ENVIRONMENTAL IMPACT ASSESSMENT

For Proposed Beach Nourishment and Installation of Six (6) Groynes

at

Sandals Negril, Norman Manley Boulevard Hanover

FINAL REPORT

October 2019

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List of Abbreviations and Acronyms

ASTM	American Society for Testing and Materials, currently known as ASTM International
cm/s	centimetre per second
DBH	Diameter at breast height
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESL	Environmental Solutions Limited
GDP	Gross Domestic Product
GPS	Global Positioning System
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JJA	June, July and August
JNHT	Jamaica National Heritage Trust
JTB	Jamaica Tourist Board
MSL	Mean sea level
NCC	Negril Chamber of Commerce
NEPA	National Environment and Planning Agency
NGIALPA	Negril Green Island Local Area Planning Authority
ODPEM	Office of Disaster Preparedness and Emergency Management
PIOJ	Planning Institute of Jamaica
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
SNG	Sandals Negril Limited
SON	September, October and November
SRI	Sandals Resorts International
STATIN	Statistical Institute of Jamaica

SWIL	Smith Warner International Limited
TOR	Terms of Reference
TPDCo	Tourism Product Development Company
TSS	Total suspended solids
UNEP	United Nations Environment Programme
UWI	University of the West Indies
WNBR	Wider Negril Beach Restoration
WQ	Water quality
ybp	years before present

Executive Summary

Introduction and Contextual Background

Environmental Solutions Limited (ESL) was contracted by Sandals Negril Limited (SNG) to undertake an Environmental Impact Assessment (EIA) in support of a proposed beach nourishment and groyne installation project at the Sandals property in Negril, Hanover.

The issue of erosion along the Negril coastline has been extensively studied and documented over the years and has been of particular concern to Sandals Negril for more than a decade given the increasing erosion along their beach. Results of analyses of the rate of change of the Negril shoreline over 50 years (1968–2018), specifically in the north of Long Bay where Sandals Negril is located, show that the shoreline has receded with an average of 0.21m/year (SWIL, 2018). In addition to the significant beach loss that Sandals has suffered following the passage of a few notable storms, the measured rate of beach erosion poses a significant challenge to this hotel as the property risks the total loss of its beach front in only a few years if nothing is done to arrest the rate of erosion.

It should be noted that SNG has made numerous attempts to mitigate the impacts of erosion. Following a particularly devastating swell event in 2010, SNG contracted Smith Warner International Ltd. (SWIL) to develop a sustainable beach enhancement and rehabilitation plan for the Sandals Negril property. After investigating several options, the preferred 2010 design consisted of one rubble mound, submerged breakwater and two (2) BioRock protective structures along with beach nourishment.

In 2018, SWIL further improved upon their 2010 design by developing a new beach restoration concept that included:

i. Repacking and lowering of the existing groyne located to the very north of Sandals property to increase circulation and address water quality issues in this area
ii. Introduction of two submerged reef-like breakwaters to reduce wave impact on the north and central area of the property shoreline
iii. Introduction of three low-crested unobtrusive groynes (beach sills) to help anchor the newly nourished beach and reduce alongshore sand movements towards the south
iv. Beach nourishment over 230m of shoreline
v. Beach nourishment to the back of the beach area to the very north of the property

Neither of these designs were implemented, and SNG contracted Olsen Associates Inc. in late 2018 to come up with a recommended plan for beach improvement and protection. The Olsen design is described herein and has been assessed and modelled independently by Smith Warner International Ltd.

Identification of Alternatives

The following scenarios were investigated in order to determine the optimal solution for the Sandals Negril property:

Proposed Scenario	Modelling Results
No Action Alternative	• The average erosion rate being experienced in the project area is 0.21m/year;

Proposed Scenario	Modelling Results
	• If left unabated, erosion is expected to continue at this average rate; • The beach will continue to narrow through acute and chronic erosion given its crenulate shape; • The no-action alternative is not viable for Sandals Negril.
Beach Nourishment Only	• The natural tendency of the shoreline along the northern section of the property is to erode towards a weak, crenulate embayment shape; • An attempt to "straighten" the shoreline – simply widening it with beach fill (without stabilisation) – conflicts with the natural tendency of the shoreline to create this weak embayment shape; • Sandals Negril nourished its beach in the past and all the sand was subsequently lost; • The addition of sand to the beach area will augment the volume and spatial extent of sand that is available for erosion and the erosion process may take approximately 60% longer (SWIL, 2018).
Beach Nourishment with Hard Structures (Above MSL)	• The shoreline remains very stable; • Groynes allow for greater predictability in shoreline behaviour and smaller impacts to the seabed and water-circulation; • Modelling results show no noticeable downdrift impacts.
Beach Nourishment with Hard Structures (Below MSL)	• General decrease in the alongshore sediment transport rates in the lee of the proposed structures due to the wave and current sheltering effects of these structures. • Long term predictions (5 years) of sediment transport indicate that the shoreline remained stable with the proposed structures in place. • South of the Sandals property, the shoreline response with the proposed concept in place always remained at the location or just seaward of the shoreline with the do-nothing configuration. • Because of the orientation of the annual wave climate and alongshore sediment transport trends, there would be no impacts to the properties north of the Sandals property.

Description of the Project

Sandals Negril now proposes to implement a solution which aims to widen their beachfront area and reduce the transport of sand away from the property shoreline (Figure 5-3). The proposed solution has three main components:

1. Reconfiguring, lowering and shortening the existing groyne at the northern end of the property – This will include the removal of less than 500 metric tonnes of rock from the existing groyne to be reused in the newly proposed groynes;
2. Beach nourishment – The process will use approximately 7,000 m^3 of sand to be sourced from a Sandals-owned property in Bloody Bay. This will increase the beach width by about 8–10m and raise the beach elevation to 0.85m;
3. Introduction of six (6) short, low profile, rock groynes – These will be located along 240m of the Sandals coastline to stabilise the planned nourishment. Approximately 3,730 metric tonnes of boulders, to be sourced from approved local quarries, will be required to construct the rock groynes. Also, about 600m^3 of sand will be excavated to establish the foundation of the groynes, and the excavated sand will be re-used on the property.

Material will be trucked to the site and a temporary access road will be constructed along the northern boundary of the SNG property to facilitate the movement of trucks and other equipment (Figure 5-4). It is anticipated that construction will take approximately 60 days and will occur while the resort is still in operation.

Description of the Existing Environment

Physical Environment – Overview

Negril's beaches, wetlands and marine area form part of a coastal system which evolved during rising sea levels over the last few thousand years.

Negril beach sediment is mainly composed of carbonate sediments, produced by green algae *Halimeda,* and other organisms found in *Thalassia* seagrass meadows (Mitchell et al., 2000). Mitchell et al. (2000) also noted that with the increase in development in the Negril area, there has been an increase in nutrient influx to the marine system that has resulted in the decline in the coral reefs. Similarly, there has been a decline in the *Thalassia* meadows with the replacement of *Thalassia* by fleshy algae due to nutrient influx and the removal and/or damage by the tourism industry. At the time, it was stated that the loss in seagrass area would lead to a reduction of carbonate sediment production and consequently, the increased likelihood of beach erosion.

According to climate change projections, sea level is expected to continue to rise at an increasing rate and high intensity storms, with associated rain, wind and oceanographic effects are expected to be more frequent. The Negril Climate Risk Atlas characterises Long Bay and Bloody Bay as 'critical risk areas'. Widespread flooding of beach and wetland areas are expected to occur due to storm surges and runoff, while long-term erosion, as well as storm-related damage, may likely continue to impact Negril's shorelines, including those where this project will be implemented.

Beach elevations are less than two metres above sea level and erosion of 20–30 metres can occur during major hurricanes, following which shoreline recovery can take four to five years. While there are variations depending on location and varying differences between time periods, aerial photographs indicate average reductions in beach width of 30–40m across the entire length of Long Bay and Bloody Bay (SWIL, 2007). In some locations, overall erosion exceeds this level.

Baseline assessments of water quality showed that though there were no adverse water quality findings from the field investigations conducted, algae were also observed at various points along the Sandals beach. The algal growth seen along the shoreline may be as a result of nutrient-rich discharges from storm drains along the beach.

Generally, baseline noise levels measured were above the National Environment and Planning Agency (NEPA) ambient guidelines for commercial zones.

Biological Environment – Overview

Terrestrial Ecology – Bloody Bay (proposed sand extraction site)

The Sandals-owned property in Bloody Bay appears to have been significantly disturbed by anthropogenic factors over the years, with signs being observed that significant clearance of the original vegetation had occurred. The vegetation found within the proposed sand extraction site is typically associated with the early stages of ecological succession. The general area displayed relatively low species diversity, as only 41 plant species from 25 families were encountered, most of them being trees and shrubs, along with a few climbers. Transects were created across the length of each of the four proposed mining sites, namely from west to east: S9, S6, S10 and S5 (See Figure 3-8). The ecological assessment revealed that the Almond and Santa Maria trees were the dominant species (i.e. numbers >20) occurring across the 4 transect sites. Other abundant species (i.e. numbers between 15 and 19) included the Long-leaved Sweetwood, Rod Wood, Breadnut, Black jointer, Woman wood, Noni, Jointer, Psychotria, and Red Birch trees.

The presence of certain species, such as mango, noni, ackee, and guinep, is also an indicator of the heavy influence of anthropogenic disturbances on the vegetation, as these are species associated with the proximity of human settlement.

The majority of the trees encountered at the site were seedlings or samplings, with only a small portion of the trees being adults. The bird species composition observed on the property was typical of a dry limestone forest. None of the bird species observed were considered abundant due to their relatively low numbers. The dominant amphibian species observed was the *Eleutherodactylus johnstonei.*

Marine Ecology – Long Bay (proposed project site)

The backreef area is shallow (0–5m) with a mix of bare substrate (sand, rubble) and fairly contiguous seagrass mats. Where present, the seagrass formed a thick, dense mat (mean cover of 78%) with mean canopy heights of up to 20cm. The abundant fish species (numbers > 100) observed during the backreef assessment were the French Grunt and Silversides.

There is a shallow fringing coral reef system, located 2-3km offshore with a depth of 20-50m, as well as a small patch reef just over 1km from the beach (Figure 3-4). Given the distance of these systems away from the site for the proposed groynes, an assessment of these reef zones was not included in the scope of this EIA. Environmental Solutions Ltd. conducted a previous assessment of the reef for an alternative beach stabilization design for Sandals Negril; the description of the reefs surveyed can be found in Appendix 12.8.

Socio-Economic Environment – Overview

The Statistical Institute of Jamaica's (STATIN) recorded Negril's population as 7,832 in their 2011 Population and Housing Census. The average age of the population in Negril reflects that the vast majority of persons are in the workforce group, accounting for 64% of the population. Assuming a staff room ratio of about 2.5 employees per room, at full occupancy the hotel accommodation sector could be employing 13,542 persons which is not an unreasonable figure, especially since direct employment in this sector in Jamaica was estimated at 97,000 in 2016. A cursory comparison with Negril's projected 2018 population in the labour force age group, estimated as 6,047, suggests that a significant number of persons employed in the hotel industry are non-residents of Negril.

In considering both population density and housing stock, an inescapable concern must be the social support capacity of Negril and by extension, given that the threat is mainly driven by the hospitality sector, the carrying capacity of the Negril beach strip. Fire, waste management, health care and other essential social services have all been described by Negril stakeholders interviewed as being in need of an upgrade.

Summary of Impacts

A summary of the potential impacts of the proposed development and the related mitigation measures are presented in the table below (See Table 8-1 and Table 8-2).

NATURE OF IMPACT	MITIGATION MEASURES
CONSTRUCTION PHASE	
Location: Bloody Bay	
PHYSICAL	
Natural hazards and climate change	• Avoid work during heavy rainfall or other major weather events • Establish buffers around stockpiled material to minimise loss due to runoff and dispersion into the marine environment
Access routes and materials storage	• Ensure that vendors and other beach users (as well as neighbouring property owners) are advised of construction activities • Ensure that proper signage and other safety measures elaborated below are put in place • Sandals could create a different access way for vendors that does not interfere with the movement of the trucks • Replanting is encouraged after completion of construction
Occupational health and safety	• Wear appropriate personal protective equipment (PPE) during construction activities

NATURE OF IMPACT	MITIGATION MEASURES
	• Include safety and emergency response training as a requirement • Erect proper signage around the construction site • Establish mechanism to log of all incidents • Provide bathroom facilities and access to medical attention for workers as basic necessities throughout the activities • Cordon off the work area to prevent direct access by individuals who are not associated with the construction activities
Noise	• Make all attempts to provide adequate notice to vendors and other beach users (as well as neighbouring property owners) of the planned activities and impacts
Water quality during construction	N/A as little to no impact to water quality is anticipated in Bloody Bay
BIOLOGICAL	
Vegetation clearance resulting in habitat loss and fragmentation	• Retain trees with a DBH >25cm as best as possible across the extraction area • Replant vegetation, as required, in areas that have been cleared
SOCIO-ECONOMIC	
Potential disruption of access for Bloody Bay vendors	Sandals could create for vendors a different access way that does not interfere with the movement of the trucks.
Contribution to economy (job creation)	Not required to be mitigated
HERITAGE	
Potential loss of undiscovered artefacts	Notify the Jamaica National Heritage Trust (JNHT) immediately if any suspected historically significant materials are found so steps can be taken to recover and record these items
Location: Long Bay	
PHYSICAL	
Natural hazards and climate change	• Avoid work during heavy rainfall or other major weather events • Establish buffers around stockpiled material to minimise loss due to run-off and dispersion into the marine environment • Maintain turbidity screens in place throughout the duration of the project works
Access routes and materials storage	• Ensure that guests are properly advised of construction activities and the estimated duration • SNG will have to decide whether the buildings immediately adjacent to the project works will remain occupied during construction

NATURE OF IMPACT	MITIGATION MEASURES
Occupational health and safety	• Cordon off work area to prevent direct access by individuals who are not associated with the construction activities • Place wardens at strategic points along the work area to enforce safety requirements • Escort the equipment by at least one Spotter, who will be on the lookout for beach patrons, to facilitate the passage of the heavy equipment in the confined space • Place Traffic Wardens at strategic locations to ensure safety of vehicular and pedestrian traffic entering and exiting the site.
Noise	• Make all attempts to provide adequate notice to staff and guests of the planned activities and impacts • Suspend, as suggested, all activities near to the construction sites during the construction phase • Schedule, where possible, all construction activities during the known off-peak seasons
Water quality during construction	• Place screens in the water to contain the increased turbidity during construction • Monitor turbidity and total suspended solids (TSS) regularly during the construction phase to ensure levels are within international guidelines • Complete chemical assessment of the sand to be used in the beach nourishment to ensure there are no adverse components that could potentially be leached to the marine environment • Consider washing sand prior to placing deposits on the beach. Wash water will need to be disposed off appropriately • Ensure that hazardous materials, such as petroleum products, which may be kept on-site, are properly stored away from any ignition source and sensitive areas (particularly marine areas) • Implement a spill management plan, if required. Having equipment such as containment booms, absorbent pads, dispensers (to aid in microbial degradation) should also be considered if there is a potential for spills to occur at sea.
BIOLOGICAL	
Impacts due to loss of seagrass	• Identify a suitable site for relocation activities prior to the commencement of works, if required • Consider alternative compensation mechanisms if no appropriate site is available
Impacts due to construction of groynes	• Use silt screens to contain or restrict sediment dispersion and settlement

NATURE OF IMPACT	MITIGATION MEASURES
	• Monitor turbidity in real time • Suspend construction if turbidity exceeds values specified by licences granted by NEPA • Suspend activities during unfavourable weather conditions, or when anticipated • If necessary, relocate seagrass and important invertebrates (e.g., Diadema) to adjacent backreef areas based on the projected footprint and estimated impacts.
Impacts due to discharges into the bay	• Use appropriate refuelling equipment (e.g., funnels) and techniques • Keep equipment for containment and clean-up of any spills on site
Impacts due to increased traffic (i.e., noise/vibration and light)	• Monitor noise levels throughout the lifespan of construction to ensure standards for marine wildlife are not exceeded
SOCIO-ECONOMIC	
Temporary inconvenience to guests	• Make all attempts to adequately notify staff and guests about the planned activities and impacts
Contribution to economy (job creation)	Not required to be mitigated
OPERATIONAL PHASE	
Location: Long Bay	
PHYSICAL	
Climate change	• Maintain and, where possible, enhance the beach system and its capacity to reduce loss of sediment from the beach area, and hence, reduce the rate and amount of erosion e.g. nourishment, seagrass protection, coastal stabilization (both ecosystem-based and engineered solutions) etc. • Where seagrasses are affected, ensure that at a minimum, the same area of functional seagrass is created in the nearshore area, by relocation and/or planting, along with the relocation of associated fauna and other organisms
Impacts of the project on future shoreline changes	• Consider more sustainable sources of sand for future nourishment exercises
Impacts on aesthetics, landscape and seascape	• Use boulders of a similar colour to the existing sand so as to limit visual impact • Clean boulders if there is any proliferation of algae on the structures • Conduct further beach nourishment exercises, if required, after and in the event of storms within 6–8 years
BIOLOGICAL I	N/A as no ecological impacts are anticipated during operation
SOCIO-ECONOMIC	

NATURE OF IMPACT	MITIGATION MEASURES
Increase in recreational use	Not required to be mitigated
Increased economic activity	Not required to be mitigated
Positive contribution to national economy	Not required to be mitigated

As a part of the mitigation strategy, the development of the following plans by the selected contractors is recommended:

- Biodiversity Management Plan
    - Seagrass Management Plan
    - Terrestrial Biodiversity Management Plan
- Construction Management Plan
    - Beach Nourishment and Monitoring Plan
- Environmental Monitoring Plan.

These will ensure the management and mitigation of the possible environmental impacts associated with sand extraction, the construction of the proposed groynes, and nourishment of the beach. The frameworks for the aforementioned plans are included in Section 9.

Conclusions and Recommendations

The following salient points can be concluded from the analysis carried out during this EIA.

Negril has a low sediment production rate and, as a result, erosion is likely to be greater than accretion (SWIL, 2007). Coupled with climate change, there is likely to be significant impact to the entire Negril coastline including the project area. With the existing, significant sand loss from the beach system due to erosion, buffers are considered necessary to reduce the cumulative extent of future climate impacts. This can be achieved by employing best practices in the design and implementation of coastal projects.

Based on the analysis of alternatives that was conducted, it was concluded that the “Do Nothing” alternative would result in further loss of the SNG coastline which would have far reaching economic implications for the hotel. With the “Nourishment Alone” option, it is estimated that the addition of sand to the beach area would augment the volume and spatial extent of sand that is available for erosion. In the area to be nourished (i.e., approx. 250m at the northern end of the SNG property), erosion will be retarded by approximately 60%. Although the area to be nourished is likely to take longer to erode, the erosion being experienced in the wider Long Bay area will continue to occur at the same average rate observed historically, or even higher in the event of hurricanes or storms; furthermore, it is most likely that the newly nourished sand will be transported to the south if no additional protection is implemented.

With the introduction of hard structures, the long-term shoreline response (i.e., after five years) remains very stable. Modelling results (SWIL, 2019) have concluded that impacts caused by the groynes will be localised and in the immediate vicinity of the groynes, no downdrift impacts are foreseen. The impacts of long-term erosion and inundation of the Bloody Bay coastline by storm surges show that although the extraction site will be inundated during modelled storm conditions, erosion is not expected to reach to the borrow zone.

Beyond the next six to eight years and possibly within them, ongoing beach maintenance will be necessary. Though hard to predict, there will be costs, benefits and environmental implications. An analysis of ongoing costs related to shoreline management may be required. This may be needed at a strategic rather than site-specific level, though individual property owners may benefit from gaining an understanding of these factors. This should include a detailed evaluation of alternative sand sources for extraction, beach nourishment, and maintenance.

To comply with the no net loss principle required in the Biodiversity Regulations, where site-based activities are unable to mitigate for biodiversity and habitat loss, compensation mechanisms will need to be considered. This will include comprehensive ecological assessments to determine suitable locations for compensation.

1 Introduction

Environmental Solutions Limited (ESL) was contracted by Sandals Negril Limited (SNG) to undertake an Environmental Impact Assessment (EIA) in support of an environmental permit for a proposed beach nourishment and groyne installation project at the Sandals property in Negril, Hanover. The EIA was conducted in accordance with the Terms of Reference provided by the National Environment and Planning Agency (NEPA) (See Appendix 12.1). This document represents the draft EIA report.

1.1 Contextual Background

Travel and tourism's direct contribution[1] to Jamaica's gross domestic product (GDP) in 2017 was US$1.4 billion or 10.3% of total GDP. In 2018, it was forecast to rise by 4.4% and is expected to rise by 4.1% per annum from 2018 to 2028 (World Travel & Tourism Council, 2017). Total stopover arrivals for 2017 reached a record of 2,352,917 people (Jamaica Tourist Board, 2018). This marked an increase of 7.8% over 2016. The resources of Negril, and in particular those found along the strip of beach at Long Bay, form a significant part of Jamaica's tourism product, reportedly providing more than 25% of the country's tourism earnings (SWIL, 2007).

Since the 1960s, Negril has become the third most popular tourist destination in Jamaica, behind Montego Bay and Ocho Rios, and in 2017 experienced total hotel stopovers of 386,055 people or 16.4% of all stopovers, which was an 8.9% increase over 2016. Negril recorded an average room occupancy of 62.2% in 2017, slightly lower than the 63.3% in 2016, however, average available hotel room capacity increased from 6,658 in 2016 to 7,555 rooms in 2017[2] (JTB, 2017). Of the 7,555 rooms available in Negril, Sandals Negril has 226.

[1] GDP generated by industries that interface directly with tourists, including hotels, travel agents, airlines and other passenger transport services, as well as the activities of restaurants and leisure industries that deal directly with tourists.
[2] These figures do not include AirBnB properties.

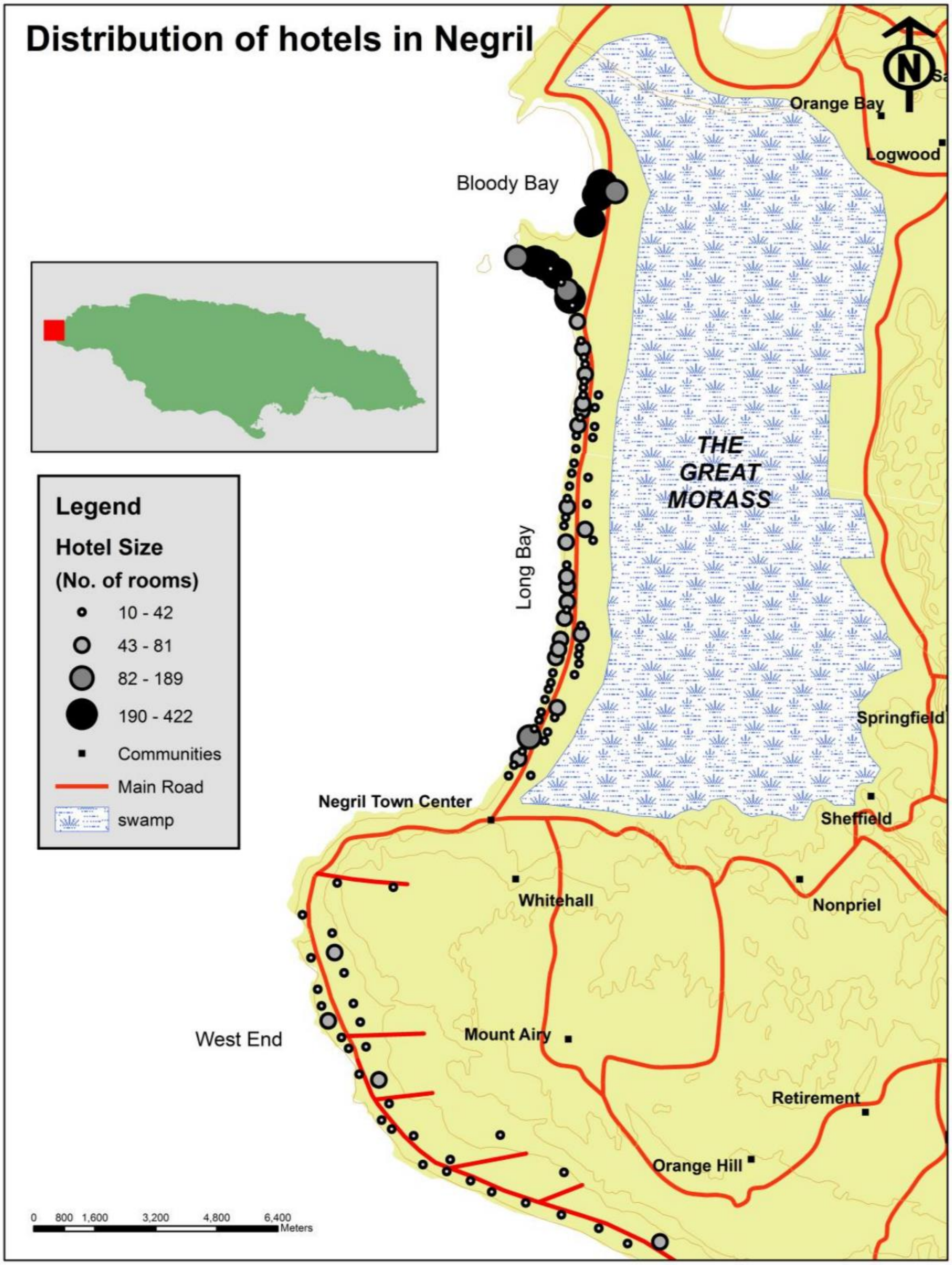

Figure 1-1: Major hotel zones in Negril (Rhiney, 2012)

Negril's main selling attraction over the years has been its "Seven Mile" Beach (Long Bay) (Figure 1-1). However, the issue of the eroding coastline has increasingly become a concern for many hoteliers, as well as the government, since Negril is a major contributor to Jamaica's tourism industry.

The issue of erosion along the Negril coastline has been extensively studied and documented. Reference can be made to studies undertaken by Dr. Malcolm Hendry (1982), the University of the West Indies (UWI, 2003), Smith Warner International Limited (SWIL, 2007), the United Nations Environment Programme (UNEP) in collaboration with the Planning Institute of Jamaica (PIOJ, 2010) and CL Environment, 2014. Erosion rates have been documented between 0.5 metres and 1.0 metres per annum (CL Environment, 2014).

Although the issue of erosion is of major concern for Negril and its stakeholders, it is not consistent for the entire length of Long Bay and Bloody Bay. A study conducted by Robinson et al. (2012) indicates that the Long Bay beach can be divided into four sections which behave differently in relation to beach erosion or accretion (Figure 1-2). Figure 1-2 highlights the location of the Sandals Negril property in relation to these sections and it shows that the section of the beach closest to the Sandals Negril property is being affected by erosion.

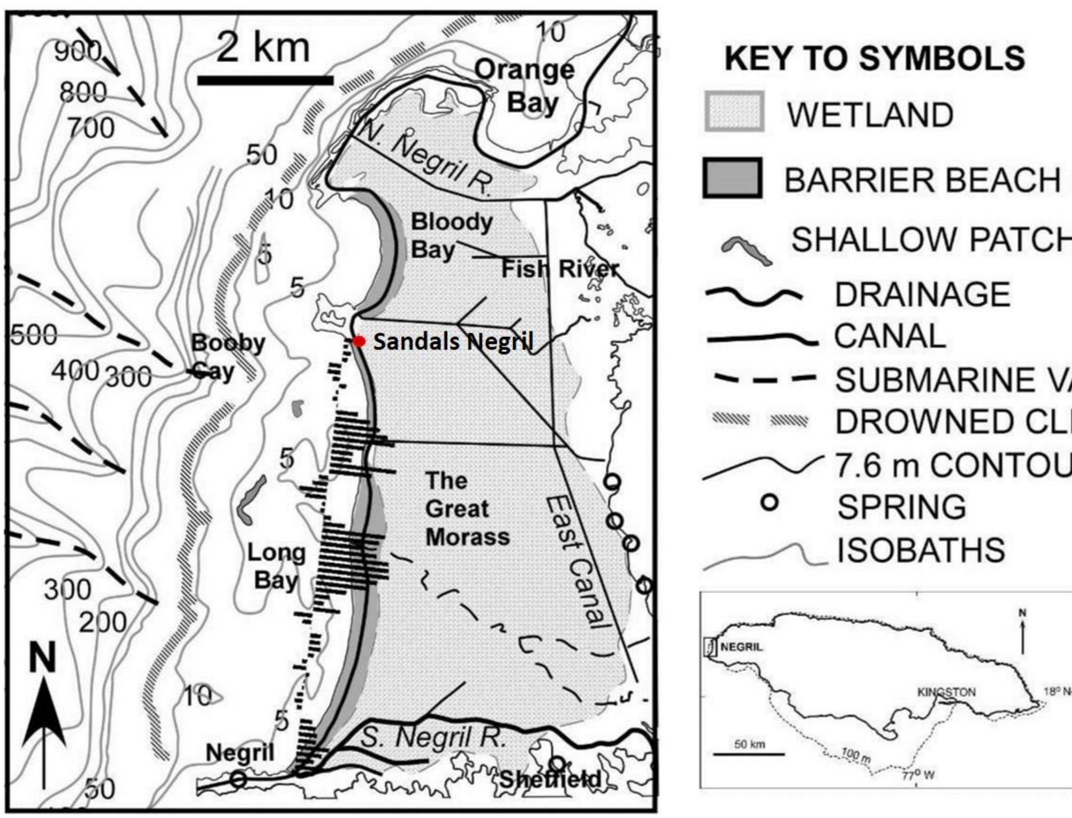

Figure 1-2: Location and major physical features of the Negril region. The set of horizontal bars normal to the Long Bay coastline indicate the shoreline changes since 1971 (bars extending to the right indicate erosion; those extending to the left indicate accretion. The dashed line represents the course of the Middle River. The location of Sandals is highlighted with a red dot.

The shoreline of Sandals Negril has receded with an average of 0.21m/year over 50 years (1968–2018), (SWIL, 2018). Although over the 50-year time span the shoreline has shown signs of both accretion and erosion, there has been a net loss of 30–40m of shoreline in Negril and Figure 1.3 provides examples of beach erosion occurring at the Sandals Negril property (SWIL, 2007). Specifically, between 1980–2010, the shoreline at Sandals Negril retreated by approximately 15–20m, with this retreat being much more evident over the northern half of the property (SWIL, 2011).

Figure 1-3: Examples of beach erosion occurring at Sandals Negril property (Source: SWIL, 2011)

In addition to the significant beach loss that Sandals has suffered following the passage of a few notable storms, the measured rate of beach erosion poses a significant challenge to this hotel as the property risks losing its total beach front within a few years if nothing is done to arrest the current rate of erosion. As mentioned above, Sandals is a key contributor to the tourism revenue in Negril and the complete loss of its beach would have significant economic implications.

This erosion has been of particular concern to Sandals Negril and so SNG has commissioned several studies to determine the best solution to rehabilitate its beach and retard the erosion rate. The most recent design has been proposed by Olsen Associates Inc., a coastal engineering firm from Jacksonville, Florida. This report presents an impact assessment of the design discussed in Section 5.

1.2 Delineation of the Boundary of the Study Area

The Environmental Impact Assessment (EIA) study area includes both Long Bay (site of Sandals Negril) and Bloody Bay (proposed location for sand extraction). The Terms of Reference (TOR) received from NEPA indicate that the EIA study area should not be less than a 1 km radius from the boundaries of the proposed project and should include all valued resources.

The consultants have extended the study area to cover the area represented in Figure 1-4. It covers Orange Bay to the north, and Whitehall, West End, and Sheffield to the south.

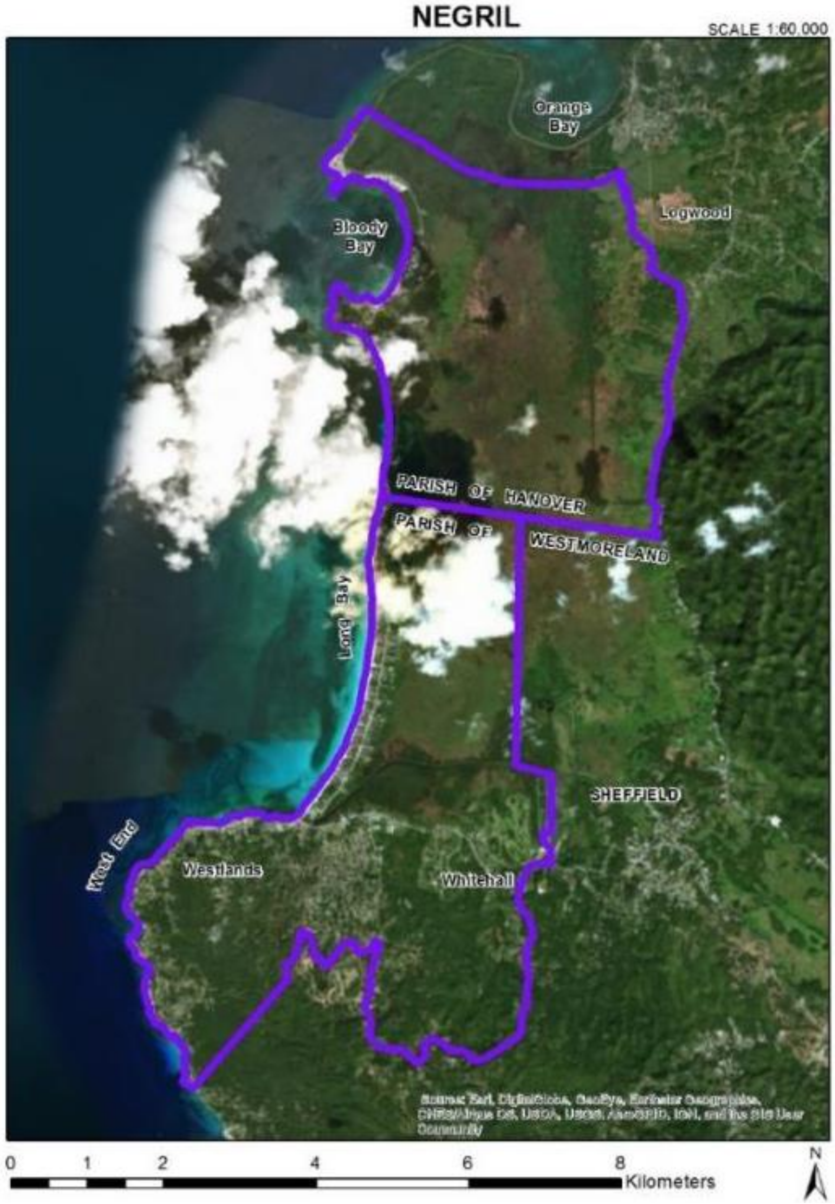

Figure 1-4: The Study Area (Source: Adapted from STATIN*)*

This extended area of investigation offers two advantages: it conveniently allows for the use of databases from the Statistical Institute of Jamaica as these describe important socio-economic characteristics; and it widens the net for capturing community opinions on the project.

1.3 General Methodology

A multi-disciplinary team of experienced professionals applied a charette-style approach to data gathering, compilation of baseline information and assessment of key issues to help inform development decisions. Team meetings were used to discuss the progress of investigations and analyses and to facilitate integration of data toward an understanding of the systems at work in both the natural and built environments.

The team of consultants conducted preliminary site investigations in order to determine the dominant environmental issues relevant to the proposed development, the critical elements for analysis, and the issues to be highlighted for the design and planning process. Field surveys to gather primary data were conducted, and other proposed developments and surrounding land use were reviewed in the context of compatibility with the project and potential positive, negative and cumulative impacts. A more detailed description of methodology is provided in Section 3.

The profiles of the project proponents and the consultants are found in Appendix 12.2.

1.4 Assumptions and Limitations

The consultants, in seeking to inform and solicit feedback, were not engaged in an opinion poll and therefore have no way of knowing how representative the comments/opinions received are of the entire Negril community. Nevertheless, by the completion of the fieldwork, the consultants had formed a firm view on the main issues of concern to those stakeholders engaged.

STATIN's 2011 census data is extensive and representative at that point in time. This data can only be challenged by undertaking a survey of similar scope, or a comparable design rigour. Given the nature of this project, which is a relatively small project for a private hotel property, and where the engineering designs available suggest no serious downstream impacts, an alternative survey design to update the census data was therefore not attempted nor considered statistically warranted as populations and their socio-demographic characteristics tend to change slowly. An effort has been made to extrapolate the available data into currently observable features, which, in turn, point to downstream issues that might need interventions or monitoring.

Various approaches to engage the different stakeholder groups were employed (See Section 3.3), including making contact via telephone and email when face-to-face meetings could not be accommodated. Respondents were given notice via a telephone call to expect an email survey, and several follow-up calls were made to gather the feedback once the emails were sent. There were, however, limited and slow responses by telephone and email from specific stakeholder groups. The stakeholder groups targeted for email surveys were, however, a small group (approximately 15 persons) most of whom were consulted face-to-face during a previous assessment of an alternative design for Sandals Negril's beach erosion.

As is the case with most environmental assessments, weather can be a limiting factor, particularly during the data collection stage of the assessment. Field equipment (light traps for zooplankton) was deployed at two points in the nearshore area of the Sandals Negril property, however, rough seas during the time of deployment created poor visibility and one of the light traps could not be retrieved. It was later found once conditions had improved, but the data, at that point, were no longer useable.

2 POLICY, LEGISLATION AND REGULATORY CONSIDERATION

The salient regulations, standards, policies, legislations, and other requirements of relevance to the Sandals Negril project are listed below. A description of each, as well an explanation of its relevance to the project, is provided in Appendix 12.4.

2.1 Legislation

- Beach Control Act 1956 (Amended 2004)

- Clean Air Act 1964
- Fisheries Act, 2018
- Jamaica National Heritage Trust Act 1985
- Mining Act 1947
- National Solid Waste Management Authority Act 2001
- Natural Resources Conservation Authority Act 1991
- Noise Abatement Act 1997
- Public Health Act 1985
- Quarries Control Act 1984
- Town and Country Planning Act (TCP Act 1957, Amended 1987)
- Wild Life Protection Act (1945) Amended 1991

2.2 Regulations

- Beach Control (Crown Licences) Regulations 1956
- Beach Control (Safety Measures) Regulations 1957
- Beach Control Authority (Licensing) Regulations 1956
- Beach Control Authority (Licensing) (Amendment) Regulations 1999
- Beach Control (Hotel, Commercial and Public Recreational Beaches) Regulations 1978
- Natural Resources (Marine Parks) Regulations 1992
- Natural Resources Conservation (Marine Parks) (Amendment) Regulations 2003
- Natural Resources Conservation (Permits and Licences) Regulations 1996 (Amended 2015)
- Natural Resources Conservation (Ambient Air Quality Standards) Regulations 1996
- Natural Resources Conservation (Wastewater and Sludge) Regulations 2013

2.3 Standards

- National Ambient Water Quality Standard

2.4 Policies

- Towards an Ocean and Coastal Zone Management Policy in Jamaica 2000
- Towards a Beach Policy for Jamaica (A policy on the Foreshore and the Floor of the Sea (2000 Draft)
- National Policy for the Conservation of Seagrasses (1996 Draft)
- Coral Reef Protection and Preservation Policy and Regulation (1997 Draft)

2.5 Development Orders and Plans

- Natural Resources Conservation (Negril Marine Park) (Declaration) Order 1998
- Natural Resources Negril Environmental Protection Area Order 1997
- Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order 1996 (Amended 2015)
- Town and Country Planning (Hanover Area) Provisional Development Order, 2018
- Town and Country Planning (Westmoreland Area) Provisional Development Order, 2018
- Town and Country Planning (Negril and Green Island Area) Provisional Development Order, 2013

- Town and Country Planning (Negril and Green Island Area) Provisional Development Order, 2013 (Confirmation) Notification, 2015.

2.6 International Conventions/Protocols/Treaties

Jamaica is signatory to a number of international treaties and conventions that obligate signatories to take wide-ranging measures in support of environmental protection and sustainable development, including enacting enabling legislation. Those relevant to this project include:

- Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) 1983
    - Specially Protected Areas and Wildlife (SPAW) Protocol
    - Land Based Sources of Marine Pollution Protocol
- Convention on Biological Diversity (CBD)
- Protected Areas Programme of Work (POW)
- Convention on Wetlands of International Importance (Ramsar Convention)
- United Nations Framework Convention on Climate Change (UNFCCC)
- UN Convention to Combat Desertification (UNCCD)

3 METHODOLOGY AND APPROACH

3.1 Physical Analysis

The primary baseline investigations carried out in relation to the physical environment included:

- Water Quality Assessments
- Noise Assessments.

The methodologies for each of the assessments are detailed below. Assessments using secondary data sources were conducted with respect to geomorphology, hydrodynamics, wave climate, and natural hazards.

3.1.1 Water Quality

Prior to the start of any development at the site, the water quality (WQ) was assessed to establish the baseline state of the marine ecosystems to be potentially impacted by the proposed groyne construction and beach nourishment activity and to provide preliminary information on the most vulnerable environmental receptors. The water quality data provide critical information on the condition of the water resources that may be directly or indirectly impacted by development. The water quality assessment had the following major objectives:

- To determine baseline water quality conditions of the marine environment
- To assess any existing impacts to the marine environment prior to the installation of the groynes and the beach nourishment exercise.

Figure 3-1 highlights the four (4) water quality sampling stations selected for investigation. Each sampling station was georeferenced for traceability and future monitoring requirements (Table 3-1). The selection of the sampling points was done considering the project sphere of influence.

Figure 3-1: Location of the water quality sampling sites for Sandals Negril, October 3, 2018

Table 3-1 provides the GPS coordinates of the water quality sampling stations.

Table 3-1: Water Quality Stations for Sandals Negril

WQ Station	Station Location	GPS coordinates (Degrees, minutes, seconds)
WQ1 (Control)	West of Booby Cay	18.336275° N -78.351461° W
WQ2	North, Beginning of Property	18.335876° N -78.340100° W
WQ3	Middle of Property	18.334438° N -78.339474° W
WQ4	South End of Property	18.332672° N -78.338737° W

The following WQ parameters were assessed during the exercise:

- pH
- Temperature
- Dissolved Oxygen
- Salinity
- Biochemical Oxygen Demand
- Alkalinity
- Turbidity
- Nitrate
- Phosphate
- Faecal Coliform
- Total Suspended Solids
- Enterococci
- Fats, Oil and Grease
- Cadmium
- Iron
- Copper
- Lead
- Zinc
- Arsenic
- Mercury

The water samples were collected below the surface of the water to obtain a representative sample. Depending on the test parameters, some of the sample containers were rinsed three times with the water to be collected before the actual sample was collected. Samples collected were kept at 4°C and transported to the ISO/IEC 17025 Accredited Quality and Environmental Health Laboratory at Environmental Solutions Limited for analysis within the analysis hold time for each test parameter.

