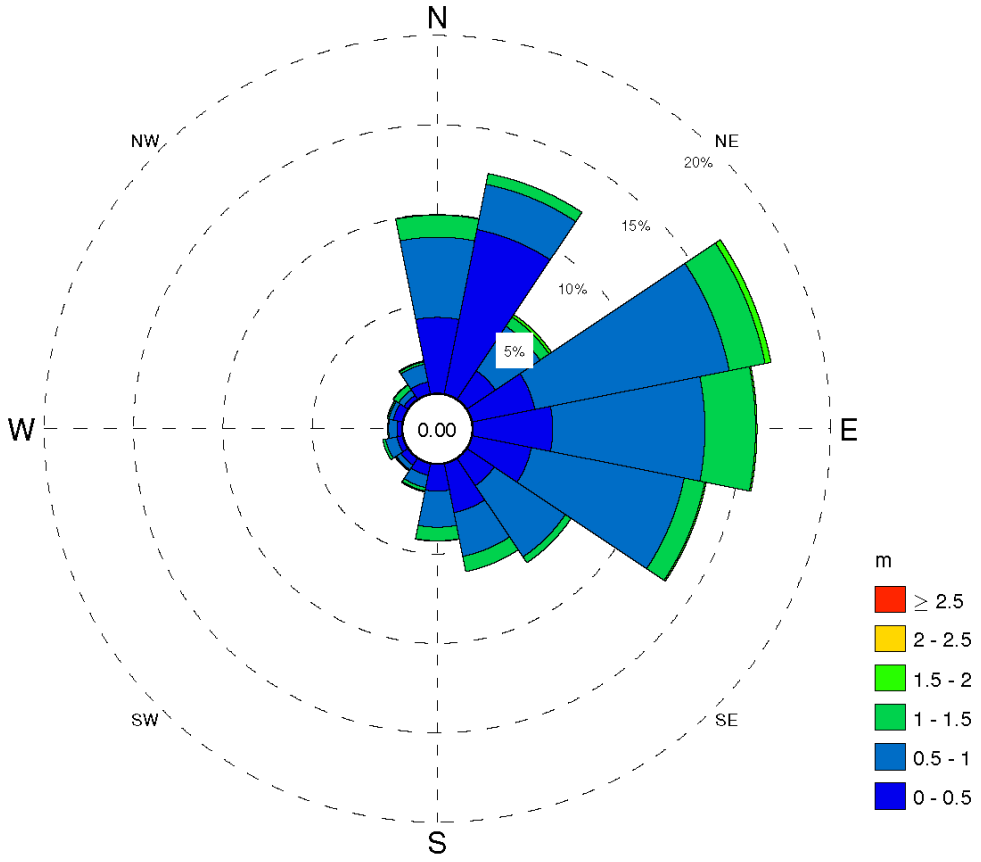


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3687, calms 0
About 0.403% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	17.98	12.88	6.37	11.42	13.83	9.68	5.21	3.93	5.83	2.33	1.03	1.11	1.25	1.22	2.12	3.80	100.00
2.5																	
2	0.24			0.33	0.24				0.22								1.63
1.5	2.69	1.27	1.87	4.34	4.23	1.68	0.68	0.54	0.84	0.43	0.19	0.11	0.24	0.19	0.71	0.57	20.59
1	7.92	4.77	2.50	4.94	6.48	4.91	2.87	2.01	2.52	0.68	0.41	0.46	0.62	0.76	0.68	2.14	44.67
0.5	7.13	6.78	1.93	1.82	2.87	3.04	1.65	1.36	2.22	1.14	0.38	0.52	0.33	0.22	0.68	1.03	33.09
0																	

Significant Wave Height (April)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

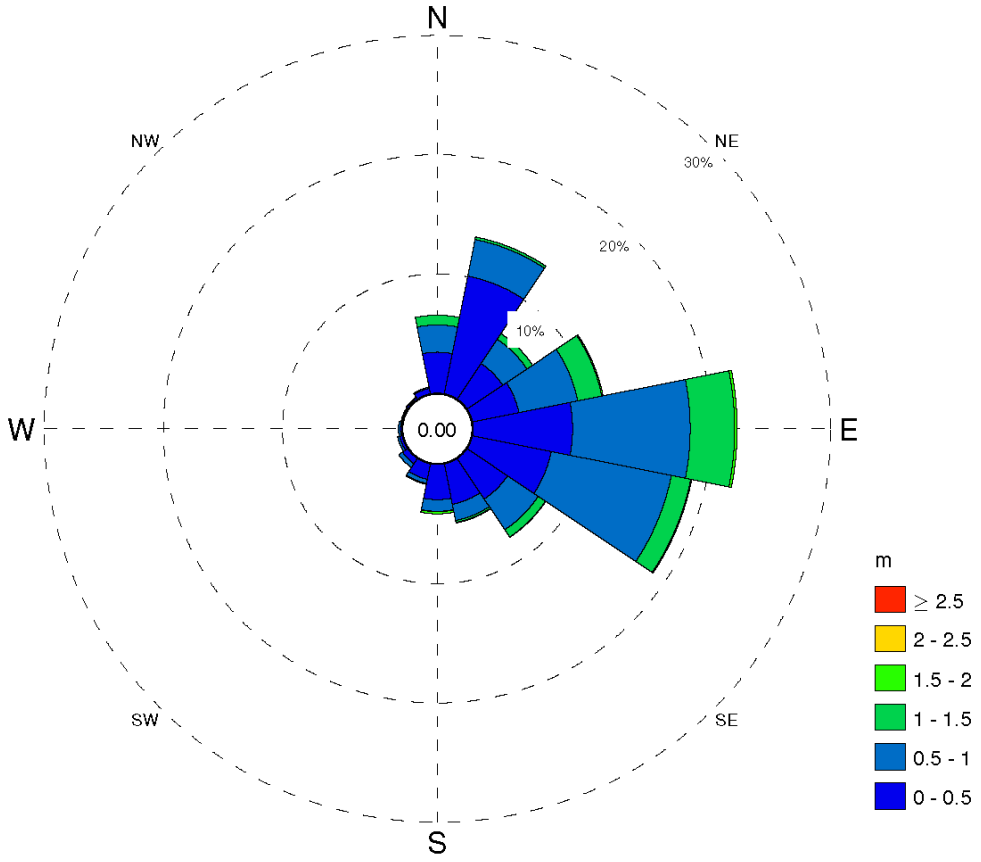


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3568, calms 0
About 0.389% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	9.98	12.56	5.69	17.04	15.89	13.34	7.01	6.14	4.29	1.60	0.84	1.12	0.78	0.87	0.98	1.88	100.00
2.5																	
2			0.17	0.34													0.92
1.5	1.23	0.62	0.62	2.05	2.83	1.18	0.39	0.87	0.76	0.20		0.17			0.34	0.14	11.58
1	4.48	2.58	3.00	11.10	8.52	8.72	4.79	2.49	2.02	0.70	0.31	0.64	0.48	0.25	0.36	1.01	51.46
0.5	4.23	9.36	1.91	3.56	4.46	3.36	1.82	2.77	1.49	0.64	0.45	0.31	0.25	0.50	0.25	0.67	36.04
0																	

Significant Wave Height (May)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

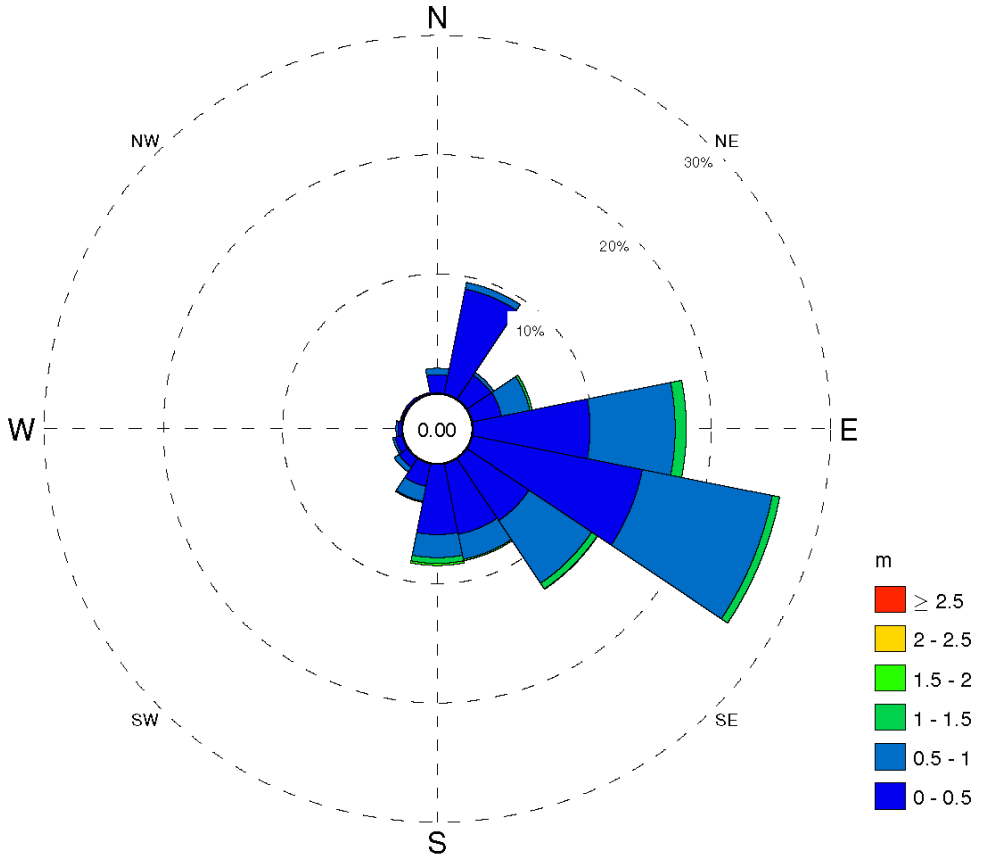


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3676, calms 0
About 0.376% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	6.53	13.41	6.61	11.18	22.17	18.77	7.94	5.06	4.13	1.74	0.90	0.41	0.27	0.11	0.19	0.57	100.00
2.5																	
2				0.11	0.22				0.19								0.68
1.5	0.82	0.22	0.57	2.07	3.73	1.66	0.73	0.16									10.07
1	2.29	3.13	2.45	5.03	9.87	10.28	3.10	1.39	0.98	0.35	0.38	0.19	0.16			0.11	39.80
0.5	3.43	10.07	3.59	3.97	8.35	6.75	4.08	3.45	2.94	1.31	0.52	0.22	0.11		0.14	0.46	49.46
0																	

Significant Wave Height (June)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