Field observations and *in situ* measurements were made with respect to odour, colour, pH, dissolved oxygen, salinity and temperature at each site. All field measurements were measured using an YSI Pro Plus Multi-parameter system (MPS).

Quality Assurance

A quality assurance (QA) and quality control (QC) plan involving all aspects of the project was instituted. This QA/QC plan forms an essential first step to generating data of the highest quality and reliability. The programme comprised the care and calibration of field equipment and the collection and preservation of samples.

The sampling programme included grab sampling and the sample types were properly identified. The sampling team recorded the time, ambient conditions and sample description at the time of collection.

The quality control procedures in the laboratory included analysis of blanks, reference standards and duplicates as well as the utilization of verified standard analytical test procedures. In all cases, appropriate chain-of-custody records were prepared and maintained for all analytical samples. All containers were properly labelled, individually packaged, stored and transported in a cooler, packed with ice.

3.1.2 Noise

Noise level readings were averaged over a 3minute interval and the average noise level recorded in decibels (dBA). Wind direction and any unusual local noise sources were recorded at each sampling location. Noise measurements was taken using Quest SoundPro SE/DL series sound level meter, which conforms to the, IEC 616721-1-2002 Class 2, Sound Level Meter Type 2, ANSI S1.4 – 1983 (R2001) Octave Band &1/3 Octave Band Filter Class 1, IEC 61260:2001 Octave Band & 1/3 Octave Band Filter Class 1, ANSI S1-11-2004 and ANSI S1.43 -1997 (R2002) Type 2 standards. The noise meter was calibrated before and after each set of readings with a calibrator, which is pre-calibrated at the factory. The results at the end of the sampling period were compared with National Environment and Planning Agency (NEPA) Standard of 65dBA for Commercial Zones since the predominant activities around the project site are tourism-related.

Baseline noise measurements were also taken at identified sensitive receptors in the project area.

Site Selection

The objective of the noise investigation was to determine a baseline noise level in and around the project site including the transportation route for the sand to be used in the beach nourishment activities (Figure 3-2). Noise was also assessed on the Sandals property along the beach at intervals of about 70m (Figure 3-3). Receptor sites located downwind of the project sphere which may be affected by the activities on the project site were selected along with stations located upwind of the project area.

Figure 3-2: Location of Monitoring Sites for Noise, Norman Manley Boulevard, October 2, 2018

Table 3.2 lists the sampling stations each of which was georeferenced for traceability and future monitoring requirements.

Table 3-2: Noise Monitoring Sites at Norman Manley Boulevard, Negril, October 2, 2018

Sample Sites	Description	GPS Coordinates (Decimal Degrees)
N1	Club Riu Hotel	18.3553140, -78.3354700
N2	Undeveloped land	18.3525880, -78.3335740
N3	UDC Office	18.3495130, -78.3329370
N4	Negril Aerodrome	18.3437980, -78.3339690
N5	Entrance at Royalton and Hideaway and Grand Lido	18.3387360, -78.3392860
N6	Sandals Entrance	18.3356270, -78.3380510
N7	Boardwalk Entrance	18.3326690, -78.3367530

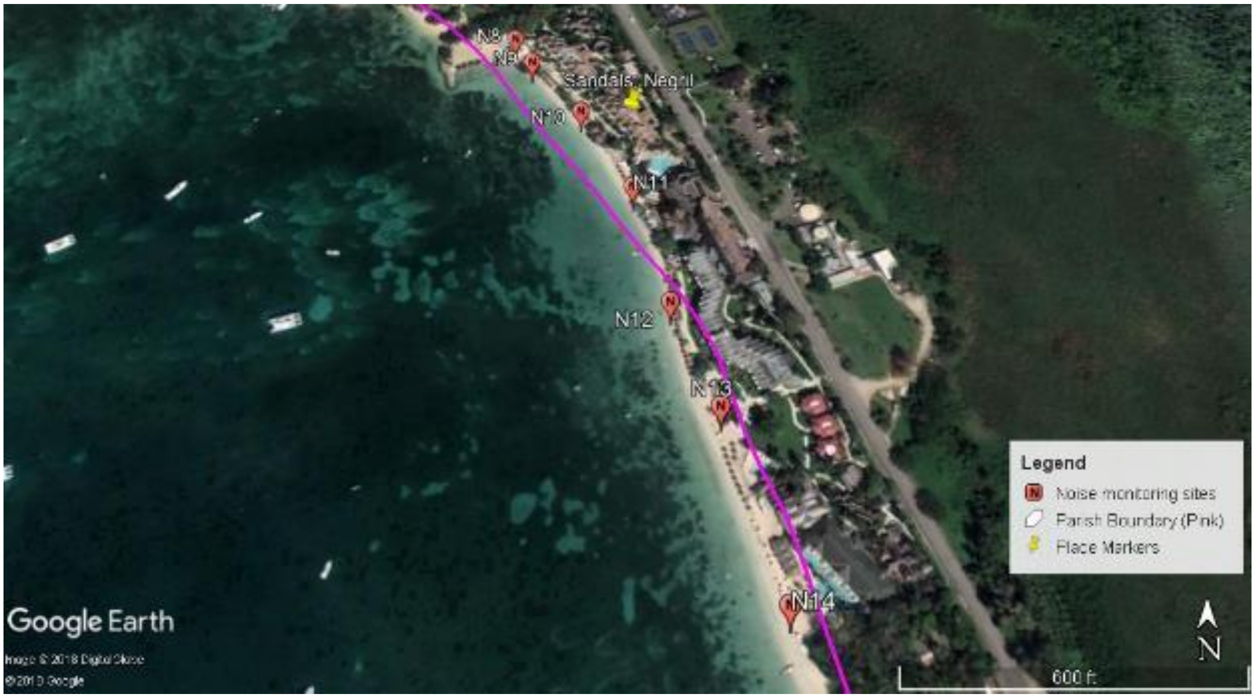

Figure 3-3: Location of Noise Monitoring Sites along Sandals Beach, October 3, 2018

Table 3-3: Noise Monitoring Sites along Sandals Beach, Negril, October 3, 2018

Sample Sites	Description	GPS Coordinates (Decimal Degrees)
N8	North End of Beach – Beginning of Sandals Property	18.336722, -78.339572
N9	–	18.336522, -78.339450
N10	–	18.336118, -78.339117
N11	Middle of Beach	18.335545, -78.338783
N12	–	18.334746, -78.338565
N13	–	18.334099, -78.3383
N14	South End of Beach – End of Sandals Property	18.333039, -78.3380

3.2 Ecological Assessments

3.2.1 Marine Environment

The marine assessment focused on seagrass and pelagic communities of the backreef area that falls within the 1km zone of influence for the proposed groynes. The methods for each are described in the following sub-sections.

Figure 3-4 is an aerial image showing a shallow fringing coral reef system, located 2–3km offshore with a depth of 20–50m, as well as a small patch reef just over 1km from the beach. Given the distance of these systems away from the site of the proposed groynes, an assessment of these reef zones was not included in the scope of this EIA. Environmental Solutions Ltd. conducted a previous assessment of the reef for an alternative beach stabilisation design for Sandals Negril; the description of the reefs surveyed can be found in Appendix 12.8.

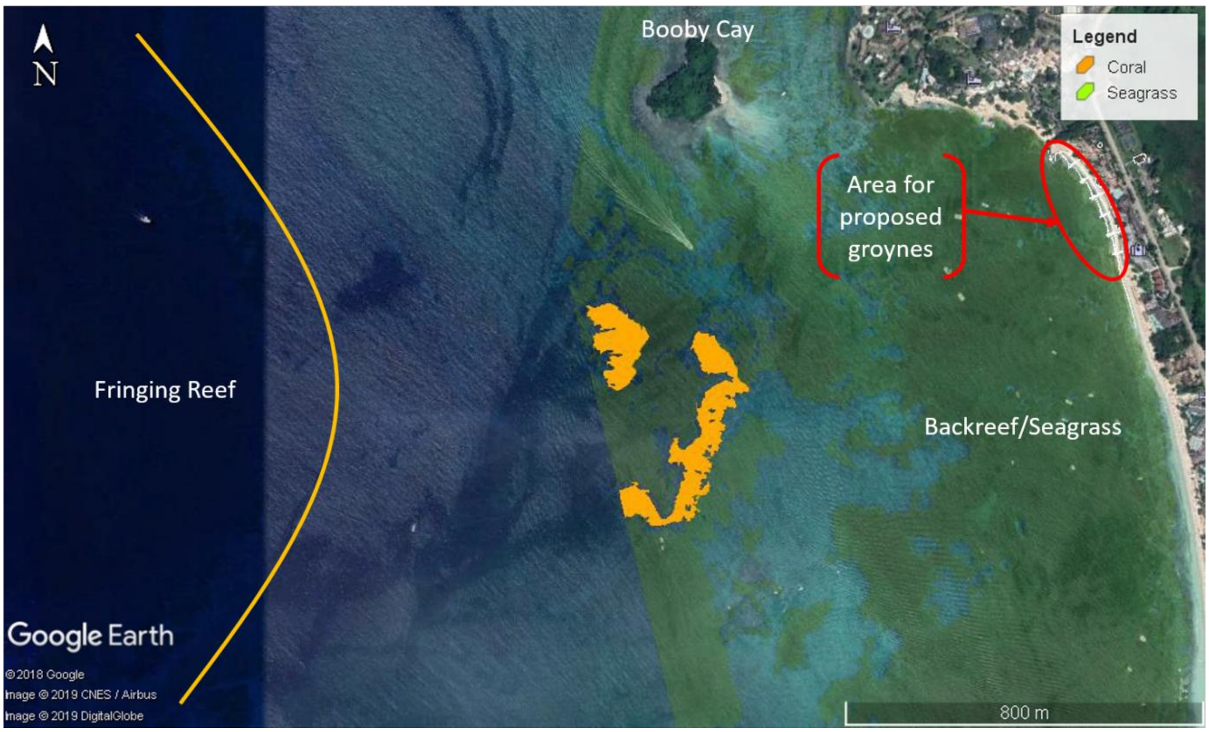

Figure 3-4: Aerial image showing distance of fringing reef (orange line) and patch reef (shaded orange) from the proposed project site (red) at Sandals Negril

3.2.1.1 Backreef Benthic Assessments

The backreef benthic surveys were conducted by snorkeling along transects. Benthic assessments were conducted for the site using the Reef Check methodology, recording the substrate type every 0.5m along a 50m transect line (no fish or invertebrate transects were conducted). The areas surveyed included the footprints of the proposed groyne structures, an existing groyne and artificial reef structures at the northern boundary of the property (Figure 3-5). Descriptions were also made of the general features of the backreef area.

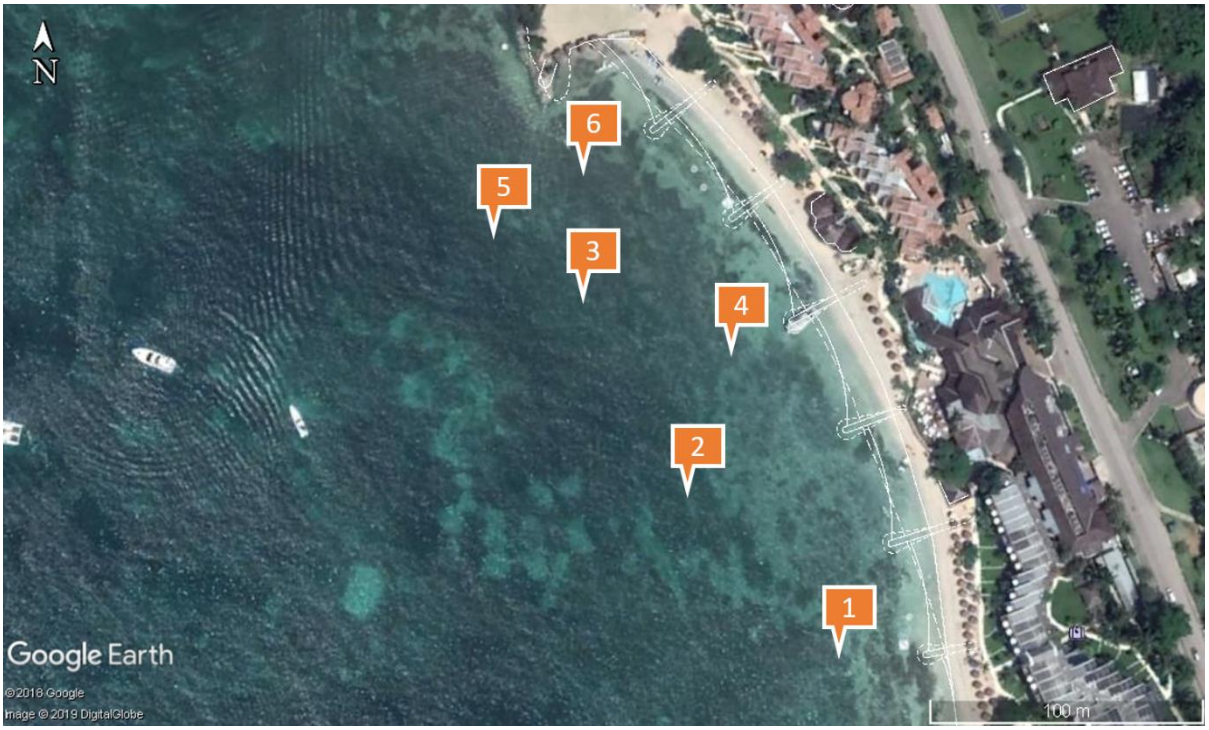

Figure 3-5: Locations of surveys for benthic seagrass assessments (Modified from Olsen, 2019)

3.2.1.2 Fish Population Assessments

Fish counts were conducted at the six (6) backreef sites using the method developed for the Atlantic and Gulf Rapid Reef Assessment (AGRRA); the same transect lines for the benthic assessment were used for the fish population assessments. It involved enumeration and estimation of size classes using a graduated T-bar swimming along the transect line, spanning a 1m wide belt. Each fish that traversed the belt (including within the water column) was included in the assessment. In addition, a 20-minute roving fish visual survey was conducted for a more holistic picture. Notable species were identified and assigned an abundance rating (**S** = Single, **F** = Few (2–10), **M** = Many (11–100) and **A** = Abundant (>100).

3.2.1.3 Planktonic Surveys

Guyah light traps (Figure 3-6) were deployed at two (2) locations in the seagrass meadows at the northern end of the Sandals Negril property, anchored to the sea floor using a concrete block and tied to floating marker buoys. The traps were left to fish overnight during the new moon on October 8th with the underwater light in place and switched on. Once retrieved, the cod end was carefully removed, and the excess water allowed to drain/filter from the outer chamber. The remaining sample was then transferred into labelled bottles containing a 1:1 ratio of 100% ethyl alcohol in seawater.

In the laboratory, samples were decanted through a 64µm mesh sieve to mitigate the loss of any organisms collected, and the decanted sample was then stored in ~70% ethyl alcohol in seawater. To achieve pseudo-replication, a modification of the 'beaker split' method (using 60ml syringes) was employed to produce three (3) separate 25ml aliquots from the original decanted sample. Each aliquot was placed in a Bogorov tray and viewed (at X 100) using a Wild Heerbrugg M5-97891 binocular microscope for species identification and enumeration. Organisms were identified to species level where possible, but in most cases, the selected major taxonomic groups (identified to order level) were suitable for describing the composition of the zooplankton community. The remaining sample was then assessed for fish larva and where found, these were extracted and placed in vials for further analyses.

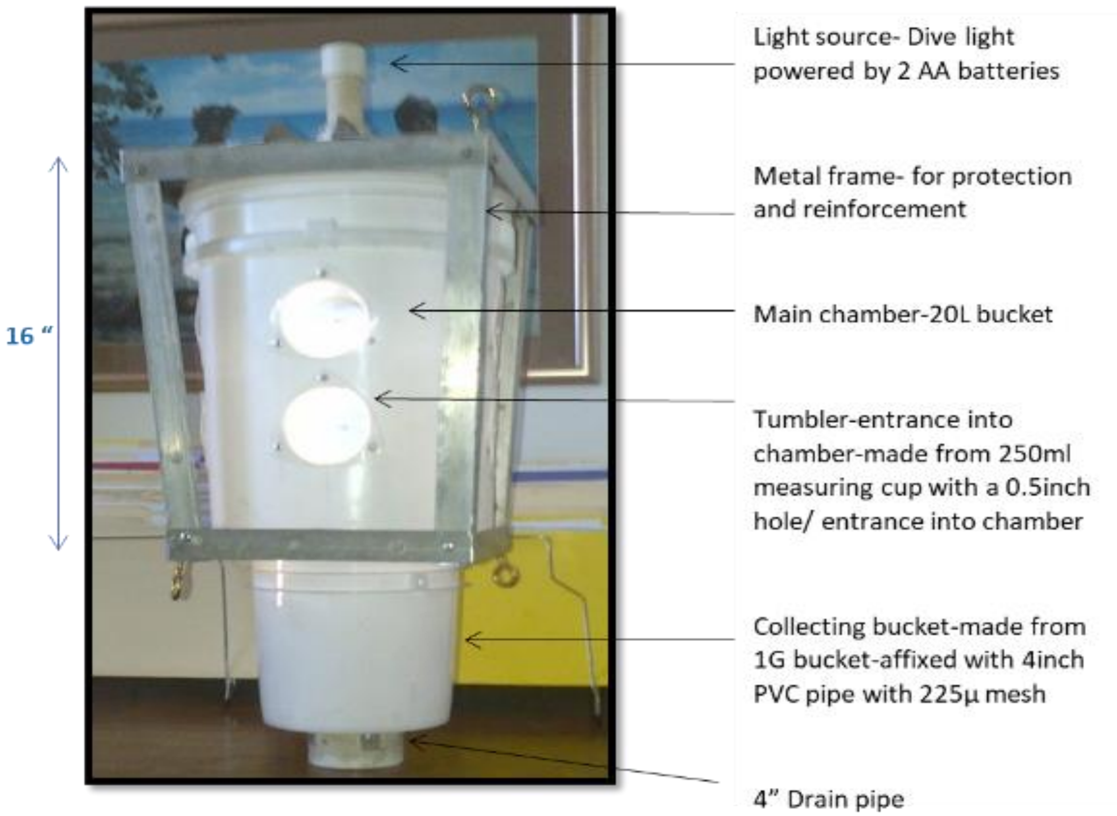

Figure 3-6: Modified light trap based on a design by Jones (2006) (Source: UWI Centre for Marine Sciences)

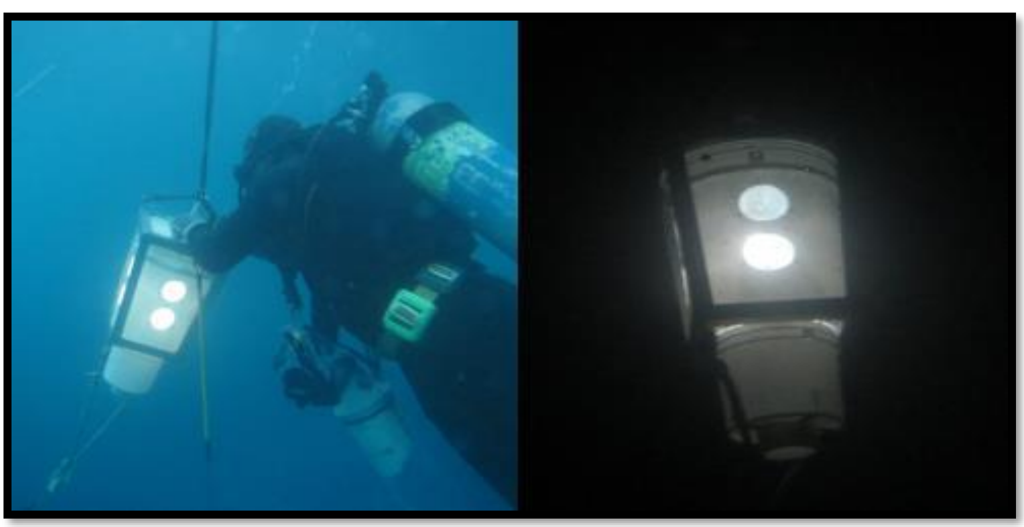

Figure 3-7: Deployment of light trap at deep site with use of a mooring and float so it rests 2m below the surface (Source: UWI Centre for Marine Sciences)

3.2.2 Terrestrial Surveys

3.2.2.1 Terrestrial Flora

A vegetation assessment was carried out at the proposed extraction sites (see Figure 3-8). The assessment was conducted on October 13 and 14, 2018. This vegetation assessment was carried out to give a thorough description of the flora at this site, with special emphasis on rare, endemic, protected or endangered species.

Transects were created across the length of each of the four proposed mining sites, namely, from west to east: S9, S6a, S6b, S10 and S5. All vegetation encountered within 2.5 metres on either side of each transect was recorded. For each species, the name, perceived dominance and its growth form was noted. The dominance was graded using the DAFOR scale (i.e., D=dominant, A=abundant, F=frequent, O=occasional and R=rare). The common names of most of the species sighted were assigned in-situ. In the case of unknown species, voucher specimens were collected to be identified at the University of the West Indies (UWI) Herbarium. All plants were identified to the species level by examining morphological features such as leaf arrangement, leaf pattern, and pattern of branching and morphology of floral and fruiting structure in conjunction with the use of Adams' (1972) *Flowering Plants of Jamaica* and preserved reference specimens of the herbarium.

3.2.2.2 Bird Surveys

Point counts – The point count method was selected and it is based on the principle of counting birds seen and heard at a defined point. The method was carried out at a predetermined time of 5 minutes, before moving to another point (Bibby et al., 1998). The points for this survey were at least 100m apart and were strategically placed in the areas (polygon) for the proposed sand removal project (see Figure 3-8). The survey was carried out over two days and one night. It should be noted that any new bird species encountered, while walking from one point to another, were also recorded.

Line transect – Due to the road network on the property, the line transect method was selected for the nocturnal avian survey. The line transect method entails walking at a steady pace along a selected path for a given distance, while recording all bird species seen or heard (Bibby et al., 1998). The "transects" were located within the areas for the proposed development activity (see Figure 3-8).

Figure 3-8: The location of the "transects" and points used to generate the fauna list for the study. (Modified from SWIL, 2018)

3.2.2.3 Herpetology

Sample sites were selected throughout the project area, with emphasis on the area for the proposed sand removal, to cover the main habitat types. The selected areas were actively searched throughout the day, and specimens were identified or pictures taken for further study, if necessary. It should be noted that the herps were identified by mainly using the Blair Hedges online key (Hedges, 2017).

Night surveys were carried out in selected areas mainly to identify the frogs when they become vocal. If a species' frog call could not be identified in the field, it was recorded on a telephone and further identified at the University of West Indies.

3.2.2.4 Arthropods

The invertebrate assessment was carried out during the day along the trails/transects and selected points illustrated in Figure 3-8. A sweep net was used to sample foliage arthropods along the trails. Special emphasis for this study was placed on butterflies. Various habitats and possible hiding places were carefully searched or examined; these included tree trunks, leaves, and dry wood and sticks.

Unknown specimens were brought to the insect collection department at UWI. UWI and the Institute of Jamaica (IOJ) both have shared collection and reference material.

3.3 Stakeholder Consultations

Since 2010, Sandals Negril has commissioned various designs to address the issue of coastal erosion. For each beach erosion solution that has been proposed, stakeholder feedback was solicited.

Environmental Solutions Ltd. (ESL) conducted stakeholder consultations based on a previous design. These initial stakeholder consultations for the original design were conducted over a 4-day period: September 27 – 28, and November 12 – 13, 2018. During this period, consultations were held with stakeholders representing hoteliers, retailers, transportation providers, other hospitality service providers, central government agencies with offices in Negril, local government agencies, NGOs, and nearby community members.

Interviews were conducted using a guideline questionnaire tailored towards each stakeholder group. Using this approach, a total of 12 interviews with 22 persons were conducted.

Two community focus group meetings were also held at the Negril Community Centre. These were mainly attended by craft vendors and other interested beach-based occupations representing the following communities:

Hanover

- The Orange Bay Community (residents and business owners)
- Orange Bay Fisherfolk
- Rutland Point Craft Market Vendors (Bloody Bay)
- Bloody Bay Vendors

Westmoreland

- Negril South River Fisherfolk
- Craft Market Vendors (near Negril South River)
- Sheffield Community
- Whitehall Community
- Red Ground Community.

The two meetings had a combined attendance of 31 persons. In total, approximately 53 persons provided input during the 2018 consultations.

The design for the hard structures to mitigate beach erosion on Sandals Negril property was most recently modified in late November 2018. Given that the project site and sphere of influence remained the same and the core concept of the beach erosion mitigation using hard structures remained, the stakeholder consultation strategy was revamped to ensure that there was further probing of the key issues derived from the initial consultations with critical stakeholders who are considered to be impacted by and/or have interest in the new design concept.

The modified consultation approach included having focus group sessions with representatives from the Negril Chamber of Commerce, and face-to-face individual and group interviews with beach-based vendors in Bloody Bay.

Stakeholder interviews were also conducted via email and telephone with the following groups:

Negril water sports operators, central government agencies with offices in Negril, local government agencies, and environmental special interest groups/NGOs (namely, the Westmoreland Municipal

Corporation, Negril-Green Island Area Local Planning Authority, Negril Environment Protection Trust (NEPT), Negril Police, and the Negril Coral Reef Preservation Society).

3.4 Impact Assessment

The potential environmental and social impacts were assessed for both the construction and operational phases of the proposed coastal works. Each potential impact of the development was assessed in terms of the following are internationally applicable criteria:

- Magnitude of impact – this assessment measured the scale of the impact
    - Significant
    - Moderate
    - Minor
- The nature of the impact – this explains how the environment will be affected and by what activities
- The spatial extent of the project impacts
- The duration
    - Short term 0–5 years
    - Medium term 5–15 years
    - Long term – lifespan of the project
- Direction of impact
    - Positive
    - Negative
- Permanence
    - Reversible
    - Irreversible.

4 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

Various engineering solutions and structural interventions have been proposed and assessed in an effort to enhance and rehabilitate the beach at Sandals Negril. These designs have undergone several iterations over the past decade and have each been subject to various forms of analysis.

The current design has been proposed by Olsen Associates Inc. (See Section 5– Project Description). It has been assessed and modelled independently by Smith Warner International Ltd. The Investigation of the Olsen Groyne Design at Sandals Negril (SWIL, 2019) provides the detailed results of the modelling conducted.

Presented below is a summary of the assessment of the various solutions which have led Sandals Negril to this current design.

4.1 No-Action Alternative

The average erosion rate being experienced at the SNG property in Long Bay is 0.21m/year. If left unabated, erosion is expected to continue at this average rate. Figure 6-6 in Section 6 shows the historical shoreline changes at the subject property for the period 1968–2018. The image shows that while the rates fluctuate between erosion and accretion, the overall trend is one of erosion. This option is untenable for Sandals Negril as at present, they have very narrow beach widths, particularly in the northern section of the property.

4.2 Beach Nourishment Only

Beach nourishment only was an option that was explored. This included increasing the beach width by approximately 13m. Figure 4-1 compares the resulting shoreline after 5 years between (i) the “Do Nothing” alternative, and (ii) the “Nourishment Alone” alternative. The yellow dashed line shows the proposed beach nourishment level and the blue line shows how the beach will respond after 5 years (this does not include the likely response if tropical storms occur). With the “Nourishment Alone” option, it is estimated that the addition of sand to the beach area will augment the volume and spatial extent of sand that is available for erosion. The area that will be nourished (i.e., approx. 250m at the northern end of the SNG property) will take approximately 60% longer to erode. However, although the area being nourished is likely to take longer to erode, the erosion being experienced in the wider Long Bay area will continue to occur at the same average rate observed historically, or even higher in the event of hurricanes or storms, and it is most likely that the newly nourished sand will be transported to the south if no additional protection is implemented.

It should also be noted that Sandals Negril has attempted to nourish its beach in the past. Sandals transported sand from another of their resort properties located in Whitehouse, Westmoreland to the SNG property. The sand, which was reportedly of a similar quality and grain size to the sand at the SNG property, washed away in a short space of time.

The “Nourishment Alone” alternative will therefore require a sustainable source of sand for beach maintenance in the future (See Section 4.3.2).

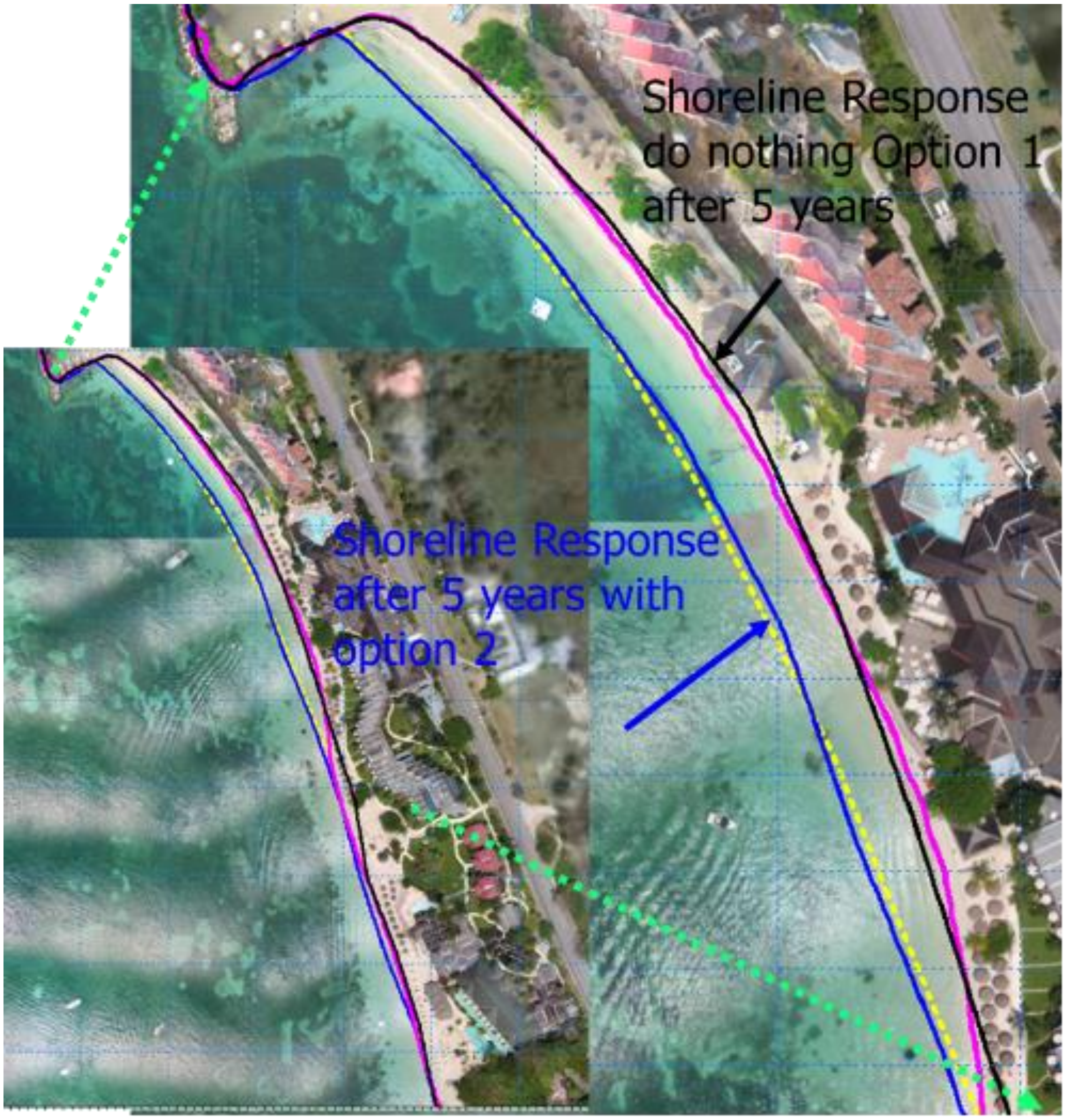

Figure 4-1: Model results comparing the "Do Nothing" Alternative to "Nourishment Alone" (SWIL, 2018)

4.3 Beach Nourishment with Hard Structures

4.3.1 Beach Nourishment with Hard Structures above MSL

The MIKE 21 shoreline model (SM) was used to compute the beach morphology and the resulting shoreline changes with the implementation of the proposed design over a 5-year period. The response to the Olsen design (described in Section 5) was compared to the "Do Nothing" and Beach "Nourishment Only" alternatives presented graphically in Figure 4-2

The results of the model show that the beach response to the proposed groynes (cyan line) is only localised and contained within the local vicinity of the proposed design and nourishment. The model results also suggest that making the investment into implementing the Olsen-designed six (6) groyne field may generate the desired shoreline position. The model results of the Olsen design, as shown in Figure 4-3, indicates there are no noticeable downdrift impacts resulting from the implementation of the proposed groyne field other than shoreline fluctuations within a similar envelope to the shoreline response with the "Do Nothing" option (magenta). The Olsen groyne field is expected to block only 10% of the sediment transport moving to the south.

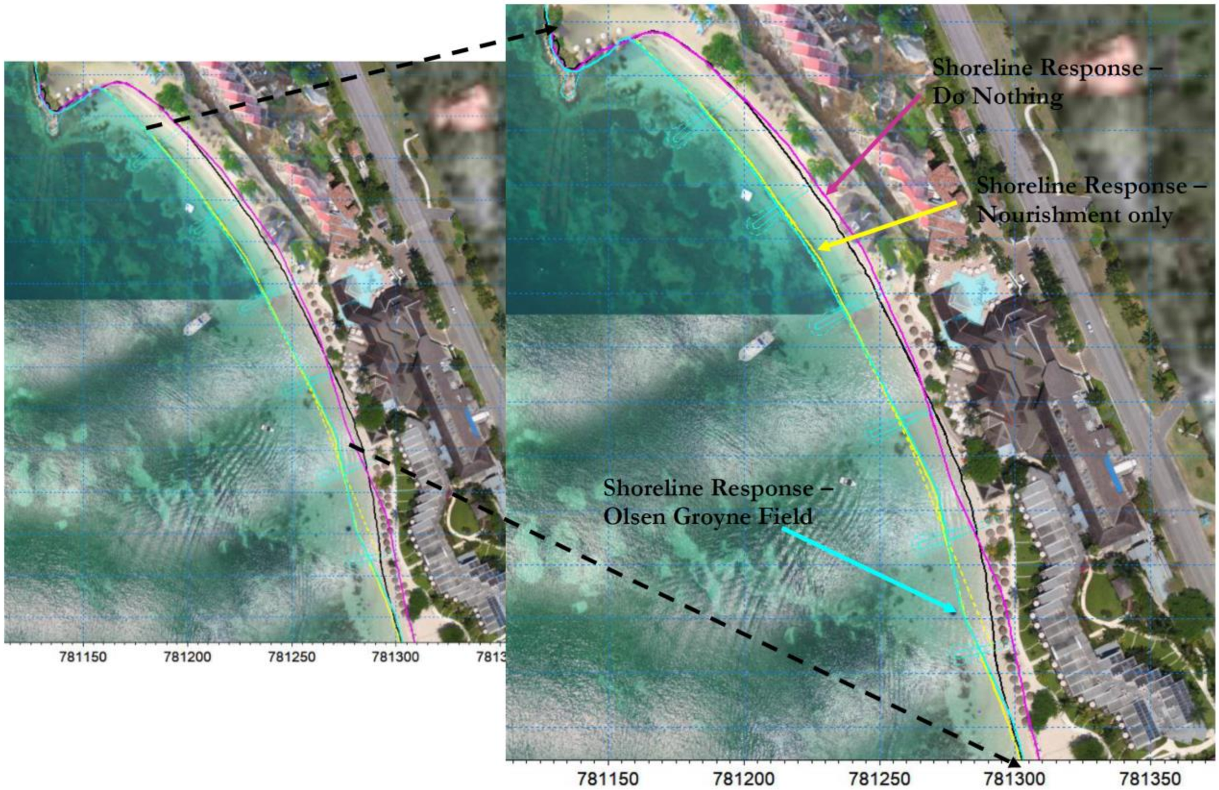

Figure 4-2: Shoreline displacement comparison after 5 years (1-Do nothing, 2-Nourishment Only, 3-Olsen Design) (SWIL, 2019).

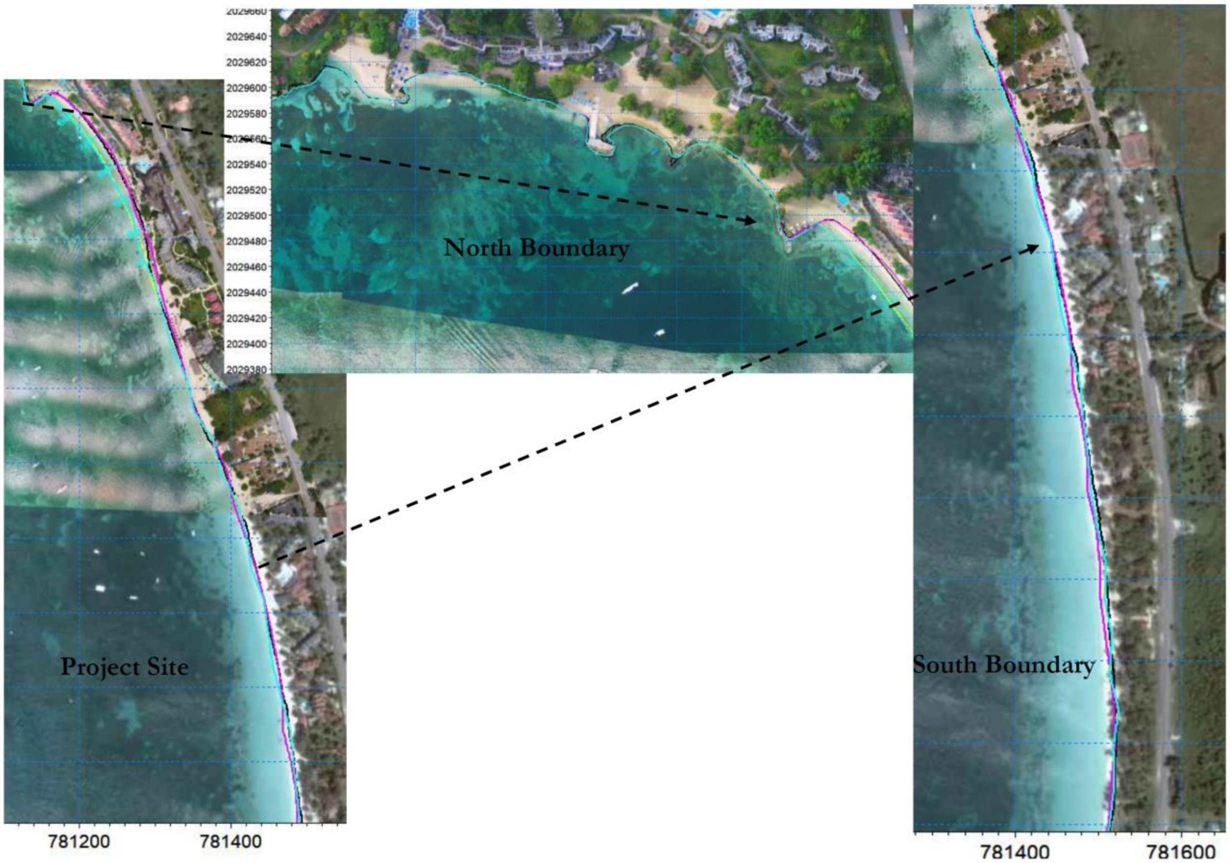

Figure 4-3: Modelled downdrift impacts after 5 years (SWIL, 2019)

4.3.2 Beach Nourishment with Hard Structures below MSL

This option proposed by Smith Warner International (2011 and 2018), included the following main elements:

i. Reshaping and lowering of the existing groyne at the north end of Sandals beach to -0.3m below MSL
ii. A detached North Breakwater (submerged) with a length of 87m.
iii. A detached South Breakwater (submerged) with a length of 78m.
iv. A North Groyne with a length of 15m.
v. A Central Groyne with a length of 48m.
vi. A South Groyne with a length of 36m.
vii. Beach nourishment of 230m of beach.
viii. Beach nourishment to the back of the beach area at the very north of the property, with added thickness of approximately 0.8m (finished elevation +1.2m above MSL). See Figure 4-4.

The actual shoreline of Sandals hotel is about 450m in length, but this option would have been implemented only over a 230m length of shoreline. This was to ensure that the proposed concept remained invisible to neighbouring properties to the south (more than 200m away from the concept extent) while any immediate morphological impacts resulting from the implementation of the proposed concept remained on the Sandals property. It would have required 9,000m^3 of sand, 3,500m^3 of armour stone, 250m^3 of filter or core material and 3514m^2 of geotextile filter fabric. Potential ecological impacts during construction include increased turbidity, smothering of benthic resources, loss of habitat/biodiversity and oil pollution.