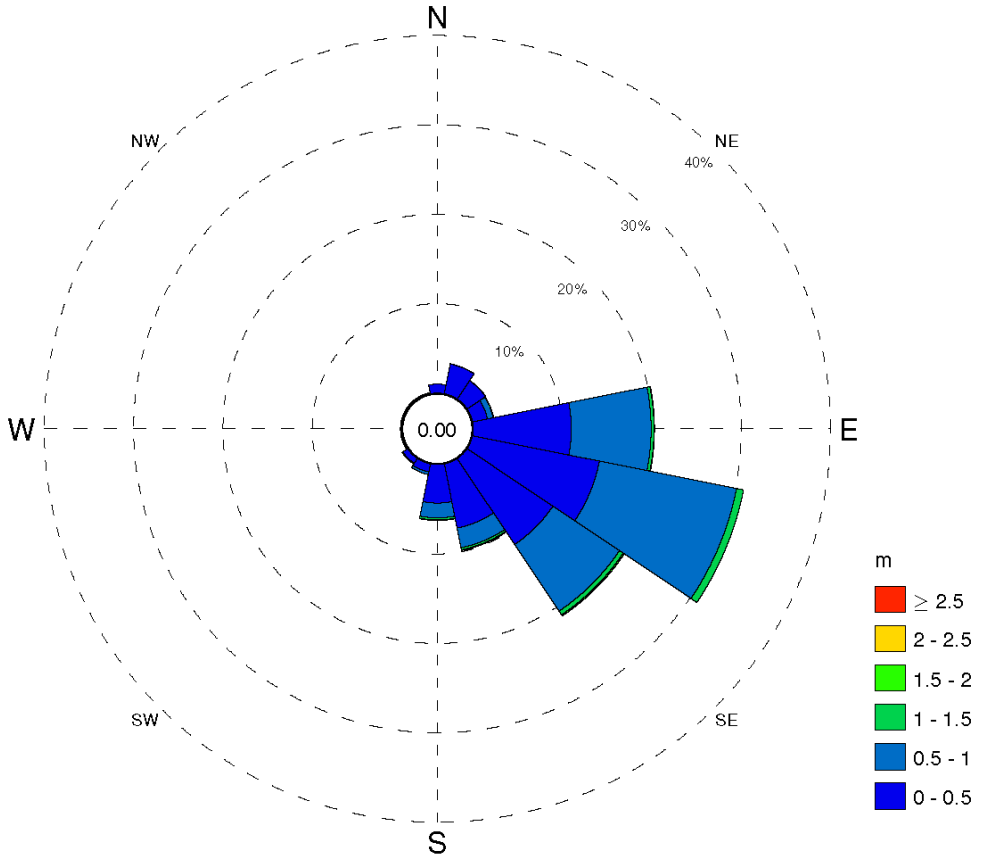


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3307, calms 0
About 0.417% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	2.09	9.53	2.69	5.11	17.90	26.31	13.18	8.29	8.47	3.30	1.36	0.82	0.48	0.18	0.18	0.12	100.00
2.5																	
2								0.12	0.18								0.33
1.5				0.21	0.94	0.64	0.57		0.48								2.93
1	0.54	0.57	0.27	2.42	7.14	11.13	6.32	2.15	1.94	1.30	0.48	0.21	0.18				34.71
0.5	1.54	8.95	2.42	2.48	9.83	14.54	6.26	6.02	5.87	1.91	0.88	0.60	0.30	0.12	0.18	0.12	62.02
0																	

Significant Wave Height (July)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

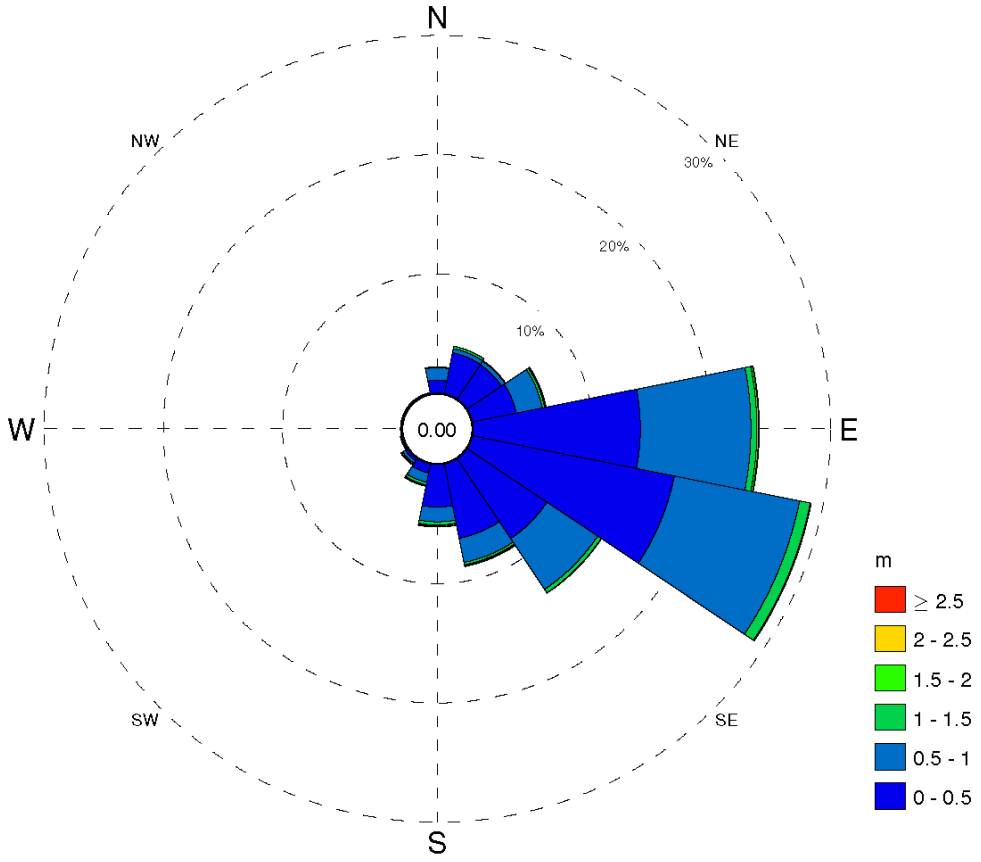


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3393, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	1.00	3.42	2.51	2.42	20.31	30.95	21.16	9.87	6.25	1.21	0.74						100.00
2.5																	
2							0.15										0.38
1.5					0.32	0.80	0.50	0.24	0.24								2.12
1				0.65	8.93	15.65	8.96	2.24	1.65	0.29							38.52
0.5	1.00	3.39	2.48	1.71	10.99	14.50	11.55	7.31	4.30	0.91	0.65						58.97
0																	

Significant Wave Height (August)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

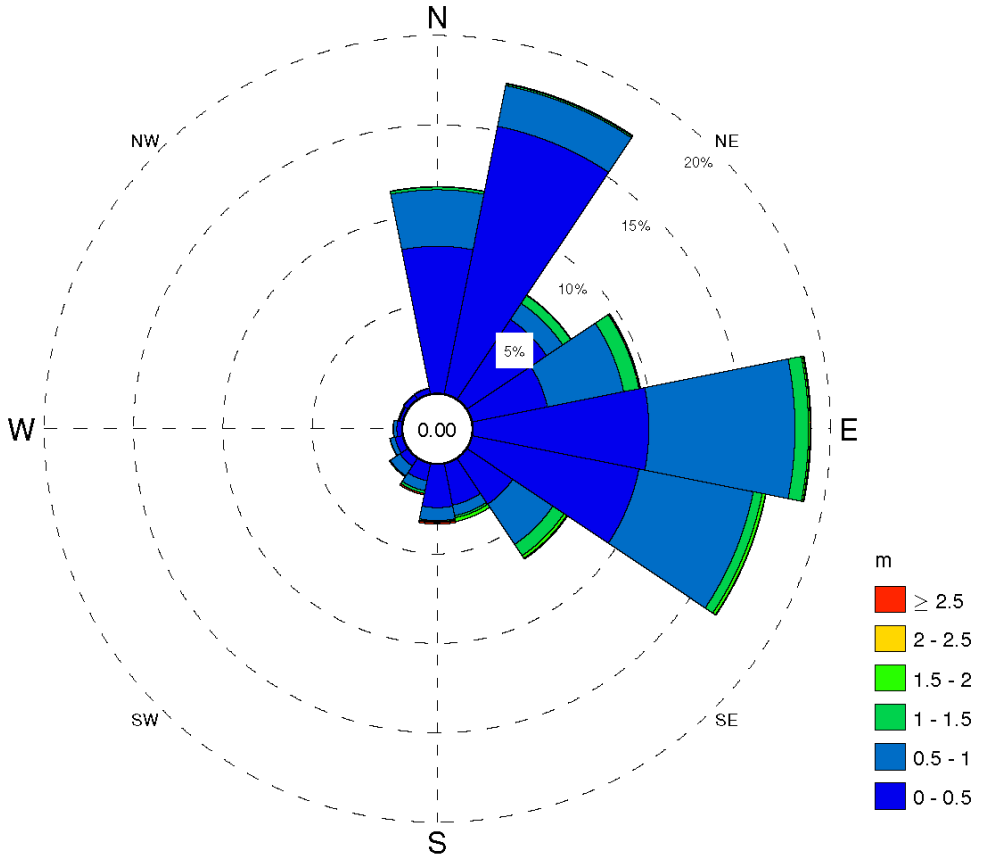


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3396, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	2.21	4.06	3.89	6.30	24.03	29.00	13.57	8.78	5.24	1.91	0.68	0.18					100.00
2.5																	0.35
2																	0.32
1.5					0.15												0.44
1		0.21		0.21	0.50	0.91	0.35	0.21	0.27	0.24	0.12						3.06
0.5	1.03	0.35	0.35	2.24	9.28	10.72	5.12	2.06	1.24	0.80	0.27						33.48
0	1.09	3.50	3.47	3.74	14.05	17.29	8.07	6.36	3.56	0.77	0.24	0.12					62.34

Significant Wave Height (September)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

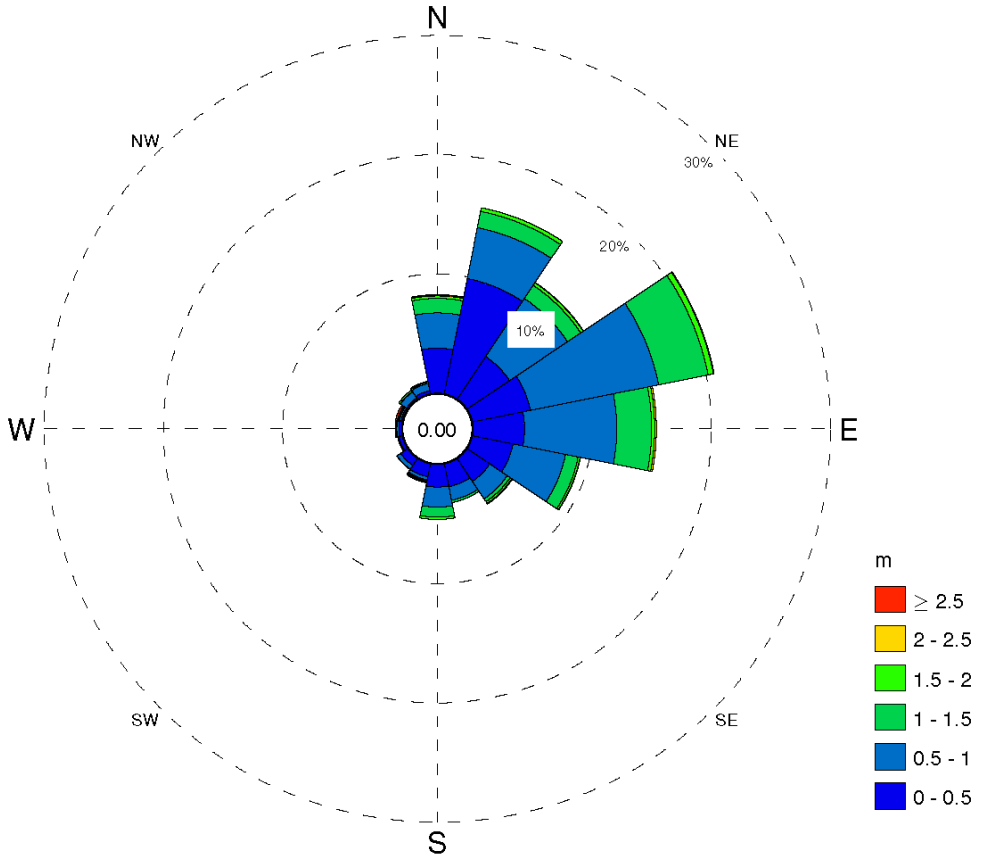


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3325, calms 0
About 0.387% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	11.55	17.71	7.01	9.59	18.92	16.75	6.77	3.28	3.34	1.77	1.23	0.72	0.48	0.24	0.30	0.33	100.00
2.5																	0.27
2																	0.21
1.5						0.18	0.18	0.21									0.93
1	0.15		0.54	0.87	0.75	0.51	0.75	0.12		0.15							4.03
0.5	3.16	2.32	1.08	4.36	8.18	6.53	2.71	0.60	0.72	0.57	0.66	0.27	0.18				31.43
0	8.21	15.25	5.35	4.27	9.83	9.50	3.07	2.35	2.41	0.96	0.51	0.42	0.27	0.15	0.27	0.30	63.13

Significant Wave Height (October)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

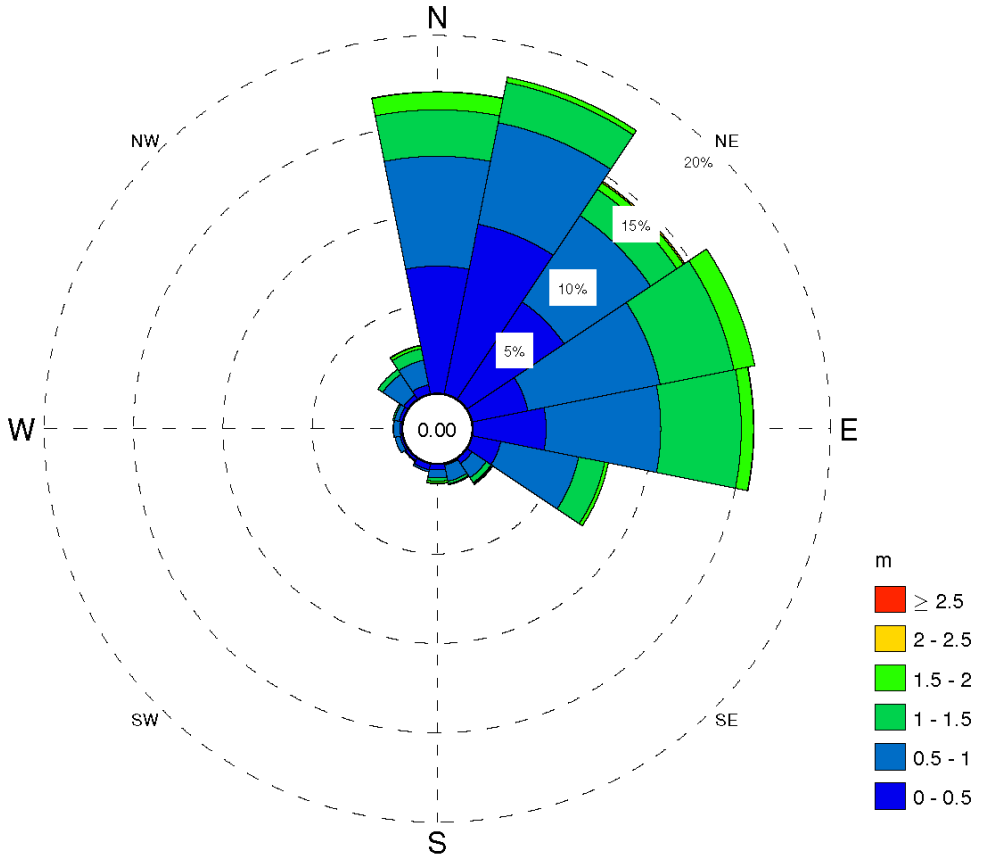


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3450, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	8.26	15.91	11.77	20.70	15.39	9.25	4.58	3.30	4.61	1.62	1.10	0.41	0.55	0.58	0.90	1.07	100.00
2.5														0.14			0.52
2					0.14												0.43
1.5	0.20	0.32	0.26	0.46	0.26	0.17	0.17		0.20						0.14		2.35
1	1.22	1.39	1.33	4.23	2.93	1.07	0.29	0.20	0.84							0.12	13.86
0.5	2.96	4.35	5.86	10.99	7.74	4.49	1.77	1.16	1.68	0.26	0.38		0.17	0.14	0.61	0.61	43.25
0	3.77	9.86	4.29	4.96	4.32	3.48	2.29	1.94	1.88	1.10	0.70	0.29	0.23	0.12	0.12	0.26	39.59

Significant Wave Height (November)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019

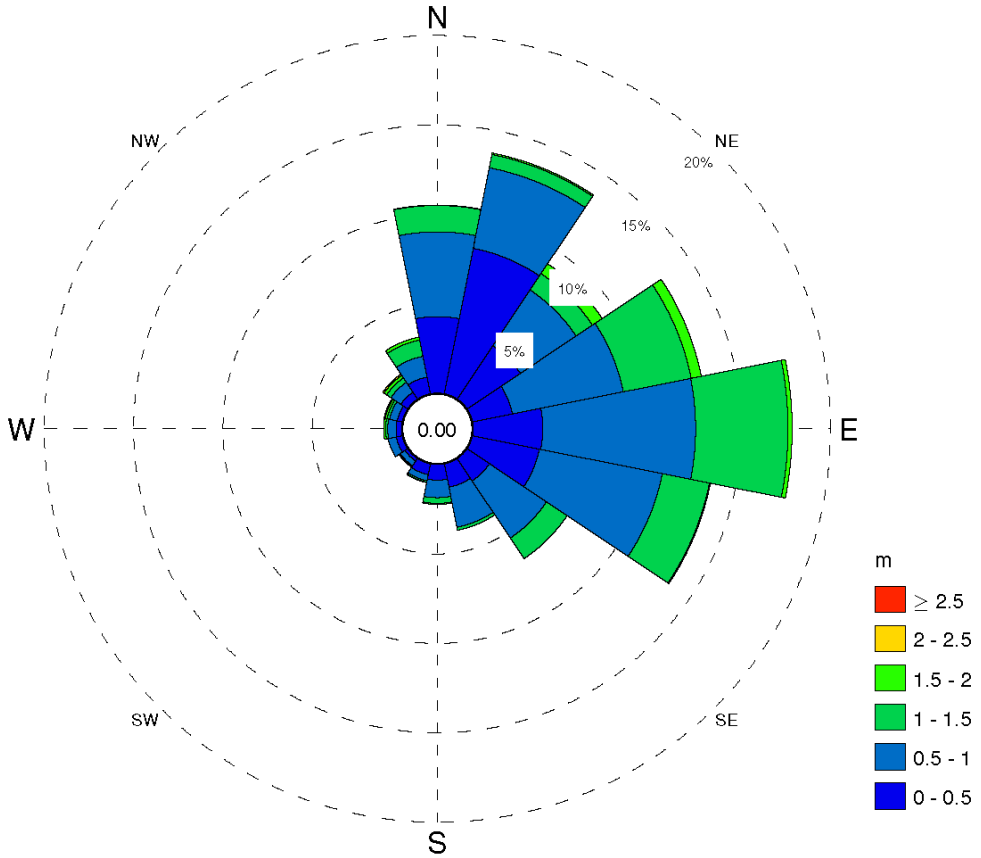


Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3352, calms 0
About 0.387% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	16.86	18.05	14.65	16.11	15.72	7.76	1.73	1.19	1.07	0.45	0.21	0.42	0.48	0.54	2.00	2.77	100.00
2.5																	0.27
2	0.98	0.30	0.45	1.19	0.69	0.21			0.12							0.18	4.15
1.5	2.60	2.30	1.76	4.21	4.50	1.49	0.33	0.15	0.18						0.33	0.66	18.62
1	6.15	5.79	5.82	7.55	6.41	4.45	0.95	0.92	0.45	0.12		0.30	0.36	0.27	1.40	1.40	42.39
0.5	7.10	9.67	6.53	3.16	4.09	1.61	0.33		0.30	0.33	0.15	0.12		0.18	0.27	0.51	34.49
0																	

Significant Wave Height (December)
Station B - NOAA WW3
Period 01-Feb-2005 to 01-Jun-2019



Direction FROM is shown
Center value indicates calms below 0 m
Total observations 3461, calms 0
About 0.375% of observations missing

Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	10.52	13.72	9.10	13.06	17.86	13.58	6.73	3.79	2.22	1.07	0.58	0.81	1.01	1.04	1.68	3.24	100.00
2.5																	0.20
2			0.66	0.58	0.23								0.12	0.12	0.17	0.17	2.34
1.5	1.47	0.75	1.10	3.87	5.17	2.69	1.39	0.17	0.32				0.12	0.14	0.29	0.92	18.49
1	4.74	4.59	3.76	6.33	8.55	7.02	3.84	2.28	0.98	0.35	0.32	0.46	0.46	0.43	0.66	1.18	45.97
0.5	4.28	8.29	3.58	2.28	3.90	3.81	1.50	1.33	0.87	0.61	0.17	0.35	0.32	0.29	0.46	0.95	33.00
0																	

Appendix D: Schematic Design Drawings

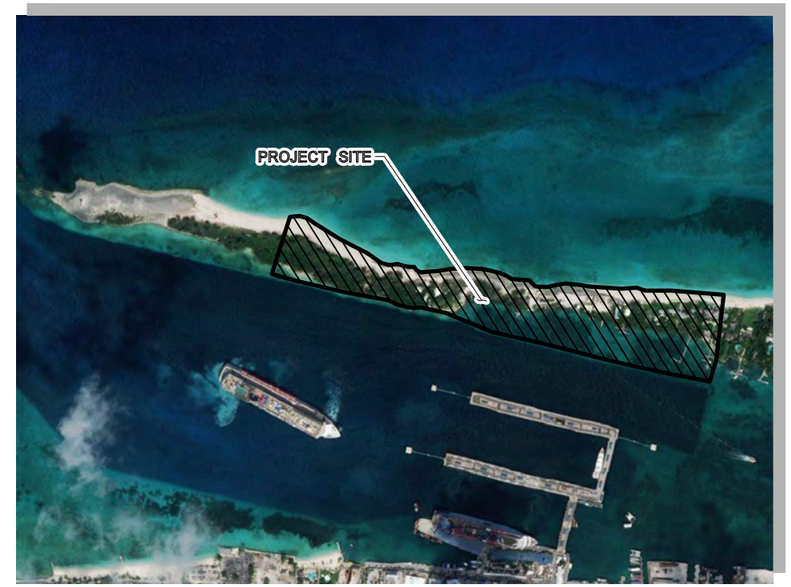
PARADISE ISLAND SHORELINE PROTECTION & COASTAL IMPROVEMENTS

NASSAU, BAHAMAS

VICINITY MAP

NTS

INDEX OF DRAWINGS		
SHEET INDEX	SHEET NO.	SHEET TITLE
1	G-001	COVER SHEET
2	G-002	NOTES AND ABBREVIATIONS
3	G-003	NOTES AND ABBREVIATIONS
4	V-101	EXISTING SITE PLAN
5	C-101	PROPOSED GRADING PLAN - AERIAL
6	C-102	CONCEPT PROPOSED GRADING PLAN
7	C-301	SECTIONS