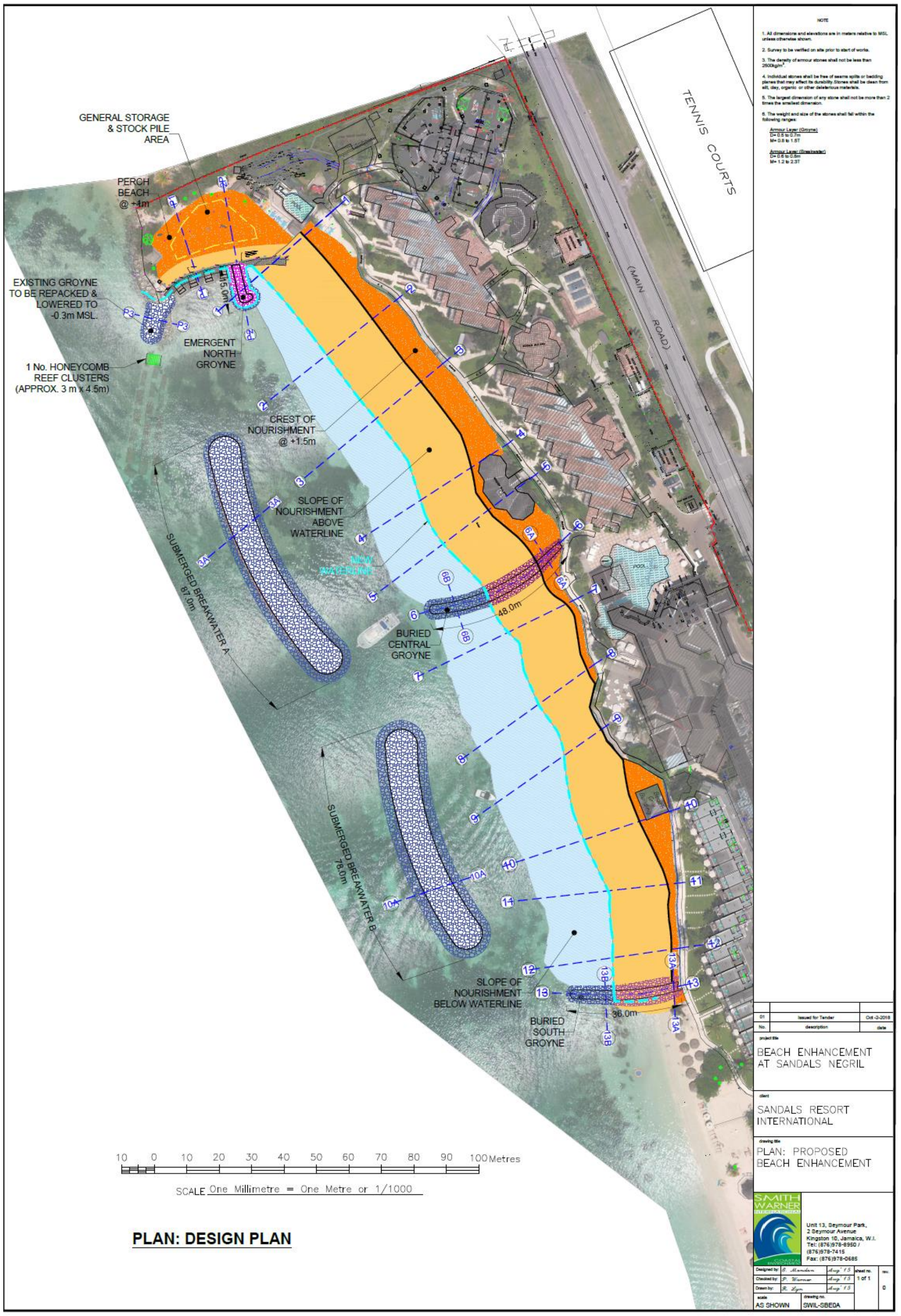

Figure 4-4: Design Plan- Beach Nourishment and Hard Structures Below MSL (SWIL, 2018)

The proposed benefits of this option include:

- Replenish the beach to former levels of width (nourishment);
- Help to hold the sand in place (nourishment and groynes);
- Reduce but not stop alongshore transport to the south (buried groynes);
- Be primarily invisible within Sandals property and to the general public in Negril;
- Improve the beach recovery after a swell event or hurricane (breakwaters); and
- Limit downdrift impacts to the beach area within Sandals property (buried groynes).

4.4 Alternative Sources of Sand

Based on the groyne design being proposed, it is likely that there will be a need for beach renourishment in the order of 6 to 8 years (Olsen Associates Inc., 2019). The developer has indicated that the proposed sand extraction site in Bloody Bay is a one-time option, and as such, alternative sources for beach nourishment and maintenance are required. In the absence of a detailed evaluation of alternative sand sources, the consultants have considered two (2) alternatives which are outlined below.

1. **Outer shelf of Long Bay and Bloody Bay**

In a 2007 study commissioned by the Negril Coral Reef Protection Society (NCRPS), it has been suggested that thick layers of sand exist between the 20 and 50m depth contours off of the outer shelf of Long Bay and Bloody Bay. The area under consideration is approximately 7km long and 200–600 m wide (Figure 4-5). It is therefore expected that more than enough sand is situated along the outer shelf of Negril to use for beach nourishment. However, no actual assessments have been conducted to determine the availability and thickness of the sand layers and quality of sediments, as well as the economic feasibility of pumping the sand from offshore. It is also not anticipated that this sort of investment could be borne solely by Sandals, but would have to be a Negril-wide initiative. If this material were to be used, several management plans would have to be prepared including a management plan to ensure that there is limited impact on corals and seagrass beds.

Figure 4-5: Potential sand source along outer reef, within the 20 to 50m contour (SWIL, 2007).

2. Importation from a third party

Another source of sand is from a third party. These sources are often located in other Caribbean islands, and therefore, the transportation significantly increases the cost of beach nourishment. The importation of this sand will also likely have local impacts on the source of origin. Prior to importation, it would be important to determine if the sand has similar sediment properties to the existing sand on Negril's beaches. This is critical both in terms of the stability of the nourished shoreline and the visual and aesthetic impact of the beach. As previously mentioned, SNG has extracted sand in the past from their Sandals

Whitehouse property. Extraction of sand from another beach system is not considered sustainable as it may reduce that beach's ability to regenerate and protect itself against storm surges and other forms of erosion.

It should be noted that Sandals Resorts International (SRI) has partnered with the Negril Chamber of Commerce (NCC) to drive the initial process of arriving at a solution to address the longstanding beach erosion issue in Negril. Dubbed the Wider Negril Beach Restoration (WNBR) Project, this project has the following main objectives and outcomes:

- Outcome 1: Successful implementation of an overarching solution to the beach erosion problem along the Negril, Long Bay and Bloody Bay region
- Outcome 2: Establishment of an effective governance framework and overarching financial mechanism to safeguard the maintenance and wider sustainable operations of the WNBR Project.

Consultations on this proposed project have already started with NEPA, the Tourism Product Development Company (TPDCo) and other key stakeholders. A detailed project brief of the WNBR Project is included in Appendix 12.10.

5 PROJECT DESCRIPTION

5.1 Project Objectives

Summarised below are the primary objectives of the proposed project:

- To reduce the longshore transport of sand away from the property shoreline;
- To widen and maintain a minimum of 8 to 10m beach width post-nourishment;
- To minimise the visual aesthetic impact of any proposed solution.

5.2 Project Timelines

The timeline for completion of construction is projected to be 60 working days. Assuming 24 working days a month, the project is proposed to be completed in 2.5 calendar months (about 75 days). This allows nominal contingency for down-time, though actual contingency for delay or adverse weather may result in a total construction time of up to 3.0 calendar months (90 days). It should be noted that construction activities are expected to occur while the hotel is still in operation; thus there is interest in minimizing the length of time of construction impacts. The construction schedule reasonably anticipates construction of each rock groyne in approximately 8 working days (per groyne) and truck-haul delivery and placement of approximately 230 cubic meters of sand per working day (about 18 to 20 truckloads per day). The anticipated construction schedule is summarized as follows, in calendar days:

Day 1 – 38 (38 days): Import rock and build four groynes.

Day 39 – 56 (18 days): Build remaining two groynes; import 3500 cubic meters of sand.

Day 57 – 74 (18 days): Import 3500 cubic meters of sand.

Day 75 (1 day): Demobilization.

5.3 Design Concept and Components

The concept, as proposed by Olsen (2019), includes the following:

Groynes

Six (6) short, low-profile, linear rock groynes, along the 240m long project shorefront, are proposed as illustrated in Figure 5-3:

- **Spacing–** The groynes will be spaced about 40m apart, almost wholly buried in sand (Figure 5-3);
- **Length–** They will be between 15m and 25m in overall length. The southern groyne, G6, is intentionally shorter (about 15m overall) and permeable to facilitate the transition from the beach fill area to the south shoreline;
- **Width–** Each groyne's width will be 2.1m across the crest (two boulders wide) as illustrated in Figure 5.1, and up to about 3m wide at the sand surface where it is exposed above the sand across the intertidal beach;

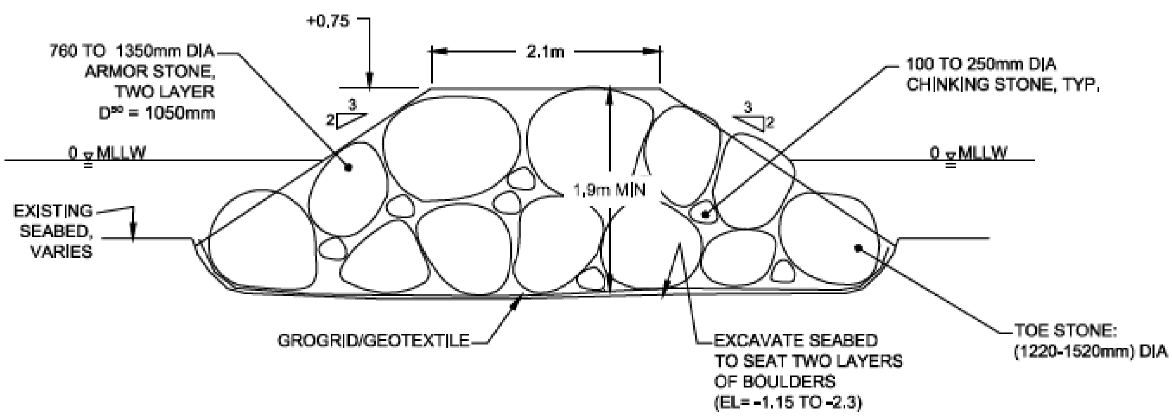

Figure 5-1:Typical groyne section (Source: Olsen, 2019)

- **Visibility–** For northern groynes, G1–G5, the total groyne length is up to about 25m, of which the landward half is wholly buried within the sand so that there is no obstruction to lateral access along the shoreline over the groynes. For the remaining 12m, about 5m is below mean sea level (Figure 5-2), leaving approximately 7m visible. The southern groyne, G6, is shorter (about 15m overall), of which roughly 8m of crest are marginally exposed above the sand, 2.5m of which are below mean sea level (leaving roughly 5.5m visible).

  The visible, exposed portions of each groyne are limited to less than 30cm high (<12") across the intertidal beach face – from the berm to about the low water shoreline – and less than about 2.5m wide.

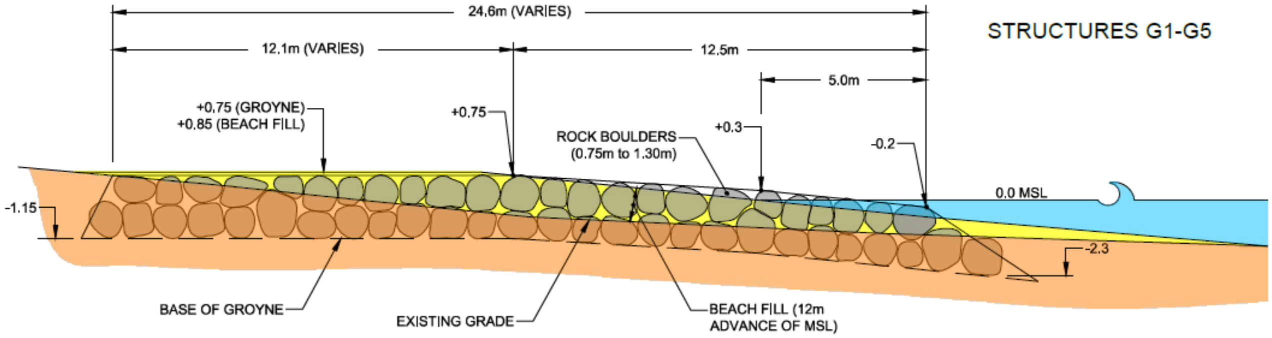

Figure 5-2: Cross sections of the proposed groynes, G1–G5 (Olsen, 2019)

Existing North Groyne

In conjunction with the proposed groynes, the existing groyne spur at the north-end headland will be reshaped and lowered to below the waterline (Figure 5-3). This is intended to improve water flow and circulation from the north, without destabilising the shoreline at the north end of the beach.

Sand Nourishment

Sand placement for this project will be approximately 7,000 m^3, sourced from a Sandals-owned property in Bloody Bay. The initial beach fill will increase the beach width from its present state to about 12m seawards (Figure 5-3). As a result of the low-energy wave environment of Negril Beach, it is anticipated that it will take between 6 and 12 months for the shoreline to come to full equilibrium at about 8 to 10m.

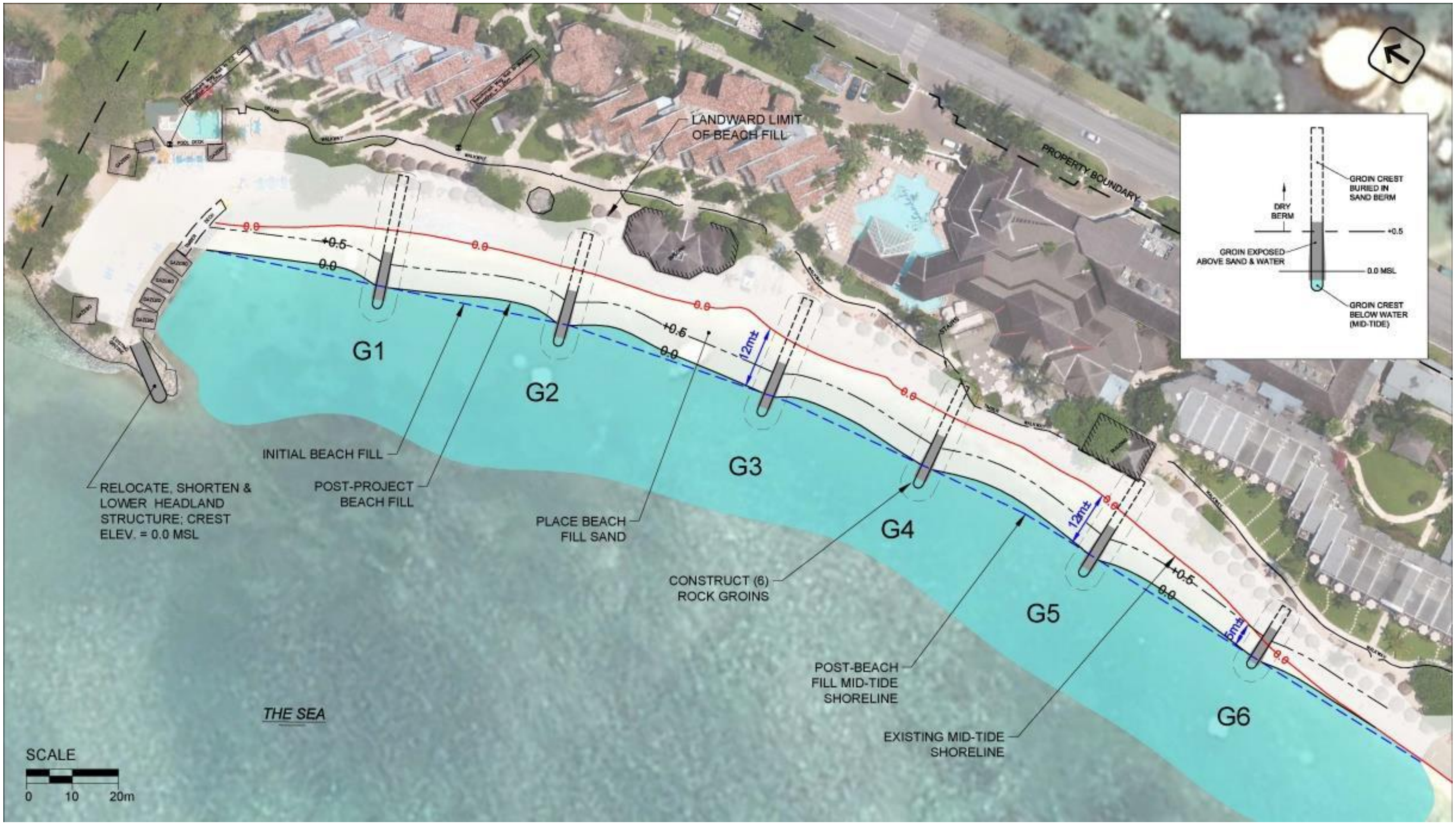

Figure 5-3: Proposed plan with beach nourishment and six groynes (Olsen, 2019)

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5.4 Material(s) to be used

The groynes will be constructed of 0.75 to 1.3m diameter boulders, two rows wide and thick, with foundation dug into the existing beach (Figure 5-1). This will require approximately 3,730 metric tonnes (4100 US tons) of boulders to construct, of which a minor portion (<500 metric tonnes) may come from reworking the existing spur groyne at the north headland.

It is estimated that approximately 600m^3 of the existing beach grade will need to be excavated in order to place the boulders. Excavated sand will be placed as beach fill immediately adjacent to each groyne, assuming that the sediment is beach compatible. Non-compatible sediment will be removed from the project site and disposed of at an approved location. These boulders will be sourced from local quarries. As of August 1, 2018, there are 23 licenced quarries in Westmoreland; 13 have current licences, while the licences of the other 10 have expired[3]. In Hanover, there are 13 licensed quarries, and 5 of these licences are current.

As mentioned above, the proposed sand extraction site is from a Sandals-owned property in Bloody Bay. Approximately 7,000m^3 of sand would be required. This represents approximately 700 truckloads of sand. Based on previous investigations, there is sufficient sand with a grain size between 0.44 and 0.51mm available from the Bloody Bay site for use at the Sandals Negril property.

5.5 Construction Methodology

The rock groynes would be constructed from land. No boat or barge work is required.

5.5.1 Access for Construction Vehicles

A 4m wide temporary access road will be created along the northern property boundary to allow for the passage of trucks and other heavy equipment to and from the beach area (Figure 5-4). It is assumed that the road will be made from compacted marl and that the temporary marl road will be removed once construction has been completed.

[3] NB: Expiration dates do not necessarily reflect the status of the licence. Some licences may be in the process of renewal. (Source: Mines and Geology Division)

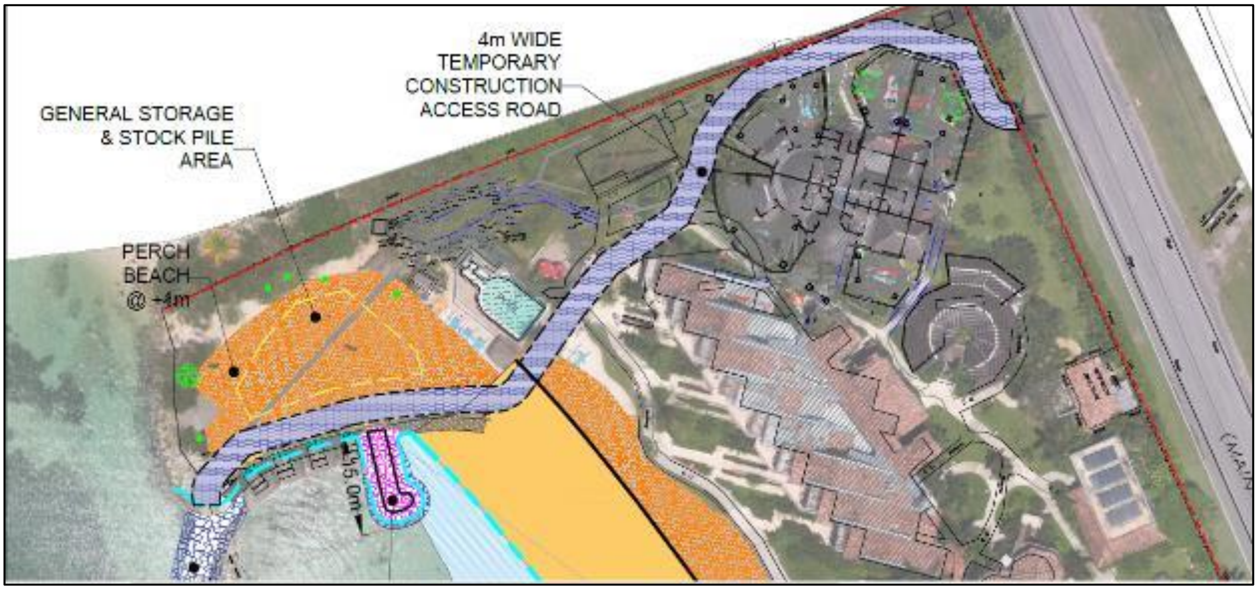


Figure 5-4: Image showing temporary access road along northern property boundary (SWIL, 2018)

Figure 7-1 in Section 7 shows an existing clearing/pathway that is currently used to access the property and the beach area in Bloody Bay. It is recommended that this clearing be upgraded and used as the access road as this will avoid the need for any additional vegetation clearance.

5.5.2 Equipment and Storage

As shown in Figure 5-4, a temporary equipment storage and material stockpile area will be located at the northernmost section of the Sandals Negril property.

At the Bloody Bay site, it is assumed that a similar area will be needed for the temporary storage of equipment and stockpiling of material. The location and size of this storage area is not yet known.

5.5.3 Site/Vegetation Clearance (Bloody Bay)

Figure 5.5 highlights the two options proposed for the sand extraction sites:

- Option 1 – approx. 8,860m^2 of vegetation would need to be cleared at minimum. Additional clearance will be required for vehicular access paths, storage areas, etc. This option will require excavation to about 2m deep which is reportedly below the water table;
- Option 2 – approx. 14,650m^2 and a much larger area. However, excavation would be to 1m depth which is above the water table.

Figure 5-5: Left – Option 1(combined area of 8,860m^2); Right – Option 2 (approx. 14,650 m^2)

6 DESCRIPTION OF THE ENVIRONMENT

6.1 Physical Environment

The Negril coastal system comprises a wetland called The Great Morass; the shorelines of Long Bay, Bloody Bay, Orange Bay to the north; and an offshore shelf containing seagrass and reef habitats, drowned cliffs and former river valleys (Figure 6-1). Understanding the relationship between these components and the processes that helped to create them provide valuable insight on the potential shoreline response at the Sandals Negril property to future climate change, coastal hazards and man-made interventions.

Figure 6-1: Profile of Negril (Climate Risk Atlas of Coastal Hazards and Risk in Negril)

6.1.1 Geomorphology

6.1.1.1 Coastal Geology and Evolution

As summarised below, the Negril coastline has, over time, undergone significant changes:

- Initial wetland formation at about 8,250 years before present (ybp), with major expansion of the wetland surface area between 7,250 and 6,500 ybp; the Negril shoreline was located 1–2 kilometres to the west and north of its present position;
- Submergence of the Orange and South Negril river valleys by the rising sea;
- Early stages of beach formation on the newly submerged shelf from about 6,500 ybp. Migration of the beaches landwards as sea level continued to rise, with wetland vegetation increasingly influenced by freshwater from land-based runoff;
- By 2,000 years ago, the beach system had migrated east to a position similar to the present day, along the western margin of The Great Morass. As the rate of sea level rise diminished, sand

accumulation was sufficient to allow beach widening towards the ocean, resulting in the creation of the modern beach (Robinson and Hendry, 2012; Hendry and Digerfeldt, 1989; Hendry, 1987; Digerfeldt and Hendry, 1987; Hendry, 1982).

6.1.1.2 Physical Components of the Coastal System

The beaches in Bloody Bay, where sand extraction is proposed, and Long Bay, where Sandals is located, are anchored between limestone headlands reaching several metres above sea level (Figure 6-1). Beach elevations in both bays are at, or below, 2 metres above sea level (Marine Geology Unit, 2008). Long Bay beach is approximately 6.5 km long, and Bloody Bay is 1.5 km long. Both bays had substantial ground and forest cover, but development has impacted this in many places.

East of the beaches, the Great Morass is almost everywhere at an elevation of less than 1 metre above mean sea level (Robinson et al., 2012) (Figure 6-1). Wetland vegetation is dominated by the sawgrass, *Cladium jamaicense*. In some areas, particularly near Orange Bay, stands of mangrove occur. The wetland contains peat deposits, formed from decaying organic matter, over 12 metres deep along the former course of the South Negril River.

Beneath Negril's beaches, boreholes revealed calcareous marine sand layers interbedded in places with peaty material, overlying clay and limestone, (Hendry, 1982, 1987). These sequences demonstrate the interplay between marine, fluvial and wetland processes, as the beaches migrated landwards during sea level rise.

The offshore shelf extends seaward to the top of a drowned cliff at 5–12 metres below sea level, between 1.5 and 2 km from the shore (Figure 6-2). From the base of this cliff, at water depths around 16–20 metres, the shelf slopes seaward at an increasing angle into deeper water (Hendry, 1982).

A patch reef approximately 500 metres long is located 1.5 km offshore from the north/central part of Long Bay. The upper surface of the reef is close to sea level. This reef influences waves approaching from deep water which, in turn, impacts on nearshore sediment transport and beach processes at Sandals. There are no fringing reefs, except at the entrance to Orange Bay, but reef assemblages have developed on the edge of the drowned cliff offshore from Bloody Bay and Long Bay, and in deeper water beyond the cliff.

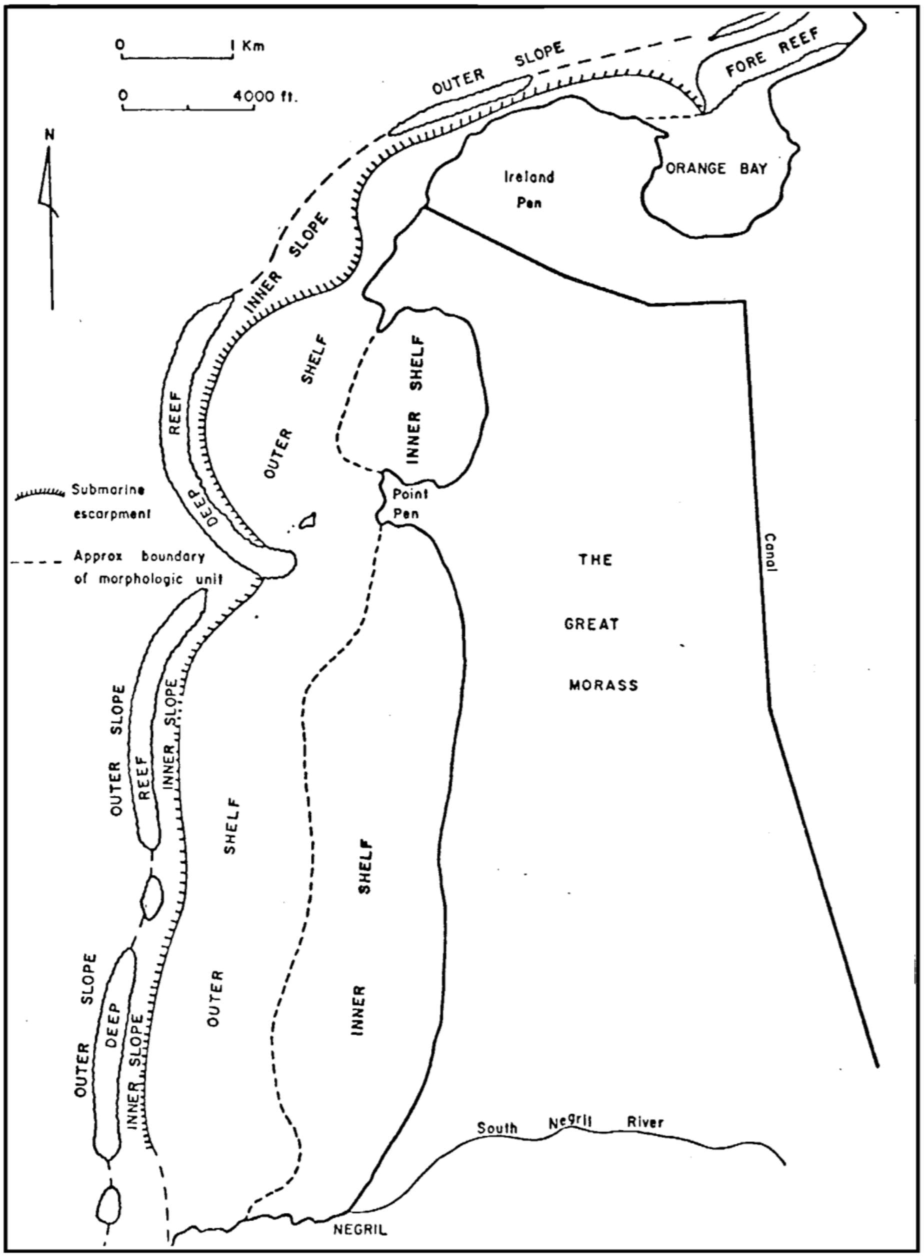


Figure 6-2: Morphology of offshore area at Negril. (Taken from Hendry, 1982)

6.1.1.3 Bathymetry and Shoreline Elevations

Analysis of the water depth contour plot, superimposed on satellite imagery (from the SWIL 2018 Design Report), provided insight on how wave propagation within the nearshore areas of Sandals affects the coastline. It also assisted in explaining why some areas along the coastline appear more vulnerable to erosion. Results indicate the following key points:

a. Locations where the shoreline has receded further inland appear to coincide with deeper areas that are closer to the shoreline. Erosion could consequently be induced by the propagation of larger waves in these deeper areas;

b. The contours may also be causing a divergence of waves away from the middle section of the beach, thereby pushing sand away to the south and focusing wave energy on the northern section of the beach.

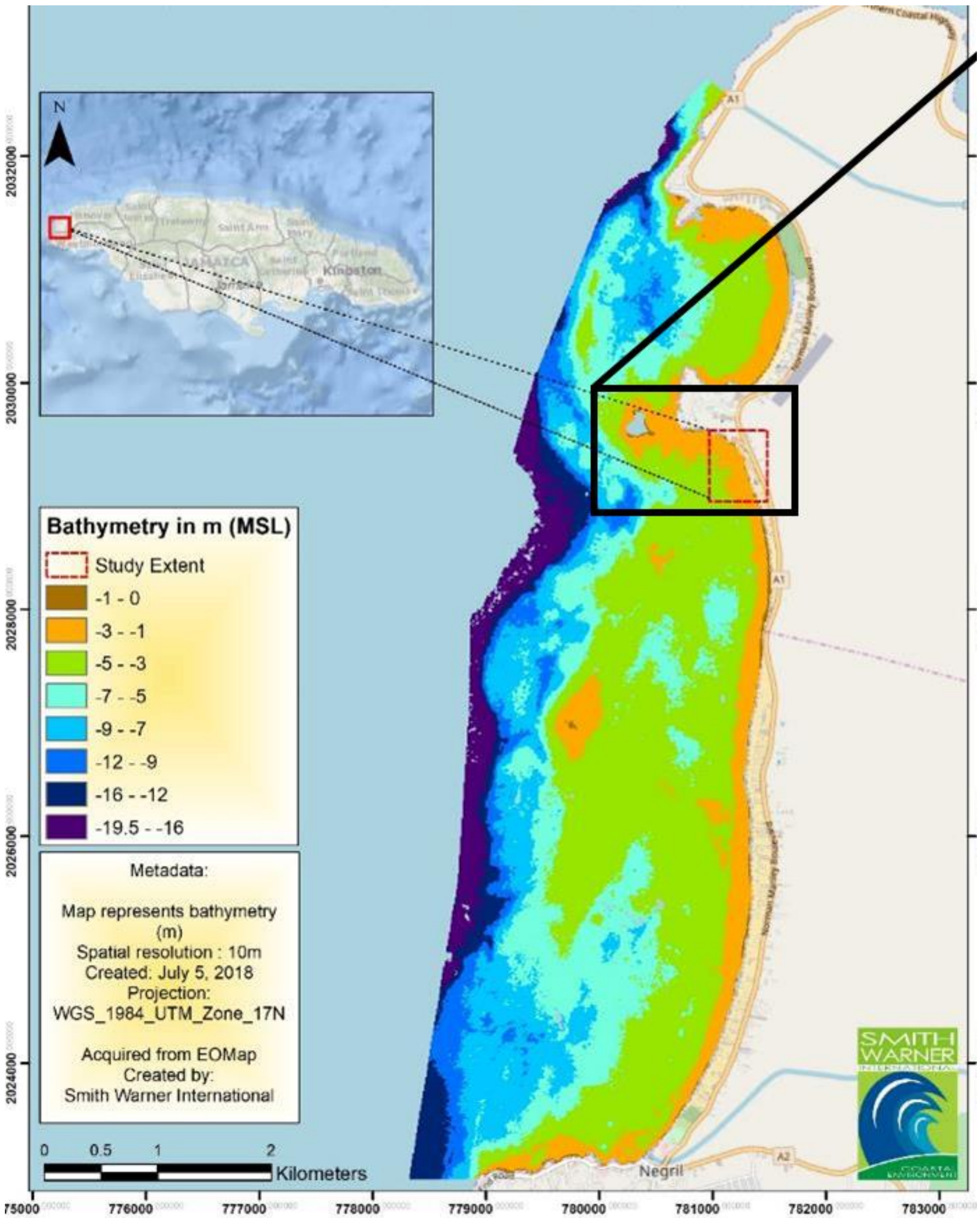


Figure 6-3: Satellite derived bathymetry of Negril Jamaica (modified from SWIL, 2018)

6.1.1.4 Beach Sediment Sources and Production

Mitchell et al. (2000) analysed Negril beach sediment (collected in 1990 and 1999) composition. The following was noted:

- The non-skeletal components are dominated by amorphous and crystalline grains;
- The skeletal grains are characterised by abundant *foraminifera* with smaller amounts of red algae, bivalves and *Halimeda* (green algae). Grains derived from corals were absent;
- The skeletal grains indicated that the carbonate sediment was produced primarily in the shallow water inner shelf, which is characterised by extensive *Thalassia* seagrass meadows and carbonate sand substrates.

Khan and Robinson (quoted in SWIL, 2007) also concluded that carbonate sediment production in Negril is predominantly a result of the green algae *Halimeda*; foraminifera (typically *Archaias*), and epibionts generated in *Thalassia* seagrass meadows.

Mitchell et al. (2000) also noted that with the increase in development in the Negril area, there has been an increase in nutrient influx to the marine system that has resulted in the decline in the coral reefs. Similarly, there has been a decline in the *Thalassia* meadows with the replacement of *Thalassia* by fleshy algae due to nutrient influx and removal and/or damage by the tourism industry. At the time it was stated that the loss in seagrass area would lead to a reduction of carbonate sediment production and consequently, the increased likelihood of beach erosion.

A study done by Shakira A. Khan and Edward Robinson indicated the following as it relates to sediment production:

- Regional investigations estimate that sediment production rates tend to range from 80 to 2,000 g/m^2/year, depending on the species and density;
- For Negril, using 2003 satellite images and field investigations, the area of seagrass beds was estimated to be 5,000,000m^2 (4,000,000m^2 for Long Bay and 1,000,000m^2 for Bloody Bay). This yields a sediment production of 200–5,000 m^3/yr for the entire Negril area, a very small amount of sand compared to the total volume of sand in Negril (millions of cubic metres).

These data suggest that Negril has a low sediment production rate. Therefore, coupled with increased erosion and loss in seagrass area, erosion of the coastline is likely to be greater than the accretion of the Negril coastline.

6.1.2 Coastal Processes and Sediment Transport

6.1.2.1 Waves

Several studies have modelled coastal processes in Negril. A 2018 SWIL report prepared for Sandals Negril updates previous Negril work, for example, the SWIL (2007) study, where background analyses included collection of wave and current data for just over five weeks between October 20 and November 28, 2006.

This was augmented by longer term data from the United Kingdom Meteorological Office whose database includes ship observations and wave hindcasting.

A brief summary of the data showed that:

- Once waves reach nearshore Negril, they approach the shoreline most often from the north, northwest and west;
- Waves with the largest magnitudes, greater than 1.5m, only occurred in the west and northwest directional sectors during this time and are probably associated with the swell wave events that occurred during the measurement period;
- The largest wave, 2.91m, was measured on November 21 during the swell event;
- A smaller fraction of waves approach from the southwest. These were generally less than 0.5m.

SWIL then transformed this data using computer programmes, propagating the waves into shallower water of the Negril area, and eventually, in to models for storm surge and longshore sediment transport.

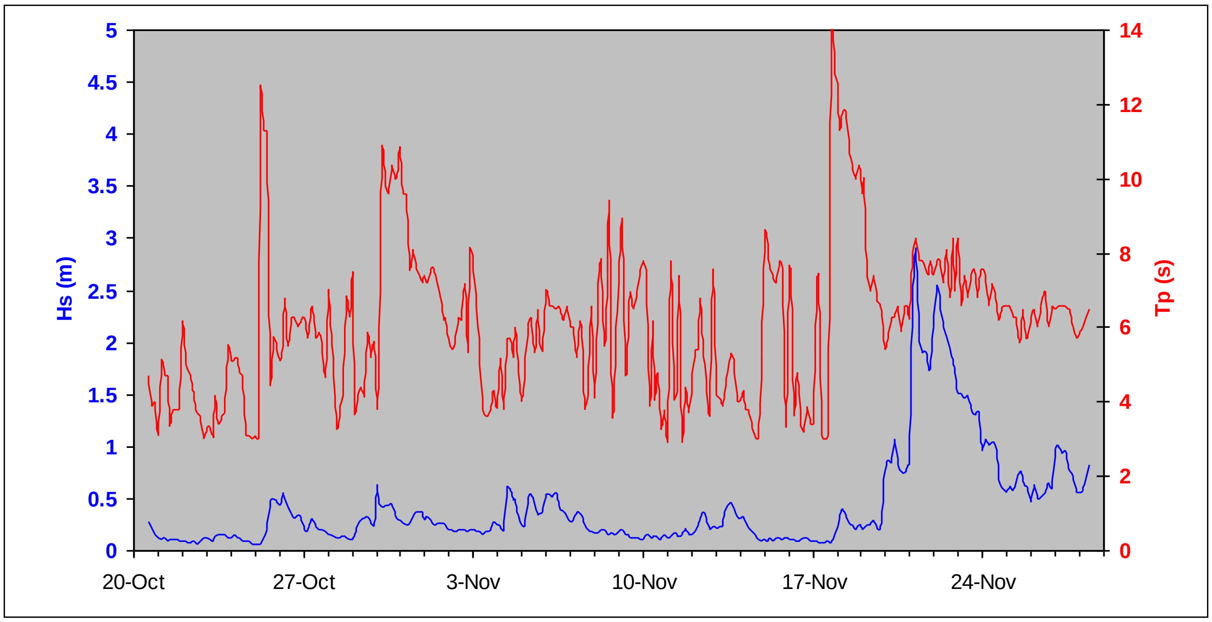


Figure 6-4: Time series of wave conditions measured in Negril (October 20 to November 28, 2007). From SWIL, 2007, Figure 5.2.

6.1.2.2 Currents

SWIL (2007) measured and modelled currents in Long Bay and Bloody Bay. In Long Bay, during rising tide current flow is to the north, with the flow direction reversing during falling tide. In northern Long Bay, nearshore currents during both rising and falling tide typically range from 8 to 12cm/s (centimetre per second). Within a small band adjacent to the shoreline, current speed drops to a range of 3 to 6cm/s. In southern Long Bay, currents range from 3 to 6 cm/s in nearshore areas, reducing as they approach the southern tip of the bay (SWIL, 2007).

Currents outside Bloody Bay are the fastest with values of 20 cm/s, but these bypass the bay. Within the Bay, currents do not exceed 2 to 3cm/s. Current directions in Bloody Bay do not differ greatly between rising and falling tide. Two gyres are formed inside the bay. The northern one circulates counter-clockwise and the southern one circulates in a clockwise direction (SWIL, 2007).

6.1.2.3 Longshore Sediment Transport

Alongshore sediment drift is a result of the daily wave action and the associated longshore currents driven by these waves. On most coastlines, waves reach the beach from different quadrants, producing day-to-day and seasonal fluctuations in transport magnitude and direction.

As with the wave and surge analysis, details for how the models are used to compute the longshore sediment transport are contained in the report by SWIL (2007). Using the bathymetric and beach profile data, SWIL created twenty (20) profile lines, extending from approximately +1.0 m above the mean sea level (MSL) to a water depth of 5m along the Negril coastline. The extensive seagrass beds in the nearshore areas were also considered in the analysis as they provide additional resistance from erosion compared to bare sand. Erosion in the model was prevented in seagrass areas, while deposition of sediments could still take place.

Figure 6-5 provides an indication of the direction and size of the longshore transport in each profile.

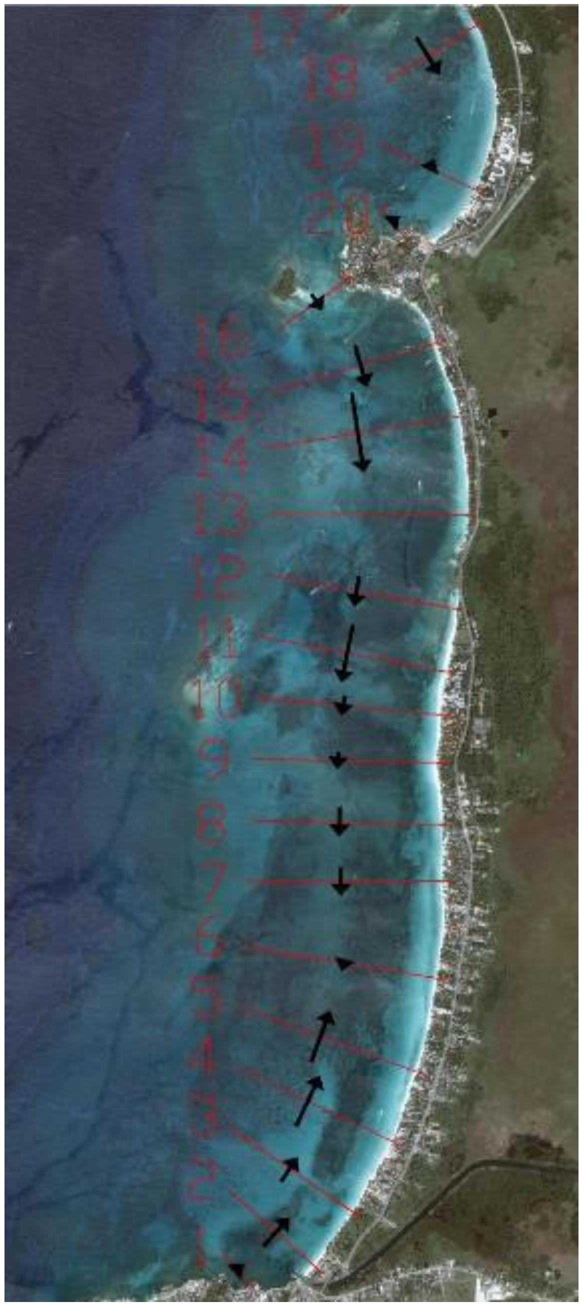


Figure 6-5: Indication of longshore transport direction and size. Longer arrows indicate higher values of transport (SWIL, 2007).