LOCATION PLAN

NTS

CONCEPTUAL
ISSUED: 2019-11-15
NOT TO BE USED FOR CONSTRUCTION

DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

COVER SHEET

Designed by: JAD
Dwn by: JAD
Ckd by: HJP
Reviewed by:
Submitted by: SUBMITTERS NAME MOFFATT & NICHOL
Date: 14/06/2019
Rev. -
M&N Project No. INSERT PROJ. NO.
Drawing code:
Drawing Scale:
Plot scale: 1:1 (D SHEET)

moffatt & nichol

SEAL

Sheet Reference No.
G-001
INDEX: 1 OF 8

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GENERAL NOTES:

1. THE WORK CONSISTS OF FURNISHING ALL CONSTRUCTION, LABOR, EQUIPMENT AND MATERIALS AND PERFORMING ALL OPERATIONS IN CONNECTION WITH THE CONSTRUCTION OF THE MARINE WORKS SHOWN ON THESE DRAWINGS.
2. THE WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL ABIDE BY ALL NOTES AND CONDITIONS INDICATED ON THE CONSTRUCTION DOCUMENTS. IF THE CONTRACTOR VIOLATES ANY CONDITION OF DOCUMENTS AND WORK IS STOPPED BY THE GOVERNMENT, THEN ANY ADDITIONAL COSTS INCURRED BY THE CONTRACTOR SHALL BE PAID BY THE CONTRACTOR AND NOT THE OWNER.
3. THE OWNER IS RESPONSIBLE FOR OBTAINING PERMITTING AGENCY APPROVAL NECESSARY FOR THIS WORK.
4. COORDINATE WITH THE OWNER'S SITE REPRESENTATIVE AT THE BEGINNING OF EACH WORK DAY. CONTRACTOR TO FURNISH DAILY CONSTRUCTION ACTIVITY LOG WITH PHOTOGRAPHS.
5. PHASING OF THE WORK SHALL BE COORDINATED WITH THE OWNER WITH RESPECT TO DATES OF WORK. THE CONTRACTOR SHALL ENSURE THAT THE SITE REMAIN UNENCUMBERED AND OPEN FOR ACCESS OTHER THAN THOSE PORTIONS OR PHASE UNDER DIRECT CONTROL OF THE CONTRACTOR.
6. EXAMINE THE CONTRACT DOCUMENTS THOROUGHLY AND PROMPTLY REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE COMMENCING THE WORK.
7. LOCATIONS, DIMENSIONS AND ELEVATIONS OF BUILDINGS, ROADS AND UTILITIES SHOWN THE BASE MAP ARE APPROXIMATE AND ARE SHOWN FOR INFORMATIONAL PURPOSES ONLY. CONTRACTOR SHALL VERIFY LOCATIONS PRIOR TO START OF CONSTRUCTION.

SURVEY NOTES:

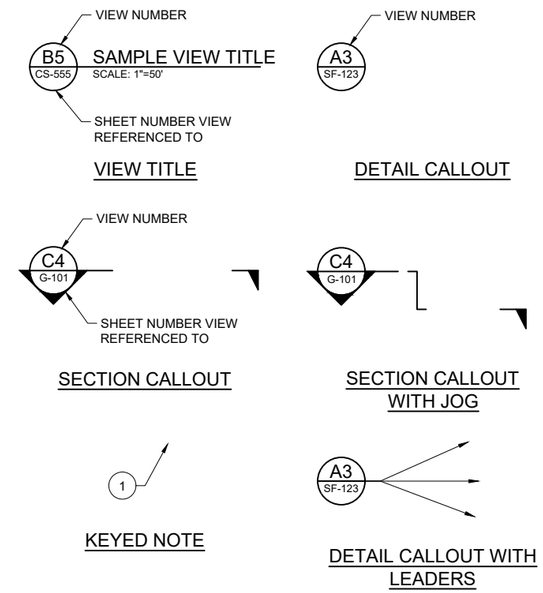
1. HYDROGRAPHIC DATA COLLECTED BY COASTAL CARIBBEAN COASTAL SERVICES ON OCTOBER 25, 2019.
2. AERIAL PHOTOGRAPHY FROM BING.
3. HORIZONTAL COORDINATES ARE IN INTERNATIONAL FEET AND REFERENCED TO NAD83 DATUM, ZONE 18, CENTRAL MERIDIAN 75D W.
4. ELEVATIONS IN FEET REFERENCED TO MSL.
5. THE INFORMATION DEPICTED ON THESE DRAWINGS REPRESENTS THE RESULTS OF THE SURVEY ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS AN INDICATION OF THE GENERAL CONDITIONS EXISTING AT THAT TIME.
6. TIDAL ELEVATIONS ARE AS FOLLOWS BASED ON OSU TIDES, TOPEX DATABASE:

MHHW	1.58
MHW	1.27
MSL	0.00
MTL	-0.01
MLW	-1.28
MLLW	-1.37

ABBREVIATIONS:

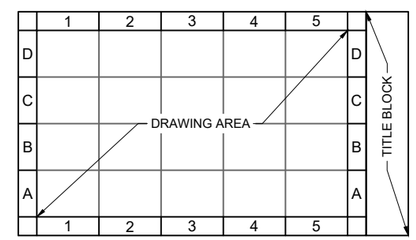
DTL	MEAN DIURNAL TIDE LEVEL
E	EASTING
EL, ELEV	ELEVATION
m	METER OR METERS
H	HORIZONTAL
MHHW	MEAN HIGHER HIGH WATER
MHW	MEAN HIGH WATER
MIN	MINIMUM
MLW	MEAN LOW WATER
MLLW	MEAN LOWEST LOW WATER
MSL	MEAN SEA LEVEL
MTL	MEAN TIDE LEVEL
N	NORTH
NO	NUMBER
TYP	TYPICAL
V	VERTICAL
W	WEST
°	DEGREE
#	NUMBER
%	PERCENT
±	PLUS OR MINUS

LEGEND



* VIEW NUMBER IS BASED ON THE (DACS) LOCATION OF THE LOWER-LEFT EXTENTS OF THE VIEW ON THE REFERENCED SHEET. WHEN REFERENCING DRAWING INFORMATION BETWEEN SHEETS, BOTH THE VIEW AND SHEET NUMBERS MUST BE QUOTED TOGETHER - EITHER IN A CALLOUT FORMAT AS SHOWN ABOVE OR IN THE FORM;
"VIEW NO./SHEET NO." (EG A1/CS-5001)

SHEET TYPE DESIGNATORS	
0	GENERAL (COVER SHEET, LEGEND, NOTES)
1	PLANS (HORIZONTAL VIEWS)
2	ELEVATIONS (NOT TYPICALLY USED)
3	SECTIONS (OVERALL VIEWS)
4	LARGE-SCALE VIEWS (PLANS, SECT. OR ELEV. - NOT DETAILS)
5	DETAILS (MAY BE PLAN, SECT. OR ELEV. VIEWS)
6	SCHEDULES
7	USER DEFINED
8	USER DEFINED
9	3D ISOMETRIC

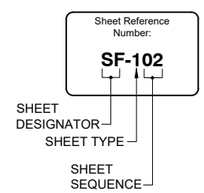


DRAWING AREA COORDINATE SYSTEM (DACS)

DISCIPLINE DESIGNATORS	
DISCIPLINE	DESIGNATOR
GENERAL	G
SURVEY/MAPPING	V
GEOTECHNICAL	B
CIVIL WORKS	W
CIVIL	C
STRUCTURAL	S
MECHANICAL	M
ELECTRICAL	E
OTHER DISCIPLINES	X

SECONDARY DESIGNATORS	
DEMOLITION	D
GENERAL	G
SUBSTRUCTURE	B
FRAMING	F
COMPONENT	C
SITE	S

REVISION NUMBERING	
A00, A01...	PRE-BID SUBMITTALS
B00, B01...	BID SUBMITTALS
000, 001...	CONSTRUCTION SUBMITTALS



CONCEPTUAL
ISSUED: 2019-11-15
NOT TO BE USED FOR CONSTRUCTION
DRAFT

DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

NOTES AND ABBREVIATIONS

Rev: -
Date: 14/06/2019
M&N Project No: INSERT PROJ. NO.
Drawing code:
Drawing Scale:
Plot scale: 1:1 (D SHEET)
Designed by: JAD
Dwn by: JAD
Ckd by: HJP
Reviewed by:
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL

moffatt & nichol

SEAL

Sheet Reference No.
G-002
INDEX: 2 OF 8

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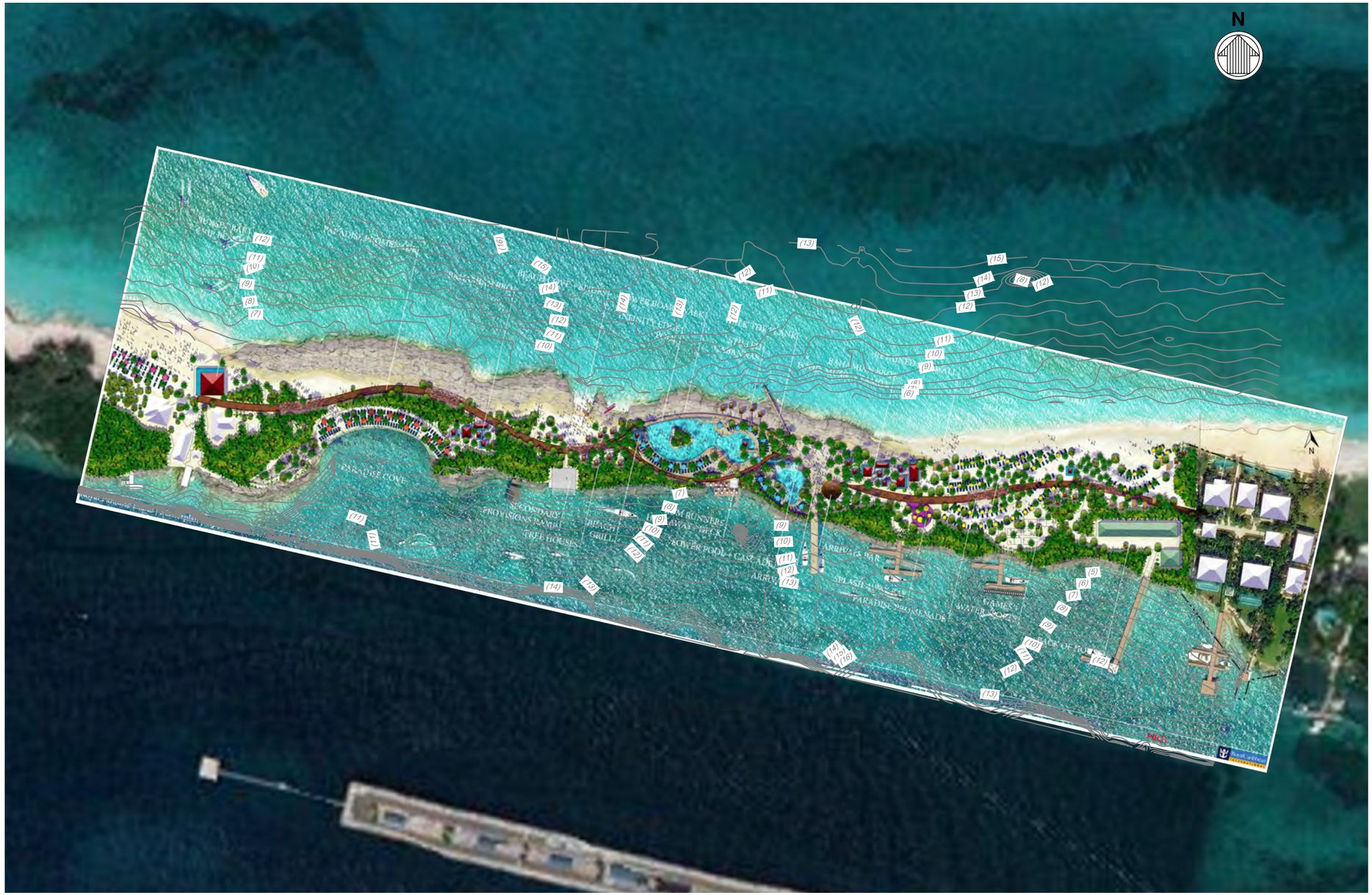

TIDES (FEET)

1.58	MHHW
1.27	MHW
0.00	MSL
-0.01	MTL
-1.28	MLW
-1.37	MLLW

120' 0' 120' 240'

SCALE: 1"=120'

CONCEPTUAL
ISSUED: 2019-11-15
NOT TO BE USED FOR CONSTRUCTION

DRAFT

ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

EXISTING SITE PLAN

moffatt & nichol

Designed by: JAD
Date: 14/06/2019
Rev: -
Dwn by: JAD
Cad by: HJP
M&N Project No. INSERT PROJ. NO.
Reviewed by:
Drawing code:
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL
Drawing Scale: Plot scale: 1:1 (D SHEET)

SEAL

Sheet Reference No.
V-101
INDEX: 3 OF 8

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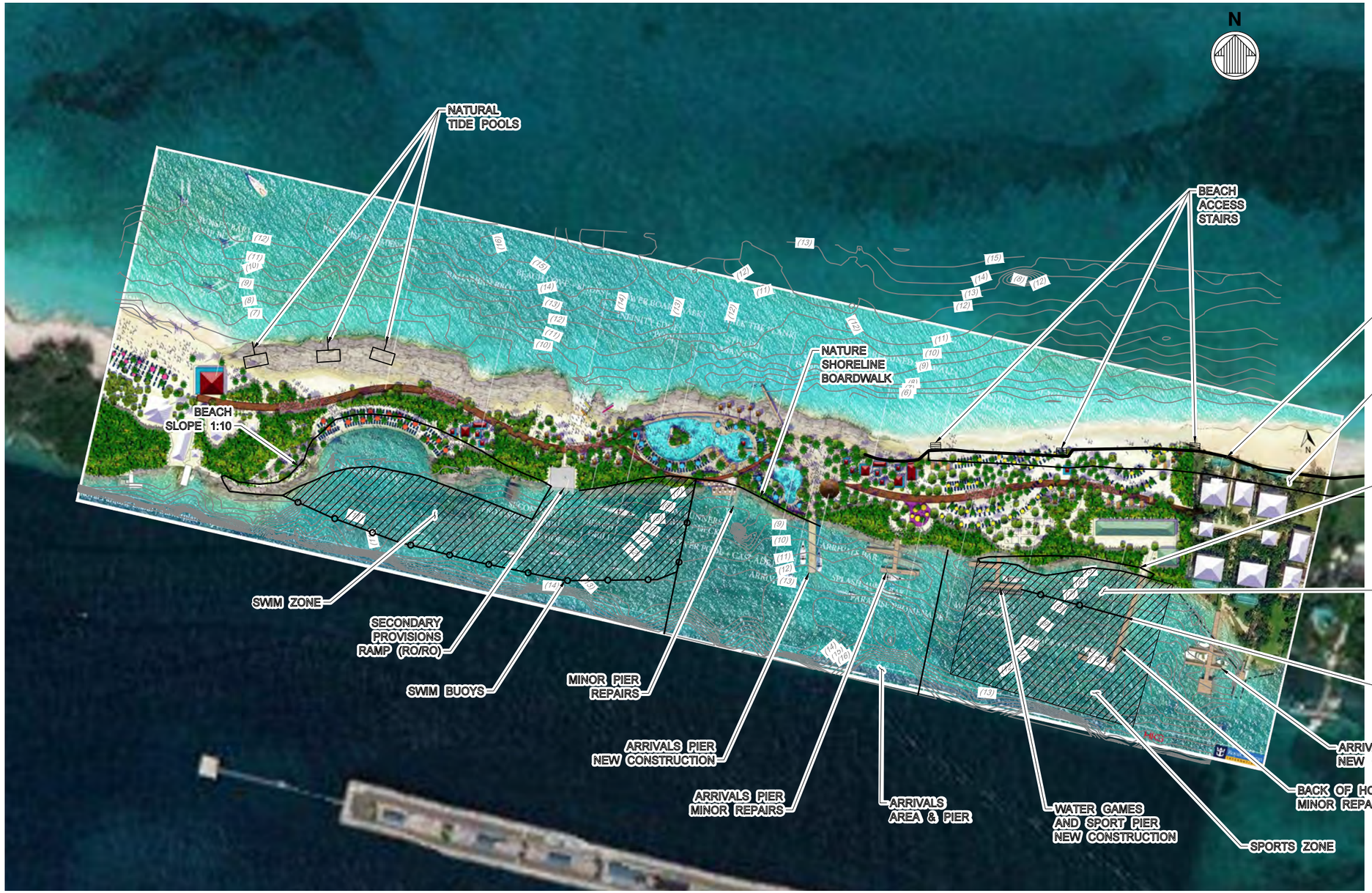
DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING



TIDES (FEET)

1.58	MHHW
1.27	MHW
0.00	MSL
-0.01	MTL
-1.28	MLW
-1.37	MLLW

120' 0' 120' 240'

SCALE: 1"=120'

CONCEPTUAL
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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

PROPOSED GRADING PLAN - AERIAL

moffatt & nichol

Designed by: JMB
Date: 14/06/2019
Rev: -
Dwn by: RG
Ckd by: HJP
M&N Project No. INSERT PROJ. NO.
Reviewed by:
Drawing code:
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL
Drawing Scale:
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SEAL

Sheet Reference No.
C-101
INDEX: 4 OF 8

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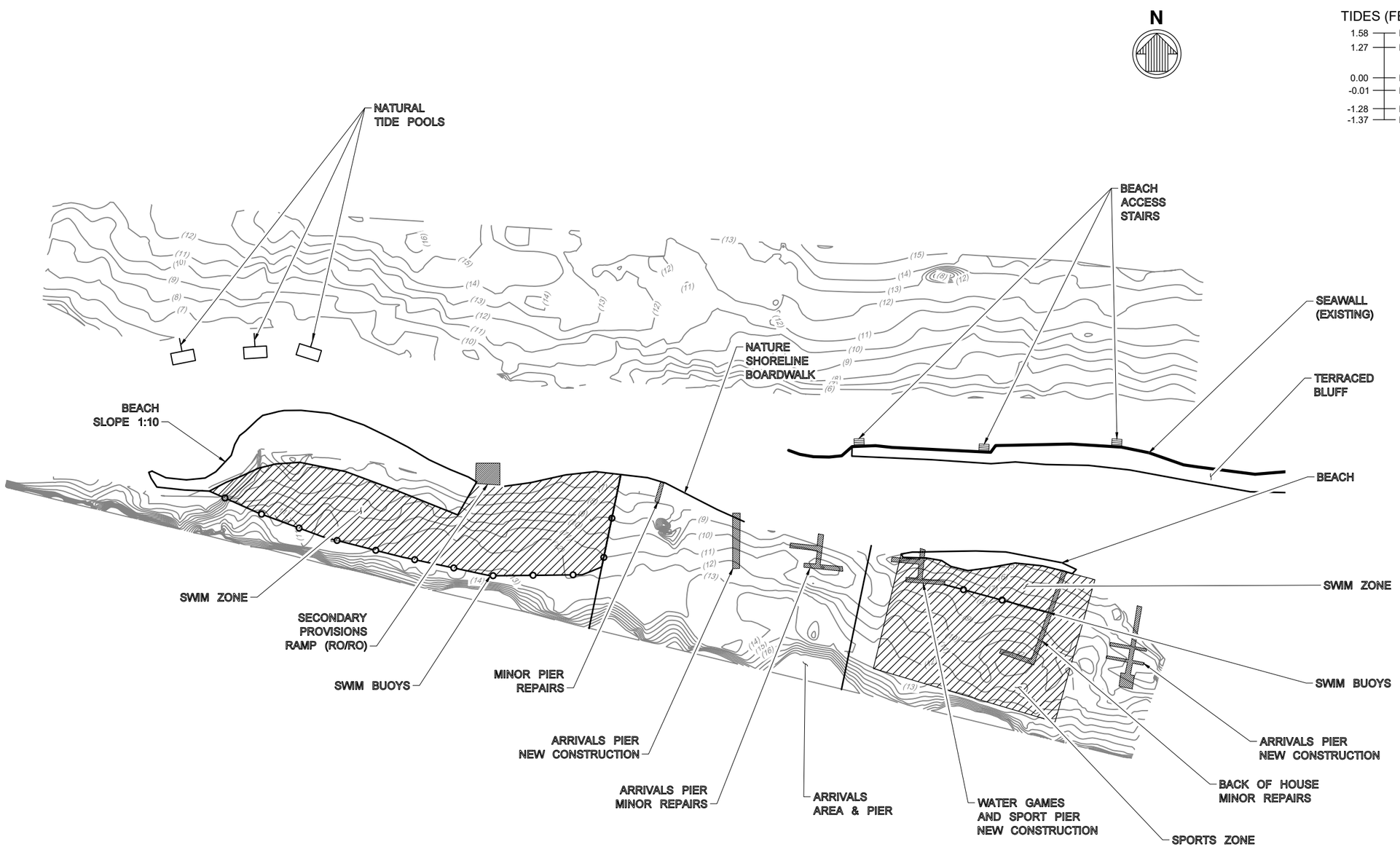

CONCEPTUAL
ISSUED: 2019-11-15
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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