Longer arrows indicate larger transport rates than shorter arrows. Profiles at the north generally show transport in a southerly direction, while in the south, sediment transport is predominantly northward. This is consistent with the bathymetry in the bay, and approach directions of refracted waves. Most of the longshore transport is directed towards the centre of the bay (SWIL, 2007) and at profiles 6, 7, 8, 9, and 10, where the magnitude of sediment transport is smaller than in the northern and southern ends of the bay. The main sediment transport zone is within 50–100m of the shoreline, within the breaker zone, where the waves transfer most of their energy.

The results of the longshore transport modelling, for net and gross annual sediment transport values for each profile shown in Figure 6-5, are summarised in Table 6-1. The results show that the overall alongshore sediment transport rates are quite low. This is also likely to be a result of the gentle offshore slope and usually mild wave conditions.

Table 6-1: Annual sediment transport per profile. Positive transport to the north and negative transport to the south.(Taken from SWIL, 2007, Table 7.1)

Profile	Net transport (m^3/year)	Gross transport (m^3/year)	Comment
1	1800	2300	South end of Long Bay
2	12900	13900	
3	9400	11400	
4	18800	23400	
5	17700	25000	
6	1300	13800	
7	-9200	15600	
8	-9200	13200	
9	-4900	19500	
10	-6200	21500	
11	-19300	20600	
12	-9400	13400	
13	0	0	
14	-25900	26100	
15	-14100	14300	
16	-6500	6500	North end of Long Bay
17	0	0	North end of Bloody Bay
18	-14300	14300	
19	600	7000	
20	1800	2700	South end of Bloody Bay

6.1.2.4 *Cross-shore Sediment Transport*

Cross-shore sediment transport includes both offshore transport, which occurs predominantly during storms with elevated water levels, accompanied by high wave activity, and onshore transport, which dominates during regular, milder, day-to-day wave activity. Offshore transport tends to occur much more rapidly and has the potential for damage and loss of land.

The same profiles used by SWIL in the longshore sediment transport analysis were used in the cross-shore modelling (Figure 6-5). The swell event was modelled to simulate the beach profile change in response to storm events. The model prediction correlated very well with the measured post-storm beach profile.

While the pre-storm profile was assumed, the amount of erosion as a result of the winter swell storm is shown to be significant, with values in the order of a 0.5 to 1.0m vertical drop. This also agreed with field measurements made by SWIL, where erosion of up to 1.0m was observed at several locations along the beach after the swell event.

SWIL (2007) concluded that while winter swell events may not be that common, occurring 2 to 8 times a year, they are responsible for a tremendous amount of erosion when they do take place. The summary below highlights important observations of the study:

- Negril beaches experience large fluctuations in beach width;
- Storm and swell events transport sediments offshore, quickly eroding the coastline;
- Day-to-day (operational) wave conditions slowly transport the sediment back onshore, enabling the beach to recover over time;
- While the sediments transported offshore during smaller storm events will likely return to the beach through daily wave processes, larger storm and hurricane events have the capacity to remove sand completely from the littoral system.

Consequently, if not replaced by sediment production from within the seagrass beds, the longer-term effects will be erosion and shoreline retreat.

6.1.2.5 Historical Shoreline Changes

There are variations in both the rates and amount of change in shoreline position which may be accounted for by different methodologies applied in several reports. Overall, however, longer term trends are consistent between these studies. Within any year, SWIL (2007) notes that shorelines can vary in width by +/− 30 metres. Both the long-term changes and short-term fluctuations are important in relation to the Sandals project.

SWIL (2018) assessed trends of accretion/erosion from 1968 to 2018 using four selected profiles on the northern Long Bay shoreline. Results indicate the shoreline at Sandals has receded with an average of 0.21 m/year over the 50-year time span. SWIL notes that while the overall trend is one of erosion, the rates fluctuate between erosion and recovery (accretion) processes.

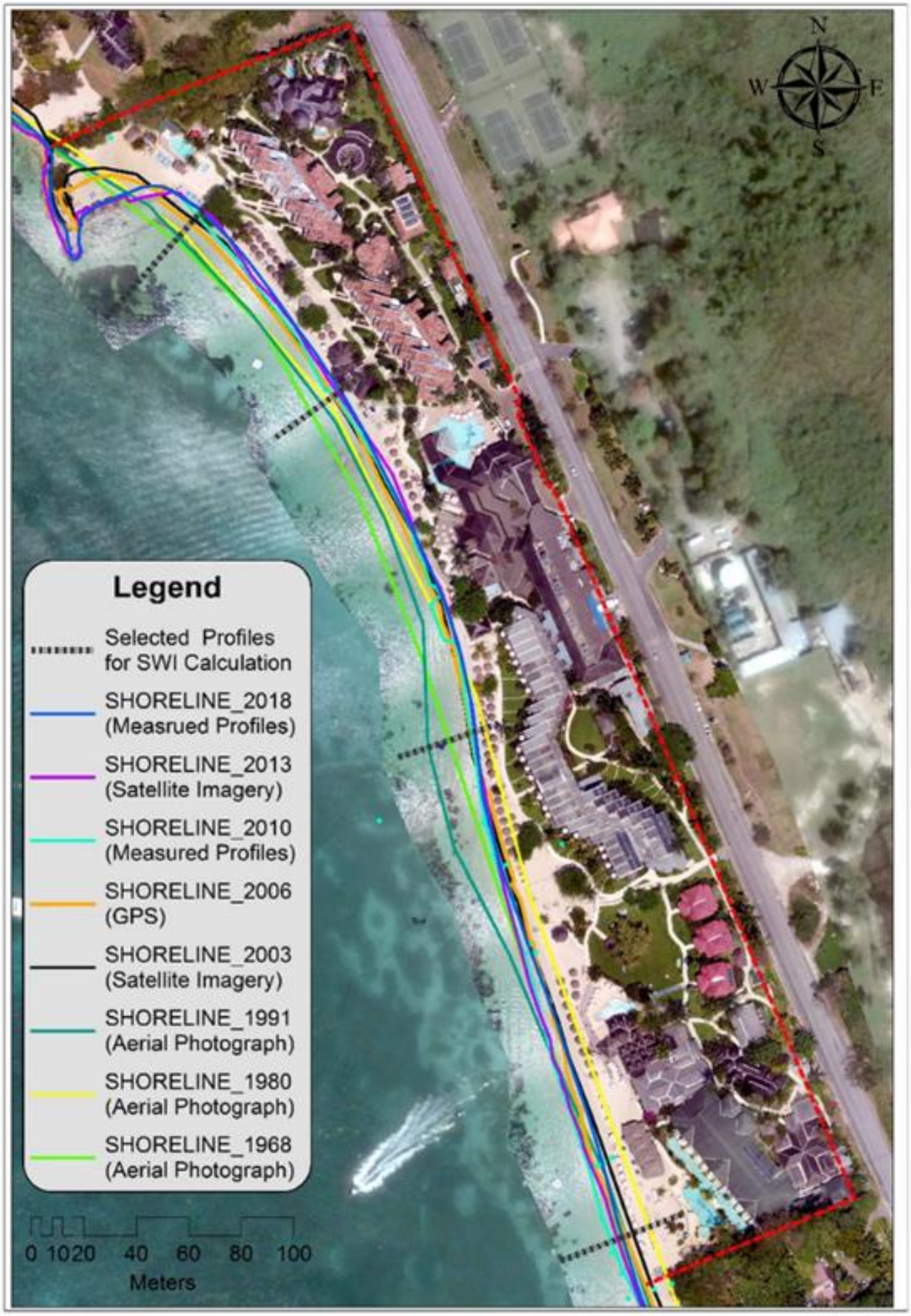


Figure 6-6: Historical shoreline comparison mapped along the shoreline of Sandals Negril from 1968 to 2018 (Source: SWIL, 2018)

Assessing changes in Bloody Bay is important given the proposed mining of sand from an area between the beach and coastal road to provide sand for nourishment in Long Bay. As with Long Bay, the longer-term trend in Bloody Bay is erosion (Figure 6-7).

Figure 6-7: Comparative shoreline positions, Bloody Bay (from SWIL, 2007). The scale bar suggests approximately 40–50 metres of land loss between 1968 and 2006.

Table 6-2 provides a summary of rates of change in Long Bay and Bloody Bay.

Table 6-2: Erosion rate in m/yr at Long Bay and Bloody Bay (from SWIL, 2007, Table 4.1).

Period of Measurement	Long Bay (m/yr)	Bloody Bay (m/yr)
1968–1980	0.80	1.25
1980–1991	1–2	1.25
1991–2006	1	0.3
1968–2006	1	0.5

Following are the highlights of the summary:

(a) While there are variations depending on location and in between different time periods, aerial photographs indicate average reductions in beach width of 30–40m across the entire length of Long Bay and Bloody Bay (SWIL, 2007). In some locations, overall erosion is greater than this;

(b) Mitchell et al. (2002), SWIL (2007), Robinson et al., (2012) and the Office of Disaster Preparedness and Emergency Management (ODPEM) Climate Risk Atlas (draft) consider shoreline erosion as a post-1950 development. This appears to coincide with the development of a high-density tourist industry along the ocean edge; and also major alterations to the wetland drainage and increased nutrient run-off affecting the health of sand-producing, shallow water seagrass ecosystems, where calcareous organisms are being replaced by fleshy algae. Mechanical removal of seagrass beds is also reducing sediment-production capacity.

6.1.2.6 Hurricane and Swell Effects on coastal erosion

McKenzie (2012) analysed the period between 1950–2007 when approximately 79 storms systems came within 250 miles of Jamaica. Thirty-one attained hurricane status at their closest points to Jamaica. McKenzie assessed erosion and recovery caused by four category 4 hurricanes in Long Bay as follows:

Table 6-3: Erosion and Recovery of Beach Pre- and Post-Hurricane events at Long Bay, Negril (Source: McKenzie, 2012)

Hurricane	Average Erosion	Average Recovery	Net change, metres
Hurricane Michelle, October 2001	Between 11m in the north to 16m in the south of the bay	14m – Between 10m in the south to 16.5m in the north	0
Hurricane Ivan, September 2004	16 metres	12 metres	-4
Hurricane Wilma, October 2005	19 metres	18m – 23m in the north to a low of 7m in the south	-1
Hurricane Dean, August 2007	11m- Between 15m in the north to-7 metres in the south	No data	No data

Hurricane effects are contained within longer-term measurements of shoreline change. However, both the longer-term changes and those changes brought about by storms have significant implications for shoreline management.

Swells are long-period waves that have often travelled beyond their area of generation. These are common in the Caribbean during winter months, often associated with cold fronts from North America. SWIL (2007) reports the influence of a swell event between November 21–24, 2006. Erosion of 1–2 metres depth occurred in southern and northern Long Bay, although the middle section, other than receiving quantities of seagrass and algae, washed up by the waves, did not change. A common response to these events, however, is that during periods of reduced wave action, sediment is moved back towards the beach area. This was further corroborated by hotel stakeholders interviewed during this EIA process.

SWIL (2007) indicates that for a storm with a 10-year return period, the significant wave height in deep water is about 6.5m. These types of high energy waves transform the profile far more drastically than swell waves and severely redistribute the sediment. However, since these storms are infrequent, they are not the cause of the long-term erosive trend, but merely exaggerate it.

6.1.3 Water Quality

Water quality samples were collected at four locations (Figure 3-1) on October 3, 2018 and analysed as outlined in Section 3.1.1. Table 6-4 below gives the results of the water quality assessment. The result certificates for samples collected are presented in Appendix 12.7

Table 6-4: Water Quality Results – October 3, 2018

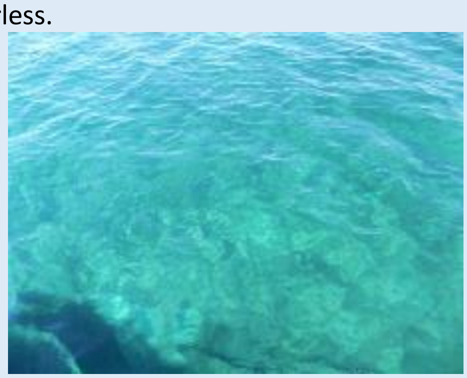
Parameter	WQ1	WQ2	WQ3	WQ4	EHU Recreational Water Standard	Ambient Water Standard – Marine
pH	8.17	8.16	8.17	8.2	–	8.00 – 8.40
Temperature (˚C)	29.2	29.2	29.3	29.4	–	–
Salinity (ppt)	35.94	36.04	36.12	36.1	–	–
Dissolved Oxygen (mg O_2/L)	5.66	5.18	5.07	6.03	–	–
Turbidity (NTU)	<0.41	0.71	1.33	0.76	–	–
Biochemical Oxygen Demand (mg O_2/L)	<0.1	<0.1	<0.1	1.1	–	0.0 – 1.16
Total Suspended Solids (mg/L)	3.5	3.5	4.1	3.3	–	–
Nitrates (mg NO3-/L)	<0.01	<0.01	<0.01	<0.01	–	0.007–0.014
Orthophosphates (mg PO_4^{3-}/L)	<0.02	<0.02	<0.02	<0.02	–	0.001-0.003
Faecal Coliform (MPN/100mL)	<1.8	<1.8	<1.8	<1.8	<400	<2 – 13
Enterococci (MPN/100mL)	<1.8	<1.8	<1.8	4	<160	–
Total Alkalinity (mg $CaCO_3$/L)	74.48	98.2	98.53	93.19	–	–
Lead (µg/L)	<20	<20	<20	<20	–	–

Iron (µg/L)	0.27	0.24	0.21	0.28	–	–
Copper (µg/L)	15	15	<10	18	–	–
Mercury (µg/L)	<0.2	0.41	<0.2	0.44	–	–
Arsenic (µg/L)	<10	<10	<10	<10	–	–
Zinc (µg/L)	<10	10	<10	10	–	–
Fats, Oils and Grease (mg/L)	1	1	<1	1	–	–
Cadmium (µg/L)	<10	<10	<10	<10	–	–

Data from October 3, 2018 were compared to data collected from nearby sites during the 2014 Negril Breakwater EIA[4]. In all cases, current values were different from the 2014 EIA values. Nitrates, pH, orthophosphates and Biochemical Oxygen Demand (BOD) values were all lower. Dissolved oxygen showed no distinct trends from the 2014 values and faecal coliform was undetected (<1.8MPN/100mL) at all sites for the 2018 assessment. Though faecal coliform was detected in 2014 near WQ2 (Figure 3-1), the EIA did not give any information as to the possible sources of these microorganisms.

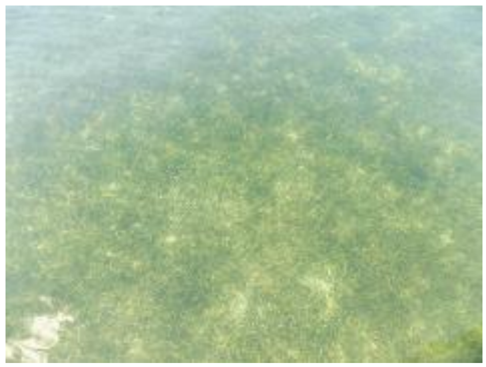
Enterococci bacteria were detected (4MPN/100mL) at WQ4 (southern end of the property) though well below the recreational water standard of 160MPN/100mL. Since this is the only site to test positive for these bacteria, it is likely that the source is localised and is potentially from stormwater outflows.

While there were no adverse findings of the water quality, the consultants made some observations that are of note.

Sample Location (Figure 3-1)	Description
WQ1	The sample was collected west of Booby Cay. Corals, starfish, sea urchins and other marine life forms were observed. The sample was collected at a depth of approximately 2 feet and was clear and colourless. 

[4] Environmental Impact Assessment: Construction of two breakwaters at Long Bay, Negril Westmoreland, CL Environmental Limited, 2014

	
WQ2	The water sample was collected north of the Sandals property.  The sample was collected approximately 2 feet below the water surface and was clear and colourless. Seagrass was observed in this area.
	The water sample was collected in the middle of the Sandals property. Bathers were in view and stormwater drains were seen on the shoreline.  The sample was collected at approximately 2 feet and was clear and colourless. Algae was observed in this area.
	The water sample was collected at the end of the Sandals property, downwind of the proposed project site. The water in this area was clear with a greenish hue; seagrass was observed in this area.

Along the beach at Sandals Negril, there are drain pipes that take water from the storm drains that run along the walkway on the beach as well as from the showers which are located ~100m apart (see Figure 6-8).

Figure 6-8:Drain pipes emptying into the beach at Sandals Negril

In some cases, as with the images above, algae were noted in the depressions made from outfall from the drain pipe. Similar depressions were observed at other areas of the property.

Algae were also observed at various points along the beach, especially in the bay marking the beginning of the Sandals property, as seen in the images below:

Figure 6-9: Algae in the bay marking the beginning of Sandals Property, Negril, October 3, 2018

Figure 6-10: Algae at other points along the beach of Sandals Negril, October 3, 2018

The algal growth seen along the shoreline may be as a result of the water being discharged from pipes along the beach. These pipes carry grey water from the shower areas and surface runoff from the lawns to the sea. Fertilisers used on the lawn and soap/body wash used for bathing may contain nutrients (both phosphates and nitrates). These nutrients are critical to the growth and proliferation of algae.

6.1.4 Noise Levels

Table 6-5 below gives the results of noise assessment done along Norman Manley Boulevard (locations shown in Figure 3-2) on October 2 and 3, 2018.

Table 6-5: Noise Levels for Sites monitored along Norman Manley Boulevard, Negril, October 2, 2018

Sample Site (Figure 3-2)	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
N1	Club Riu Hotel	56.1	65	This area was an 80km/hr zone upwind of the proposed extraction site. Wind was blowing in a southerly direction and the sky was cloudy. Background noises included chatter and rustling of leaves as well as the intermittent passing of vehicles.  
N2	Undeveloped land	65.1		This area was an 80km/hr zone across the roadway from the proposed sand extraction site. Wind was blowing in a southerly direction. The land was undeveloped on both sides and background noises primarily from vehicular traffic (cars speeding pass). 
N3	UDC Office	68.5		This area was an 80km/hr zone downwind of the proposed site where the sand to be used in the Sandals beach nourishment exercise is located. The site was also upwind of an active construction site (at

Sample Site (Figure 3-2)	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
				the time of the assessment) at the RIU Hotel in Bloody Bay.  Wind was blowing in a southerly direction and the sky was cloudy.
N4	Negril Aerodrome	61.0		The site was also downwind of an active construction site (at the time of the assessment) at the RIU Hotel in Bloody Bay. Cars were parked on the side of the road. The area was dusty with trucks approaching from the south. 

Sample Site (Figure 3-2)	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
				 
N5	Entrance at Royalton and Hideaway and Grand Lido	76.8		This area was a 50km/hr zone located at the entrance to the Royalton, Hideaway and Grand Lido Hotels.  Background noise included cars and bikes passing with tooting horns.

Sample Site (Figure 3-2)	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
				 An undeveloped lot was located across from this area.
N6	Sandals Entrance	70.7		This site was at the entrance to the Sandals Hotel. A parking lot was located across from the hotel. Winds were blowing in a southern direction and the sky was overcast.  
N7	Boardwalk Entrance	74.2		This site was at the entrance to the Boardwalk resort. An undeveloped lot was located across from this area.

Sample Site (Figure 3-2)	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
				   Winds were blowing in a southern direction and the sky was overcast.

Table 6-6 below gives the results of the noise assessment done along the Sandals Negril beach. (Figure 3-3 shows the locations of the sample sites).

Table 6-6: Noise Results along Sandals Beach, Negril, October 3, 2018

Sample Site	Location	Noise Level (dBA)	NEPA Ambient Noise Standard (dBA)	Description
N8	North End of Beach – Beginning of Sandals Property	60.0	65	Assessments done along the beach at Sandals, background noise primarily included music playing, waves crashing along the shore, the engines of passing boats and the chatter from bathers.
N9	–	61.0		
N10	–	66.2		
N11	Middle of Beach	70.4		
N12	–	61.8		
N13	–	66.0		
N14	South End of Beach – End of Sandals Property	67.6		

Based on the results obtained, the Norman Manley Boulevard which is a major thoroughfare generally has noise levels above the NEPA ambient guidelines for commercial zones. The noise levels obtained were due primarily to traffic along the road and a construction site that was active at the time of the assessment. The noise levels measured were, however, below the 95dBA standard which NEPA uses for the operation of Large Commercial Vehicles.

Noise along the beach on the Sandals property (Table 6-6) is primarily influenced by the music and chatter from bathers as well as intermittent impacts from water sporting activities.

6.1.5 Sources of existing Pollution

Extensive algal growth along the shoreline of Sandals was observed during the water sampling exercise indicating nutrient-rich (nitrates and phosphate) effluents are impacting this area. Enterococci, a bacteria found in the gut and whose presence in the environment indicates fecal contamination, was also detected in the water sample collected at sampling station WQ4 (Figure 3-1).

The storm drains may also be the source of the nutrients impacting the shoreline of the Sandals property. The consultants strongly suggest the client determine the sources of both the bacteria and nutrients. The characterisation of the effluents from the stormwater drain pipes should be the first step in determining if they are the source of both the enterococci and the nutrients impacting the sea.

The continued influence of nutrient-rich effluents will encourage the growth and proliferation of algae which will result in a deterioration water quality, affect coral growth and negatively impact the quality of the marine environment. There will also be an additional economic cost for the continued removal of algal growth from the water body. The presence of enterococci in the water (although low) should also be closely monitored. The presence of these microorganisms also suggests that other potentially more harmful microorganisms such as E coli may also be presence. Fecal contamination poses a serious public health risk.

No ground water samples were collected for analysis at or nearby the site. The Water Resources Authority (WRA) database shows the nearest well with available water quality data being approximately 4km away and the data recorded is from 1973.

The noise impacts on the property are mainly from the nearby thoroughfare and from the engines of personalised watercraft.

6.2 Biological Environment

6.2.1 Terrestrial Assessment (Bloody Bay Sand Extraction Site)

6.2.1.1 Terrestrial Flora

The general project area was designated at the macro level in the Forestry Department's land use map as secondary forest and field. While ground-truthing of the project area, the main vegetation habitat type observed was woodland/overgrown fields.

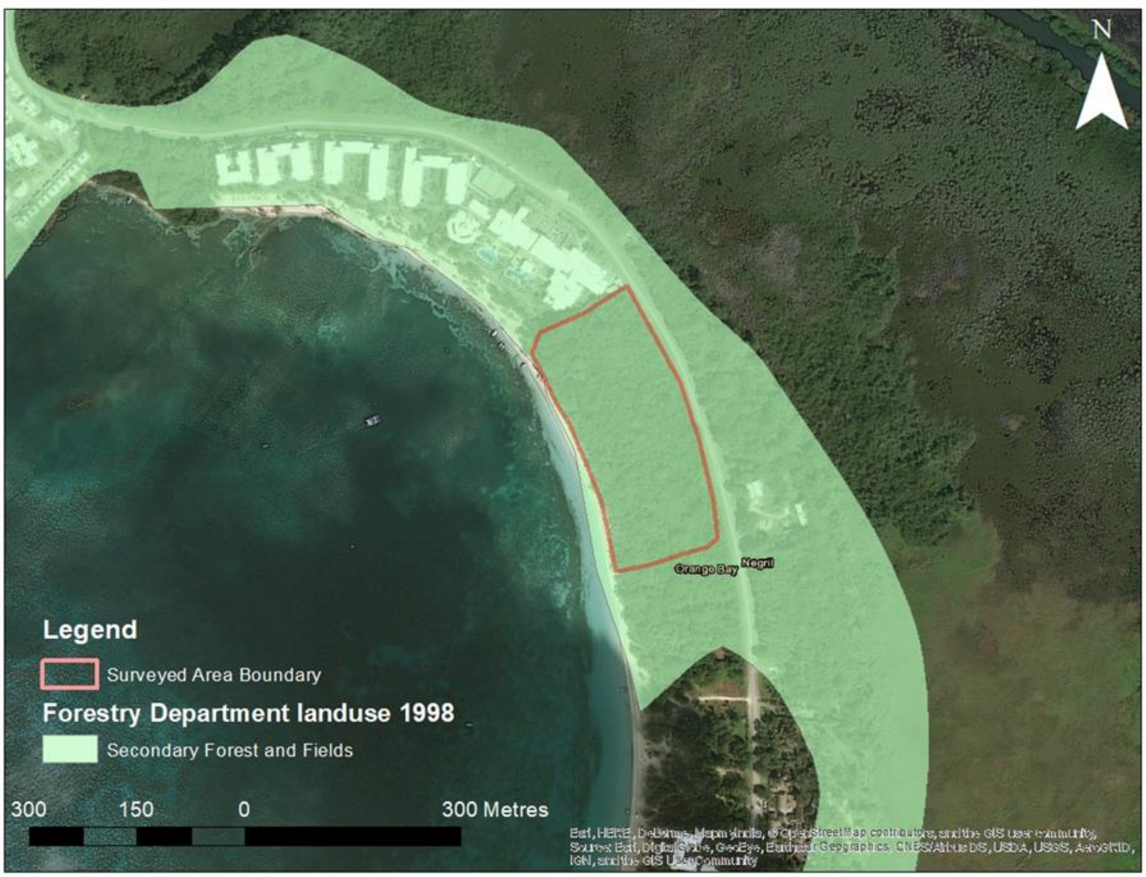


Figure 6-11: The main vegetation habitat type within the project area according to the Forestry department land use classification

The area of interest appears to have been significantly disturbed by anthropogenic factors over the years, with signs that significant clearance of the original vegetation had occurred. The vegetation found within the proposed sand extraction site is typically associated with the early stages of ecological succession. The general area displayed relatively low species diversity, as only 41 plant species from 25 families were encountered, most of them being trees and shrubs, along with a few climbers. The presence of certain species, such as mango (*Mangifera indica)*, noni (*Morinda citrifolia*), ackee (*Blighia sapida*) and guinep (*Melicocca bijuga*), is also an indicator of the heavy influence of anthropogenic disturbances on the vegetation, as these are species associated with the proximity of human settlement.

The majority of the trees encountered at the site were seedlings or saplings, with only a small portion of the trees being adults. The few mature trees observed during the assessment included mango (*Mangifera indica)*, cotton (*Ceiba pentandra*), royal palm (*Roystonea regia*) and red birch (*Bursera simaruba*) trees.

Most of the species encountered are classified as being most commonly found in thickets, ruinate, and secondary woodlands. Of the 41 plant species found within the study site, 5 of them are endemic to Jamaica. None of the species encountered during this study are deemed to have any special conservation status (protected/endangered species).

Within the S9 sample area (Figure 3-8), a total of 31 species were identified, belonging to 23 families. The S9 block had the highest number of species and families when compared to the other blocks sampled. The most dominant plant species observed in this area were almond (*Terminalia catappa*), black jointer (*Piper nigrinodum*) and Santa Maria (*Calophyllum calaba*). The understory within this block was dominated by seedlings of the following species: Santa Maria (*Calophyllum calaba*), rod wood (*Eugenia disticha*), ackee (*Blighia sapida*) and black jointer (*Piper nigrinodum*). The block also had several almond trees having a diameter at breast height (DBH) greater than 35cm. A large cotton tree (*Ceiba pentandra*) with DBH > 50cm was observed within the S9 block.

The S6a block had a total of 21 plant species belonging to 17 families. The most dominant species observed within this block was almond (*Terminalia catappa*). A total of 5 endemic species was identified within this sample area. The S6a area was vegetated primarily with seedlings that covered the understory; the larger trees were mostly immature trees with DBH <15cm, with mature trees with DBH >25cm scattered sparsely across that block.

In block S6b, a total of 18 plant species were observed belonging to 17 families. The most dominant species observed within this block was almond (*Terminalia catappa*). A total of 2 endemic species was identified within this sample area. This block had the lowest number of species when compared to the other blocks.

Within block S5, a total of 22 species and 18 families was identified, 3 of which were endemic. The most dominant species encountered within this block was Santa Maria (*Calophyllum calaba*).

6.2.1.2 Bird Surveys

Thirty-four (34) species of birds were identified during the assessment of the Bloody Bay property (see Appendix 12.6 for all species lists). Thirty (30) terrestrial and 4 wetland birds were observed. Of the 34 species, there were 8 endemics, 9 migrants and 13 residents. Their abundance was ranked using the DAFOR scale (See Appendix 12.6).

- **Wetland birds**

The wetland birds observed during the study were herons and egrets. Of note, none of the species encountered had special conservation status. The night herons were observed foraging on the beach at dusk.

- **Terrestrial birds**

Only thirty terrestrial species were observed during the study over the two days and one night. The majority of the species were observed foraging in the canopy cover. The bird species composition observed on the property was typical of a dry limestone forest (Downer and Sutton, 1990). These birds included the Columbids, Parakeets, Hummingbirds, Jamaican Woodpeckers, Orioles, and Warblers. Only 8 of the 31 endemics found in Jamaica were observed. It should be noted that only 4 of the endemics were forest-dependent. The Red-billed Streamer-tail Humming bird and the Jamaica Woodpecker were the two most common endemics on the property. A possible nest for the endemic Jamaican Parakeet was observed in a termite mound (Figure 6-12).

Figure 6-12: Termite mound used as a nest for by the endemic Jamaican Parakeet

Nine migrants (1 summer and 8 winter) were observed during the study. The winter migrants usually arrive to Jamaica as early as the month of September. Seven (7) of the 9 migrants observed were warblers. It should be noted that the Louisiana Waterthrush, another migrant, was observed foraging in the potholes on the road which were filled with water. The Grey Kingbird which is a summer migrant was also observed on the property. It should be noted that the majority of the species migrate back to South America in the winter.

6.2.1.3 Amphibians

Only two amphibians were recorded on the property, *Eleutherodactylus johnstonei* and *Eleutherodactylus pantone.* The *Eleutherodactylus* species observed are not endemics and are usually found in highly disturbed areas.

The area was visited during the night survey and no other frog species were heard calling. A large number of the amphibians found in Jamaica are found exclusively in bromeliads. Only a few bromeliads were observed in the woodland area of the property (Figure 6-13).

Figure 6-13: Tank Bromeliads observed on the property during the study

6.2.1.4 Reptiles

Five (5) reptiles were identified during the assessment (See Table 12-8). Three species were endemic, however, they all are widely distributed throughout the island. The most abundant reptile in the study area was *Anolis sagrei,* which is an introduced species. At least one was observed on each of the trees (Figure 6-14).

Figure 6-14: The Cuban Anole observed on the tree on the property

6.2.1.5 Arthropods

A low number of invertebrates was observed during the assessment of the property. Only 15 species of insects were observed during the assessment. Only 4 butterfly species from 4 families were identified during the study. None of the species was endemic or of any special conservation status.

The giant metallic Ceiba Borer (*Euchroma gigantea*) beetle was observed on the cotton trees on the property. They are not protected by law, however, their numbers have reduced significantly over the island because they are dependent on the cotton trees, which are also decreasing in numbers (Figure 6-15).

Figure 6-15: The Giant Metallic beetle observed on the cotton tree

It should also be noted that several large termite nests were observed on a few of the trees. During the night survey a few fire flies and unidentified moths were observed.

6.2.1.6 Other fauna

Crustaceans

Two land crabs were observed on the property namely the Purple (*Gecarcinus ruricola*) and the Blue (*Cardisoma guanhumi*) Land Crabs (see Figure 6-16). Several *Cardisoma guanhumi* holes were observed during the survey of the property and there were approximately 4 holes/m^2. Several were seen foraging during the night surveys.

Figure 6-16: Purple land crab (Gecarcinus ruricola) observed on the property

Mammals

Cats and dogs were seen on the property during the survey.

Bats

Fruits bats were observed in the almond tree during the night survey. Fish-eating bats were also seen foraging on the coast during the night survey.

6.2.2 Marine Assessment (Long Bay)

6.2.2.1 Benthic Assessment of Backreef

The backreef area is shallow (0–5m). Satellite imagery and ground-truthing show that the substrate within the footprint of the proposed groynes was largely bare (sand, rubble) (see Figure 6-17). Where present, the seagrass formed a thick, dense mat (mean cover of 78%) with mean canopy heights of up to 20cm. Seagrass species makeup is predominantly *Thalassia testudinum* (Turtle grass), and secondarily *Syringodium filiforme* (Manatee grass). Large, fleshy macro-algae, for example, *Padina*, *Dictyota* and *Halimeda* sp were absent. Numerous species of fauna across different groups were observed in the backreef including invertebrates (urchins, anemones and sea stars) and other fish (grunts, damselfish, and wrasses).

Figure 6-17: Habitat Map of northern Long Bay (source: SWIL, 2018)

Table 6-7: Mean percent cover of substrate observed during the backreef assessment at Long Bay (Sandals Negril)

Groyne Footprint Area	Mean % cover of substrate (per 50m²) observed during Backreef Assessment				
	Seagrass (SG)	Sand (SD)	Pavement, Rubble (RB)	Hard Coral (HC)	Other Live (OL)
1	71%	22.5%	4%	0.5%	1%
2	46%	52%	2%		
3	73%	21%	5%		1%
4	32%	64%	4%		
5	21%	76%	3%		
6	22%	74%	4%		

Figure 6-18: Example of substrate observed in the footprint of the northern groyne and proposed groynes 1, 2 and 3

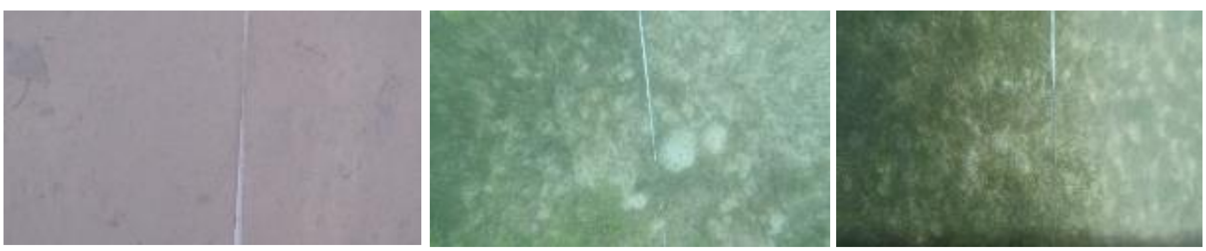


Figure 6-19: Example of sandy/bare substrate in the footprint of proposed groynes 3, 4 and 5

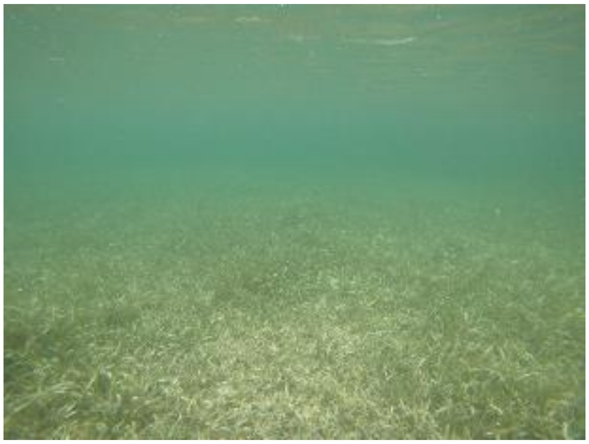


Figure 6-20: Example of seagrass typical of the wider backreef area (left) interspersed with fauna, e.g., small coral colonies (right)

6.2.2.1.1 Existing groyne and artificial reef structures

To the south-west of the existing groyne are artificial reef structures, or domes, created from steel bars and mesh. The substrate within this area is primarily sand and rubble, while the artificial reef structures are covered in macroalgae.

The area within the footprint of the northern groyne and within the crevices created by the placement of the existing rock groyne appears to be a nursery for juvenile fish (squirrelfish, grunts, damselfish and wrasses), and coral recruits (mainly *Porites astreoides, Porites furcata*). While the abundance of fish was moderate, the diversity (number of species) was low. The black long-spined urchin (*Diadema antillarum*) was frequently observed in this area. This species is of special interest as they are recognised as an important consumer of algae, and populations islandwide are still recovering from a massive die-off in the late 80s. Their presence is considered positive for both the seagrass and reef communities in Long Bay (see Appendix 12.6 for lists of all species observed).

Figure 6-21: Artificial reef structures act as habitats for fish and other invertebrates (left) and are covered in macroalgae (right) (Image source: SWIL, 2018)

Figure 6-22: Fish foraging within the area of the existing northern groyne (Image source: SWIL, 2018)

Figure 6-23: Example of coral colonies and juvenile fish observed in the area of the existing groyne (Image source: SWIL, 2018)

6.2.2.2 Fish Assessment

The fish community of the backreef was characterised by low densities, biomass and species diversity. Large schools of French Grunts (*Haemulon flavolineatum*) and Silversides (*Hypoatherina harringtonensis*) were abundant. While these species are too small to be considered commercially important (<5cm), they are a food source for larger carnivorous reef fish (for example, groupers) and can be used as baitfish. French Grunts are also commonly used as display fish in public aquaria.

Figure 6-24 School of silversides observed in the backreef area of Sandals Negril

Juvenile parrotfish were frequent in the backreef, though very few adult parrotfish were observed. In Jamaica, parrotfish are considered a keystone species, and an important indicator of reef health as they graze on macroalgae that compete with juvenile corals for space, and in doing so, one parrotfish can produce up to 100kgs of sand per year. The presence of juvenile parrotfish potentially signifies that the backreef area is used as a foraging ground, refuge and/or habitat for a commercially and economically important species.

Additionally, carnivorous fish, for example, Yellowtail Snapper (*Ocyurus chrysurus*) and barracuda (*Sphyraena barracuda)*, were also frequent in the backreef area, however, these were typically small (5-10cm).

6.2.2.3 Planktonic Survey

Zooplankton are the main grazers of primary production in marine ecosystems and are also a principal food source for ecologically and economically important fish. They also respond quickly to environmental variability, and changes in their population dynamics and species composition can indicate changes in local or large-scale ocean conditions. Hence, they are useful indicators for assessing ecosystem status (Webber et al., 2005).

The zooplankton community from the backreef area sampled was largely dominated by Cumacea, an Order of small marine crustaceans that are typically found in sandy and muddy benthos. Many fish feed on these organisms, hence Cumacea are considered to be an important link in the marine food chain. Additionally, small numbers of other food sources, namely fish, shrimp and crab larvae, were also found in the water column. Overall, this is an indication that the backreef area could generally serve as a foraging/feeding ground for marine fish, as is typical for seagrass communities.

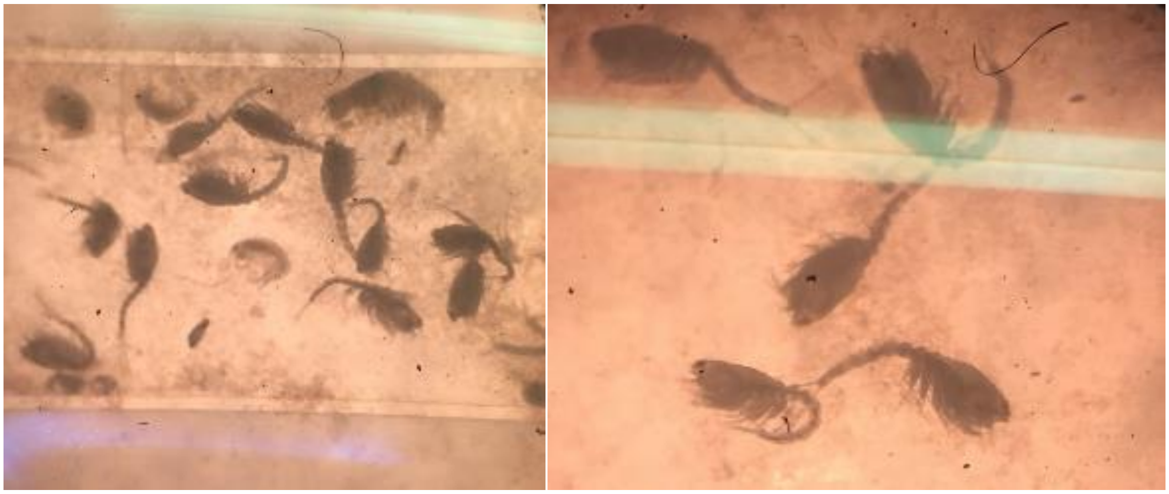


Figure 6-25: Left: Typical field of view displaying a selection of zooplankton spp. found at Sandals Negril; Right: Cumacea (dominant species found in samples)

Figure 6-26: Left: Amphipods of varying sizes; Right: Crab larvae (Megalops)

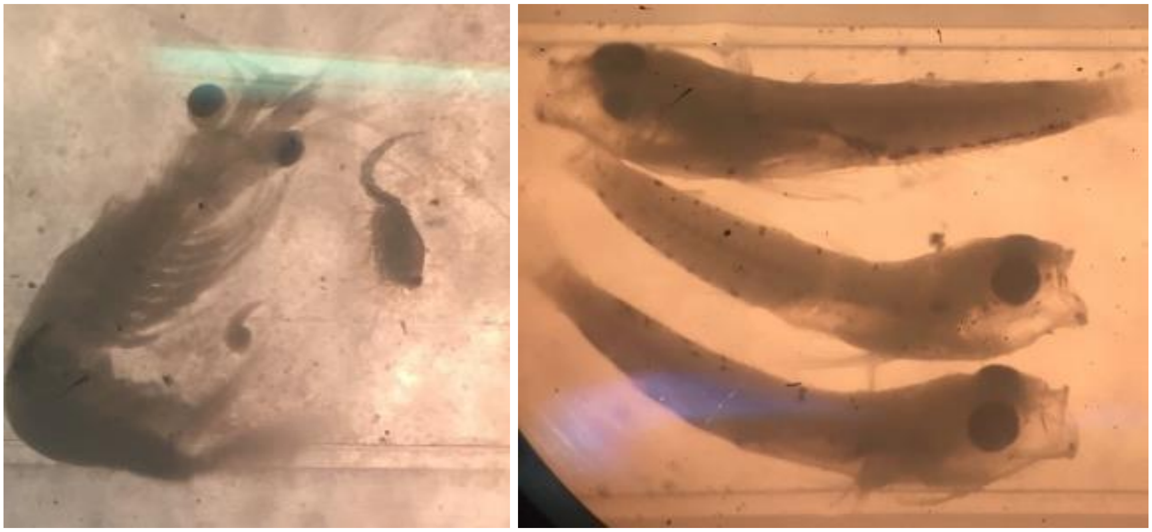


Figure 6-27: Left: Large shrimp larvae (decapod) and a species of Cumacea (small); Right: Fish larvae found in sample

6.3 Socio-Economic Environment

The socio-economic description of the study area is based mainly on the 2011 census data from STATIN, as well as updates, where available, and reasoned inferences by the consultants. The southern and central areas of Negril are the more densely populated and located in Westmorland, whereas the less populated northern area is in Hanover.