CONCEPT PROPOSED GRADING PLAN

Designed by: JMB	Date: 14/06/2019	Rev. -	
Dwn by: RG	Ckd by: HJP	M&N Project No. INSERT PROJ. NO.	
Reviewed by:		Drawing code:	
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL		Drawing Scale: Plot scale: 1:1 (D SHEET)	

moffatt & nichol

SEAL

Sheet Reference No.
C-102
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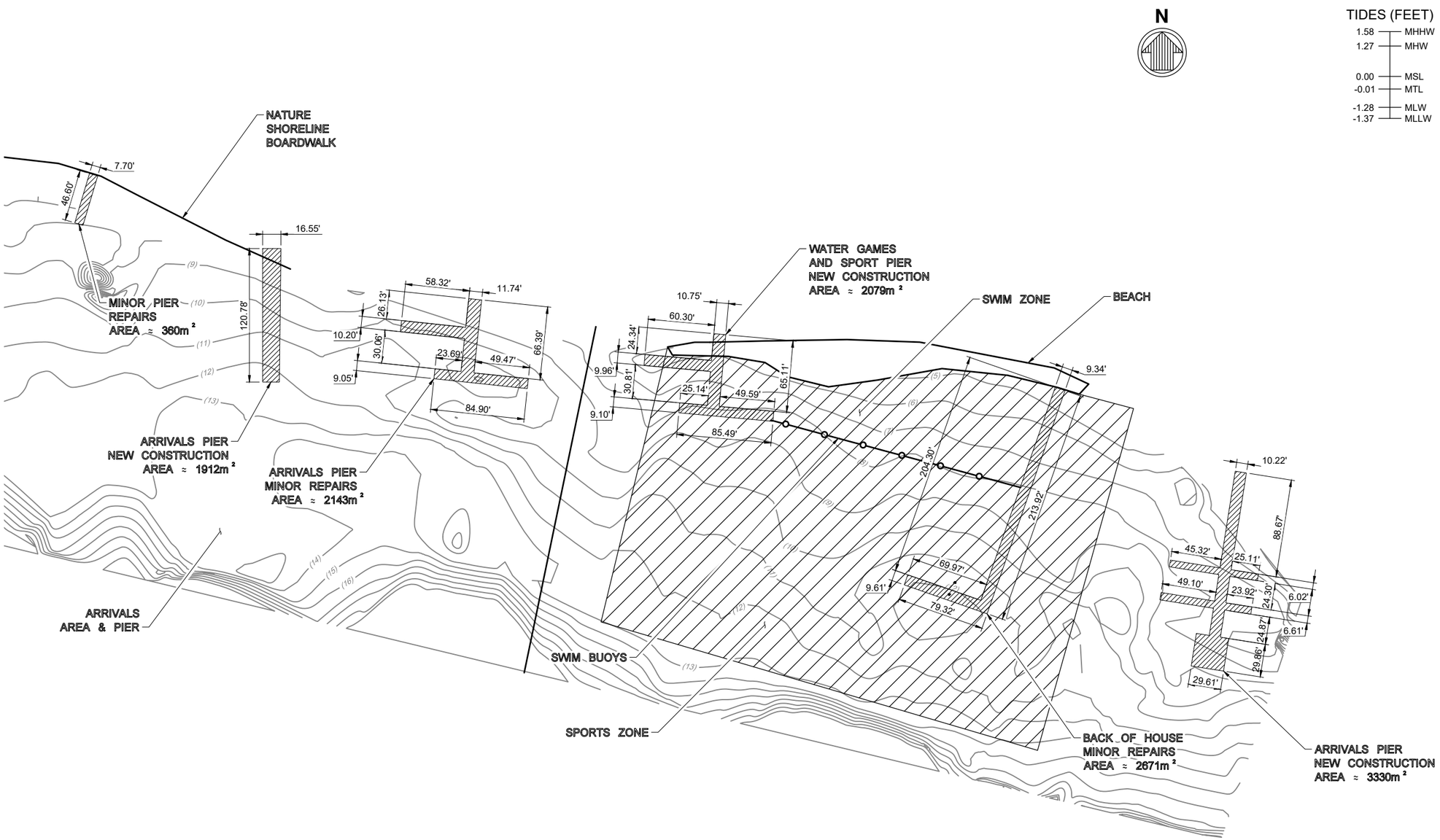

TIDES (FEET)

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1.27	MHW
0.00	MSL
-0.01	MTL
-1.28	MLW
-1.37	MLLW

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SCALE: 1"=50'

CONCEPTUAL
ISSUED: 2019-11-15
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ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

PIER PLAN

Date: 03/22/2019
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Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL

moffatt & nichol

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Sheet Reference No.
C-103
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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

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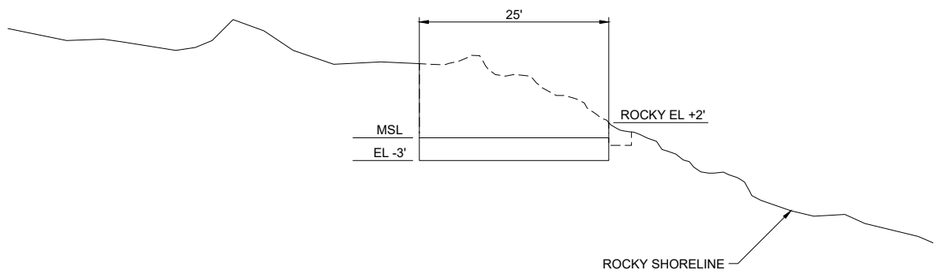

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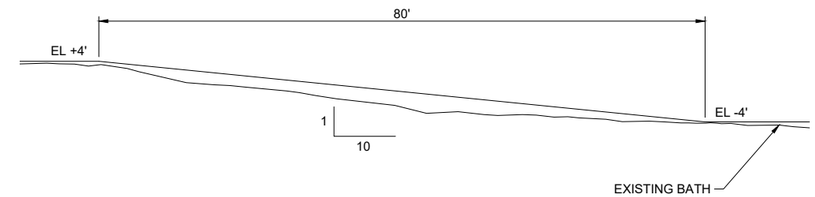

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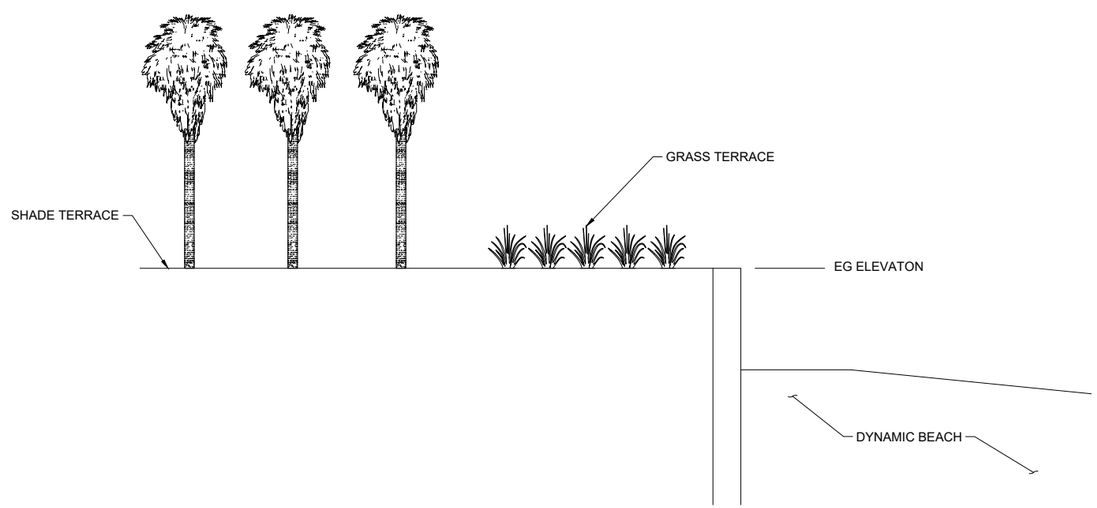

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SCALE: 1"=10'

5' 0' 5' 10'
SCALE: 1"=5'

CONCEPTUAL
ISSUED: 2019-11-15
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ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

SHORELINE SECTIONS

moffatt & nichol

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Date: 14/06/2019
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Dwn by: RG
Ckd by: HJP
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Sheet Reference No.
C-301
INDEX: 7 OF 8

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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

TIDES (FEET)

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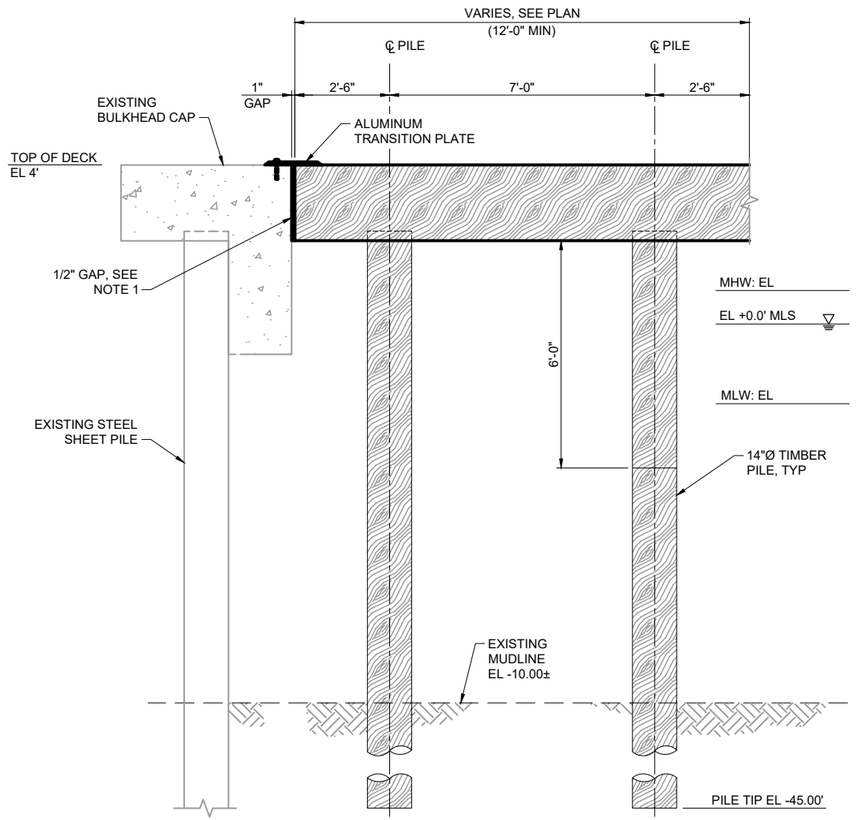
-0.01	MTL
-1.28	MLW
-1.37	MLLW



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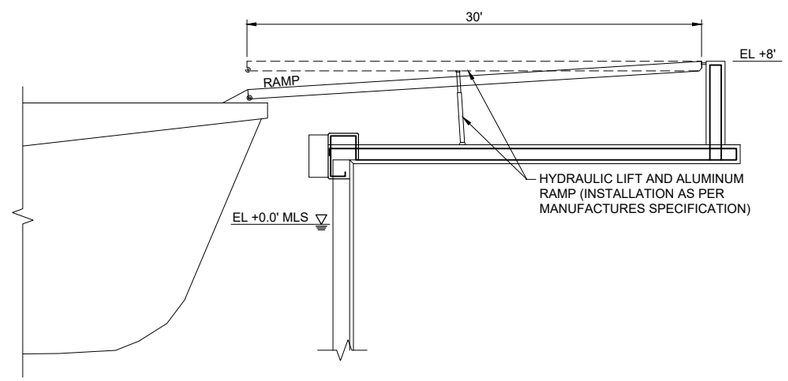

RO/RO RAMP (TYP)

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SCALE: 1"=5'

2' 0'-0" 2' 4'

SCALE: 1/2"=1'-0"

CONCEPTUAL
ISSUED: 2019-11-15
NOT TO BE USED FOR CONSTRUCTION

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ISLANDS BY DESIGN

Mark	Description	Date	Appr.

PARADISE ISLAND SHORELINE IMPROVEMENTS

STRUCTURES SECTIONS

Designed by: JMB
Date: 03/22/2019
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Dwn by: RG
Ckd by: HJP
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Drawing code:
Reviewed by:
Submitted by: SUBMITTER'S NAME MOFFATT & NICHOL
Drawing Scale: Plot scale: 1:1 (D SHEET)

moffatt & nichol

SEAL

Sheet Reference No.
C-302
INDEX: 8 OF 8

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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

B. PRELIMINARY UTILITY ASSESSMENT

APPENDIX B

PROVISION OF UTILITY SERVICES FOR PROPOSED ROYAL BEACH CLUB AT PARADISE ISLAND

Memo

To: Department of Environmental Planning and Protection

From: Islands by Design

Re: Paradise Island RCCL Development Proposal.