The Negril community can conveniently be described as comprising three main areas:

1. The beach area
2. The town centre
3. The residential areas of Westlands, and Whitehall.

Each is described in its respective sections below.

6.3.1 The Beach Area

The beach area extends from Bloody Bay, through Long Bay to the West End in the south (see Figure 6-1). This zone is mainly dedicated to tourism and comprises resort villas, apartments, guesthouses, restaurants, water sports facilities, craft vendors and other hospitality-oriented entities. Currently, an average of 7,500 rooms are available in the resort area of Negril (JTB, 2017).

The proposed project by SNG falls within the beach area. Sandals Negril was opened in 1988 and prior to that the Sundowner and Coconut Grove hotels were located at the present project site. The Sundowner Hotel dates to circa 1960s. Since 1988, SNG has grown to 226 rooms, and continues to be a major contributor to the local economy in Negril as well as the wider national economy through its foreign exchange earnings, employment opportunities, etc.

6.3.2 The Town Centre

The Town Centre is delineated by the point where the main road turns east towards Westmoreland. It contains the mercantile traders, financial institutions, government agencies, and private services such as service clubs, churches, and medical and educational institutions. It is also the main transportation hub for Negril.

6.3.2.1 Social/Cultural Amenities

Community members interviewed have characterised the social amenities in Negril as available, but not adequate for Negril's present population, both domiciled and visiting. The main social amenities are briefly described below.

The Negril Police Station

It is located within a short distance of the town centre. It falls within the Jamaica Constabulary Force's Area 1 Command, headquartered in St James. Operationally, it falls under the Westmorland Division located in Savanna-la-Mar. Planned refurbishment, in addition to basic repairs and maintenance, includes the housing of a c**losed-circuit television** (CCTV) facility.

Figure 6-28: Negril Police Station

Fire Brigade

The Fire Brigade station in Negril is in Red Ground. It falls under the Area 4 command of the Jamaica Fire Brigade Services. The Westmorland division of this command is in Savanna-la-Mar. Currently, this division has 4 trucks, of which 2 are in Negril. The station also has an ambulance. It is reported to need refurbishing. Community members think this level of service is inadequate to serve the fire emergency needs of Negril.

Figure 6-29: The Negril Fire Brigade Station

Health

Negril is currently served by a Type 3 health clinic. It is located along the Nonpariel Road, a short distance away from the town centre. It falls under the Western Regional Health Authority headquartered in Montego Bay. It provides mainly maternal and child healthcare, first aid, wound dressing, health promotion and education, basic laboratory services, community outreach and home visits.

Both the Sandals and Riu properties have provided support to the Clinic in the past: Sandals with refurbishing and the addition of examination rooms; while Riu Resorts has supported the Paediatric Orthotic Services Clinic in Negril, which is now housed at the health centre.

Figure 6-30: Negril Health Centre

In relation to public hospitals, the nearest are the Savanna-la-Mar Type B hospital and the Noel Holmes Type C hospital in Lucea. These are both approximately half an hour's driving time from Negril.

Other health care services are offered by private medical doctors. The Omega Medical Services (OMS) Limited, a firm that specialises in health-care support for the hospitality industry, is just commencing construction at its location on the Norman Manley Boulevard. It is proposed to be a 3-storey, 15,000 sq. ft development designed to serve both locals and visitors.

Stakeholders interviewed have expressed their dissatisfaction with the current level of health care facilities available to Negril. It is hoped that once constructed, the new facility will help to alleviate some of the pressures facing the health sector.

Negril Community Centre

The Negril Community Centre provides an auditorium/meeting venue and the building also houses the office of the Negril Green Island Local Area Planning Authority (NGIALPA), a regional office of the National Environment and Planning Agency (NEPA) as well as the Negril Area Environmental Protection Trust (NEPT).

Craft Market Vendors

Some other amenities that do not necessarily serve the local population of Negril are the craft market vendors.

Long Bay

In Long Bay, the main vending area is the craft market located at the southern-most end of the Norman Manley Boulevard leading into the town centre. There are approximately 131 stalls in the craft market. The majority of the vendors are a part of the Negril Local Authentic Craft Association, formerly known as the Negril Craft Traders Association. Each vendor has an annual lease agreement with NGIALPA which manages the complex. Vendors are also required to have TPDCo licences and must be up to date with their association dues.

Figure 6-31: Picture of Craft Market near the Negril South River (Source: Flickr)

Bloody Bay

About 56 stalls (comprising mainly craft vendors and approximately 3 food vendors) presently operate along a stretch of beach in Bloody Bay. They are situated next to the Sandals-owned property identified as the main source of sand extraction for the project's beach nourishment. These vendors serve mainly the tourists that visit the Riu Hotel which is the largest hotel in the Bloody Bay area. Most vendors reportedly have their TPDCo licences.

Figure 6-32: Vending stalls along Bloody Bay Strip

6.3.3 The Residential Areas

In keeping with many rural coastal townships, Negril's residential areas are a mix of residential and non-residential elements, often co-mingling commercial, religious and educational activities. Overall, this locale presents mixed housing styles in variable states of maintenance. For the entire Negril area, the 2011 Census recorded the number of houses as being 2,958.

In 2011, STATIN's Population and Housing Census recorded Negril's population as 7,832, which included the sections of Negril in both Hanover and Westmoreland, encompassing the area shown in Figure 1-4.

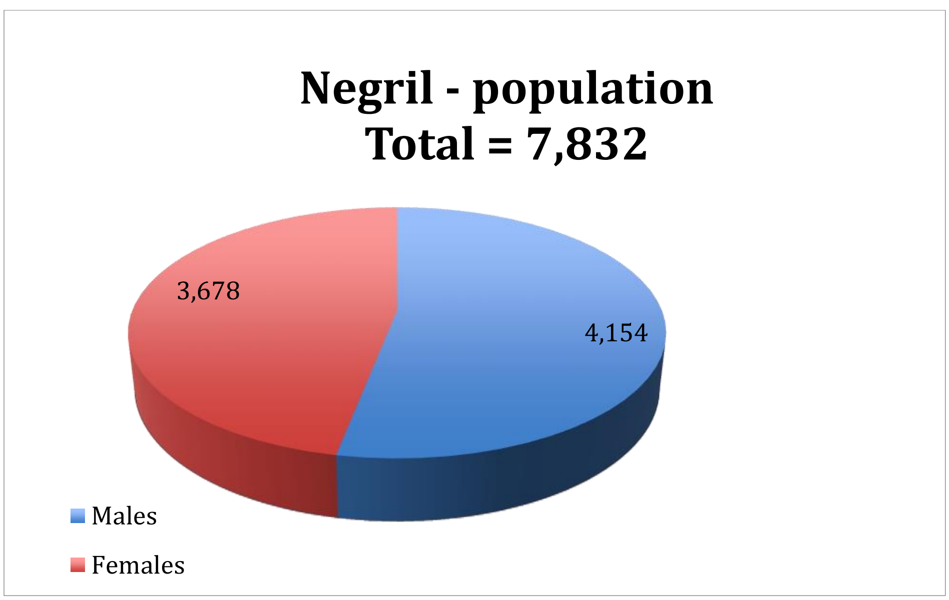


Figure 6-33: Negril's Population (Source: STATIN)

Estimation of the current population trending at a growth rate of 2.95% per year, places the area at 9,449 in 2018.

Demographics

The working age population of Negril reflects that a large majority of persons are in the workforce age group, accounting for 64% of the population. Persons under age 14, generally referred to as the young, accounted for 28% and those persons 65 years and over, considered the elderly, accounted for 8%.

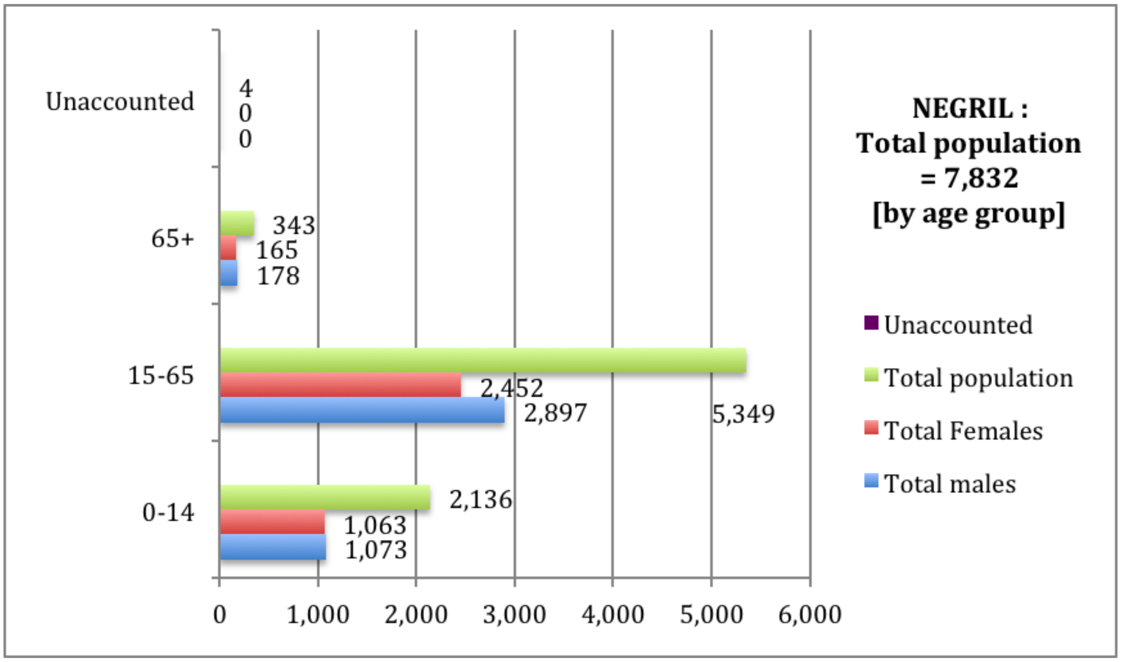


Figure 6-34: Age Distribution

Because the census figures above captures persons domiciled in Negril, the number of persons visiting at any one point in time will likely exceed this figure significantly. This non-residency population will mainly be tourism-related and be both fluctuating and seasonal.

Based on the number of hotel rooms available and assuming a typical family-type hotel ratio of 3.5 occupancy, then at full occupancy, the incremental population of tourists staying in hotels alone, could be 19,000 (5,417 rooms x 3.5). The figure does not include the 'AirBnB' sector or guest houses. Assuming a staff room ratio of about 2.5 employees per room, at full occupancy the hotel accommodation sector could be employing 13,542 persons which is not an unreasonable figure, especially since direct employment in this sector in Jamaica was estimated at 97,000 in 2016.

A cursory comparison with Negril's projected 2018 population in the labour force age group, estimated as 6,047, suggests that a significant number of persons employed in the hotel industry are non-residents of Negril. An indicative number being 7,495, equivalent to 79% of Negril's estimated resident population.

In 2011 the dependency ratio, which is an indication of the dependency by the young and elderly on the labour force, was 56%, meaning that out of every 10 persons in the population, 5.6 depended upon the other 4.4, who were assumed to be income earning. Jamaica's population has been aging and if this holds true for Negril, it means that a larger percentage of that age group will become dependent on a proportionately smaller number of income earners.

Since demographic characteristics are population-related, they would have changed by the current period. Any changes, however, are likely to be relatively small shifts, because population growth has been low.

The dependency ratio is only one measure of population pressure on the Negril community. Negril is already experiencing 'imported' population pressures as indicated above. This is evidenced by pressures on housing, over-burdened social amenities, and inadequate physical infrastructure. These indicators have been consistently confirmed in the stakeholder interviews.

6.3.3.1 Housing

In 2011, the official number of housing units in Negril was 2,958. The number of households was 3,463. There were 2.7 persons per housing unit and the average size household was 2.3. The typical dwelling therefore comprises persons from more than one household.

From observation, the housing stock within the study area appears to be in a good habitable condition. Only a few examples of "zinc houses" were noted in the community reconnaissance, although not all parts of Negril were visited. A currently small, but growing informal community is reportedly developing along the South Negril River. Of interest is the fact that in 2011, some 50% of all housing units had wooden outer walls. It could be argued that the difference is simply reflective of the income/housing disparity evident in many Jamaican coastal towns with strong tourism enclaves.

In considering both population density and housing stock, an inescapable concern must be the social support capacity of Negril and by extension, given that the threat is mainly driven by the hospitality sector, the carrying capacity of the Negril beach strip.

6.3.4 Overall Public Perception

The section below details the general attitudes and perceptions of key stakeholders towards the project and general Negril social and environmental aspects.

General Negril Planning and Social Challenges

- It is generally accepted that Negril needs planning attention with respect to roads, drainage and garbage disposal;
- Garbage collection is a problem. Often residents' garbage is not picked up. Infrastructure has not kept pace with development and the rapid hotel room increase in the last 3 or so years;
- Negril has frequent power cuts and there are very few streetlights;
- There are no acceptable public sanitary conveniences;
- Stakeholders interviewed were not aware of any downstream plans that would significantly affect the current project;
- Some persons believe that several hotel structures are not in accordance with set-backs;
- Negril does have a problem supporting hotel workers' housing and population which appear to be leading towards squatting both in Whitehouse, but more recently also along the Nonpariel Road;

- The public amenities are limited; health facilities are lacking and policing services require more investment;
- In decisions affecting their hometown, the local Negril inhabitants do not often have a say equal to that of influential developers;
- Once free-flowing rivers/streams have been blocked by developers who do not want water washing through their properties;
- Community tourism needs to be promoted, as hoteliers are not encouraging interaction with the locals. 'All-inclusives' should become more engaged with the local community. Adopting a school would be one suggestion;
- Negril reportedly has a large underground economy. Negril should remain a resort and the housing development should be out of its proverbial bounds. Over habitation and uncontrolled density will invite crime;
- The practice of hotels being given Ground Transportation Licences is inimical to a rational and fair transport policy. Also, it is not a practice known in other jurisdictions;
- Persons felt that overbuilding was taking place along the Negril beach and was only likely to increase;
- Some believed that the reality of employment together with economic growth and income generation meant that the Negril beach needed to be protected in a much shorter time frame than nature would allow.

Negril Beach Erosion

- Public awareness is needed although the municipality is reportedly concentrating on mobilising persons to focus on climate change, resilience and the vulnerability of Negril's coastline;
- It was recommended that the breakwater structure undertaken at the "Issa house" should be reviewed;
- Some sections of Negril's beach have not experienced any erosion and it must be recognised that beaches are dynamic;
- Nature's sediment flowing along the bays are cyclical and will therefore expand the beach and contract it accordingly, thus, no man-made interventions are necessary;
- Movement of sand in the Negril bays has never been monitored;
- Hard structures interfere with offshore beach replenishment and require maintenance. Evidence-based research in other countries suggests that in most cases, similar hard structures have not been successful;
- The advice of foreign consultants suggests that alternatives such as mining deeper sea sand and creating "sand engines" are part of the preferred alternatives;
- Other suggestions include the replacement of removed sea grass, and the removal of all physical structures in the area previously submerged over the past 40 years;
- A holistic approach to solving Negril's beach erosion problems is needed and should avoid the risk of any hasty, ill-conceived beach nourishment solutions. Many stakeholders consulted supported the implementation of the WNBR Project (see Appendix 12.10 for more details);
- The Government needs to be the driver of beach nourishment in Negril; it would require proper management and a sustainable, long-term solution;

- Persons were able to confirm that some 20 to 25 years ago the shoreline was much further out;
- In Little Bay, there is an example of where the use of stones – as breakwaters – reportedly pushed the water further onto the beach;
- Other hoteliers have also employed various techniques, including the use of sandbags to prevent beach erosion. One hotel reportedly tried to pump sand from offshore, but this was unsuccessful;
- There are many examples of hotels in Negril that have lost significant areas of their beach – Negril Treehouse was used frequently as an example;
- Native and older local seafarers do need to be consulted in order to understand how the beach behaves over time;
- High waves push material up onto the beach, but thereafter come back to remove same;
- It may be worthwhile modelling the effect of removing the hook – separating Bloody Bay from Long Bay – to enable less impediment to the transport of sand along the entire shoreline.

Marine Environment

- A reef just off the northern end of the Sandals property was reportedly very well stocked with fish;
- The inshore areas of both Long Bay and Bloody Bay are reportedly important for some fishermen as this is where they set their traps.

The Sandals Negril Project

Bloody Bay

- The vendors in Bloody Bay were generally accepting of the project, provided that it didn't have any impact on their ability to access or utilise the shoreline;
- Some vendors requested that Sandals create a new pathway for them to access the beach, so that there would be no impact/interference with trucks and other construction equipment during the sand extraction process;
- Some believed that sand extraction from the Sandals property in Bloody Bay will have negative impacts. This area reportedly floods extensively and water takes long periods to recede;
- During heavy rainfall, black and smelly water can be seen draining towards the coast. This is attributed to the underlying peat;
- Excavated sand, reportedly from the SNG property, has been stockpiled in the Bloody Bay area for some 3–4 years now and is still in evidence.

Long Bay

- Sandals has apparently contributed to its own beach loss by an ill-designed groyne on its northern perimeter, which blocks the flow of currents. Also, the question could be asked as to whether a building (restaurant) being impacted on the SNG property was constructed in observance and in accordance with the set-back regulations;
- A major concern is that the Sandals project will set a precedent for allowing the proliferation of hard structures along the Negril beach;

- Performance guarantees should be required if the Sandals design is allowed;
- Sandals needs to stop removing washed up seagrass off-site as its accompanying removal of sand is a contributory factor to sand erosion;
- SNG does not practise the burying of washed-up seagrass as other hotels do;
- Sandals Negril has undertaken beach nourishment in the past, but it has not been successful;
- Some stakeholders expressed empathy for the loss of beach being experienced by Sandals;
- Fishermen interviewed did not necessarily feel that their livelihoods would be affected by the project.

6.3.5 Heritage

The following section contains extracts from a report prepared by the Jamaica National Heritage Trust for Sandals Negril dated September 2018:

Taino

Two Taino sites were located within the environs of the area. A cave with Taino remains was found. This cave was apparently sealed to prevent looting.

Historical

(a)Spanish

The Spaniards also established a settlement here and called the area *Punta de Negrillo* because of the black water emanating from the peat-laden Great Morass (***negro*** means black in Spanish).

(b)Bloody Bay

A section of Negril Harbour is called Bloody Bay because of the wholesale slaughter of whales and Pedro seals (*Monachus tropicalis*) which used to take place there (the latter are now extinct).

(c)The Negril Harbour

The Negril Harbour was used as anchorage for large ships. It was used as a base for pirates and assembly point for convoys on their outward journey.

British merchantmen used to gather here to be joined by men o'war to travel to England in convoy. It was here in 1702 that the famous British Admiral, John Benbow, assembled his squadron to engage the French Admiral, Jean-Baptiste DuCasse, and it is in that engagement that he was fatally wounded. "Calico" Jack Rackham (1682–1721), the notorious pirate lay here in the harbour, waiting to attack Spanish ships travelling to Havana; in November, 1720, Captain Jonathan Barnett (1677–1744) led a surprise attack against Rackham and his unsuspecting drunk crew; he was captured , taken to Port Royal, and hanged at Gallows Point; his body hung up in a frame at what is now called Rackham's Cay. In 1746, Salmon-Moll named "*Point Negril, at the west end of the island*" as one of the four main ports in the Island. In November 1814, Major-General Sir Edward Michael Packenham secretly assembled a squadron of 50 warships and 6,000 men in Negril to capture Louisiana; the British subsequently lost the "Battle of New Orleans".

Lighters transported dark red logwood from the shore to schooners anchored in the bay.

Figure 6-35: Extract from Craskell &Simpson – 1763 map of Jamaica showing anchorage at Long Bay

Figure 6-36: Extract from Emanuel Bowen's Map of Jamaica 1747

(d) Plantations and Settlements

Emanuel Bowen's map of 1747 shows plantations in the area belonging to Pool, Mills and Giles. The key notes these as cotton and provision. Booby Island and Alligator River are named.

Thomas Harrison's cadastral map of 1890 makes reference to settlements in the area along the beach.

(e) Booby Cay

Formerly known as Gibraltar, booby birds nest on this cay which is quite close to the mainland. The birds are also called Sooty Terns (*Sterna fuscata*); they are easily captured, and their eggs were a delicacy until the species was protected in 1960. This cay featured in the 1954 Walt Disney film "20,000 Leagues under the Sea".

Figure 6-37: An aerial view of Booby Cay

Booby Cay is now attached to the Hedonism II resort, and is used for nude bathing.

(f) Norman Manley Boulevard

The Sandals property is accessed by the Norman Manley Boulevard. This is the highway from the North Negril River along the Negril 7-mile beach). It is named after National Hero and founder of the People's National Party (PNP), Norman Washington Manley, KC (1893–1969), Premier of Jamaica (1955–1962) whose idea it was to build this road on the western edge of the Negril Great Morass which opened up Negril and the Seven Mile Beach for tourism development. Manley personally came to Negril and met with the residents to obtain their support and participation. The road was built by Raymond Construction of the USA, and was completed in the late 1950s. The government have raised the height of the road, and built a high revetment.

7 IMPACT IDENTIFICATION AND ANALYSIS & PROPOSED MITIGATION

This EIA assessed individual aspects of the environment, that is, the physical, biological, social, economic and cultural aspects, likely to be affected by the proposed project. Impacts related to both Bloody Bay and Long Bay were assessed and are discussed below. Impacts have been presented by project phase, i.e. construction and operation. Mitigation measures have been proposed in relation to specific impacts, and where practical, opportunities for environmental enhancement have been offered.

7.1 Potential Impacts and Mitigation during Construction

7.1.1 Physical Environment

Section 6.1 describes the physical environment of the project site and its immediate environs. The sections below describe how the physical environment is likely to be impacted by construction works associated with the project, as well as whether the physical environment is expected to have any impact on construction activities.

7.1.1.1 Natural Hazards and Climate Change

As stated previously, and further elaborated in Section 7.2.1.1, Negril is already highly susceptible to climate-related hazards (being affected by coastal erosion during normal conditions and hurricanes, and flooding) and therefore, it stands to reason that climate change will only exacerbate the current trends and their impacts on the coastal system of Negril.

Construction activities are therefore at risk of being impacted by natural hazards such as flooding, hurricanes and storms, inundation and coastal erosion due to storm surges and other weather-related events.

Mitigation

As best as possible, it is being recommended that work be not conducted during heavy rainfall or storm periods. Some sort of buffer should be placed around stockpiled material to minimise loss due to runoff and dispersion into the marine environment. Turbidity screens should also be kept in place throughout the duration of project works.

7.1.1.2 Access Routes and Materials Storage

Sections 5.5.1 and 5.5.2 discuss access for construction vehicles and heavy equipment, and the need for the creation of materials storage areas. A temporary construction road is proposed at the northern section of the SNG property (Figure 5-4) to allow for vehicular and heavy equipment access to the Sandals Negril property in Long Bay. This access way will run immediately adjacent to existing buildings and amenities which include the Dive Shop and some luxury rooms referred to as the Millionaire Suites. Similarly, a materials storage area will be created at the northern boundary shared with the Hedonism Hotel. The storage area will be behind the existing cabanas (Figure 5-3).

An access road for construction vehicles and equipment at the Bloody Bay property is also required. There is an existing pathway on the Bloody Bay property that leads from the main road to the beach front. This is the current pathway used by vendors to access the beach area. The beach is accessed via car and/or on foot. This pathway will need to be upgraded in order to allow for trucks and other heavy equipment to pass through.

During consultation with the vendors in Bloody Bay, it was reported that they often maintain the existing pathway on the property by infilling it with marl. This they consider to be necessary as the vendors also reported that the area is frequently inundated due the underlying peat that does not drain well.

In terms of impacts related to these required access points and storage areas, the following has been considered:

- Visual/aesthetic impacts for guests who may be staying in nearby hotel rooms, as well as a potential noise nuisance during the hours when construction is taking place. This impact is considered temporary and will last only the duration of the construction period (approximately 2 months). Both the temporary roadway and the materials storage areas are expected to be removed after construction is complete;
- It is assumed also that existing landscaping on the property will have to be removed/relocated during construction. It is assumed that vegetation used in landscaping can be replanted after the road is removed;
- Temporary inconvenience/loss of beach access may be experienced by persons occupying the northern end of the property;
- Extensive vegetation clearance in Bloody Bay may not be required if the existing access path is utilised. This is because vegetation along this path has already been removed. Minimal impact is expected;
- Vegetation clearance will be anticipated for the creation of a materials storage area;
- Access to the beach area in Bloody Bay by vendors may be affected by roadworks and the constant movement of vehicles.

Mitigation

It is important to ensure that guests are properly advised of construction activities and its estimated duration. SNG will have to decide whether the buildings immediately adjacent to the project works will remain occupied during construction. Further mitigation measures related to visitor health and safety are elaborated in Section 7.1.1.3 below.

For Bloody Bay, it will also be necessary to ensure that vendors and other beach users (as well as neighbouring property owners) are advised of construction activities and proper signage and that other safety measures elaborated below are put in place. During consultation with the vendors, some suggested that Sandals could create a different access way for them that did not interfere with the movement of the trucks.

It is recommended that prior to the start of construction, the area to be cleared should be canvassed and seedlings and saplings should be removed and held in a nursery for replanting of the area after construction is complete.

7.1.1.3 Occupational Health and Safety

As with any construction project, occupational health and safety risks or any hazards related the proposed activities have the potential to cause injury or ill health. As it relates to the SNG project, these risks include injuries caused by equipment and vehicles; slips, trips or falls; noise-induced injuries; and ill health caused by dust and other emissions, to name a few.

Mitigation

The occupational health and safety risks associated with the groyne installation and beach nourishment activities can be readily mitigated once the necessary procedures are implemented. The following precautionary measures should be included among safety practices:

- The wearing of appropriate personal protective equipment (PPE), such as high visibility vests and hard hats and boots (in compliance with the appropriate American Society for Testing and Materials (ASTM) standards), should be adopted during construction activities;
- Safety and emergency response training should be required;
- Proper signage around the construction site should be erected;
- A mechanism should be put in place for the logging of all incidents;
- The provision of bathroom facilities for workers and access to medical attention throughout the activities are necessities.

Occupational Health and Safety also applies to visitor safety. The construction methodology prepared for this project outlines the following:

- The work area will be cordoned off to prevent direct access by individuals who are not associated with the work;
- Wardens will also be placed at strategic points along the work area to enforce safety requirements;
- The equipment will be escorted by at least one Spotter who will be on the lookout for beach patrons and to facilitate the passage of the heavy equipment in the confined space;
- Traffic Wardens will be placed at strategic locations to ensure safety of vehicular and pedestrian traffic entering and exiting the site.

7.1.1.4 Noise

The major noise impacts on the Sandals property will be during the construction phase and are expected to be short term. Baseline noise levels (see Section 6.1.4) are expected to be amplified by the following construction-related activities:

- The constant movement of trucks transporting material to and from the project sites. A commercial dump truck has an average capacity[5] of about 7.6 to 10m^3, therefore, this project may require up 700 truckloads in order to transport 7000m^3 of sand from Bloody Bay to the SNG property. Using the 60-day timeline provided, this could be on average 11 truckloads per day. This does not include the required truckloads to rehabilitate the extraction site with fill material (such as gravel), or to bring the boulders to the site for groyne construction;
- The use of excavators and other equipment at Bloody Bay during the sand extraction process;
- The use of excavators and other equipment at the SNG property to remove sand for the groyne foundation, as well as the removal of boulders from the existing northern groyne.

[5] Consultants estimate using online references. Not an actual measurement

Mitigation

Because of the current layout of the site, it may be difficult to put physical structures in place (i.e., noise barriers) to mitigate against the impacts. The client should therefore make all attempts to give staff and guests adequate notice about the planned activities and impacts.

It is being suggested that activities near to the construction sites be suspended during the construction phase. Water sports activities are not expected to be impacted. Another consideration is to schedule construction activities during known off-peak seasons.

7.1.1.5 Water Quality during Construction

There were no adverse findings from the baseline assessment of water quality, outside of algal growth in the nearshore. There is, however, the potential for construction activities to negatively impact the marine water quality. This includes the potential for:

- Increased turbidity during the construction phase;
- Possible release of petroleum range organics from oil spills from the construction equipment;
- Leaching of constituents from the sand to be used in the beach nourishment exercise.

Mitigation

To mitigate against these, the client should consider placing screens in the water to contain the increased turbidity during construction. Monitoring of turbidity and total suspended solids (TSS) should also be conducted regularly during the construction phase to ensure levels are within international guidelines. A complete chemical assessment of the sand to be used in the beach nourishment exercise should be done to ensure there are no adverse components that could potentially be leached to the marine environment over the operation phase of the project. Also, sand washing is encouraged prior to placing any sand on the beach.

The client should ensure that preventive/mitigative strategies are in place to address any oil spills as soon as they occur. The storage of hazardous materials, such as petroleum products (fuel), on site should be done in accordance with international best practices. Fuel should be stored away from any ignition source and sensitive areas (particularly marine areas). Depending on the quantities, a spill management plan may be required. Having equipment, such as containment booms, absorbent pads, dispensers (to aid in microbial degradation), should also be considered if there is a potential for spills to occur at sea.

7.1.2 Biological Environment

7.1.2.1 Bloody Bay Sand Extraction Site

The proposed activity is expected to have an impact on the fauna and flora in areas assessed in Bloody Bay. It would result in the removal of some of the vegetation which would displace some of the fauna on the property. Two sand extraction options exist (see Figure 5-5), ranging in size from roughly 8,000m^2 to 14,000m^2.

The baseline assessments of the proposed areas concluded that no species with any special conservation status were observed during the assessments. Thus, the impacts are not considered major. However, the impacts related to fragmentation, loss of habitat/feeding/nesting grounds, and disruption of migration patterns of some migratory bird species are considered moderate.

Mitigation measures

- Efforts should be made to retain some of the larger trees on the property. A few trees with a DBH >25cm should as best as possible be retained across the extraction area. These trees will aid in soil retention/reduction of the risk of erosion, as the root systems of the trees will tend to bind soil particles.
- The large cotton tree (*Ceiba pentandra*) in the S9 block should be retained, if possible, as 3 cotton tree beetles were observed on this tree. This tree can be located using the following GPS coordinate: N18°21’12.62988” W78°20’6.63648”. Cotton trees are also increasingly rare in Jamaica where they were once prolific.
- A large royal palm (*Roystonea regia*) located in S6b should be retained, if possible. The tree appears to be a primary food source for bats, as several partially eaten fruits were observed under the tree. This tree can be located using the following GPS coordinate: N18°21’8.93376” W78°20’7.31652”.
- It is recommended that prior to the start of construction, the area to be cleared should be canvassed and seedlings and saplings should be removed and held in a nursery for replanting of the area after construction is complete.

7.1.2.2 Long Bay (SNG Property)

As described in Section 6.2.2.1, the backreef area, in general, is marked by healthy and productive seagrass beds (Figure 7-1) which support numerous species of fish. The backreef area provides an important breeding ground, nursery for juvenile fish, habitat for important benthic fauna (e.g. urchins), and is used as a foraging ground for larger fish species. Shallow tropical seagrass beds, such as these, also function as carbon sequestration filters that mitigate atmospheric carbon dioxide (CO_2) increases.

Within the immediate footprint of the groynes, there is mostly sandy bottom with sparse patches of seagrass. Project activities that could affect this baseline include construction of the groynes and the nourishment of the main beach area and creation of swimming area, all of which entail use of land-based, heavy machinery within the Sandals property. With appropriate mitigation measures in place, these impacts are expected to be minor or negligible.

Figure 7-1: Aerial image showing seagrass within the vicinity of the groynes (Base map: Google image, 2016)

Impacts due to loss of seagrass: If appropriate mitigation measures are not employed, the proposed project will potentially impact 32m^2-76m^2 of seagrass and associated benthic organisms within the vicinity of construction of groynes 1, 2 and 3, and the beach area to be nourished. The impacts on marine ecology from the loss of seagrass beds during construction may be moderate to minor, depending on the appropriate implementation of mitigation measures. Removal of seagrass may impact ecosystem processes and services typically provided by these zones, for example, sand accretion, carbon sequestration, habitat for ecologically sensitive or commercially important species, and foraging grounds.

Mitigation

To mitigate habitat and biodiversity loss, a suitable site for relocation activities should be identified prior to the commencement of works. Prior to relocation, it will be necessary to reassess the coverage and health of the seagrass within and around the project footprint to determine (i) if relocation is a viable mitigation measures and (ii) the acreage of seagrass to be relocated. If no appropriate site is available, then alternative compensation mechanisms should be considered.

Impacts due to construction of groynes: The suspension of fine sediments during the placing of boulders on and below the seafloor can impact seagrass beds. The resuspension of sediment and subsequent deposition are probable and subsequent effects on the benthic habitat are likely to remain. This will affect seagrass within the backreef and other associated biological communities. With increased turbidity in the water column during construction, fish may move away to more pristine waters, and larvae and eggs may become smothered. Sessile or slow-moving fauna (urchins, etc.) will also be affected by suspended sediments. For example, the black long-spined sea urchin, *Diadema antillarum,* an important grazer on coral reefs that plays a critical role in reef restoration and resilience, was observed during the benthic assessments of the backreef.

Mitigation

The extent of the impact of increased sediment suspension in the water column will depend on how well it is contained in the immediate construction area. The use of silt screens should be mandatory to contain or restrict sediment dispersion and settlement, accompanied by real time turbidity measurements. Should turbidity in the water column adjacent to areas protected by nets exceed values specified by licences granted by NEPA, construction should be suspended. Failing this, or if the silt screens are not appropriately deployed, the impact area could potentially be amplified. Activities should also be suspended during unfavourable weather conditions, or when anticipated. Where seagrass and important invertebrates (e.g., *Diadema)* need to be relocated based on the projected footprint and estimated impacts, they can be relocated in the adjacent backreef areas. Any benthic habitats lost in adjacent areas will likely recover within one (1) to three (3) years after the cessation of construction.

Impacts due to discharges into the bay: If fuel leaks or spills from equipment used for groyne construction or sand nourishment during refuelling or operation are not contained as soon as they occur, this could potentially result in impacts of moderate significance.

Mitigation

Appropriate refuelling equipment (for example, funnels) and techniques should be used at all times and appropriate equipment for containment and clean-up of any spills should be kept on site. With effective mitigation, impacts will be minor.

Impacts due to increased traffic: Potential impacts of minor significance from machine/equipment noise, lighting and movements on benthic fauna and fish are likely.

Mitigation

Noise levels should be monitored throughout the construction phase to ensure standards for marine wildlife are not exceeded.

7.1.3 Socio-Economic Environment

If implemented in accordance with the mitigation recommendations in the EIA, the project will not have any significant impact on the socio-economic environment, in the foreseeable future. Impacts listed below relate to both the construction and operational phases.

- No changes in resource use are expected at the SNG property in Long Bay. At present, the proposed extraction site in Bloody Bay is not being utilised and is covered in secondary forest.

- Public access is not expected to be altered at either of the project sites. At present, Sandals allows the vendors in Bloody Bay to access and use the beach front of their property with the understanding that once Sandals is ready to construct a hotel, they will have to relocate. Sandals has indicated, however, that there will be opportunities made available, as with their other hotels, for vendors to be allowed to sell their products on the hotel property once it is constructed.
- There is no indication that the issue of prescriptive rights will arise in either the Long Bay or Bloody sites, since vendors have accepted their right to be removed from the property when the necessary time for them to do arises.
- The existing recreational use at the SNG property will benefit arising from the recovery and expansion of beach area currently eroded.
- Impacts on existing and potential economic activities will be positive in relation to any increased recreational use of the beach area. The livelihoods of Bloody Bay vendors are not expected to be impacted.
- Public perception, as sampled by the consultants, is currently mixed as reported on above.
  The solution to beach erosion is likely to continue to be an issue of debate until it is perhaps laid to rest by actions in the future that will restore the once pristine span of Negril Beach.
- With regard to the contribution to the growth of the national economy and the development of surrounding communities, it is anticipated that to the extent that the results of the project are achieved, and Sandals Negril restores its beach loss and protects it, then the project will benefit the developer, the Negril community and the national economy through job creation, increased visitor arrivals, and so on.
- It has not been demonstrated objectively that any of the neighbouring properties will be negatively impacted by the project. The modelling results actually show that newly placed sand at the Sandals property will inevitably be lost and this will actually benefit neighbouring properties to the south. The sole possible negative outcome is that construction impacts may cause relatively short-term inconvenience, that is, increased traffic, noise, and visual impact; any anticipated impact is likely to remain localised on the Sandals property.

The available datasets provide a reasonable characterisation of Negril as being a more developed coastal community, with indicators of population pressures comparing favourably with national data, but facing current and downstream social and economic challenges for the community. Direct project impacts by the Sandals development on the landside are mainly project construction related and very unlikely to have any impact on the population demographics described and/or therefore their resulting consequences. Similar conclusions relating to recreational populations using the marine side, would be reasonable.

7.1.3.1 Heritage

No trace of Taino material or anything else of historical value was found during the JNHT conducted survey. The Bowen map of 1747 indicated cotton and provision plantations in the area, but these, unlike sugar estates, did not have substantial structures. These areas would have reverted to ruinate over time. Furthermore, extensive excavations for the construction of hotels would have destroyed or previously unearthed whatever existed. If, however, any such material is seen, the JNHT should be notified immediately so steps can be taken to recover and record these items.

7.2 Potential Impacts and Mitigation during Operational Phase

7.2.1 Physical Environment

7.2.1.1 Climate Change

The State of the Jamaican Climate (2015) outlines the following historical trends in observed climate for Negril:

- Increase in temperature at a rate of 0.41^{o}C per decade over the period 1973–2008, particularly in the months of June, July and August (JJA);
- Decreased rainfall of 18% per decade over the period 1973–2008;
- Decreasing trend in wind speed observations from nearby Montego Bay, though not statistically significant;
- Slight increase in relative humidity in nearby Montego Bay by 1.0–1.5% per decade, but this trend is only significant in annual and September, October and November (SON) data;
- An increase in local sea levels by approximately 0.9 mm/year.

Regional Climate Models (RCM) projections show:

- Increase in mean temperatures by 3.6–3.8^{o}C by the 2080s under the A2 scenario, with marginally more warming in JJA and SON than the other seasons;
- Changes of −11 to +17% in mean rainfall by the 2080s, with a general mean trend towards drying;
- Changes in seasonality of rainfall vary based on the driving general circulation models (GCMs), but there is a consensus on overall annual drying;
- Small decreases in mean annual wind speeds of approximately −0.1 ms−2 by the 2080s.

Negril is already highly susceptible to climate-related hazards (being affected by coastal erosion during normal conditions and hurricanes, and flooding) and therefore, it stands to reason that climate change will only exacerbate the current trends and their impacts on Negril's coastal system.

The report also states that by 2100, a 25-year storm surge event is projected to reach elevations of 1.42 m, and a 100-year event could reach 1.64 m. This will more than likely result in inundation of coastal hotels as well as lands in the Great Morass.

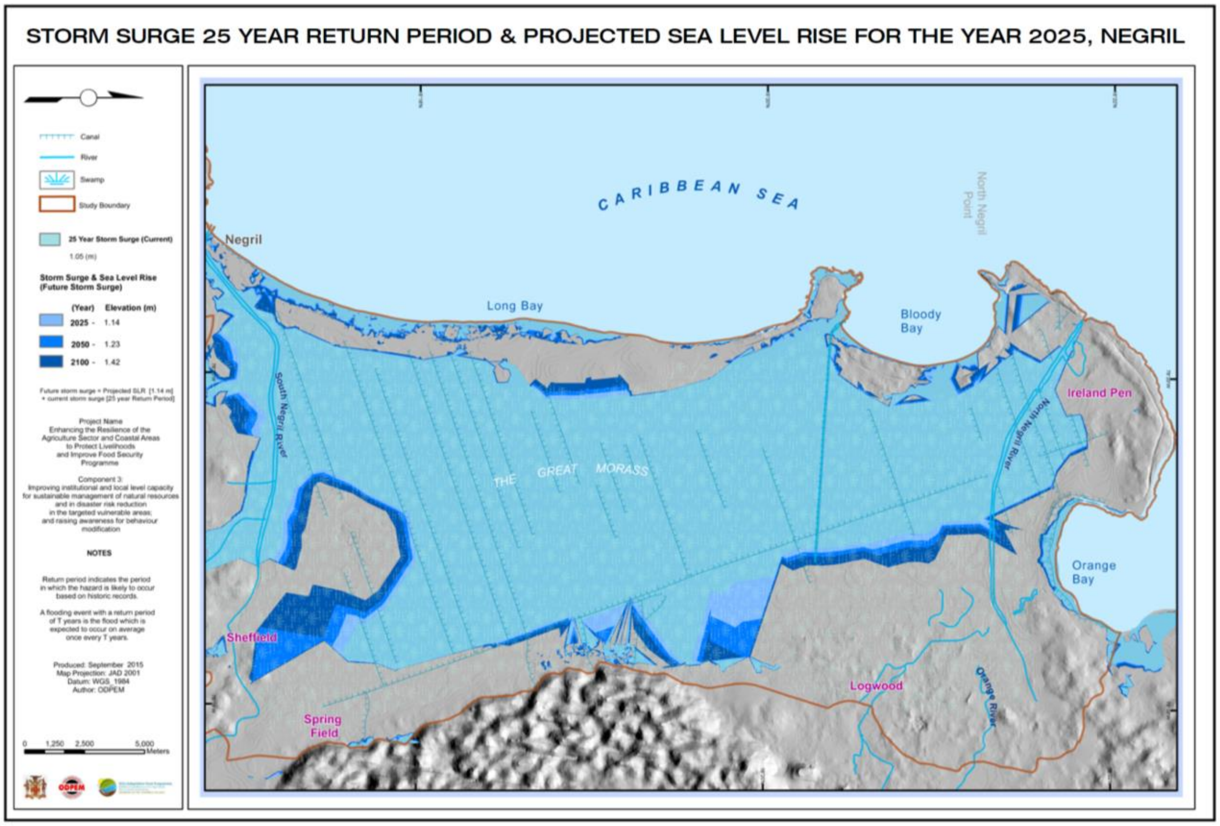


Figure 7-2: Map showing impacts of 25-year storm surge event (light blue) and future storm surge event under projected sea level rise for the year 2025, Negril. (Source: ODPEM 2015)

Mitigation – SNG/ Long Bay area

As outlined above, climate change is likely to impact the entire Negril coastline including the project area. As such, the following mitigation measures suggested are to increase the resilience of the project area to climate change:

- Maintain and, where possible, enhance the beach system and its capacity to reduce loss of sediment from the beach area, and hence, reduce the rate and amount of erosion. In this context, the impacts of the proposed interventions in Long Bay are positive;
- Ensure seagrass meadows, in which most of Negril's beach sand is created, are not impacted. Where seagrasses are affected, ensure that, at a minimum, the same area of functional seagrass is created in the nearshore area, by relocation and/or planting, along with the relocation of associated fauna and other organisms. The proposed concept is not expected to result in significant losses of seagrass.

7.2.1.2 Impacts of the Project on Future Shoreline Changes

7.2.1.2.1 Long Bay

The results of the modelling of shoreline response over a 5-year period shows that the project is not expected to have any significant shoreline changes in the Long Bay area during this time period. The groynes are designed to hold only the initial beach fill placed immediately adjacent to the groynes, and not to entrap or hold additional beach width.

Due to the short nature of the proposed groynes, it is likely that there will be a need for beach re-nourishment in the order of 6 to 8 years. This is dependent on the storm impacts to the project. The proposed concept is only expected to block 10% of sediment transport to the south. Since it does not cover the entire length of the Sandals Long Bay property the impacts of this will likely be contained within their property boundary.

7.2.1.2.2 Bloody Bay

Figure 5-5 shows the locations in Bloody Bay from where proposed extraction will take place. The impacts on future shoreline changes are more uncertain for this section of the coastline:

- This area is expected to be developed by Sandals in the future, but no timeline has been provided;
- The proposed extraction site is located approximately 50m inland from the shoreline. The average erosion rate is 0.5m/year based on measurements obtained between 1968 and 2006. Future shoreline erosion estimates suggest that the coastline could recede to the sand extraction site in approximately 100 years, if no protection measures are implemented at this property. Therefore, whether or not sand is extracted from this site, if it is not protected, it is likely to continue to erode;
- Modelling of shoreline processes during the 1 in 50 and 1 in 100-year storm events suggests that the sand extraction site will be inundated, but is unlikely to be subject to erosion during these events (SWIL, 2019);
- The ODPEM Climate Risk Atlas map further confirms the proposed borrow area will be flooded by storm surges for 25, 50 and 100-year hurricane events. Reports from stakeholders consulted also suggest that the area presently floods and takes long periods to recede;
- Because there is a net loss of sand from littoral areas in Negril over time, some of the sand removed from the Bloody Bay beach system and placed in Long Bay will be lost offshore, thereby reducing overall system resilience.

Mitigation

The following mitigation measures are proposed to reduce the potential of the project to have significant impacts on future shoreline changes:

- Ensure that there is no net reduction of sediment movement to beaches to the north and south of Sandals in Long Bay. SWIL's modelling of the proposed design suggests that the beach response to the groynes will be localised and within local vicinity of the proposed design and nourishment. Figure 4.2 offers some evidence that the beach response is more noticeable towards the southern section of the property where both erosion and accretion zones are noticeable with the 'Do Nothing' option and amplified with the groyne field (SWIL, 2019). As stated above, the proposed concept is only expected to block 10% of sediment transport to the south and have no impact on the beaches to the north;

- Consider using more sustainable sources of sand for future nourishment exercises. Two other sources of sand were considered by SWIL (2007):
    - Sand bank located on the outer shelf of Long Bay and Bloody Bay
    - Importation of sand from other Caribbean islands;

  The report states that further investigation would be required to ensure the availability and thickness of the sand layers offshore, and Sandals would need to explore the economic viability of alternative sources.

7.2.1.3 Impacts on Aesthetics, Landscape and Seascape

Once completed the project is not expected to have significant visual impact. Based on the artistic impression of the proposed project in Figure 7-3 the exposed portions of the groynes are not very obtrusive. As described in Section 5.3, approximately 7m of the 25m groynes G1–G5 are visible and roughly 5.5m of the 15m groyne at G6 is visible.

The visible, exposed portions of each groyne are limited to less than 30 cm high (<12”) across the intertidal beach face – from the berm to about the low water shoreline – and less than about 2.5m wide.

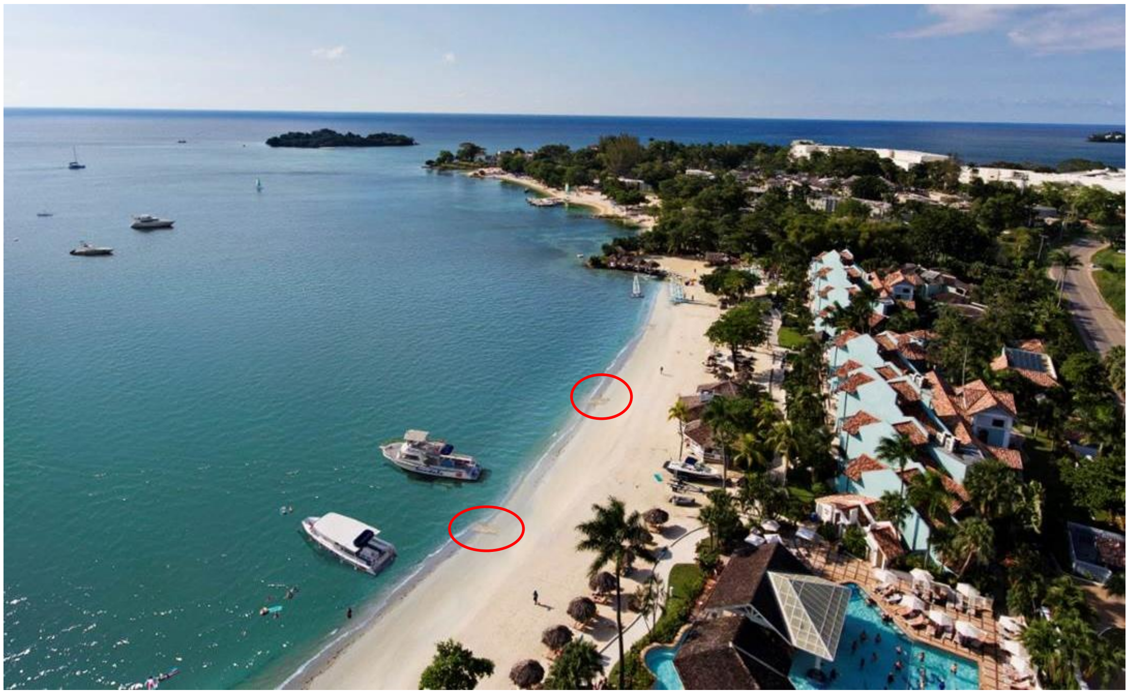


Figure 7-3: Artistic Impression of proposed concept – red circles illustrate areas of exposed groynes (Source: Olsen)

Mitigation

The developers have indicated that the boulders would be a similar colour to the existing sand so as to limit visual impact. Boulders would be maintained by scrubbing them if there is any proliferation of algae on the structures.

Further beach nourishment may be required after and, in the event of storms, within 6–8 years.

7.2.2 Biological Environment

During the operation phase no ecological impacts are expected.

7.3 Cumulative Impacts

Physical

- Additional sand will be required for ongoing maintenance nourishment of the Sandals property, and as such, an optional site will need to be established.
- Multiple major storms over a short time frame are possible and will have cumulative effects on the shoreline possibly increasing the rate of erosion.
- With forecasts of increased rates of sea level rise, and more intense storms, the long-term outlook for shorelines is not healthy, and strategies to address these are a worldwide concern.
- Projections for ongoing shoreline erosion at Negril are in the tens of metres, and the capacity to sustain ongoing beach maintenance will be a challenge for all of Negril, including Sandals.
- Ongoing maintenance nourishment can have effects on beach resilience to climate change if sand is removed from within a beach system.

Biological

- In Negril, significant vegetation cover has been lost to give way to hotel construction. Cumulatively, this leads to a loss of flora and fauna, and decrease in biodiversity.
- Vegetation loss on a beach system also makes the area less resistant to stress, for example, hurricane resilience may be reduced.
- Continued loss of seagrass will exacerbate historical reduction in sediment productivity due to physical removal and increased nutrient load in seagrass meadows.
- Seagrass degradation also results in biodiversity loss and a loss of ecosystem services provided by seagrass, for example, carbon sequestration, and shoreline stabilisation.

Socio-Economic

- Negril's infrastructure has not kept pace with the growth of the town. As growth continues, social amenities and infrastructure will continue to be stressed, if not improved.
- An understanding of the carrying capacity of existing vending in Negril is needed.

8 Summary Impacts and Mitigation

The tables below present a summary impacts matrix for the proposed project.

8.1 Construction Phase

Table 8-1: Potential Impacts during the Construction Phase

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
LOCATION	**(A) BLOODY BAY**															
NATURE OF IMPACT:																
PHYSICAL IMPACTS																
Natural hazards and climate change		X			X	X			X		X		X	At average rate of erosion, shoreline not expected to recede to excavation site for 100 years (if no protection measures are put in place)		• Avoid work during heavy rainfall or storm periods • Establish buffers around stockpiled material to minimise loss due to runoff and dispersion into the marine environment
Access Routes and Materials Storage		X	X			X	X				X	X		At some point in the future, it is anticipated that this site will be developed into a hotel. Further vegetation clearance is anticipated resulting in further fragmentation and loss of habitat for flora and fauna.	Location and size of materials storage area in Bloody Bay	• Ensure that vendors and other beach users (as well as neighbouring property owners) are advised of construction activities before they commence • Ensure that proper signage and other safety measures elaborated below are put in place • Consider creating a different access way for vendors that does not interfere with the movement of the trucks • Replanting of coastal vegetation (especially dune stabilizing vegetation – to minimize erosion) after construction is complete is encouraged.
Occupational health and safety			X			X	X				X		X			• Wear appropriate personal protective equipment (PPE), during construction activities • Organise safety and emergency response training for workers as a requirement of the construction project

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
																• Erect proper signage around the construction site • Put in place a mechanism to log all incidents • Provide bathroom facilities for workers and access to medical attention throughout the activities as a basic project requirement • Cordon off work area to prevent direct access by individuals who are not associated with the work
Noise			X			X	X				X		X	If exposed to loud noises for long periods, damage to auditory functions can be irreversible. However, this impact is expected to be only temporary.		• Make all attempts to give vendors and other beach users (as well as neighbouring property owners) adequate notification about the planned activities and impacts
Water quality during construction	–	–	–	–	–	–	–	–	–	–	–	–	–			• N/A as no impact to water quality is anticipated in Bloody Bay
BIOLOGICAL IMPACTS																
Vegetation Clearance resulting in habitat loss and fragmentation			X			X	X	X			X		X	• Loss of vegetation cover • Loss of habitat for fauna • Decrease in biodiversity • Area less resistant to stress, e.g., hurricane resilience may be reduced • There is the possibility that changes in species interactions in the vegetated areas that will remain.		• Retain trees with a DBH >25cm as best as possible across the extraction area • Replanting of coastal vegetation (especially dune stabilizing vegetation – to minimize erosion) after construction is complete is encouraged.

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
SOCIO-ECONOMIC																
Potential disruption of access for Bloody Bay vendors			X			X	X				X	X				• Consider creating a different access way for vendors that does not interfere with the movement of the trucks
Contribution to economy (job creation)			X	X	X	X	X			X		X				N/A
HERITAGE																
Potential loss of undiscovered artefacts			X			X			X		X		X			Notify JNHT immediately if any suspected historically significant materials are found so steps can be taken to recover and record these items
LOCATION	**(B) LONG BAY**															
PHYSICAL IMPACTS																
Natural hazards and climate change		X			X	X	X				X		X			• Avoid work during heavy rainfall or storm periods • Establish buffers around stockpiled material to minimise loss due to runoff and dispersion into the marine environment • Maintain turbidity screens in place throughout the duration of project works
Access Routes and Materials Storage			X			X	X				X	X				• Ensure guests are properly advised of construction activities and their estimated duration • Decide whether the buildings immediately adjacent to the project works will remain occupied during construction
Occupational health and safety			X			X	X				X		X			- Cordon off work area to prevent direct access by individuals who are not associated with the construction project

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
																• Place wardens at strategic points along the work area to enforce safety requirements • Escort the equipment by at least one Spotter who will be on the lookout for beach patrons and this will also facilitate the passage of the heavy equipment in the confined space. • Place Traffic Wardens at strategic locations to ensure safety of vehicular and pedestrian traffic entering and exiting the site
Noise		X	X			X	X				X		X			• Make all attempts to adequately notify staff and guests about the planned activities and impacts • Consider suspending activities near to the construction sites during the construction phase • Consider scheduling construction activities during known off-peak seasons
Water quality during construction		X	X			X	X				X		X			• Place screens in the water to contain the increased turbidity during construction • Monitor turbidity and total suspended solids (TSS) regularly during the construction phase to ensure levels are within international guidelines • Complete chemical assessment of the sand to be used in the beach nourishment to ensure there are no adverse components that could potentially be leached to the marine environment

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
																• Consider washing sand prior to placing any sand on the beach. Wash water will need to be disposed of appropriately • Properly store hazardous materials on site, such as petroleum products (fuel), away from any ignition source and sensitive areas (particularly marine areas) • Create a spill management plan as this may be a requirement. Having equipment such as containment booms, absorbent pads, dispensers (to aid in microbial degradation) should also be considered if there is a potential for spills to occur at sea.
BIOLOGICAL IMPACTS																
Impacts due to loss of seagrass			X		X	X	X				X		X	• Continued loss of seagrass will exacerbate historical reduction in sediment productivity due to physical removal and increased nutrient load in seagrass meadows. • Seagrass degradation also results in biodiversity loss and a loss of ecosystem services provided by seagrass, e.g., carbon sequestration, shoreline stabilisation.		• If required, identify a suitable site for relocation activities prior to the commencement of works • Consider alternative compensation mechanisms if no appropriate site is available
Impacts due to construction of groynes		X	X			X	X				X		X			• Use silt screens to contain or restrict sediment dispersion and settlement

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
																• Monitor turbidity in real time • Suspend construction if turbidity exceeds values specified by licences granted by NEPA • Suspend activities during unfavourable weather conditions, or when anticipated • If necessary, relocate seagrass and other important invertebrates (e.g., Diadema) to adjacent backreef areas based on the projected footprint and estimated impacts
Impacts due to discharges into the bay			X			X	X				X		X			• Use appropriate refuelling equipment (e.g., funnels) and techniques • Keep equipment for containment and clean-up of any spills on site
Impacts due to increased traffic (i.e., noise/vibration and light)			X			X	X				X		X			• Monitor noise levels throughout the lifespan of the construction to ensure standards for marine wildlife are not exceeded
SOCIO-ECONOMIC																
Temporary inconvenience to guests			X			X	X				X		X			• Make all attempts to notify staff and guests adequately about the planned activities and impacts
Contribution to economy (job creation)		X	X		X	X	X			X		X				

8.2 Operational Phase

Table 8-2: Potential Impacts during the Operation Phase

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
LOCATION	**LONG BAY**															
PHYSICAL IMPACTS																
Climate change		X			X	X			X		X		X		Beyond the next 6–8 years and possibly within them, ongoing beach maintenance will be necessary. There will be costs and benefits and environmental implications. A sustainable source of beach nourishment needs to be identified.	• Maintain and, where possible, enhance the beach system and its capacity to reduce loss of sediment from the beach area, and hence, reduce the rate and amount of erosion. Eg, nourishment, seagrass protection, coastal stabilization (both ecosystem-based and engineered solutions etc. • Where seagrasses are affected, ensure that at a minimum, the same area of functional seagrass is created in the nearshore area, by relocation and/or planting, along with the relocation of associated fauna and other organisms • Consider alternative compensation mechanisms if planting/relocation is not feasible
Impacts of the Project on Future Shoreline Changes		X			X	X	X			X		X				• Consider using more sustainable sources of sand for future nourishment exercises.
Impacts on aesthetics, landscape and seascape			X			X			X		X	X		Concern was raised by some stakeholders that the approval of this project will lead to the proliferation of		• Use boulders of a similar colour to the existing sand so as to limit visual impact • Clean boulders if there is any proliferation of algae on the structures

IMPACT CRITERIA	Magnitude			Spatial Extent			Duration			Direction		Permanence		Cumulative	Data Deficiencies	Mitigation
	Significant	Moderate	Minor	National	Regional (Wider Negril)	Local (Site Specific)	Short-Term (0–5 years)	Medium-Term (5–15 years)	Long-Term (Project Lifetime)	Positive	Negative	Reversible	Irreversible			
														hard structures along the Negril landscape.		• Determine if further beach nourishment is required within or after 6–8 years, and in the event of storms
BIOLOGICAL IMPACTS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A as no ecological impacts are anticipated.
SOCIO-ECONOMIC																
Change in Resource Use/ Recreational Use		X				X	X	X		X		X				N/A
Economic Activity		X			X		X	X		X		X		New investment potential		N/A
National Economy			X		X		X	X		X		X		Employment and economic growth		N/A

9 Environmental Management and Monitoring Plan

This section presents the environmental management, mitigation, monitoring and institutional measures to be implemented during the construction and operational activities of the Project (sand excavation in Bloody Bay; beach nourishment and construction of groynes in Long Bay). These measures aim to reduce adverse or deleterious environmental and social effects to acceptable levels and enhance positive effects. This plan provides a framework and requirements/guidance for preparation of a series of sub-plans to be prepared later. It does not present all the actual individual plans to be implemented. It specifically defines what actions must be taken and who is responsible, to reduce adverse operational impacts.

The Environmental Management and Monitoring Plan identifies the principles, approach, procedures and methods that will be used to control and minimize the environmental and social impacts of all the Project's construction and operational activities. It is intended to complement the Environmental Impact Assessment (EIA) and is tailored to the hazards and risks established for developments of this nature.

9.1 Noise

Ambient noise readings will be measured in accordance with the monitoring requirements of the environmental permits issued by NEPA. The permits will stipulate the frequency with which monitoring should take place during the construction and operations phase. Noise level readings, wind direction and any unusual local noise sources should be recorded. Measurements should be taken using approved and calibrated sound level meters. The frequency spectrum of the noise will be measured.

The results at the end of the sampling period will be compared with NEPA standards. The NRCA (NEPA) Standards are presented in *Table 9-1*. Through monitoring noise levels, the Client will ensure that both they and their sub-contractors comply with NEPA guidelines for this parameter.

Table 9-1: Noise Standards

	NRCA (NEPA) Standard	
	Day (7am – 10pm)	Night (10pm – 7am)
Residential	55dBA	50dBA
Commercial	65dBA	60dBA

9.1.1 Monitoring Equipment and Stations

A calibrated sound level meter will be used to measure noise. The model of the equipment will be clearly stated, and the meter will be calibrated before each survey.

Monitors will be located approximately 1.5 m above the ground and no closer than 3m to any reflecting surface (e.g., wall). The noise level readings will be taken over a period of 2-3 minutes and the average (geometric mean) noise level recorded in decibels (dBA). In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation. In addition, before and after the survey, the instrument will be checked with a calibrator, which is factory calibrated.

Figure 3-2 and Figure 3-3 show the sampling stations utilised during the EIA, each of which was georeferenced for traceability and future monitoring requirements. It is recommended that the same monitoring points be utilized.

9.1.2 Monitoring and Reporting Frequency

The environmental permits will stipulate the frequency with which monitoring and reporting should take place during the construction and operations phase.

The consultants however recommend that monitoring be carried out every 2 weeks for the duration of construction and monthly reports be submitted to NEPA and other relevant agencies, or as stipulated by NEPA (whichever is more stringent). Based on the results, this can be reduced, if allowed by NEPA.

The results from the sampling exercise will be compared to NEPA noise pollution standards and included in the environmental monitoring report prepared and submitted to NEPA. If there are any exceedances, this will be reported immediately to allow for management strategies to be changed according to the results.

9.1.3 Management and Mitigation Measures

In addition to the monitoring procedures, The Contractor will ensure the following noise reduction options are implemented where necessary.

- Workers must be properly protected from noise above 90dBA using the appropriate protective gear (according to US OSHA Permissible Noise Exposure Limits). The National Institute for Occupational Safety (NIOSH) recommended exposure limit for occupational noise exposure is 85dBA for an 8 Hour shift.
- The area is a commercial area and as such noise should not exceed 65dBA.
- All pneumatic tools to be used in close proximity to residential, commercial tourism properties should be fitted with an air exhaust silencer.
- Consider utilising noise mitigation measures (including the construction of bunds, metal sheet walls) in order to limit noise levels at sensitive receptors.
- Ensure that equipment to be used meets industry best standard in relation to noise attenuation.
- Ensure that construction works are only undertaken in defined working hours (e.g. weekdays 8h00 – 17h00 and weekends 8h00 – 13h00). In the event that noisy activities are undertaken outside of the specified working hours, all nearby stakeholders will be informed of such activities in advance.
- Assess and manage all noise complaints.
- Undertake noise monitoring at locations with persistent noise complaints.
- Vehicle speeds should be limited to 20km/h on unpaved surfaces

9.1.4 Roles and Responsibilities

It is the responsibility of the developer to ensure that all mitigation measures are implemented by their contractors and that monitoring reports are prepared. It is recommended that an Environmental Health and Safety (EHS) Manager is employed to oversee the specific requirements of these plans.

The Client is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

9.2 Water Quality

9.2.1 Monitoring Standards

Monitoring of water quality for the Project will mostly consider environmental health during the construction phase and public health during the operational phase. The parameters to be monitored during construction to ensure protection of the marine environment will be stipulated by NEPA in the relevant licenses and the sampling protocol used will meet at a minimum, the Ministry of Health & Wellness (MoHW) Environmental Health Laboratory Sampling and Field Measurements Protocol. Nevertheless, standards for marine water quality stipulated by NEPA are given in the table below.

Table 9-2: NEPA Marine Water Quality Standards

Parameters	NRCA Ambient Water Standard
pH	8.0 -8.4
Phosphate (mg PO_4^{3-} -P/L)	0.001-0.003
Nitrate (mg NO_3^- - N/L)	0.007-0.014
Total Coliform (MPN/100 ml)	2 -256
Faecal Coliform (MPN/100 ml)	<2 -13
Biochemical Oxygen Demand (mg O_2/L)	0-1.16

Regarding public health and safety, the MoHW has set out guidelines in its "RECREATIONAL BATHING WATER MONITORING PROGRAMME" through its Environmental Health Unit (EHU). The standard outlines the protocols for monitoring and guideline values for faecal coliform and faecal enterococci in marine water used for bathing. These are given in the table below:

Table 9-3: Ministry of Health and Wellness Recreational Marine Water Quality Standards

Parameters	Guideline
Faecal Coliform	75% of all samples shall be less than 100MPN/100mL (No one sample shall exceed **400MPN/100mL** for the entire period. A minimum of four (4) samples is required to obtain an assessment)
Faecal Enterococci	75% of all samples shall be less than 40MPN/100mL (No one sample shall exceed **160MPN/100mL** for the entire period. A minimum of four (4) samples is required to obtain an assessment)

9.2.2 Monitoring Frequency

Water quality monitoring for protection of environmental health will be conducted according to the stipulations of the environmental license issued by NEPA. Monitoring of the marine environment for *recreational* purposes should be conducted monthly with inspection of beaches and other bathing waters.

At least one bacteriological and one chemical sample should be collected according to the EHU Sampling and Field Measurements Protocol, 2005 and submitted to an EHU approved laboratory for testing. Sampling points should be selected at recreational water sites according to the following criteria in order of priority:

i. Samples must be collected within the bathing area.
ii. The most vulnerable points within the area should be preferred such as points of entry of tributaries, rivers, effluent. If none of these are present other vulnerable points such as points of highest bather density may be used.
iii. For extended areas of coastal or freshwaters one (1) sample should be collected every 500m. Some hotels and other beach operators along a strip may collaborate and have a single sampling point and monitoring programme.
iv. All stakeholders should be collaborating and agree on the sampling areas for consistency.
v. Three dimensional GPS co-ordinates for sampling points should be obtained.
vi. Maps and GIS coordinates of sites and sampling locations should be retained.

9.2.3 Management and Mitigation Measures

If any sample is observed to exceed the values listed in *Table 9-3*, a beach warning notice should be posted, and weekly sampling done to confirm pollution status. If pollution remains for the next three (3) samples, the beach should be closed pending return to safe levels. Safe levels should be confirmed by four (4) consecutive tests at maximum weekly sampling which demonstrate that the guideline is being met.

9.2.4 Data Analysis and Reporting

All samples collected during the monitoring exercise will be analysed using verified/validated analytical methods at an EHU approved laboratory. The Certificate of Analysis (COA) obtained from the laboratory should contain at least the following information:

1. Sample identification/information and description
2. Sample collection date and time
3. Sample submitting information (temperature and condition of sample, time and date of submission)
4. Analysis date
5. Test results with units of measurement
6. Test methods
7. Notes regarding anomalous tests results
8. Applicable standard
9. QA/QC documentation

10. Signature of authorized persons

The data obtained from the certificate of analysis will be analysed, taking into consideration statutory requirements and operational standards as well public health and safety. These reports will be prepared by the environmental specialists (internal/ external) and submitted to the EHS Manager who will then review and take necessary actions and report to the relevant regulatory agencies according in the reporting frequency in their License).

9.2.5 Roles and Responsibilities

The schematic of the reporting structure will be as follows:

Environmental Specialist

Oversees monitoring exercise and generates report for EHS Manager

↓

EHS Manager

Reviews reports and disseminates exceedances to senior managament

↓

Regulatory Agencies

Reviews reports for compliance and evaluate appropriateness of corrective/ preventative actions taken

9.3 Waste Management

The administration and oversight of solid waste management is primarily to be carried out by the Contractor. Below is the definition used in the management of solid waste:

Solid (Non-Hazardous) Waste

The International Finance Corporation (IFC) General Environment, Health and Safety (EHS) Guidelines define solid (non-hazardous) waste as generally any garbage refuse including domestic trash, inert construction/demolition materials, refuse such as scrap metal and empty containers.

Hazardous Material/Waste

The International Finance Corporation (IFC) General Environment, Health and Safety (EHS) Guidelines define hazardous waste as Substances that possess at least one of four characteristics; ignitability, corrosivity, reactivity, or toxicity - or appear on special lists.

The International Finance Corporation (IFC) General Environment, Health and Safety (EHS) Guidelines define hazardous material as materials that represent a risk to human health, property, or the environment due to their physical or chemical characteristics. They can be classified according to the hazard as explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; and corrosive substances.

9.3.1 Monitoring Frequency

Monitoring of waste should be done twice per month or as per the frequency with which material is being removed and transported from the site to ensure that all measures are being implemented and followed.

9.3.2 Management and Mitigation Measures

The Contractor will ensure that the following mitigation measures are implemented during construction so as to reduce the possible negative impacts of improper waste disposal and management:

- Potential hazardous material should be identified prior to the start of construction.
- All non- hazardous waste generated should be disposed of using approved methods. Waste should only be dumped at an approved landfill, the closest is Retirement Landfill. It must be transported by either NSWMA or an approved contractor by NSWMA.
- Material that can be recycled should be separated and carried to approved collection points.
- Burning of any kind of waste is prohibited.
- Any hazardous material such as waste oil and contaminated soil should be disposed of via approved contractors in locations approved by NEPA.
- A schedule for collection of waste must be developed
- In the event of leaks/ spills they should be cleaned up immediately
- Portable toilets, if used, must only be transported and disposed of by approved contractors.
- Hazardous materials shall be stored in properly bunded areas to contain any leaks.
- Workers handling hazardous waste should be properly equipped with PPE (masks, gloves, hard hat, hard boots, etc).
- Appropriate spill kits must be available in areas of proximity to watercourses and drains;
- All personnel shall be trained and educated during induction on the safe handling of hazardous substances on site.
- The Project Site should be kept clean and free of litter and no litter from the site shall be allowed to disperse to surrounding areas;
- All personnel shall be instructed to dispose of all wastes in a proper manner;
- All construction materials should be suitably stored and protected so that they do not become damaged and unusable.

9.3.3 Roles and Responsibilities

It is the responsibility of the Contractor to ensure that all mitigation measures are implemented and that monitoring reports are prepared. The Contractor should consider employing an EHS Manager to oversee the specific requirements of this plan.

The Client is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

9.3.4 Data Analysis and Reporting

Monitoring will be carried out by the Contractor monthly.

9.4 Biodiversity Management and Monitoring Framework

This subsection describes habitat offset/ restoration primarily for seagrass meadows.

9.4.1 Seagrass Meadows Habitat Offset

The proposed project will potentially impact $32m^2$-$76m^2$ of seagrass and associated benthic organisms within the vicinity of construction of groynes 1, 2 and 3, and the beach area to be nourished.

The seagrass that may have to be removed will be replanted in another location prior to the start of construction. An equivalent of 120% of the area that could potentially be impacted by coastal works will be replanted. It is proposed that no relocation or restoration of seagrasses occurs shallower than 1.5m, for the comfort of wading beach users, nor deeper than 3.0m, so that ambient conditions are as close as possible to those at the harvest sites.

Based on the environmental conditions that were observed in the vicinity of the area that will be impacted, it is appropriate to use any nearby disturbed areas of the seagrass bed for the relocation of impacted resources.

Using disturbed areas that are within an otherwise healthy seagrass meadow as recipient sites precludes the need for extensive water quality testing and other investigations, as the goal of those investigations would be to evaluate whether the environmental conditions (e.g. substrate, light penetration, water quality, flushing, depth) at the recipient site was suitable for the seagrasses to flourish.

There are significant areas of sand within the seagrass meadow, as parts of the seagrass bed have experienced ‘blow-outs’, bed erosion, or which have been otherwise damaged from boating activity (such as anchor or propeller damage).

Prior to replanting the donor mats or establishing meristems the recipient areas should be appropriately prepared by filling the “blow outs” or trenches with sand, so as to bring these disturbed areas up to level with the adjacent seagrass beds or to achieve at least 30cm of substrate depth.

The seagrass beds affected by relocation at the donor sites may need to have appropriate stabilization treatment so as to prevent any erosion of the bed edges. This stabilization may be carried out using mesh and pins.

All invertebrates (such as sea urchins) and any small corals in the harvest area may be collected by hand and transported underwater where they will be relocated to nearby seagrass beds.

9.4.2 Monitoring Indicators

Biodiversity monitoring is the repeated observation or measurement of biological diversity to determine its status and trend. The biodiversity indicators being monitored may be qualitative (e.g. presence or absence of an indicator species) or quantitative (abundance or population density of a species, distribution area of a habitat, number of typical species in the habitat, etc.). Specifically, the seagrass ecosystem will be monitored during the construction and operation phase of the Project. Several parameters and specific indicators will be used for the seagrass habitat and the main goal of the monitoring activity is to determine that there is no net loss. The table below outlines the monitoring programme in greater detail.

9.4.3 On-going Monitoring

The table below presents the Monitoring Framework for both Construction and Operation.

Table 9-4: Draft Monitoring Framework

Ecosystem/ Habitat	Parameters	Equipment	Monitoring activity	Indicator	Monitoring frequency	Location	Responsible organization
CONSTRUCTION							
Seagrass Ecosystem	Seagrass species and associated fauna (species and the abundance)	Quadrats, digital camera, aerial photographs and GPS	Determine the spatial extent of the seagrass beds from aerial photographs and ground truthing. Seagrass species composition. Abundance of associated fauna	No net decrease of the area cover by seagrass and no net change in species composition	Monthly; when beach nourishment is close to the sensitive areas identified monitoring should be weekly	Northern Section of Long Bay (Sandals Negril)	Monitoring may be done in conjunction with NEPA
OPERATION PHASE							
Seagrass Ecosystem	Seagrass species and associated fauna (species and the abundance)	Quadrats, digital camera and GPS	Representative sampling to check status of seagrass beds and species composition of associated fauna	No net decrease of the area cover by seagrass and no net change in the species composition	Bi-Annually (once in wet and dry season) in the first year, thereafter once per year. If there is an extreme event, monitoring of the affected area should be done immediately after.	Northern Section of Long Bay (Sandals Negril)	Monitoring may be done in conjunction with NEPA

9.4.4 Roles and Responsibilities

It is the responsibility of the Client to employ a marine ecologist trained in seagrass replanting and monitoring to remove, replant and monitor the works prior to construction. The Client is responsible for monitoring the ecologist to ensure that monitoring is being undertaken and mitigation measures are being enforced.

9.5 Occupational Health and Safety

This section relates to both worker health and safety as well as the safety of visitors and other neighbouring stakeholders.

9.5.1 Monitoring Frequency

Monitoring will be carried out by the Contractor daily to minimize possible incidents.

9.5.2 Management and Mitigation Measures

The Contractor will ensure that the following mitigation measures are implemented during construction to reduce the possible negative impacts of workers and surrounding residential areas:

- The contractor must have a health and safety policy that is known and understood by all workers. It must also be visible to the workers on site.
- Construction areas should be clearly demarcated with safety signs and barriers to prevent possible incidents.
- Workers should be properly equipped with health and safety equipment and trained in the proper use of construction equipment.
- All workers must be trained in the proper use of all health and safety equipment.
- All workers must be trained in the proper handling and management/ disposal of all types of waste.
- The contractor EHS Manager/ Officer shall maintain a register of all EHS related incidents that have occurred as a result of the activities associated with the contract. EHS incidents that should be recorded include fires, accidents, spills of hazardous materials that contaminate soil or water resources, stop-order notices issued by NEPA, Hanover Municipal Corporation or any other relevant agency, non- compliance with this EMP.
- Each EHS related incident will be investigated by the client's EHS officer and an incident report forwarded to the contractor. An incident report will be presented within five working days;
- EHS incident reports will include as a minimum, a description of the incident, actions taken to contain any damage to the environment, personnel or the public, and the corrective actions to repair/remediate any damage;
- All construction plant and equipment, tanks and machinery shall be maintained in a good state of repair throughout the construction period
- Equipment maintenance should be carried out on an impermeable surface
- Leakage from equipment will be prevented by regular inspection and repair
- Emergency medical supplies must be available and easily accessible in the case of an incident.

- In the event that the onsite medical supplies are not adequate, the incident needs to be escalated to the hospital.
- In the event that a worker is exposed to hazardous material they should immediately be taken for medical attention.

9.5.3 Roles and Responsibilities

It is the responsibility of the Contractor to ensure that the health and safety management policy is clearly understood by all workers and that all mitigation measures are carried out and that monitoring reports are prepared.

It is the responsibility of the workers to ensure that they understand the health and safety requirements and that they abide by them.

The Client is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

9.5.4 Data Analysis and Reporting

If there are any violations, this will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

9.6 Beach Monitoring Plan

The outline for a beach monitoring plan has been prepared by Olsen Associates Inc. and is included in Appendix 12.9.

10 CONCLUSION AND RECOMMENDATIONS

The following salient points can be concluded from the analyses carried out during this EIA.

Negril has a low sediment production rate and, as a result, erosion is likely to be greater than accretion (SWIL, 2007). Winter swells, which occur between 2–8 times per year, have been responsible for tremendous amounts of erosion. Coupled with climate change, there is likely to be significant impact to the entire Negril coastline including the project area. With existing, significant sand loss from the beach system due to erosion, buffers are considered necessary to reduce the cumulative extent of future climate impacts. This can be achieved through best practices in the design and implementation of coastal projects.

The following has been noted with regard to the current proposal being put forward by Sandals Negril:

- The initial nourishment will increase the existing beach width in the northern half of the SNG property by 12m. After 6–12 months (the time the beach will take to reach equilibrium), approximately 2–4m of the newly nourished sand will be lost to longshore and cross-shore movement (Olsen, 2019);
- This is because the proposed groyne structures have been designed to trap only 10% of longshore drift moving in a southerly direction. There will be an increase in net sediment movement to the south which may have a positive impact on properties south of Sandals;
- As a result of the above, it is likely that the SNG beach would need renourishment in 6–8 years;

- With or without the groynes, the coastline is still susceptible to storm wave impacts and after extreme events, renourishment may be required;
- The Bloody Bay sand extraction site has been described as a one-time option for sand, and as such, an alternative sand source will need to be identified. This option also requires roughly between 8,800 and 14,600m^2 of vegetation to be cleared at minimum from the proposed Bloody Bay site.

Based on the analysis of alternatives that was conducted, it was concluded that the "Do Nothing" alternative would result in further loss of the SNG coastline which would have far reaching economic implications for the hotel. With the "Nourishment Alone" option, it is estimated that the addition of sand to the beach area will augment the volume and spatial extent of sand that is available for erosion. In the area that will be nourished (i.e., approx. 250m at the northern end of the SNG property), it will take approximately 60% longer to erode. Although the area being nourished is likely to take longer to erode, the erosion being experienced in the wider Long Bay area will continue to occur at the same average rate observed historically, or even higher in the event of hurricanes or storms, and it is most likely that the newly nourished sand will be transported to the south if no additional protection is implemented. In fact, an attempt by Sandals Negril to nourish their beach in the past failed as the sand was subsequently lost by wave activity.

The proposal for the introduction of groynes has been met with mixed reactions from the wider Negril community. Fears/reservations were expressed about potential downdrift impacts, as well as the possibility that approval of this project would cause the proliferation of hard structures along the Negril coastline. Concerns were also raised about the potential destabilisation of the beach system in Bloody Bay by the removal of sand from that system. Many stakeholders in Negril are calling instead for a more holistic approach to tackling erosion in Negril rather than an individualised approach. SRI, in collaboration with the Negril Chamber of Commerce, is however in the process of spearheading an initiative aimed at arriving at a solution to address the longstanding beach erosion issue in Negril (see Appendix 12.10).

Modelling results (SWIL, 2019) have concluded that impacts caused by the groynes will be localised in the immediate vicinity of the groynes and no downdrift impacts are foreseen. The impacts of long-term erosion and inundation of the Bloody Bay coastline by storm surge show that although the extraction site will be inundated during modelled storm conditions, erosion is not expected to reach to the borrow zone.

10.1 Recommended Additional Investigations

10.1.1 Shoreline and Beach Works

Beyond the next 6–8 years and possibly within them, ongoing beach maintenance will be necessary. Though hard to predict, there will be costs, benefits and environmental implications. An analysis of ongoing costs related to shoreline management may be required. This may be needed at a strategic rather than site-specific level, though individual property owners may benefit from gaining an understanding of these factors. This should include a detailed evaluation of alternative sand sources for extraction, beach nourishment and maintenance.

10.1.2 Biodiversity and Ecology

To comply with the no net loss policy required in the Biodiversity Regulations, where site-based activities are unable to mitigate for biodiversity and habitat loss, compensation mechanisms will need to be considered. This will include comprehensive ecological assessments to determine suitable locations for compensation.

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12 Appendices

12.1 NEPA Terms of Reference

TERMS OF REFERENCE
For An
ENVIRONMENTAL IMPACT ASSESSMENT

For Proposed Installation of Six (6) Groynes and Beach Nourishment at Sandals Negril, Norman Manley Boulevard, Hanover

By
Sandals Negril Limited

2019

Submitted by: Sandals Negril Limited
Modified by: Environmental Solutions Ltd.
Date: February 8, 2019
Revised: May 21, 2019

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The purpose of this document is to establish the Terms of Reference (TOR) for the Environmental Impact Assessment (EIA) for Proposed Installation of Six (6) Groynes and beach nourishment at Sandals Negril, Norman Manley Boulevard, Hanover. An EIA seeks to identify the impacts the proposed project is likely to have on the area in which the physical development will be carried out as well as the impact of the environment on the proposed development. It also outlines mitigation measures necessary to reduce the negative impacts of the project. The EIA will be prepared using a participatory approach involving key stakeholders. This TOR is specific to works that is to be conducted within the marine environment.

The EIA report must be produced in accordance with the agreed TOR issued by the National Environment and Planning Agency (NEPA) to Sandals Negril Limited.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EIA study.

The National Environment and Planning Agency and the Natural Resources Conservation Authority (NRCA) reserves the right to reproduce, transfer and disclose any and all contents contained in the submitted environmental impact assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Impact Assessment (EIA) are as follows:

1 EXECUTIVE SUMMARY

Provide a brief statement on the content of the EIA report. The executive summary should provide a comprehensive overview and objectives of the project proposal, natural resources, justification for the project, etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions in the report.

2 INTRODUCTION

The introduction should provide a background and seek to explain the need for and the context of the project and the EIA. It should also provide the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study. Additionally, a profile of the project proponent, implementing organization, project consultants, etc. should also be provided. The study area should not be less than 1 km and include all valued resources.

3 POLICY, LEGISLATION AND REGULATORY CONSIDERATION

This section should provide details of the pertinent regulations, standards, policies and legislations governing environmental quality, safety and health, cultural significant finds, protection of sensitive areas, protection of endangered species, tourism enterprises, siting and land use control at the local and national levels. The examination of the legislation should include at a minimum the Natural Resources Conservation Authority Act 1991, Natural Resources Conservation Regulations 1996, amended 2015, Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013, Beach Control Act, Wild Life Protection Act, Jamaica National Heritage Trust Act, the Fishing Industry Act, Natural Resources Conservation (Marine Parks) (Amendment) Regulations, 2015, National Solid Waste Management

Authority Act, the Town and Country Planning Act, Building Act and Codes and Standards promulgated there under, Development Orders and Plans and all appropriate international convention/protocol/treaty where applicable. Describe traditional land use and advise of any prescriptive rights including public access rights.