December 14, 2020

Summary

Basic utility services for this project are available from various utility operators, but there is some latitude in selection, depending on the priorities ascribed to the various considerations; e.g. whether it is preferred to maintain full independence in services supply, or if it is preferred to leave the services provision responsibility to those already providing services in the various fields.

The back of House Utility site will be located on East end of property with aesthetics comparable to other buildings and surrounded by heavy landscape.

Water

A 150 000-gallon Reverse Osmosis Plant to be installed inside a closed building with 2- 150,000-gallon storage tanks, to ensure continuous supply.

Electricity

Electricity utility service in the entire Bahamas is by statute, the sole prerogative of the Bahamas Power & Light Company Limited, whose performance in recent years has been anything but reliable. Therefore, while a service connection to that utility is a legal requirement, it is essential that a stand-by power supply, equivalent to the full load demand of the development be provided against the possibility of supply failure.

BPL will be requested to install two 500kW transformers as a primary service.

Full site will include low-voltage installations to support CCTV and Wi-Fi connectivity for the safety and enjoyment of RCCL guests.

Waste Water Handling

Although the public utilities systems in New Providence Island, and the near-by Paradise Island have improved dramatically over the past decade, service availability is still limited. The Water & Sewerage Corporation do not provide service on Paradise Island, where the main waste treatment services provider is Paradise Islands Utilities. While it would be possible to establish a service connection to this provider, the geographical separation between the two locations may preclude this as being a viable option, leaving self-provision of treatment services as being the only available viable option.

Wastewater therefore will be treated locally at the site through a wastewater treatment plant.

Wastewater Treatment Plant to treat 110,000 gallons per day with above grade membrane bioreactor treatment system.

BACK OF HOUSE LOCATION (SHOWN IN RED BOX)

C. OVERWATER VISTAS ON PARADISE ISLAND

APPENDIX C

ROYAL BEACH CLUB AT PARADISE ISLAND
NASSAU, THE BAHAMAS

PDI PARADISE LTD.

A WHOLLY OWNED SUBSIDIARY OF

ROYAL CARIBBEAN CRUISES LTD.

D/B/A

ROYAL CARIBBEAN GROUP

OVERWATER VISTAS ON PARADISE ISLAND

Royal Caribbean Group
Royal Beach Club at Paradise Island
Overwater Vista

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1 Overview

Royal Caribbean Group (RCG), proposed development on the western end of Paradise Island seeks to feature overwater vistas similar to those currently enjoyed at Coco Cay, Berry Island. These overwater vistas will be for day use only allowing cruise passengers a shaded and dry perch above the turquoise Bahamian waters. RCG proposes a maximum of 10 (ten) single story vistas connected to the mainland.

Structurally, the vistas will be constructed of treated timber and piles with the roof being manufactured thatch. Each vista will have electricity and water supply, however, no toilets thus generating no liquid waste streams. Essentially, the overwater vistas are no different from a marina dock with the exception of ventilated walls and roofing. Likewise, marina facilities run electricity and water underneath docks to berthing vessels.

With regards to climate variability, the vista design considers sea level rise and extreme weather events. The Bahamas lies within the North Atlantic Hurricane zone and experiences tropical cyclones from time to time. To account for potential storm surge and sea level rise, the vistas are designed for 180 mph wind speed velocity and will sit at seven feet three inches (7’ 3”) above mean sea level, above a twenty five (25) year storm event.

Environmental consequences and risks generated by an overwater vista can be extrapolated from impacts associated with similarly constructed docks and marinas. Environmental considerations for overwater structures pertain to the issue of habitat degradation due to impacts of shading and physical disturbance.

Shading alters the penetration of light, thus the light intensity, through the water column, vital for photosynthesis. Impacts of shading are most pronounced in estuarine environments where light rarely penetrates farther than two (2) to five (5) meters below the surface. In The Bahamas light penetration far exceeds five (5) meters along most coastlines and any impacts as a result of shading are mitigated by placement of overwater structures away from dense seagrass beds and at heights that allow light penetration dependent on the orientation and daily migration of the sun.

Physical disturbance for the construction of overwater vistas mimics that of docks where disturbance is typically greatest during construction when sediments are displaced for the installation of piles. With appropriate pile installation methodology and management of sediment dispersal, sediment impacts can be mitigated.

Overall, the environmental impacts for the proposed overwater vistas at Royal Beach Club are considered minimal. Vista design and site placement allow light penetration, minimize disturbance to the seafloor, avoid pollutant inputs, and account for climate variability.

Conclusion

Overwater vistas will have minimal environmental impact but have a great benefit for the project and The Bahamas. Overwater vistas will improve the guest experience by offering a unique product that is not currently available in The Bahamas and only minimally available in the Caribbean. The exclusive experience will market blue waters and beaches of The Bahamas through social media as well as Royal Caribbean's direct media marketing. The overwater vistas will deliver a VIP experience and employ a higher number of Bahamians compared with landside cabanas.

2 Description of Overwater Vistas

RCG proposes 10, day vistas located on the south side of the Royal Beach Club. The finished floor level of the vista will sit at a height of seven feet (7' 3") above mean sea level.

Each vista will be one level at ten (10) feet in height with 220 square feet of floor use. The vistas will feature electricity for the purposes of ceiling fans and potable water but no toilets meaning there would be no transport of liquid waste. All vistas will have slides.

Toilet facilities are located on land within 500 feet of the vistas.

Structurally, the vistas will have natural timber wood framing with wood plank siding and a wooden trellis for shade. A manufactured thatch would constitute the roofing material. All vistas will feature a slide. All slides will be removable and will be removed and secured landside prior to a storm event. Additional materials include a rope railing and wooden ladder. The vistas are designed to wind load velocity of 180 mph.

In addition to wind, the decks may be subjected to waves generated during a hurricane due to storm surge. Circular piles shed much of the water energy due to their profile. However, this energy must be considered in the design of the superstructure. The proposed superstructure decking is either Ipe (Brazilian Walnut) or Cumaru (Brazilian Teak), which are two of the strongest types of decking available. In addition, a significant portion of vertical wave forces (uplift) can be attributed to the entrapment of air between the deck and the wave. Therefore, the decking will be fastened to the stringers using screws with a 3/8" spacing between boards. This spacing will substantially reduce the wave forces yielding a more durable structure.

Electrical supply to the vistas from shore side will be in electrical conduits as per Bahamas Building Code (Edition III) and affixed below decks as per typical dock construction.

A limited potable water supply will be provided to each vista, similarly the PVC conduits will be affixed below the decking.

Images of Overwater Vistas on Coco Cay

3 Marine Benthic Discussion

The vistas will be placed in an area of mostly sand with some sparse sea grass. A full description of the marine benthic environment is available within “Royal Beach Club at Paradise Island – Environmental Impact Assessment “, prepared for RCG by Islands By Design Ltd.

4 Coastal Processes

For a Full Coastal Report please refer to the main body of the EIA.

4.1 Hurricanes

A hurricane is defined as a severe tropical, cyclonic storm with sustained wind speed above 119 km/hr. Hurricanes impact coastal areas by increasing water levels (storm surge) and developing large storm waves that can cause severe damage to coastal communities. In the Northern Hemisphere, hurricanes typically develop in north of the equator in the tropical and subtropical latitudes of the Atlantic Ocean. Characteristics of hurricanes include: low barometric pressure, high winds, heavy rainfall, large waves, and storm surges. The hurricane season for project vicinity generally lasts from the middle of May through November.

The National Hurricane Center (NHC) tropical storm and hurricane database (HURDAT) provides tropical storm and hurricane data including a time series of center locations, maximum sustained wind speeds, and central pressures at 6-hour intervals. Examination of the HURDAT records between 1918 and 2018 revealed that 48 storms passed within the 105-kilometer radius of the Project site. A list of the extracted historical hurricanes showing date, name and maximum wind speed (1-minute) is presented in Table 4-1. The largest wind speed recorded between 1918 and 2018 is Table 4-1: Historical Storms (1918 – 2018) within 105-kilometer Radius.

Table 4-1: Historical Storms (1918-2018) within 105-kilometer radius

No.	Date	Storm Name	Wind Speed (m/sec)	Category
1	Sep. 5, 1932	UNNAMED	69	H4
2	Aug. 24, 1992	ANDREW	64	H4
3	Sep. 18, 1926	UNNAMED	64	H4
4	Oct. 6, 2016	MATTHEW	62	H4
5	Sep. 3, 1933	UNNAMED	62	H4
6	Sep. 26, 1929	UNNAMED	62	H4
7	Sep. 7, 1965	BETSY	57	H3
8	Aug. 26, 1949	UNNAMED	57	H3
9	Jul. 26, 1926	UNNAMED	57	H3
10	Sep. 14, 1999	FLOYD	54	H3
11	Sep. 3, 2004	FRANCES	49	H2
12	Oct. 6, 1941	UNNAMED	49	H2
13	Aug. 25, 2011	IRENE	46	H2

14	Nov. 5, 2001	MICHELLE	41	H1
15	Sep. 3, 1979	DAVID	41	H1
16	Oct. 13, 1945	UNNAMED	41	H1
17	Aug. 1, 1995	ERIN	39	H1
18	Oct. 3, 1966	INEZ	36	H1
19	Aug. 6, 1928	UNNAMED	36	H1
20	Oct. 7, 1958	FOX	33	H1

The effects of Hurricane Andrew in the Bahamas included three direct fatalities and $250 million (1992 USD) in damage. The hurricane made its first landfall in The Bahamas on Eleuthera as a Category 5 hurricane.

More recently, Hurricane Matthew raked across the main northern islands of the Bahamas with its full Category 4 force. It was the first major hurricane to strike Nassau and New Providence, home to the bulk of the Bahamas' population of 375,000, since 1932. Experiencing a direct hit from the eyewall of Matthew, Grand Bahama also suffered extensive damage. An estimated 95 percent of homes in Eight Mile Rock and Holmes Rock sustained severe damage. Numerous trees and power lines were toppled by the storm's high winds, rendering roads impassable. Flooding-induced by the backside of the storm affected much of the western half of the island. Total losses from Matthew in the Bahamas are estimated to be approximately $580 million (2016 USD).

Between Sept. 1 and 3 2019, Hurricane Dorian struck Grand Bahama and Abaco with punishing winds and storm surges, with the island of New Providence also suffering some impacts. A new report estimates the total cost of the impacts and effects of Hurricane Dorian on The Bahamas at $3.4 billion, with hundreds dead or missing and impacts on the economy that will last for years. (https://www.iadb.org/en/news/damages-and-other-impacts-bahamas-hurricane-dorian-estimated-34-billion-report#:~:text=GREAT%20ABACO%2C%20The%20Bahamas%20%E2%80%93%20A,that%20will%20last%20for%20years)

4.2 Water Levels and Storm Surges

In order to establish the tide datums on site, the Oregon State University (OSU) tidal database which is based on TOPEX/Poseidon satellite altimetry data (Egbert et al., 1994; Egbert and Erofeeva, 2002) was used to extract astronomical tides at the same location of the data point. Table 4-2 shows tidal datums according to a tidal constituents analysis performed on water levels extracted from the Global TPXO8 1/6 + Coastal (2016) model for the 1983-01-01 to 2001-12-31 Epoch. The elevations are shown in reference to MSL. The tides at the Project site are semi-diurnal with a mean range of 0.78 m and a great range of 0.9 m.