4 METHODOLOGY & APPROACH

Clearly outline the methodologies and approaches in conducting the study including collecting and analyzing data, stakeholder consultation, dates on which surveys were conducted etc. The qualifications of persons conducting the EIA will be included.

5 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

Alternatives to the proposed development or specific components and the potential environmental consequences of each proposed alternative, including but not limited to the no-action alternative should be examined. These should be assessed according to the physical, ecological and socio-economic parameters of the site including the effects of climate change. Each alternative including no-action alternatives should be examined and where possible include natural resources evaluation

6 PROJECT DESCRIPTION

This section should provide a comprehensive description of the overall project concept and specify the different components. It should include the following:

- History and background of the project
- A location map at a scale of 1:12,500 (or an appropriate scale) The total area of the site
- Existing site and its characteristics (landward & seaward) Description of the surrounding areas
- Site maps illustrating areas to be impacted and areas to be preserved in their existing state, in particular the marine benthos.
- A master site layout plan showing the various components and design elements of the proposed development. The GPS coordinates for each component is to be included.
- Detailed description of the project, project objectives and phases (where applicable), including all applicable timelines for the various aspects of the project (from pre to post development). The description should also provide details of the design concept, design components, material(s) to be used, source, total number, grain size analysis, and types of groynes, dimensions of structures (where applicable), beach nourishment works to be undertaken, including but not limited to methodology and source of sand. This should be supported by the use of maps, diagrams and other visual aids where appropriate.
- All phases of the project should be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.
- Detailed description of all activities and features which will introduce risks or generate an impact (positive or negative) on the environment including but not limited to seagrass and/or coral relocation and shading; increased turbidity, disruption of sediment transport and circulation patterns and dredging.
- Details of the methods, equipment and machinery to be employed to undertake each aspect of the project including coral/seagrass relocation, dredging, transportation of material, disposal

of spoils (if applicable), storage of material, construction of groynes, nourishment, installation of required infrastructure and secondary activities such as refueling of vessels, proposed location(s) for equipment storage (staging area) and establishment of a site office.

- Details regarding access points and accessibility to the proposed work site(s) Estimated duration of the project for construction
- Details of any required decommissioning of the works and/or facilities.

7 DESCRIPTION OF THE ENVIRONMENT

A survey of the proposed development site should be conducted; taking into account the types of resources located in this area and the magnitude of the associated impacts. The study area should be large enough to include all valued resources that might be significantly affected by the project. The study area should be clearly delineated and referenced and the survey should be conducted for both the wet and dry seasons. This information will form the basis upon which impacts of the project will be assessed. The following aspects should be described in this section:

7.1 Physical Environment

This section should provide a complete description of the study area including geographical boundaries and methodologies used for the collection of baseline data. The description should include the following aspects of the environment:

A. Water Quality

i. Baseline water quality should include study areas and associated environs and control sites. These should be accurately mapped and a spatial comparison of the data should be done in order to determine any possible source(s) of pollutants (the data should be geo-referenced).

ii. Water quality should include but not be limited to the following parameters:

a) Turbidity
b) nutrients (nitrates and phosphates)
c) Faecal Coliform
d) BOD
e) COD
f) oil and grease

iii. Results from the water quality sampling should be compared to local and international water quality standards.

iv. Historical data should be used for comparisons where possible.

B. Hydrodynamics

i. Existing and proposed final bathymetry and/or elevation profiles of the site including areas to be dredged, reclaimed or used as temporary storage.

ii. Baseline sediment transport and circulation patterns.

iii. Erosion and accretion profile of the beach.

iv. Historical data should be at least 20 years

C. Noise levels of current site and the ambient noise in the area of influence

D. Sources of existing pollution (coastal, surface, and ground water) and extent of contamination

7.2 Biological Environment

Description of habitats, existing vegetation, flora and fauna surveys inclusive of a species list and abundance; commentary on the ecological health, function and value in the project area, threats and conservation significance. This should include:

Coastal/Terrestrial Assessment

v. Benthic surveys should be conducted with emphasis placed on those areas (seafloor) which will be impacted by the proposed development.

vi. Coastal surveys should be conducted in order to describe the plant and animal community present within the project/impact areas - including temporary staging, equipment and materials storage areas. The ecosystems and habitats identified within the impact areas should be described and mapped. This should include but not be limited to the seagrass beds, corals and other ecologically important habitats and or species.

vii. A pelagic planktonic study should be conducted which should detail the larval stages of any economically sensitive marine animals.

viii. A species list should be generated with special emphasis on those species considered rare, threatened, endangered, endemic, protected, invasive and economically or nationally important. Identification and description of the different ecosystem types and structure including species dominance, species dependence, habitats/niche specificity, community structure and diversity, possible biological loss or habitat fragmentation ought to be considered. The assessment must be done according to internationally (scientific) acceptable standards and the provision of photographic inventory is preferred.

ix. Any sea turtle, sea turtle nests or dolphins observed in or around the project area should be recorded and mapped. This should be supported by information including but not limited to the following; existing sea turtle nesting sites and seasons; and habitat usage by migratory species.

x. Habitat map of the area.

7.3 Socio-economic Environment

This section should provide details on the demography, regional setting, location assessment, current and potential land -use patterns (of neighbouring properties); description of existing infrastructure; and other material assets of the area. There should also be an assessment of the present and proposed uses of the site and surrounding areas including any land acquisition needs, any prescriptive or public access rights, and impacts on current users of the area during and post development. Effects on socio-economic status such as changes to public access and recreational use, impacts on existing and potential economic activities, public perception, contribution of development to national economy and development of surrounding communities.

A socio-economic survey to determine public perception of the project (both negative and positive) should also be completed and this should include but not be limited to potential impacts on social, aesthetic and historical/cultural values. This assessment may vary with community structure and may take multiple forms such as focus groups, public meetings or questionnaires. The methodology for conducting the survey should be included as the EIA report. In addition, the questionnaire must be approved by the Agency prior administering same.

7.3.1 PUBLIC PARTICIPATION

This section should detail the results of the public perception surveys conducted. It should summarize the issues identified during the public participation process and how these have been addressed or incorporated in the EIA report.

It should describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups. The sampling methodology employed must be appropriate for the population size and distribution, and must be weighted towards the communities/interest groups including but not be limited to hotel and other tourism interest groups in closest proximity to the proposed development. The instrument used to collect the information must be included in the appendix. Stakeholder meetings should also be held to inform the public of the proposed development and the possible impacts and gauge the feeling/response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meeting(s) should be held in accordance with the Guidelines for Conducting Public Presentation (NEPA, October 2007) at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once completed and submitted for consideration. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document and project should be clearly outlined to the public.

7.4 Heritage

An assessment of artifacts, archaeological, and cultural features of the site should be undertaken. Where there is a need this should be conducted in collaboration with the Jamaica National Heritage Trust.

8 IMPACT IDENTIFICATION AND ANALYSIS & PROPOSED MITIGATION

A detailed analysis of the project components should be done in order to identify major potential environmental, health and safety impacts of the project. This section shall seek to distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect impacts, reversible or irreversible impacts, long term and immediate impacts and identify unavoidable impacts.

The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate or minor, and presented in separate matrices for all the phases of the project (i.e. preconstruction, construction, operational, and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts.

All impacts should be listed, ranked and assessed, preferably in a single table.

This section should also provide mitigation measures which should endeavour to avoid, reduce or remedy the potential negative impacts identified, while enhancing the positive impacts identified. Mitigation and abatement measures should be developed for each potential negative impact identified. Full details of the methods proposed to be employed in the implementation of these measures should be provided, including details on the scheduling/timelines, source of materials, location and responsible parties, where appropriate. Maps and diagrams should also be used to illustrate areas where mitigation measures are proposed to be implemented.

The impacts to be assessed should include but not be limited to the following:

8.1 Physical Environment

i. Impacts of coastal modification such as:
   a. Dredging relating impacts,
   b. Shoreline modification,
   c. Removal of seagrass and corals, relocation of seagrass and corals, shading
   d. Sediment plume dispersal,
   e. Reef modification
   f. Modification of waves and current patterns
   g. Modification of sediment transport and circulation patterns
   h. Water quality during construction and operation phases (pollution of coastal and marine)
   i. Working footprint for construction activities and machinery
   j. Access points for construction machinery
   k. Spoil disposal

ii. Impacts of construction activities such as:
   l. Encroachments
   m. Occupational health and safety
   n. Beach access

iii. Impacts of potential spills (such as oil and chemical spills)

iv. Impacts of climate change

v. Noise

vi. Impacts on aesthetics, landscape and seascape

8.1.1 Natural Hazards

Potential impact of natural hazards including tropical storms, hurricanes and tsunamis

A risk assessment of the development in relation to the following must be undertaken

i. Tropical Storms, Hurricanes, Tsunamis, storm surges
ii. The natural hazard risk assessment should take in account climate change projections.
iii. The changes in impact of natural hazards and extreme storm events on surrounding developments as a result of the captioned project should be included

8.2 Biological Environment

This should include an assessment of the direct and indirect impacts of the project on the ecology of the marine habitats/environment with emphasis being placed on rare, endemic, threatened, protected, endangered, invasive, and economically important species found. This should include habitat loss and fragmentation, loss of species, inclusive of pelagic planktonic stages of economically important species, and natural features, and the impact of noise and vibration on fauna.

8.3 Socio-economic Environment

This should include effects on socio-economic status including changes in resource use, public access, prescriptive rights, existing recreational use, impacts on existing and potential economic activities; public perception; and the contribution of development to the national economy and development of surrounding communities, hotel and other tourism interest groups.

8.4 Heritage

An assessment of artifacts, archaeological, geological, paleontological and cultural features should be undertaken. Where there is a need this should be conducted in collaboration with the Jamaica National Heritage Trust.

8.5 Cumulative Impacts

Cumulative impacts should also be evaluated taking into account previous developments and any proposed development immediately adjacent to the subject development The major concerns surrounding environmental, health, and safety issues should be noted and their relative importance to the design and implementation of the project indicated.

9 ENVIRONMENTAL MANAGEMENT AND MONITORING

An Environmental Management and Monitoring Plan should be developed which will detail the requirements for construction and operational phases of the project. This should include, but not be limited to training for construction and operation staff, as well as include recommendations to ensure the implementation of mitigation measures and long-term minimization of negative impacts. Special emphasis should be placed on the preparation of Coral Management Plan, Seagrass Management Plan, Dredge Management Plan and Beach Nourishment Management Plan if applicable. A draft environmental monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval should the permit be granted and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

i. The locations/sites selected for monitoring. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
ii. The parameters which will be monitored for each activity or implemented mitigation measure
iii. The methodology to be employed for the monitoring of the various parameters and the frequency of monitoring.
iv. The frequency of the submission of the monitoring reports to NEPA and other relevant agencies
v. The responsible parties for the monitoring
vi. Possible energy and water conservation measures
vii. The Monitoring report should also include, at minimum:
    o. Raw data collected. Tables and graphs are to be used where appropriate
    p. Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
    q. Recommendations
    r. Appendices of data and photographs if necessary.

10 CONCLUSION AND RECOMMENDATIONS

11 LIST OF REFERENCES

12 APPENDICES

The appendices should include but not be limited to the following documents:

i. Reference documents
ii. Photographs/ maps
iii. Data Tables
iv. Glossary of Technical Terms used
v. Final Terms of Reference
vi. Profile of the project proponent and implementing organization
vii. Composition of the consulting team, team that undertook the study/assessment, including name, qualification and roles of team members
viii. Notes of Public Consultation sessions
ix. Instruments used in community surveys

All findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as, references. GIS references should be provided where applicable. One hard copy and an electronic copy must be submitted to NEPA for review after which the Agency will indicate the number of hard copies along with an electronic copy of the report to be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, proposed streetscapes (that will demonstrate the preservation of the windows to the sea concept from the roadway), the study team and their individual qualifications, photographs, and other relevant information. All of the foregoing should be properly sourced and credited.

12.2 Profiles – Project Proponent and the Consultants

SANDALS NEGRIL LTD.[6]

Sandals Resorts International (SRI) is one of the most well-known and award-winning hospitality companies in the world with five brands and 24 properties in seven countries. The SRI brand includes:

1. Sandals – 15 resorts across the Caribbean
2. Beaches
3. Grand Pineapple
4. Fowl Cay Resort, Bahamas
5. Your Jamaican Villas - The Private Villas of Sandals & Beaches

Sandals Montego Bay, opened in 1981, was the first of the Sandals Resorts properties and Sandals Negril was opened shortly thereafter in 1988. Sandals Negril has received many accolades over the years including an EarthCheck Double Platinum Certification for an unwavering commitment to environmental excellence for over a decade, and being awarded Jamaica's Leading Resort (World Travel Awards Winner 2016).

SRI demonstrates their commitment to service and corporate social responsibility by mandating that every resort under the SRI banner adopt schools and in some cases, entire communities to ensure that the messages of health, safety, environmental concern, community and opportunity are shared as much as possible. In 2007, Sandals Resorts earned the Condé Nast Traveler World Savers Award for the Adopt-A-School program and the work in the Caribbean communities where Sandals Resorts operates.

ENVIRONMENTAL SOLUTIONS LTD.

Environmental Solutions Limited (ESL) is a Caribbean-wide resource of environmental excellence and was the first company established in Jamaica (April 22, 1991) to bring an integrated approach to environmental management and development. ESL has built a solid track record in pioneering environmental awareness and integrated management through promotion of "The Environment as Good Business" and has delivered wide-ranging services in in Jamaica and the Caribbean.

Environmental Solutions Limited applies an interdisciplinary approach to its service offerings and has incorporated several environmental sub-disciplines of pure and applied sciences, social sciences, and engineering to provide practical solutions for the private sector, governments and non-governmental organizations. ESL works in areas such as infrastructure planning and development (highways, water supplies, waste management, airports, seaports, hydropower, telecommunications,); tourism and resort development; mining; manufacturing; housing; land development; disaster risk reduction and management; climate change mitigation and adaptation; institutional capacity building and awareness training.

[6] Information extracted from Sandal's website - www.sandals.com

Over the last 27 years ESL has gained a wide range of experience in many different types of environmental assessments, for the private sector as well as for Governments locally and overseas. Biographies of the project team members are presented in Appendix 12.3.

Table 12-1: ESL Recent Environmental Assessment Project Experience

PROJECT NAME AND CLIENT	PROJECT TYPE	LOCATION	YEAR
Environmental Impact Assessment for Caribbean Broilers Development in Hill Run, St. Catherine	EIA	Jamaica	2018
Environmental Impact Assessment for proposed Whim Estate Housing Development, Old Harbour, St. Catherine	EIA	Jamaica	2018
Strategic Environmental Assessment for Proposed University Heights Housing Development in Dallas Mountain	SEA	Jamaica	2017
Strategic Environmental Assessment for New Court Development in Coral Springs, Trelawny	SEA	Jamaica	2017-2018
Environmental Impact Assessment of Georgetown Sea Defense Regional Disaster Vulnerability Reduction Project	EIA	St. Vincent and the Grenadines	2013-2016
Environmental Impact Assessment for Phase 1C of Highway 2000 East West (May Pen to Williamsfield)	EIA	Jamaica	2016-2017
Quinam Coastal Protection Works- Preliminary Environmental Impact Assessment	EIA	Trinidad	May 2017 to January 2018
Coastal Environmental Assessment for Proposed Resort Development in Llandovery. St. Ann – Karisma Hotel Group	EA	Jamaica	2017
Strategic Environmental Assessment for Proposed Resort Development in Llandovery. St. Ann – Karisma Hotel Group	SEA	Jamaica	2016-2017
Environmental and Social Assessment for 37MW Solar PV Power Plant in Westmoreland – Eight Rivers Energy Company	ESA	Jamaica	2017
Environmental and Social Impact Assessment of the upgrade of the Port and the dredging of the Kingston Harbour	ESIA	Jamaica	2015
Supplementary Hydrological and Environmental Study, Les Cayes, Haiti. Water and Sanitation in Intermediate Cities Project HA-L1039	Hydrological and Environmental Study	Haiti	2014

PROJECT NAME AND CLIENT	PROJECT TYPE	LOCATION	YEAR
Environmental and Social Assessment - 20MW Solar Power Plant, Content Village Clarendon	ESA	Jamaica	2013-2014
Mooring/ Berthing Facilities at Orange Valley and Brickfield Fish Landing Sites	EIA	Trinidad	2013-2014

12.3 Project Team bios

Biographies for the key team members who contributed to this report are presented below:

Eleanor Jones, M.A., Environmental Management Specialist and Project Director

Mrs. Eleanor Jones, international development professional, has been working for over thirty years as a change agent for integrating land use and economic development with hazard vulnerability reduction, sound environmental management and sustainable development principles through policies and practice of governments, international development agencies, and business enterprise. She has led the development of Strategic Environmental Assessments (SEAs) for major infrastructural projects, Environmental Impact Assessments (EIAs) for site-specific project interventions, and Phase I environmental assessments for guiding investment decisions. Mrs. Jones is committed to integrating sound environmental management and sustainability principles with development and has developed environmental management systems and community development plans for private, public and civil entities, leading participatory and consultative dialogue in the context of community, government and private enterprise as an integral part of her work in environment and development.

An experienced program/project analyst and manager, strategic planner, public awareness program designer, and trainer, Mrs. Jones has managed several projects that entailed congruence of development imperatives, environmental sustainability, natural hazard vulnerability reduction and climate change mitigation and adaptation strategies. She has worked with bi-lateral and multilateral regional and international institutions in the attempt to effect institutional and operational change. Mrs. Jones has applied her expertise in every CARIFORUM country and the non-independent states of the Caribbean, as well in the Maldives in South Asia, Switzerland, Canada, USA, and West Africa.

Abigail McIntosh, B.A.– Environmental Analyst and Project Manager

Abigail McIntosh currently serves as a Senior Environmental Analyst. Ms. McIntosh's has over 8 years of experience in coordinating and preparing environmental technical documents and regulatory filings, which involves preparing and submitting environmental permit applications, negotiating permit conditions with agencies, and overseeing pre-construction, construction and post-construction permit compliance for multiple projects. Ms. McIntosh is trained in project management and is responsible for liaising with and engaging external technical consultants and regulatory agencies as needed, and manages all aspects of client contracts under her portfolio. Abigail previously served as Deputy Quality Manager where she assisted with Quality Assurance and Quality Control of the ISO 17025 accredited ESL Quality and Environmental Health Laboratory. She has worked on a number of projects spanning a vast range of disciplines including renewable energy projects, wastewater management, housing development construction, ambient and indoor air quality, sustainable development and capacity building projects, etc.

and she performs other duties and responsibilities as assigned. Ms. McIntosh has also gained experience in conducting water and air quality sampling exercises, analysis and preparation of environmental monitoring reports, preparing project proposals and in managing and documenting project budgets, etc.

Danielle Nembhard M.Sc. – Marine Ecologist

Danielle A. Nembhard is a marine scientist and project manager with a strong cross-sectoral project management acumen. Her recent work has involved academic research on tropical coral reef ecosystems in the Caribbean, Australia and the Philippines, investigating their resilience as complex, social-ecological systems. Her work outside of academia and marine ecology includes a 9-year track record of successful team management and operations oversight in the Caribbean and Central America, including project managing the business development and launch of several contact centres in the region, as well as spearheading business critical process improvement initiatives. Danielle also has extensive experience conducting field work in remote locations and has refined her relationship building skills across cultural and language barriers.

Theresa Rodriguez-Moodie, PhD – Coastal Geomorphologist

Dr. Rodriguez-Moodie is an environmental scientist with over 9 years of experience as an environmental management specialist and project manager with a background in Geography. Her PhD research was focused on coastal geomorphology and paleoclimatology.

Her professional experience includes working as Environmental Specialist and Climate Change Vulnerability Specialist on projects locally and regionally. She has also acted as project manager for many large complex projects in Jamaica and the region, research and consulting for studies/projects such as climate change impact assessments, resource assessments, strategic assessments, climate change, legal and institutional reviews, environmental permit/licence applications and processes, and policy review and preparation.

She is a company director, and also the Manager of Environmental Management Services at ESL and is directly responsible for three service areas: Environmental Risk Management and Climate Change, Pollution Prevention and Control and Environmental Planning and Sustainable Management.

Her specialist skills are in Geographical Information Systems (GIS), coastal geomorphology, marine and coastal zone management, watershed management, hazard analysis and mitigation, impact assessments and vulnerability and risk assessments.

Damion Whyte PhD (pending), PMP – Terrestrial Biologist

Damion Whyte is a Zoology PhD student at University of the West Indies (UWI), Mona, where he is currently evaluating Goat Islands for the reintroduction of the Jamaican Iguana. This entails a study of the flora and fauna on the island. He has a Postgraduate Diploma in Environmental Management and also an international certification as a Project Management Professional (PMP), with over 16 years' experience in the field of environmental management.

He has conducted fauna surveys (etc. birds, bats, and crocodiles), botanical surveys, wetland assessments, water quality analysis, environmental audits, environmental remediation and environmental monitoring for several of the leading environmental firms over 16 years. He also serves on several Committees (etc.

Chairperson for the Endangered Species Working Group for the National Environmental and Planning Agency (NEPA), Jamaican Iguana Working group, American Crocodile Working Group) in relation to the environment and is a member of several organizations including Birdlife Jamaica, Jamaica Institute of Environmental Professionals, Jamaica Cave Organization (JCO) and Natural History Society of Jamaica (NHSJ).

Rashidah Khan-Haqq, MPhil – Environmental Chemist

Mrs. Khan-Haqq is an Environmental Chemist with a Master of Philosophy (MPhil) degree in Atmospheric Chemistry at the University of the West Indies. She is the manager of the Quality Environmental Health Lab at ESL, and has significant experience in environmental project management, and in air, soil and water quality monitoring and assessment particularly in industrial and commercial sectors in Jamaica. She is trained as an assessor for the ISO 17025 standard.

Her work typically involves coordinating and conducting environmental assessment fieldwork that involves collecting soil, groundwater, and surface water and air samples. Mrs. Khan-Haqq is experienced in conducting site monitoring and surveying of construction sites, waste water treatment plants, and commercial and industrial organizations of varying complexity. She is proficient at analyzing diverse samples following standard methods. Documenting field activities and data is also a major part of her daily functions as well as compiling, processing, and presenting field data in tables, figures and plans. Mrs. Khan-Haqq has a strong aptitude for interpreting technical data and presenting appropriate recommendations.

Mario Christie, B. Sc. – Chemical Analyst

Mario Christie holds of a First Class Honours Bachelor of Science Degree from the University of the West Indies. He is an analytical chemist & project officer whose focus primarily includes food safety, water quality assessments and quality control. He is trained in the principles of HACCP and other food safety management systems as well as various ISO management systems. His work involves conducting various chemical analyses, validation and verification of analytical methods, food safety assessments including HACCP/GMP audits and quality assurance related analyses, HACCP plan development as well as standard operating procedures and good manufacturing practices development, implementation and training. Mr. Christie aids in overseeing the technical operations of ESL's Environmental Health and Analytical Services (EHAS) department and plays an integral role in the maintenance and improvement of the EHAS Quality Management System.

Malcolm Hendry, PhD (Coastal Zone Management Specialist) and **George Campbell, M.Sc.** (Socio-Economic Specialist) also provided their expert opinions and valued inputs to this consultancy.

12.4 Policy, Legislation and Regulatory Considerations

The following legislation and regulations are considered relevant to the project:
The Natural Resources Conservation Authority (NRCA) Act (1991)

The Natural Resources Conservation Authority Act provides for the management, conservation and protection of the natural resources and is the chief Environmental Act for Jamaica. The Act establishes the Natural Resources and Conservation Authority (NRCA), tasked with the role of effectively managing the physical environment of Jamaica. A noted provision of this Act is that it gives the NRCA the power to directly request as a condition for receiving a permit, an Environmental Impact Assessments for any undertaking, in any area where it considers the activities to have adverse impacts on the environment; this is also for existing projects undergoing expansion. NRCA's powers and responsibilities include the following:

- Establishing and enforcing pollution control and waste management standards and regulations;
- Guiding environmentally appropriate development through such tools as prescribing areas;
- Requiring environmental impact assessments, and granting permits and licenses;
- Maintaining a system of national parks and protected areas;
- Promoting broad public awareness through information, environmental education and outreach activities;
- Monitoring and enforcing environmental laws and regulations, especially those included in the NRCA, Beach Control, Watershed Protection, and Wildlife Protection Acts;
- Providing national environmental leadership, coordinate activities of other government agencies, and support local, non-government efforts at protecting and enhancing the environment;

The Natural Resources Conservation Authority (NRCA), as the organization charged by the Government with responsibility for overall environmental management, has the pivotal role in the establishment of a National System of Protected Areas. The NRCA has responsibility under the Wildlife Protection Act, the Watersheds Protection Act and the Beach Control Act for other types of protected areas, including game sanctuaries and game reserves.

The Wild Life Protection Act (1945) *Amended 1991*

This Act is primarily concerned with the protection of specified species of fauna and precludes the hunting of any protected species. The Act also stipulates the periods for hunting; prescribes the conditions for such activities and the penalties for going in contravention of these provisions. The Act prohibits the removal, sale, or possession of protected animals and the use of dynamite, poison or other noxious material to kill or injure fish. It also prohibits the discharge of trade effluent or industrial waste into any harbour, stream, river canal etc. However, it has been superseded by the NRCA Act which provides for permits or licenses for the discharge of trade effluent into waters. There is also Draft Trade Effluent and

Sewage Regulations promulgated under the NRCA Act and these regulations incorporate trade effluent standards which specify limits for discharges of trade effluent and draft ambient water quality Standards.

The Watersheds Protection Act, 1945

This Act provides for the protection of watersheds to include areas adjoining watersheds and the conservation of water resources for Jamaica. The Act makes provision for conservation of watersheds through the implementation of provisional improvement schemes whereby soil conservation practices are carried out on land. Also, the Minister may declare an area a watershed subject to the provisions under the Act. Furthermore, regulations may be made by the designated authority, subject to the approval of the Minister, for ensuring the proper, efficient and economic utilization of land within the watershed area. This may include the prohibiting, regulating or restricting the planting of any crop specified in the regulations.

The Beach Control Authority (Licensing) Regulations (1956)

The Beach Control Act 1956 (amended in 2004) was passed to ensure effective management of Jamaica's coastal and marine resources. It includes a system of licensing of activities on the foreshore and sea floor. It also addresses issues related to access to the shoreline and other rights associated with fishing and public recreation, as well as the establishment of marine protected areas.

The Forest Act, 1996

The Forest Act is the only piece of legislation in Jamaica that uses the word 'biodiversity'. This Act sets out the role and function of the Forestry Department and the Conservator of Forests.

The Act vests responsibility in the Conservator of Forests for developing and maintaining an inventory of forests and lands suitable for the development of forests.

The Forestry Department is required to make an assessment of forestry lands to determine their potential for maintaining and enhancing biodiversity. Provisions have been made in the Act for the controlled utilization of forest resources in a rational manner.

Jamaica has over 100 gazetted forest reserves. Under the Act, private lands may be acquired for declaration as forest reserves. One of the purposes of forest reserves is to protect and conserve endemic flora and fauna.

The Act calls for the creation of forest management plans, which stipulate the allowable annual cut where appropriate, conservation and protection measures, and the roles of other Government departments. The purpose of forest management plans is to ensure the protection and conservation of forests, soil, water, wildlife, and forest products.

The Act makes it an offence to destroy trees, cause damage, light fires, carry axes, or kill or injure wild birds or animals in a forest reserve or forest management area.

The Fishing Industry Act (1975)

This Act is the main piece of legislation that provides for the regulation of the fishing industry in Jamaica Along with this Act are the Fishing Industry (Exemption) Order, 1976; The Fishing Industry (Declaration of Close Season) (Lobsters) Order, 1987 and the Fishing Industry Regulations, 1976. The Act (1975) gives the Fisheries Division responsibility for licensing fishermen and fishing boats, protection of the fishery by establishment of closed season, creation of fish sanctuaries, and penalties for landing or sale of illegally caught fish. The Director of Fisheries, is empowered by the Act to issue licenses, and is required to keep a register of all licenses issued. In addition to the license to fish, every boat used for fishing whether for business, recreation or sport, must be registered under the Act and the owner of the boat must possess a license authorizing the boat to be used for fishing. Fisheries Division is also responsible for managing Marine Protected Areas.

The Jamaica National Heritage Trust (JNHT) Act 1985

The Jamaica National Heritage Trust (JNHT) Act 1985 has established the Jamaica National Heritage Trust, with the main goal of preservation and protection of the country's national heritage. They also have the mandate to promote and develop Jamaica's material cultural heritage.

Town and Country Planning Act, 1948 (amended in 1999)

Substantial amendments were made to the Town and Country Planning Act in 1999 to provide for effective enforcement. The Act is currently being revised to provide a more comprehensive control over planning in Jamaica.

The objective of this Act is to ensure the orderly development of land. Presently, the entire island is not covered by Development Orders. Existing orders are not updated regularly. In areas covered by a Development Order, planning permission is required from the local authority or from the Town and Country Planning Authority if the area is "called in" or if the development does not conform to the zoning in the Development Order. In considering development applications, the planning authorities take into account the Development Order and other material considerations.

The Act also provides for the making of Tree Preservation Orders (Section 25) whereby a local authority may seek to preserve trees or woodlands in their area and prohibit willful damage or destruction of trees, or require the replanting of trees. The Act provides for notification of, designation, and the right to submit objections to the declaration of such an Order including provisions for compensation. These Orders are not widely used.

The Tree Preservation Order

This order falls under the Tree Preservation Act. The order provides for the protection of all trees from destruction or mutilation of any kind, except with the express permission of the local planning authority under the National Land Policy (1996). Forestry Department is responsible for managing Forest Reserves.

The Local Improvements Act (Amended 1991)

It controls the subdivision of land and requires that anyone wishing to subdivide land for building, lease, sale, or other purposes, must provide the local planning authority with a plan for approval. The act is administered by the Kingston & St. Andrew Corporation (KSAC) and the Parish Councils, which have the power to approve or deny subdivision applications within their jurisdictions, based on the advice of their Planning and Building Subcommittee and the local Fire Superintendent.

Public Health Act (1976)

This Act establishes the Central Health Committee with the local bodies being resident under the Parish Council of respective parishes. The functions and powers of the local boards are also outlined under this Act for the enforcement of all regulations and orders. There are provisions under section 14 which empowers the designated Minister to make regulations relating to air and soil pollution, occupational diseases and employment health hazards and for the control and destruction of rodents, mosquitoes and other insects, termites, and other vermin. Further, the Public Health (air, soil and water pollution) Regulations 1976 aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms.

Relevant Policies

The following policy are considered relevant:

Policy for the National System of Protected Areas (1997)

Jamaica has a rich and diverse natural heritage created by its geographical location and its varied topography, geology and drainage. In the face of deteriorating environmental conditions, a system of protected areas provided the means to conserve and ensure the sustainable use of Jamaica's biological and cultural resources. The Natural Resources Conservation Authority (NRCA) is the organization charged by the Government with responsibility for overall environmental management. It has the pivotal role in the establishment of a National System of Protected Areas.

The Protected Area System Master Plan (PASMP), 2015

The PASMP covers a five-year period 2013–2017 and presents guidelines to establish and manage a comprehensive network of Protected Areas. The PASMP enables Jamaica to:

1) Relate protected areas to national priorities;
2) Move away from a case-by-case approach to resource management;
3) Make additions to the PA System in a more rational and integrated manner;

4) Facilitate integration with other development plans such as those for tourism, biodiversity conservation and sustainable development;
5) Implement an improved process for the management of PAs, by sharing resources and responsibilities among government agencies, communities, NGOs and the private sector;
6) Improve meeting obligations under international treaties.

The Protected Areas System Master Plan (PASMP) Jamaica is a direct attempt of the Jamaican Government to protect and conserve biodiversity through the legal demarcation of areas with designated rules that protect the area from being destroyed by certain types of development activities. The completion of the PASMP will meet the main objective of the UN Convention on Biological Diversity and the plan addresses Goal 1 of the 2003 NBSAP directly.

Despite the developments outlined above, Jamaica's biodiversity still sustains threats from habitat loss, overexploitation, the impact of alien invasive species, weak law enforcement, inadequate awareness of the value of natural resources, urban population growth, poor spatial planning and land use, and climate change. These will be discussed throughout this Gap Analysis Report.

The Forestry Policy (Green Paper), 2015

This Policy governs all forests in Jamaica whether owned by the State or by private interests. Its scope covers land with reforestation potential and forests in urban settings and addresses national priorities as well as international obligations and commitments relating to climate change, biodiversity conservation, and the sustainable use of wetlands. The Goals of this Policy can be classified under three broad headings which relate to:

- Governance of the forestry sector and more specifically the mandate of the Agency, other public sector entities and other interest groups in this regard;
- The conservation and protection of forest ecological systems; and
- Relevant Socioeconomic considerations.

Following two years (2011–2012) of extensive consultations, a new Draft Forest Policy (2013) was presented and moved to Green Paper status in February 2015. This new policy will provide the basis on which the necessary changes to the legislative and management framework can be instituted. The policy will address crucial gaps and needs for the sector, namely,

- The development of forest management plans,
- The introduction of mechanisms to govern forest management data collection,
- The demarcation of jurisdictional boundaries and the regulation of
    - activities on Crown and privately-owned lands
    - the forest sector and
    - forest-based industries
- Documenting the importance of a wide stakeholder involvement in the management of the island's forests to include the public and private sectors, non-government organizations,

community-based organizations, Local Forest Management Committees (LFMCs) and special interest groups.

It is expected that amendments will be made to the Forest Act upon completion of the Forest Policy legislative process.

The Draft Watersheds Policy, 2015

The Draft Watersheds Policy for Jamaica was updated in 2015 following the commencement of the review process in 2012. The policy, which includes drafting to amend the Watershed Protection Act (1965), is intended to guide all watershed management activities, strategies and programmes as well as legislative and institutional reforms related to watersheds management to be undertaken over the next three (3) years by Government departments and agencies, private land owners and donor agencies.

The National Land Policy (1996)

The goals and objectives of this Policy are to ensure the sustainable, productive and equitable development, use and management of the country's natural resources. It is comprehensive in order to achieve complementary and compatible development which is in harmony with the socioeconomic development initiatives of the country. It allows for the development and implementation of a rational set of strategies, programmes and projects to facilitate stable and sustainable development. Chapter 3 of the National Land Policy includes rural development and the protection of watershed and fragile areas, exploitation of mineral resources, and crop and livestock production.

Mangrove and Coastal Wetland Protection Draft Policy and Regulations (1996)

Government has adopted the mangrove and coastal wetlands protection policy and regulation in order to promote the management of coastal wetlands to ensure that the many benefits they provide are sustained. The policy sets the following five goals in support of the overall aim of sustainable use of wetlands:

i. Establish the guidelines by which wetlands can be developed in order to ensure their continued existence;
ii. Bring to an end all activities carried on in wetlands which cause damage to these resources;
iii. Maintain the natural diversity of the animals and plants found in wetlands;
iv. Maintain the functions and values of Jamaica's wetland resources;
v. Integration of wetland functions in planning and development of other resource sectors such as agriculture, forestry, fisheries, ecotourism, and waste management;

The policy specifically seeks to:

- Provide protection against dredging, filling, and other development;
- Designate wetlands as protected areas;
- Protect wetlands from pollution particularly industrial effluent sewage, and sediment;

- Ensure that all developments planned for wetlands are subject to an Environmental Impact Assessment (EIA);
- Ensure that traditional uses of wetlands are maintained;

The Natural Resources Conservation (Permits and Licenses) Regulations (1996)

Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated.

Guidelines for the Planning and Execution of Coastal and Estuarine Dredging Works and the Disposal of the Dredged Materials.

This guidance document is intended to eliminate or mitigate the potentially harmful impacts that dredging works can have on the coastal and estuarine environment. Typically, an EIA is required for dredging projects. The guidelines state that along with the general description of the project and its objectives the EIA should also have adequate descriptions of the physical and biological environment, the socio-cultural and economic environment and relevant legislative and regulatory framework. It must include descriptions of the anticipated direct and indirect the environmental impacts from dredging, disposal of dredged material and the potential long-term impacts from dredging. It also indicates that the report should contain detailed plans for monitoring and mitigating any adverse effects and should include contingency plans for dealing with any hazardous situations.

The guidelines indicate that tests on suspected contaminated sediments should be carried out in typically representative areas ad depths to characterise the degree of contamination in the materials to be dredged. It states that selective analysis can be used to assess the potential for pollution effects. Alternatively, the substances identified in the London Dumping Convention can be used as the list of compounds to be investigated.

The guidelines provide three options for disposal of sediments; open-water, shoreline sites and upland sites. This project will be disposing in open-water and on shoreline sites.

Jamaica is signatory to a number of international treaties and conventions that obligate signatories to take wide ranging measures in support of environmental protection and sustainable development, including enacting enabling legislation. Those relevant to this project include:

Specially Protected Areas and Wildlife (SPAW) Protocol

It was adopted in 1990 and entered into force in 2000. The SPAW Protocol seeks to "Take the necessary measures to protect, preserve and manage in a sustainable way:

a. areas that require protection to safeguard their special value, and
b. Threatened or endangered species of flora and fauna."

12.5 Example of Stakeholder Questionnaire

Environment Impact Assessment for proposed coastal works at Sandals, Negril

Public Perception Surveys

Identification of the interview	
Interview number	
# of Persons Responding	
Date	
Name of the interviewer	

Identification of the interviewee	
Name	
Contact	
Occupations/Organisation	

Environmental Solutions Ltd. has been retained by Sandals Negril Ltd. (SNG) to prepare an Environmental Impact Assessment in support of an environmental permit application for proposed coastal works. The purpose of these works is to reduce coastal erosion on their property. SNG valued the feedback received during the stakeholder consultations held in September 2018 and has since revised their coastal designs. They now propose an alternative design to tackle their ongoing problem.
The revised project concept entails the following:

1. *Reconfiguring, lowering and shortening the existing groyne at the northern end of the property – This will include the removal of less than 500 metric tonnes of rock from the existing groyne to be reused in the newly proposed groynes.*
2. *Beach nourishment using approximately 7,000 m^3 of sand to be sourced from a Sandals-owned property in Bloody Bay. This will increase the beach width by about 8-10m and raise the beach elevation to 0.85m.*
3. *Introduction of six (6) short, low profile, rock groynes along 240m of the Sandals coastline to stabilize the planned nourishment. This will require approximately 3,730 metric tonnes of boulders to construct, which will be sourced from approved local quarries. Also, about 600m^3 of sand will be excavated to establish the foundation of the groynes, which will be re-used on the property.*

The rock groynes would be constructed from land. Construction is anticipated to take approximately 60 days, including beach nourishment which would typically occur immediately after and adjacent to construction of the groynes (Images shown to participants are found at Figure 5-3 and Figure 7-3).

Q1 - Do you think the proposed design is suitable to achieve the desired results of reducing coastal erosion?

Q2 - Do you consider the design to be acceptable for the Negril landscape?

Q3 - Do you have any environmental concerns regarding the project? If, yes, please outline below:

Q4 - Alternative solutions to the issue of coastal erosion, if any.

12.6 Species Lists

Table 12-2: List of floral species identified in the S9 area.

Common name	Scientific name	Family	Distribution Islandwide (Adams, 1972)	DAFOR
Long - leaved Sweetwood	*Nectandra antillana*	Lauraceae	Very common	A
Almond	*Terminalia catappa*	Combretaceae	Common	D
Santa Maria	*Calophyllum calaba*	Clusiaceae	Common	D
Rod Wood	***Eugenia disticha****	**Myrtaceae**	**Common**	**A**
Worm wood	*Andira inermis*	Fabaceae	Very common	O
Bitter Damson	*Simarouba glauca*	Simaroubaceae	Common	O
Black Jointer	***Piper nigrinodum****	**Piperaceae**	**Occasional**	**F**
Ackee	*Blighia sapida*	Sapindaceae	Common	R
Mango	*Mangifera indica*	Anacardiaceae	Common	R
Woman wood	*Oreopanax capitatus*	Araliaceae	Very common	O
Breadnut	*Brosimum alicastrum*	Moraceae	Common	F
Psychotria	*Psychotria pedunculata*	Rubiaceae	Common	F
Wild Coffee	*Faramea occidentalis*	Rubiaceae	Common	O
Maiden plum	*Comocladia pinnatifolia*	Anacardiaceae	Common	O
Cotton tree	*Ceiba pentandra*	Bombaceae	Occasional	R
Toad wood	*Cupania glabra*	Sapindaceae	Common	R
Royal Palm	*Roystonea regia*	Arecaceae	Uncommon	R
White poui	*Tabebuia angustata*	Bignoniaceae	Common	O
Dog wood	*Piscidia piscipula*	Facaceae	Common	O
Noni	*Morinda citrifolia*	Rubiaceae	Common	F
Cock spur	*Macfadyena unguis*	Bignoniaceae	Very Common	O
Wild pimento	*Pimenta jamaicensis*	Myrtaceae	Common	R
Logwood	*Haematoxylum campechianum*	Caesalpiniaceae	Common	F
Red birch	*Bursera simaruba*	Burseraceae	Common	O
Bullet	***Bumelia rotundifolia****	**Sapotaceae**	**Common**	**R**
Wild guinep	*Exothea paniculata*	Sapindaceae	Occasional	O
Trumpet tree	*Cecropia peltata*	Moraceae	Common	O
Yellow sanders	*Fagara elephantiasis*	Rutaceae	Common	R
Corn wood	*Alchornea latifolia*	Euphorbiaceae	Common	O
Iron wood	*Linociera domingensis*	Oleaceae	Widely distributed	O
Black lancewood	*Oxandra lanceolata*	Annonaceae	Occasional	O

*** Endemic species**

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-3: List of floral species identified in the S6a area.