Table 4-2: Predicted Water Levels

Datum	Elevation (m)	Elevation (ft)
Mean Higher High Water Level (MHHW)	0.48	1.58
Mean High Water Level (MHW)	0.39	1.27
Mean Sea Water Level (MSL)	0.00	0.00
Mean Low Water Level (MLW)	-0.39	-1.27
Mean Lower Low Water Level (MLLW)	-0.42	-1.37

Storm surge occurs due to the onshore movement of water from onshore wind, and from the rise in the mean sea level as a result of low pressures in the center of a storm. In Nassau, storm surge is typically related to the passage of a tropical storm or hurricane.

In 2008, Baird performed comprehensive storm surge simulations as part of the Nassau Port deepening project. The model results indicate that the 100-year storm surge level would be in the order of 1.2 m above a mean high tide level.

4.3 Winds and Waves

The wind and wave data were extracted from the NOAA WAVEWATCH III model. The wind data is from the Global Forecast System (GFS). The acquired data includes a time series of approximately fourteen years of wind and wave information at a 3-hour interval. The wind speeds and directions were extracted at project site. The offshore waves were extracted at two offshore locations (see Figure 4-1).

Figure 4-1: Wind and Wave Data Locations

5 Environmental Considerations

The Bahamas coastline is a heterogeneous mix of rocky shoreline, sandy beaches, and mangrove wetlands that transition to the marine environment at the littoral zone. Most near shore environments are characterized by hard bottom, sand, seagrass and corals. It is the impact of overwater structures to these coastal ecosystems, terrestrial and marine, that draws concern from coastal resource managers.

Dependent on the location and present baseline conditions, environmental considerations associated with any overwater structure include to a varying degree impacts to vegetation (habitat degradation) and physical substrate (sediment disturbance,) and risks (hurricane and fire risk).

Docks and commercial marinas introduce additional environmental considerations for the management of utilities namely wastewater and petroleum products. However, in the case of Royal Beach Club these potential pollution sources are non-existent.

It must be reiterated that the environmental baseline present at the proposed location determines the extent of anticipated impacts. With a mostly sand and sparse sea grass benthic environment, long term impacts are not anticipated. Some short-term degradation of sea grasses may occur due disturbance of the seafloor due to pile installation and construction.

5.1 Shading

Of primary importance and consideration is the benthos below the proposed footprint of the overwater vistas. Most marine shallow-water habitats and benthic invertebrates rely heavily upon photosynthesis, thus the introduction of shading alters the transmissibility of light limiting the diversity of marine organisms. Environmental factors such as water quality, tide regimes, and water depth also influence the penetration of light. This impact is most pronounced in estuarine environments where dock structures exacerbate low light conditions negatively affecting submerged vegetation by inhibiting photosynthesis. In The Bahamas, the transmissibility of light well beyond five (5) meters mitigates the concern for shading impacts. Furthermore, the placement of overwater vistas at a height of seven (7) feet above MSL further reduces the potential for shading impacts.

Dock height, orientation, width, and plank spacing have been identified as factors affecting the survival of seagrass under docks. Dock height is the most influential and subject to the specific tidal regime of the area (Shafer & Ludin, 1999). Dock height was the only statistically significant variable: docks less than 12-16 inches above the marsh shaded out all vegetation in every study site for estuarine environments (Kearney et al, 1983). At seven (7) feet above MSL, the overwater vistas are placed well above sixteen (16) inches.

5.2 Pile Installation

Impacts associated with the physical installation of pilings and dock structures are directly related to the installation methodology and existing marine benthos. Methodology used for the installation of piling is the greatest contributing factor to potential vegetation and sediment impacts. Suspended sediment generates turbid conditions which reduces light penetration invoking the effects of shading as mentioned above.

An unavoidable loss of vegetation and disturbance of sediments is expected for the footprint of the piling; however, disturbance and the potential for regrowth in the immediate vicinity of the piling depends largely on the installation methodology. Jetting in particular leads to a greater disturbance on the seafloor than that of socketing and drop hammering. Pile installation methodology will be chosen in coordination with the contractor and environmental impacts, if any, managed through implementation of an Environmental Management Plan (EMP).

5.3 Wood Preservative

The most commonly applied wood preservative is chromated copper arsenate (CCA) which replaces the heavily toxic creosote and pentachlorophenol (PCP) now banned for use on small dock and piers by most states in the United States. Wood used for dock structures is continuously exposed to, if not fully emerged, in saltwater known to accelerate decay. To thwart the onset of decay and to deter wood-boring and fouling organisms that hasten decay, wood destined for marine use is treated with a preservative, such as CCA.

CCA treatments are applied in a variety of strengths (the amounts of preservative retained in the wood after treatment) depending on use and not surprisingly, wood placed in saltwater receives the highest concentration at 2.50 lbs./cu. Ft versus 0.10 to 0.25 lbs./cu. Ft for above ground installation according to recommendations from the Southern Pine Council. Approximately 99% of the leaching occurs within the first 90 days in the marine environment. The leaching rate decreases by about 50% daily once the wood is immersed in seawater (NOAA NCCOS OCRM, 2005)

It is important to note that the metals leached from CCA adsorb more readily onto fine grained sediments (silts/clays) than sand which dominates Bahamian substrate. Moreover, given the semidiurnal tidal regime of The Bahamas bioaccumulation of contaminants is unlikely.

All treated wood piles will be in accordance with AWPA M4-06 and ASTM D25 -12 (2017).

5.4 Water Quality

Environmental consideration for water quality again pertains to environmental baseline conditions, construction methodology and management during operation. Suspended sediment and silt generate turbid conditions suppressing light penetration, releasing adsorbed contaminants contributing to poor water quality and negatively impacting present marine biota.

Changes in water movement due to pilings redirecting water flow or speeding movement around the pile may result in scour and alter predator-prey behavior. Minimizing the numbers and size of piling is supported by the scientific literature (Shafer & Lundin, 1999) (Shafer & Robinson, 2001).

But such issues are moot should the overwater structure be built to the Bahamas Building Code and properly sited and operated such that poor water quality would not ensue. The Bahamas has a semi-diurnal tide regime with an average tidal fluctuation of approximately 2.5 ft, with slightly greater variations in spring or neap tide events.

5.5 Fire

All buildings associated with the development will comply with all fire requirements of The Bahamas Building Code, thus minimizing to the extent possible all fire-associated risks. There are, however, no current or intended municipal fire services and the developer will provide this service at his discretion.

5.6 Hurricane

Structures perched over the water are at risk for extreme ocean conditions most often associated with a large tropical event such as a hurricane. The Bahamas resides in the Hurricane Belt and the structures are proposed to be located over seabed and subject to those anticipated conditions. Extensive flooding can occur in low-lying coastal areas from storm surges cause by extreme low barometric pressures when the ocean sometimes rises as much as twelve (12) to seventeen (17) ft. The rising sea destroys onshore structures as seawater surges onto shore and then rushes back to the ocean as the storm passes. The beach may incur significant changes including erosion or accretion depending on the intensity, direction, and length of storm. Sea structures may be weakened or damaged after days of intense wave action.

All construction standards will be in compliance with the Bahamas Building Code 3rd Edition where new structures will be built to endure winds of up to 160 miles per hour as per the hurricane construction standards.

6 References

Bimini Bay. (2011, October 9). *Bimini Bay Resort Readies for New Era of Development*. Retrieved May 17, 2012, from Bimini Bay: http://www.bahamasbahamasbahamas.com/blog/bimini-bay-resort-readies-for-new-era-of-development/

Brown, K., Turner, R. K., Hameed, H., & Bateman, I. (1997). Environmental Carrying Capacity and Tourism Development in the Maldives and Nepal. *Environmental Conservation, 24* (4), 316-325.

Bulleri, F. C. (2010). The introduction of coastal infrastructure as a driver of change in marine environments. *Journal of Applied Ecology, 47*, 26-35.

Burdick, D., & Short, F. (1999). The effects of boat docks on eelgrass beds in coastal waters of Massachusetts. *Environmental Management* , 231-240.

Dawson, A. R., Warwick, R. M., Clarke, K. R., & Brown, B. E. (1992). An analysis of fish community responses to coral mining in the Maldives. *Environmental Biology, 33*, 367-380.

Department of Environment, Belize. National Guidelines on Overwater Structures. *Belize's Overwater Structures Guidelines.* (Belize Environmental Technologies)

Domroes, M. (2001). Conceptualising State-Controlled Resort Islands for an Environment-Friendly Development of Tourism: The Maldivian Experience. *Singapore Journal of Tropical Geography, 22* (2), 122-137.

Holland, A.F.; Gainey, C.; & Denise M. Sanger. (2004). Cumulative Impacts of Dock Shading on Spartina alterniflora in South Carolina Estuaries. *Environmental Management, 33* (5), 741-748.

Kearney, V., Segal, Y., & M.W. Lefor. (1983) The Effects of Docks on Salt March Vegetation. The Connecticut State Department of Environmental Protection, Water Resources Unit, Hartford, Ct.

Kelly, C., Essex, S., & Glegg, G. (2012). Reflective practice for marine planning: A case study of marine nature-based tourism partnerships. *Marine Policy, 36*, 769-781.

McInnis, R. (2009, January 30). Letter: Port of Los Angeles Wilmington Waterfront Development Project. *150308SWR2008PR00070* . California, United States of America: United States Department of Commerce: NOAA.

Morner, N.-A., Tooley, M., & Possnert, G. (2004). New Perspectives for the Furture of the Maldives. *Global and Planetary Change, 40*, 177-182.

Nightengale, Barbara, & Charles Simenstad. (2001). Overwater Structures: Marine Issues. Washington State Transportation Center. White Paper. Research Project T1803, Task 35.

NOAA NCCOS OCRM. (2005). Managment of Small Docks and Piers. Environmental Impacts and Issues. *Environmental Impacts of Docks.* National Oceanic and Atmospheric Administration National Centers for Coastal Ocean Science and the Office of Ocean and Coastal Resource Management.

Shafer, D., & Ludin, J. (1999). Design and construction of docks to minimize seagrass impacts. *WRP Technical Notes Collection (TN WRP-VN-RS-3.1)* .

Shafer, D.J. and Robinson, J. (2001) An evaluation of the use of grid platforms to minimize shading impacts to seagrasses. WRAP Technical Notes Collection (ERDC-TN-WRAP-01-02), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/wrap

van Alphen, K., van Sark, W. G., & Hekkert, M. P. (2007). Renewable energy technologies in the Maldives-determining the potential. *Renewable and Sustainable Energy Reviews, 11*, 1650-1674.

Washington State. (2008). *Overwater Coverage: State Guidelines WAC 173-26-231 Shoreline Modifications.*

7 Appendix - Examples of Overwater Structures Bahamas

Bonefish Pond National Park N.P.

Kamalame Cay – Andros

Potters Cay – P.I. Bridge

Great Harbour Cay – Berry Islands

Compass Cay – Exuma

Highbourne Cay – Exuma

Harbour Island – Eleuthera

Harbour Island – Eleuthera

Harbour Island – Eleuthera

Harbour Island – Eleuthera

Twisted Lime in Sandy Port https://sealifecaribbean.com/restaurants/twisted-lime-bar-grill/

Never say Never Again Bar https://disneycruiselineblog.com/wp-content/uploads/2019/06/Nassau-Never-Say-Never-Again-Bar-Grill_20190621.jpg

Coco Cay – Berry Islands

https://www.overwaterbungalows.net/new-overwater-bungalow-resort-bahamas-wins-approval-build.html

https://www.overwaterbungalows.net/overwater-bungalows-in-the-caribbean