Common name	Scientific name	Family	Distribution Island wide	DAFOR
Breadnut	*Brosimum alicastrum*	Moraceae	Common	A
Rod wood	***Eugenia disticha****	**Myrtaceae**	**Common**	**A**
Red Birch	*Bursera simaruba*	Burseraceae	Common	F
Black jointer	***Piper nigrinodum****	**Piperaceae**	**Occasional**	**A**
Woman wood	*Oreopanax capitatus*	Araliaceae	Very common	A
Maiden Plum	*Comocladia pinnatifolia*	Anacardiaceae	Common	O
Logwood	*Haematoxylum campechianum*	Caesalpiniaceae	Common	F
Royal Palm	*Roystonea regia*	Arecaceae		R
Bullet	***Bumelia rotundifolia****	**Sapotaceae**	**Common**	**O**
Bell flower	***Portlandia grandiflora****	**Rubiaceae**	**Fairly common**	**R**
Noni	*Morinda citrifolia*	Rubiaceae	Common	A
Jointer	*Piper amalago*	Piperaceae	Very common	A
White Poui	*Tabebuia angustata*	Bignoniaceae	Common	O
Black lancewood	*Oxandra lanceolata*	Annonaceae	Occasional	O
Coby wood	*Matayba apetala*	Sapindaceae	Widely distributed	O
Long – leaved wild grape	*Coccoloba longifolia*	Polygonaceae	Common	O
Broom thatch	*Thrinax parviflora*	Arecaceae	Very common	F
Almond	*Terminalia catappa*	Combretaceae	Common	D
Odor wood	***Xylopia muricata****	**Annonaceae**	**Generally distributed**	**O**
Iron wood	*Linociera domingensis*	Oleaceae	Widely distributed	O
Philodendron	*Philodendron lacerum*	Araceae	Common	F

*** Endemic species**

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-4: List of floral species identified in the S6b area.

Common name	Scientific name	Family	Distribution Isandwide	DAFOR
Long – leaved wild grape	*Coccoloba longifolia*	Polygonaceae	Common	F
Rod wood	***Eugenia disticha****	**Myrtaceae**	**Common**	**A**
Corn wood	*Alchornea latifolia*	Euphorbiaceae	Common	O
Royal Palm	*Roystonea regia*	Arecaceae	Uncommon	R
Broom thatch	*Thrinax parviflora*	Arecaceae	Very common	F
Black jointer	***Piper nigrinodum****	**Piperaceae**	**Occasional**	**A**
Psychotria	*Psychotria pedunculata*	Rubiaceae	Common	A
Philodendron	*Philodendron lacerum*	Araceae	Common	F
Long - leaved Sweetwood	*Nectandra antillana*	Lauraceae	Very common	A
Red Birch	*Bursera simaruba*	Burseraceae	Common	A
White Poui	*Tabebuia angustata*	Bignoniaceae	Common	F
Bitter Damson	*Simarouba glauca*	Simaroubaceae	Common	O
Coby wood	*Matayba apetala*	Sapindaceae	Widely distributed	O
Logwood	*Haematoxylum campechianum*	Caesalpiniaceae	Common	F
Galipee	*Dendropanax arboreus*	Araliaceae	Common	O
Santa Maria	*Calophyllum calaba*	Clusiaceae	Common	A
Almond	*Terminalia catappa*	Combretaceae	Common	D
Breadnut	*Brosimum alicastrum*	Moraceae	Common	A

*** Endemic species**

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-5: List of floral species identified in the S5 area.

Common name	Scientific name	Family	Distribution Isandwide	DAFOR
Maiden Plum	*Comocladia pinnatifolia*	Anacardiaceae	Common	O
Santa Maria	*Calophyllum calaba*	Clusiaceae	Common	D
Rod wood	***Eugenia disticha****	**Myrtaceae**	**Common**	**A**
Breadnut	*Brosimum alicastrum*	Moraceae	Common	A
Bitter Damson	*Simarouba glauca*	Simaroubaceae	Common	F
Galipee	*Dendropanax arboreus*	Araliaceae	Common	O
Black jointer	***Piper nigrinodum****	**Piperaceae**	**Occasional**	**A**
Sweet wood	*Nectandra coriacea*	Lauraceae	Common	F
Logwood	*Haematoxylum campechianum*	Caesalpiniaceae	Common	F
Long – leaved wild grape	*Coccoloba longifolia*	Polygonaceae	Common	O
Long - leaved Sweetwood	*Nectandra antillana*	Lauraceae	Very common	A
Iron wood	*Linociera domingensis*	Oleaceae	Widely distributed	F
Yellow sanders	*Fagara elephantiasis*	Rutaceae	Common	R
Noni	*Morinda citrifolia*	Rubiaceae	Common	A
Bullet	***Bumelia rotundifolia****	**Sapotaceae**	**Common**	**O**
Philodendron	*Philodendron lacerum*	Araceae	Common	O
Psychotria	*Psychotria pedunculata*	Rubiaceae	Common	F
Almond	*Terminalia catappa*	Combretaceae	Common	A
Trumpet tree	*Cecropia peltata*	Moraceae	Common	F
Ackee	*Blighia sapida*	Sapindaceae	Common	O
Cotton tree	*Ceiba pentandra*	Bombaceae	Occasional	R
Guinep	*Melicoccus bijugatus*	Sapindaceae	Common	R

*** Endemic species**

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-6:The birds observed during the assessment on the Bloody Bay property.

Common Name	Scientific Name	Status	Habitat	DAFOR
American Redstart	*Setophaga ruticilla*	*Migrant*	Terrestrial	*F*
Bananaquit	*Coereba flaveola*	*Resident*	Terrestrial	*F*
Black and White Warbler	*Mniotilta varia*	*Migrant*	Terrestrial	*R*
Black-Crowned Night Heron	*Nycticorax*	*Resident*	Wetland	R
Black-faced Grassquit	Tiaris bicolor	*Resident*	Terrestrial	O
Black-throated Blue Warbler	*Dendroica caerulescens*	*Migrant*	Terrestrial	*R*
Cape May Warbler	*Dendroica tigrina*	*Migrant*	Terrestrial	*R*
Cattle Egret	*Bubulcus ibis*	*Resident*	Wetland	R
Common Ground Dove	*Columbina passerina*	*Resident*	Terrestrial	*R*
Common Yellowthroat	*Geothypis trichas*	*Migrant*	Terrestrial	*R*
Gray Kingbird	*Tyrannus dominicensis*	*Migrant*	Terrestrial	*R*
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	Terrestrial	*O*
Jamaican Elania	***Myiopagis cotta***	***Endemic***	**Terrestrial**	***R***
Jamaican Mango	***Anthracothorax mango***	***Endemic***	**Terrestrial**	***R***
Jamaican Oriole	***Icterus leucopteryx***	***Endemic***	**Terrestrial**	***O***
Jamaican Pewee	***Contopus pallidus***	***Endemic***	**Terrestrial**	***R***
Jamaican Vireo	***Vireo modestus***	***Endemic***	**Terrestrial**	***R***
Jamaican Woodpecker	***Melanerpes radiolatus***	***Endemic***	**Terrestrial**	***O***
Little Blue Heron	*Egretta careulea*	*Resident*	Wetland	R
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	Terrestrial	*F*
Louisiana Waterthrush	*Seiurus motacilla*	*Migrant*	Terrestrial	*R*
Nothern Mockingbird	*Mimus polyglottos*	*Resident*	Terrestrial	*O*
Olive-throated Parakeet	*Aratinga nana*	*Resident*	Terrestrial	*O*
Praire Warbler	*Dendroica discolor*	*Migrant*	Terrestrial	*R*
Red-billed Streamertail	***Trochilus polytmus***	***Endemic***	**Terrestrial**	***O***

Common Name	Scientific Name	Status	Habitat	DAFOR
Sad Flycatcher	***Myiarchus barbirostris***	***Endemic***	**Terrestrial**	***R***
Turkey Vulture	*Carthartes aura*	*Resident*	Terrestrial	*R*
Vervain Hummingbird	*Mellisuga minima*	*Resident*	Terrestrial	*R*
White Crowned Pigeon	*Columba leucocephala*	*Resident*	Terrestrial	O
White-Winged Dove	*Zenaida asiatica*	*Resident*	Terrestrial	*O*
Yellow-Crowned Night Heron	*Nycticorax violaceus*	*Resident*	Wetland	R
Yellow-faced Grassquit	*Tiaris olivacea*	*Resident*	Terrestrial	*F*
Yellow-throated Warbler	*Dendroica dominica*	*Migrant*	Terrestrial	*R*
Zenaida Dove	*Zenaida aurita*	*Resident*	Terrestrial	*R*

*** Endemic species**

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-7:The arthropod species observed during the assessment of the Bloody Bay property.

Order and Family	Genus and Species	DAFOR
BLATTODEA		
Termitidae	*1 species*	F
DIPTERA		
Culicidae	*Aedes* sp.	
HYMENOPTERA		
Ichneumonidae	*Ophion* sp.	R
Formicidae	*2uk.sp*	R
LEPIDOPTERA		
Hesperiidae	*Pyrgus oileus*	O
Heliconiidae	*Dryas iulia delia*	R
Pyralidae	*1 uk .sp*	F
Geometridae	1 uk sp.	O
COLEOPTERA		
Lampyridae	*Fire fly sp*	O
Bombacaceae	Euchroma gigantea	0
Cerambycidae	1 uk sp.	R
HEMIPTERA		
Cicadidea	1 uk sp.	R
HOMOPTERA		

Order and Family	Genus and Species	**DAFOR**
Cercopide	2 uk sp.	O

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

***Uk.sp. – unknown species**

Table 12-8: Amphibians and Reptiles recorded the assessment of the Bloody Bay Property.

Herps		Introduced	DAFOR SCALE
Eleutherodactylus johnstonei	Amphibian	Introduced	D
Eleutherodactylus pantoni	Amphibian	Introduced	F
Anolis garmani	Reptile	Endemic	O
Anolis grahami	Reptile	Endemic	F
Anolis lineatopus neckeri	Reptile	Endemic	O
Anolis Sagrei	Reptile	Introduced	D
Aristelliger praesignis	Reptile	Native	O

DAFOR Scale (D – Dominant >20, A-Abundant 15-19, F- Few 10-14, O – Occasional 5-9, R – Rare <4)

Table 12-9: Backreef Assessment

Common name	Taxon or Scientific name	SFMA Rating [Single, Few, Many, Abundant]
Coral		
Finger Coral	*Porites divariacata*	F
Mustard Hill coral	*Porites asteroides*	F
Other Invertebrates		
Banded Coral Shrimp	*Stenopus hispidus*	F
Boring Rock Urchin	*Echinometra lucunter*	F
Comb Jelly	*Ctenophore*	F
Longspined Urchin	*Diadema antillarum*	F
Star Fish	*Oreaster reticulatus*	F

A – Abundant (>100) ; M – Many (11 – 100); F – Few (2 – 10); S – Single (1)

Table 12-10: Backreef Fish assessment

Common name	Taxon or Scientific name	SFMA Rating [Single, Few, Many, Abundant]
Barracuda	*Sphyraena barracuda*	F
Caesar Grunt	*Haemulon carbonarium*	M
Doctorfish	*Acanthurus chirurgus*	M
Dusky Damselfish	*Stegastes dorsopunicans*	M
Foureye Butterflyfish	*Chaetodon capistratus*	F
French Angelfish	*Pomacanthus paru*	F
French Grunt	*Haemulon flavolineatum*	A
Schoolmaster	*Lutjanus apodus*	M
Sergeant Major	*Abudefduf saxatilis*	M
Silversides	*Hypoatherina harringtonensis*	A
Spotted Goatfish	*Pseudopeneus maculatus*	F
Squirrelfish	*Holocentrus adscensionis*	M
Stoplight Parrotfish	*Sparisoma viride*	F
Striped Parrotfish	*Scarus croicensis*	F
Yellowtail Snapper	*Ocyurus chrysurus*	F

A – Abundant (>100) ; M – Many (11 – 100); F – Few (2 – 10); S – Single (1)

12.7 Results of Sample Analysis

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

A division of environmental SOLUTIONS

ISO 17025 ACCREDITED LABORATORY

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Kingston 10, Jamaica
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Certificate of Sample Analysis

CSA#: ESL 18100336-39

Attention:
Mario Christie
Environmental solutions Limited - EHAS

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Sample(s) Information

Job Number:	**18100336-39**
Date of Report:	06/11/2018
Revision Date:	**Not Applicable**
Sample(s) Collected:	03/10/2018
Sample(s) Submitted:	03/10/2018
Temperature on Arrival:	0.6°C
Number of samples:	4
Analysis Started:	04/10/2018
Analysis completed:	02/11/2018
Prepared By:	**Trevor Mighty, Technical Assistant**

Verified By ....
Mandesa Jackson,
Analyst

Approved By............................
Kearion Simpson,
Quality Manager

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Results of Sample Analysis

Sample ID (Matrix) - Qualifier: Sandals WQ1 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	Recreational Water Standard	Ambient Water Standard - Marine
Total Alkalinity (mg $CaCO_3$/L)	Mod H-8221	74.48	-	-	-
Biochemical Oxygen Demand (mg O_2/L)	H-10099	<0.1	-	-	0.0 – 1.16
Turbidity (NTU)	EPA 180.1	<0.41	BDL, b(1)	-	-
Total Suspended Solids (mg/L)	SM-2540D	3.5	-	-	-
Nitrate (mg NO_3^-/L)	H-8039	-	BDL, E(M1)	-	-
Nitrate as Nitrogen (mg NO_3^--N/L)	H-8039	<0.01	BDL, E(M1)	-	0.007-0.014
Phosphate as Phosphorus (mg PO_4^{3-}-P/L)	H-8048	-	BDL	-	0.001-0.003
Phosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	-	-
Enteroccoci (MPN/100ml)	SM-9230 B	<1.8	-	<160	-
Faecal Coliform (MPN/100ml)	SM-9221	<1.8	-	<400	<2 - 13
Salinity (ppt)	DR	35.94 @ 29.2°C	c	-	-
pH (pH units)	DR	8.17 @ 29.2°C	c	-	8.00 – 8.40
Dissolved Oxygen (mg O_2/ L)	DR	5.66 @ 29.2°C	c	-	-
Lead (µg Pb/L)	FAAS	<20	a	-	-
Iron (µg Fe/L)	FAAS	0.27	a	-	-
Copper (µg Cu/L)	FAAS	15	a	-	-
Mercury (µg Hg/L)	CV-AAS	<0.2	a	-	-
Arsenic (µg As/L)	COL	<10	a	-	-
Zinc (µg Zn/L)	FAAS	<10	a	-	-
Fats Oils and Grease (mg/L)	EPA-180.1	1	a	-	-
Cadmium (mg Ca/L)	FAAS	<10	a	-	-

*Blue shaded parameters are ISO/IEC 17025:2005 accredited

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Sample ID (Matrix) - Qualifier: Sandals WQ2 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	Recreational Water Standard	Ambient Water Standard - Marine
Total Alkalinity ($mg\ CaCO_3/L$)	Mod H-8221	98.20	-	-	-
Biochemical Oxygen Demand ($mg\ O_2/L$)	H-10099	<0.1	UMR	-	0.0 – 1.16
Turbidity (NTU)	EPA 180.1	0.71	b(1)	-	-
Total Suspended Solids (mg/L)	SM-2540D	3.5	-	-	-
Nitrate ($mg\ NO_3^-/L$)	H-8039	-	BDL, E(MI)	-	-
Nitrate as Nitrogen ($mg\ NO_3^-$-N/L)		<0.01		-	0.007-0.014
Phosphate as Phosphorus ($mg\ PO_4^{3-}$-P/L)	H-8048	-	BDL	-	0.001-0.003
Phosphate ($mg\ PO_4^{3-}/L$)		<0.02		-	-
Enterococci (MPN/100ml)	SM-9230 B	<1.8	-	<160	-
Faecal Coliform (MPN/100ml)	SM-9221	<1.8	-	<400	<2 - 13
Salinity (ppt)	DR	36.04 @ 29.2°C	c	-	-
pH (pH units)	DR	8.16 @ 29.2°C	c	-	8.00 – 8.40
Dissolved Oxygen ($mg\ O_2/L$)	DR	5.18 @ 29.2°C	c	-	-
Lead (µg Pb/L)	FAAS	<20	a	-	-
Iron (µg Fe/L)	FAAS	0.24	a	-	-
Copper (µg Cu/L)	FAAS	15	a	-	-
Mercury (µg Hg/L)	CV-AAS	0.41	a	-	-
Arsenic (µg As/L)	COL	<10	a	-	-
Zinc (µg Zn/L)	FAAS	10	a	-	-
Fats Oils and Grease (mg/L)	EPA-180.1	1	a	-	-
Cadmium (mg Ca/L)	FAAS	<10	a	-	-

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Sample ID (Matrix) - Qualifier: Sandals WQ3 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	Recreational Water Standard	Ambient Water Standard - Marine
Total Alkalinity ($mg\ CaCO_3/L$)	Mod H-8221	98.53	-	-	-
Biochemical Oxygen Demand ($mg\ O_2/L$)	H-10099	<0.1	UMR	-	0.0 – 1.16
Turbidity (NTU)	EPA 180.1	1.33	b(1)	-	-
Total Suspended Solids (mg/L)	SM-2540D	4.1	-	-	-
Nitrate ($mg\ NO_3^-/L$)	H-8039	-	BDL, E(MI)	-	-
Nitrate as Nitrogen ($mg\ NO_3^-$-N/L)		<0.01		-	0.007-0.014
Phosphate as Phosphorus ($mg\ PO_4^{3-}$-P/L)	H-8048	-	BDL	-	0.001-0.003
Phosphate ($mg\ PO_4^{3-}/L$)		<0.02		-	-
Enterococci (MPN/100ml)	SM-9230 B	<1.8	-	<160	-
Faecal Coliform (MPN/100ml)	SM-9221	<1.8	-	<400	<2 - 13
Salinity (ppt)	DR	36.12 @ 29.3°C	c	-	-
pH (pH units)	DR	8.17 @ 29.3°C	c	-	8.00 – 8.40
Dissolved Oxygen ($mg\ O_2/L$)	DR	5.07 @ 29.3°C	c	-	-
Lead (µg Pb/L)	FAAS	<20	a	-	-
Iron (µg Fe/L)	FAAS	0.21	a	-	-
Copper (µg Cu/L)	FAAS	<10	a	-	-
Mercury (µg Hg/L)	CV-AAS	<0.2	a	-	-
Arsenic (µg As/L)	COL	<10	a	-	-
Zinc (µg Zn/L)	FAAS	<10	a	-	-
Fats Oils and Grease (mg/L)	EPA-180.1	<1	a	-	-
Cadmium (mg Ca/L)	FAAS	<10	a	-	-

*Blue shaded parameters are ISO/IEC 17025:2005 accredited

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Sample ID (Matrix) - Qualifier: Sandals WQ4 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	Recreational Water Standard	Ambient Water Standard - Marine
Total Alkalinity (mg $CaCO_3$/L)	Mod H-8221	93.19	-	-	-
Biochemical Oxygen Demand (mg O_2/L)	H-10099	1.1	-	-	0.0 – 1.16
Turbidity (NTU)	EPA 180.1	0.76	b(1)	-	-
Total Suspended Solids (mg/L)	SM-2540D	3.3	-	-	-
Nitrate (mg NO_3^-/L)	H-8039	-	BDL, E(MI)	-	-
Nitrate as Nitrogen (mg NO_3^--N/L)		<0.01		-	0.007-0.014
Phosphate as Phosphorus (mg PO_4^{3-}-P/L)	H-8048	-	BDL	-	0.001-0.003
Phosphate (mg PO_4^{3-}/L)		<0.02		-	-
Enterococci (MPN/100ml)	SM-9230 B	4.0	-	<160	-
Faecal Coliform (MPN/100ml)	SM-9221	<1.8	-	<400	<2 - 13
Salinity (ppt)	DR	36.10 @ 29.4°C	c	-	-
pH (pH units)	DR	8.20 @ 29.4°C	c	-	8.00 – 8.40
Dissolved Oxygen (mg O_2/ L)	DR	6.03 @ 29.4°C	c	-	-
Lead (µg Pb/L)	FAAS	<20	a	-	-
Iron (µg Fe/L)	FAAS	0.28	a	-	-
Copper (µg Cu/L)	FAAS	18	a	-	-
Mercury (µg Hg/L)	CV-AAS	0.44	a	-	-
Arsenic (µg As/L)	COL	<10	a	-	-
Zinc (µg Zn/L)	FAAS	10	a	-	-
Fats Oils and Grease (mg/L)	EPA-180.1	1	a	-	-
Cadmium (mg Ca/L)	FAAS	<10	a	-	-

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Certificate of Quality

Parameter: Biochemical Oxygen Demand
QEHL Personnel: T. Thompson & M. Dawkins **Date of Analysis: 04/10/18**

Parameter: Phosphate
QEHL Personnel: M. Dawkins **Date of Analysis: 04/10/18**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD
MB		0.02	
BD		<0.02	-
		<0.02	
SRS	1.91 – 2.09	2.02	

Parameter: Faecal Coliform
QEHL Personnel: M. Jackson **Date of Analysis: 04/10/18**

Media/Test Item (Batch #)	SS LTB (03/10/18)	DS LTB (03/10/18)	EC (05/10/18)
Sterile (Yes/No)	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical

Parameter: Nitrate (LR)
QEHL Personnel: D. Steen **Date of Analysis: 04/10/18**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD
MB		0.01	
BD		<0.01	-
		<0.01	
SRS	0.35 – 0.45	0.41	

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ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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Parameter: Total Suspended Solids
QEHL Personnel: G. Williams **Date of Analysis: 09/10/18**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD
MB		<1.6	
BD		280.0	0.4
		281.0	

Parameter: Alkalinity
QEHL Personnel: M. Betton **Date of Analysis: 05/10/18**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD %
Triplicates		73.15	
		73.15	3.1
		77.15	

Parameter: *Enterococci*
QEHL Personnel: M. Mighty **Date of Analysis: 04/10/18**

Media/Test Item (Batch #)	SS ADB (21/08/18)	DS ADB (29/08/18)	BEA (28/09/18)	BHI Broth (29/08/18)	BHI Broth + NaCl (29/08/18)
Sterile (Yes/No)	Yes	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical	Typical

Parameter: Salinity
QEHL Personnel: M. Betton **Date of Analysis: 03/10/18**

Action Limit mS/cm	Reading After Calibration mS/cm	Temperature (°C)
1.970 – 2.010	1.998	22.1

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Parameter: pH
QEHL Personnel: M. Betton **Date of Analysis: 03/10/18**

Standard (Buffer)	pH After Calibration	Temperature (°C)
3.90 – 4.08	4.02	21.9
6.90 – 7.08	7.01	22.1
9.98 – 10.05	10.02	22.0

Parameter: Dissolved Oxygen
QEHL Personnel: M. Betton **Date of Analysis: 03/10/18**

Action Limit mS/cm	Dissolved Oxygen (mg O_2/L)	Temperature (°C)
95.0 – 105.0	7.98	30.1

Parameter: Turbidity
QEHL Personnel: T. Thompson **Date of Analysis: 04/10/18**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD
BD		0.70	2.8
		0.72	
SRS	4.61 – 4.99	4.90	
	48.0 – 52.4	51.7	
	540 - 548	545	

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Glossary

µg/L	microgram per litre
µS/cm	microsiemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
cfu	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength azide dextrose broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was above QC limits. Results for this may be affected by same bias
E(L2)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was below QC limits. Results for this analyte may be affected by the same bias
E(M1)	Estimated Value. Result calculated using calibration curve of interfering compound
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
EC-MUG	*E. coli* Media with 4-methylumbelliferyl-ß-D-glucuronide
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry

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H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.
ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not yet Available. Sample matrix interferences prevented data acquisition.
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	Nation Water Commission (Jamaica)
P(I)	Non-routine pre-treatment required due to the presence of high levels of non-target analytes or other matrix interference.
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
SM	Standard Methods for the Examination of Water and Wastewater 22nd Edition
SRS	Standard Reference Solution
SS ADB	Single Strength Azide dextrose broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSYE	Tryptone Soy Yeast Extract
TTC	Triphenyl Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

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12.8 Coral Reef Description

The benthic assessment of the fore-reef completed in September 2018 revealed generally degraded coral reefs with low cover of live, hard corals (4.98%) and high macroalgal cover (40.89%). Bare pavement is the major benthic category with 48%, while sponges and gorgonians on the fore-reef account for 2.56% and 1.04%. Cover of crustose coralline algae, the ideal substrate for coral settlement and an indicator of reef health, was notably low on the reef. These percentages categorize the reef surveyed as 'critical' using the Coral Reef Health Index (CRHI, Kaufman et al. 2011)

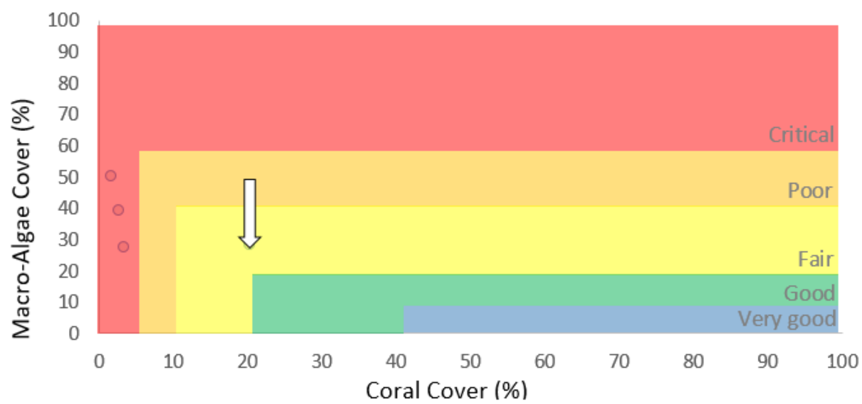

Figure 12-1: Comparison of current survey results with national Coral Reef Health Index (CRHI) of 2013. Source: Coral Reefs of Jamaica: An evaluation of ecosystem health 2013

A total of fifteen (15) coral species were represented throughout the area, but in very low numbers. Coral species diversity was also low, with the dominant hard-coral species being *Sidastrea* sp. Encrusting corals (*Sidastrea* sp., *Porites* sp.) were common on the reef while fast growing, reef building species, namely *Acropora palmata* and *A cervicornis* were rarely observed, and only in small colonies. These branching corals have a high degree of rugosity, provide micro-habitats for reef fish and mitigate wave/surge impacts. These species have suffered a dramatic decline in the Caribbean region and are listed as critically endangered on the IUCN red list (Aronson et al. 2008).

Coral species composition has been shown to significantly influence reef community structure, as well as system-wide resilience to disturbances. Coral reefs with high or diverse initial coral cover that incur losses may have limited effects on fish habitats if the habitat availability remains sufficient (Richardson et al 2018). A system such as the one assessed is generally characterized as unstable with low resilience, unlikely to recover following major disturbances (intense storms, hurricanes, bleaching etc.).

An important species for reef resilience, the black long-spined urchin (*Diadema antillarum*) was observed on the reef. This presents an opportunity for recovery from natural and anthropogenic disturbances, once the community remains intact.

For the purposes of the assessment, the reef was divided into northern, central and southern sections.

Northern Section

On the northern section of the surveyed reef, live coral cover was higher than other sections, covering 5.67% of the benthic substrate. This section is dominated by sand, rubble and pavement (48.15%) with high macroalgal cover (40.49%). The structure of this section of the fringing reef is characterized by overhangs, ledges forming a number of caverns and arches (see image below). This is an indication of a structurally complex habitat unlike the uniform flat benthos observed in the backreef (the proposed area for the location of the six groynes).

Figure 12-2: The northern section of the forereef showing arch formation typical of the area and high cover of bare substrate (sand, rubble, pavement)

Central Section

The benthos in the central section of the surveyed reef had the highest percentage of macroalgal cover. with 43.33%. Live coral cover in this section was the lowest of the sites sampled at 4.41%, highlighting the poor condition of this reef. Bare substrate (sand, rubble, pavement) accounted for 47.21% coverage along the reef system. The figure below shows a sample image from the central section of the reef. There were signs of sedimentation noted in this area, which is also used heavily as a dive and snorkel site. These cumulative pressures can act to erode reef resilience.

Figure 12-3: The central section of the reef showing cover of macroalgae

Southern Section

On the southern section of the fringing reef surveyed, the cover of live coral and macroalgae was 4.98% and 40.9% respectively. These results have similarities to the northern sections of the reef, with slight decreases in live hard coral cover and macroalgal growth. Sand and rubble are the dominant feature of the benthic substrate (48.65%).

Figure 12-4: Observations in the southern section of the forereef included significant cover of bare pavement (sand, pavement, rubble) with mounds of live coral and sponges interspersed

Reef Fish Assessment

The reef fish community was characterized by low densities and biomass, dominated by small herbivorous species (<10cm), such as parrotfish (*Scaridae*) and damselfish (*Chromis* sp.). Juvenile parrotfish were particularly abundant, though little to no adult parrotfish were observed. Carnivorous fish, for example, Snappers, Grunts, were observed in the northern sections of the reef, however they were only present in small densities with none exceeding 20cm in total length.

The low species and size diversity observed within the fish community has implications for reef resilience and the capacity of the ecosystem to recover from natural or anthropogenic disturbances. This is ultimately of concern as the reef areas surveyed, which has social-ecological functions for the wider Negril community (i.e. inter alia shoreline protection, recreation and tourist attraction, livelihood), show the characteristics of a reef that is under pressure from overfishing and degraded benthic conditions (critically low coral cover, high algal cover).

Species List

Table 12-11 Coral Reef Assessments

Generic name	Taxon or Scientific name
Coral	
Boulder Star Coral	*Orbicella annularis*
Colonial Fire Coral	*Millepora alcicornis*
Finger Coral	*Porites porites*
Golfball Coral	*Favia fragum*
Graham's sheet Coral	*Agaricia grahamae*
Great Star Coral	*Orbicella cavernosa*
Knobby Cactus Coral	*Mycetophyllia aliciae*
Lesser Starlet Coral	*Siderastrea radians*
Massive Starlet Coral	*Siderastrea siderea*
Mountainous Star Coral	*Orbicella faveolata*
Mustard Hill Coral	*Porites asteroides*
Pillar Coral	*Dendrogyra cylindrus*
Ridged Cactus Coral	*Mycetophyllia ferox*
Symmetrical brain Coral	*Diploria strigosa*
Thin Finger Coral	*Porites divaricate*
Macrcoalgae	
Y-branched algae	*Dictyota* sp.
Watercrest algae	*Halimeda* sp.
White Scroll algae	*Padina* sp.
-	*Sargassum* sp.

Table 12-12 Reef Fish Assessments

Generic name	Taxon or Scientific name	Feeding habit	SFMA Rating [Single, Few, Many, Abundant]
Barjack	*Carangoides ruber*	Piscivore/Omivore	S
Beaugregory	*Pomaccentrus leucostictus*	Herbivore	F
Black Durgon	*Melichthys niger*	Omnivore	M
Blue Chromis	*Chromis cyanea*	Herbivore	A
Blue Tang	*Acanthurus coeruleus*	Herbivore	M
Bluehead Wrasse	*Thalassoma bifasciatum*	Invertivore	F
Brown Chromis	*Chromis Multilineata*	Herbivore	M
Creole Wrasse	*Clepticus parrae*	Invertivore	M
Dusky Damselfish	*Pomacentrus fuscus*	Herbivore	M
Foureye Butterflyfish	*Chaetodon capistratus*	Invertivore	M
French Grunt	*Haemulon flavolineatum*	Invertivore	M
Graysby Grouper	*Cephalopholis cruentata*	Piscivore/Omivore	F
Green blotch Parrotfish	*Sparisoma atomarium*	Herbivore	F
Harlequin Bass	*Serranus tigrinus*	Invertivore	M
Indigo Hamlet	*Hypoplectrus indigo*	Carnivore	F
Lane Snapper	*Lutjanus synagris*	Piscivore/Omivore	S
Lizardfish	*Synodus saurus*	Carnivore	S
Mahogany Snapper	*Lutjanus mahogoni*	Piscivore/Omivore	F
Ocean Surgeon	*Acanthurus bahianus*	Herbivore	F
Princess Parrotfish	*Scarus taeniopterus*	Herbivore	M
Redband Parrotfish	*Sparisoma aurofrenatum*	Herbivore	M
Rock Beauty	*Holacanthus tricolor*	Invertivore	S
Schoolmaster Snapper	*Lutjanus apodus*	Piscivore/Omivore	S
Spotted Trunkfish	*Lactophrys bicaudalis*	Omnivore	S
Squirrelfish/Soldier fish	*Holocentrus adscensionis*	Carnivore	M
Stoplight Parrotfish	*Sparisoma viride*	Herbivore	M
Striped Parrotfish	*Scarus iserti*	Herbivore	M
Threespot Damselfish	*Pomacentrus planifrons*	Herbivore	M
Yellowhead Wrasse	*Halichoeres garnoti*	Invertivore	M
Yellowtail Damselfish	*Microspathodon chrysurus*	Herbivore	S
Yellowtail Goatfish	*Mulloidichthys martinicus*	Carnivore	S

A – Abundant (>100) ; M – Many (11 – 100); F – Few (2 – 10); S – Single (1)

Table 12-13 Other reef fauna

Generic name	**Taxon or Scientific name**	**SFMA Rating [Single, Few, Many, Abundant]**
Beaded anemone	*Epicystis crucifer*	M
Common Comet Star	*Linkia guildinigii*	F
Eagle Ray	Myliobatidae	S
Elegant anemone	*Actinoporus elegans*	M
Fireworm	*Hermodie caruncuata*	M
Giant anemone	*Condylactis gigantean*	F
Long-Spined Urchin	*Diadema antillarum*	F
Rock Boring Urchin	*Echninometra lacunter*	M
West Indian Sea Egg	*Tripneustus ventricosus*	M

A – Abundant (>100) ; M – Many (11 – 100); F – Few (2 – 10); S – Single (1)

12.9 Physical Beach Monitoring Plan (Olsen Associates Inc.)

Sandals, Negril Beach
Physical Monitoring Plan for Proposed Beach Improvements

A physical beach monitoring plan will be implemented to assess the performance and effects of the beach improvements at Sandals Negril Beach, including potential impacts to associated adjacent shorelines.

The monitoring plan shall measure the beach profiles at 13 fixed locations within and south of the project area, including 5 locations within the project area and 8 locations within approximately 1000 meters south of the project area. The beach profiles shall be surveyed at the following intervals:

- At least once prior to construction (pre-construction),
- At within 30 days after project construction (post-construction), and
- At 6-month intervals after the post-construction survey for three (3) years.
- The biannual surveys after the post-construction survey shall be measured at approximately the same time each year (ideally in April and October of each year, more or less).

The beach profiles shall be approximately located as follows (see **Figure A**):

- Profiles 1-5: at mid-points between the six proposed groins, within the project area
- Profile 6: 35 m south of the project area (35 m south of groin G6)
- Profile 7: 85 m south of the project area (50 m spacing from profile 6)
- Profile 8: 140 m south of the project area (55 m spacing from profile 7)
- Profile 9: 215 m south of the project area (75 m spacing from profile 8)
- Profile 10: 315 m south of the project area (100 m spacing from profile 9)
- Profile 11: 490 m south of the project area (175 m spacing from profile 10)
- Profile 12: 740 m south of the project area (250 m spacing from profile 11)
- Profile 13: 990 m south of the project area (250 m spacing from profile 12).

The beach profiles shall be surveyed relative to fixed monuments (or virtual monument within 20 cm horizontal accuracy) established at the upland, and along repeated grid/compass azimuths, and relative to a common vertical datum, at each profile location. The profile surveys shall measure the distance and elevation of the beach grade -- relative to the monument location and vertical datum – with profile measurement extending from the upland (vegetation line or seaward limit of fixed development, at minimum) to a distance of at least 80 meters (260 feet) seaward therefrom. Beach profile elevations shall be recorded at breaks in slope and not greater than 5 m spacing along the profile.

The beach profile survey data shall be evaluated to discern (i) the change in beach profile width at the shoreline (mean sea level), and (ii) the change in beach profile volume within uniform limits of the survey, at each profile location, relative to prior surveys. A report of the survey data and observed beach changes will be prepared within 60 days after each survey.

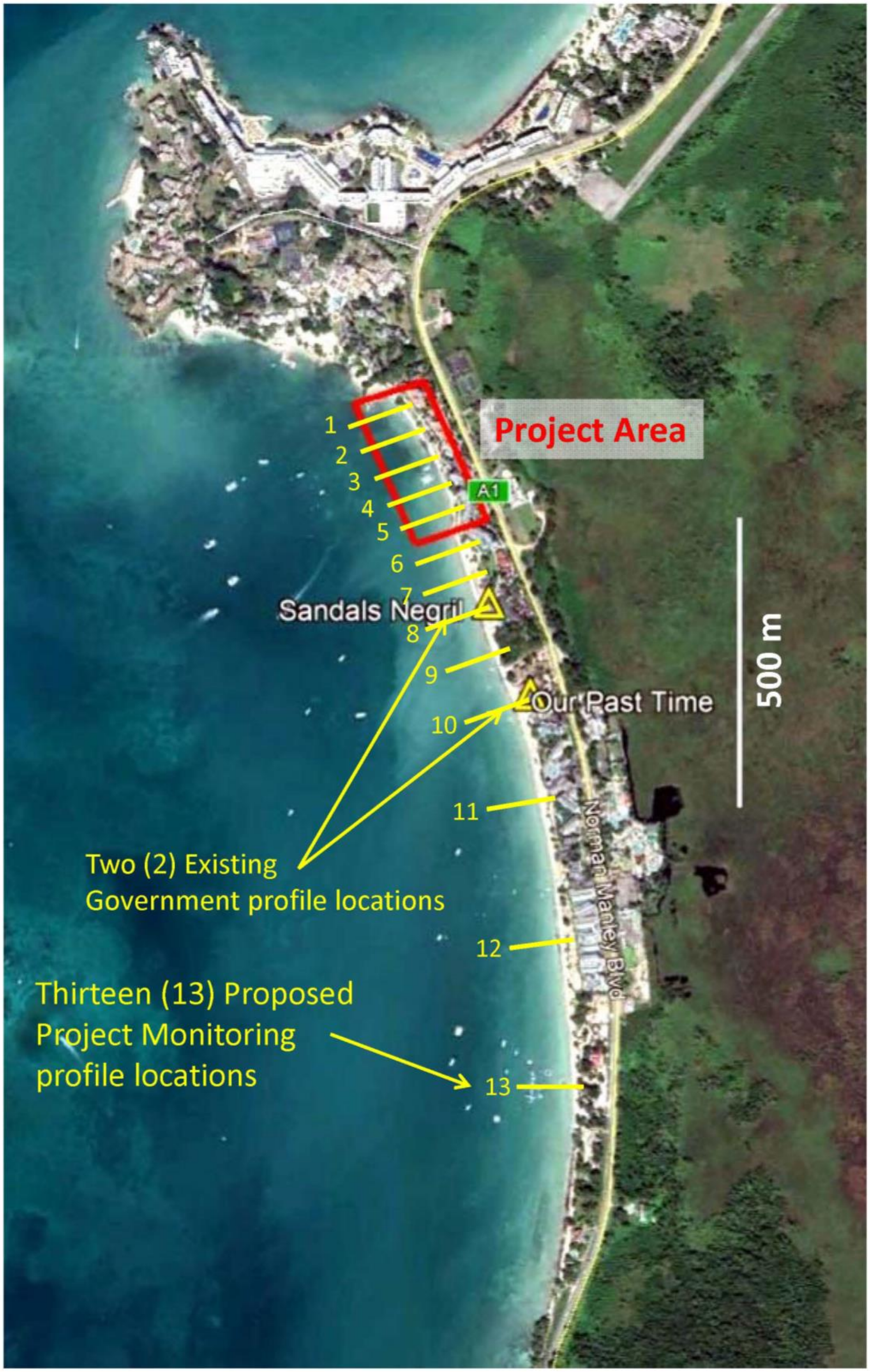

Figure A: Beach profile monitoring locations.

From these survey data, the performance and overall impacts of the project shall be assessed by evaluating the changes in the beach width and volume within the project area to that adjacent (south) of the project area. For example, erosion of the beach within the project area would suggest that the project is "feeding" sand to the adjacent shorelines, in which case, the adjacent shorelines would exhibit less erosion (or accretion) relative to that observed within the project area [i.e., no impact, or positive impact]. Erosion rates that are higher along the adjacent beaches than within the project area for a given period -- and likewise higher than historical norms -- may suggest that the project is retaining sand at the expense of adjacent shorelines [i.e., negative impact]. Owing to the natural variability of shoreline change along Negril Beach, an absolute "threshold" value of shoreline or beach volume change cannot be established to determine the absence or presence of effect from the project. Instead, *comparative analysis* of the relative changes in the beach condition along the renourished project area and along the adjacent shoreline is required to assess the project's performance and impacts.

Potential adverse impacts of the project would be first observed immediately adjacent to (south of) the project area; i.e., along the south end of the Sandals property. Such impacts would be observed fairly soon after project construction. For this reason, the beach profile monitoring plan is purposefully spatially weighted toward the immediate south (or presumed downdrift) adjacent shoreline, because adverse (erosional) impacts from the project would be first observed along the shoreline immediately adjacent to the project area. That is, the first three monitoring profiles south of the project area (profiles 6-7-8, within 140 m south of the southernmost groin) would be the first, and clearly most obvious, to exhibit any increased erosion effects from the project. The profiles south thereof (profiles 9-13) are farther afield, and changes to these profiles may be considered to be weakly related or unrelated to the project if the profiles closest to the project (profiles 6-8) do not exhibit anomalous behavior. The alongshore extent of the monitoring plan (profiles 12 and 13, at 740 m and 990 m south of the project) is ample to capture the potential effect of the project and to likewise represent background changes unrelated to the project. These profiles are located at a distance that is 3 to 4 times downdrift of the total overall shoreline length of the project, and well over 40 times downdrift of the length of the groin structures.

The temporal plan of pre, post, and semi-annual surveys for three years is sufficient to capture the overall performance and effects of the project, and adequately account for seasonal variations. By comparison, the typical monitoring requirement for similar projects in Florida, by the Florida Dept. of Environmental Protection, is pre, post and *annual* surveys for three years, extending over shoreline lengths similar to that proposed herein (i.e., 1000 m alongshore).

The Government has previously established 14 beach profile monitoring locations along the Negril Beach shoreline. These are illustrated in **Figure A** and **Figure B**. Two of these profiles are located within 140 m and 315 m south of the project area ("Sandals Negril" and "Our Past Time", respectively). These two profile locations are included within the proposed monitoring plan: viz., Profiles #8 and #10 (see **Figure A**). The other twelve Government profiles at Negril Beach are located too far afield to reasonably capture effects of the proposed Sandals Negril project. Specifically, four of the profiles are located between 1.6 and 2.2 km north of the project area and separated by a headland, and eight are located beyond 2.8 km south of the project area (see **Figure B**). These profiles are too far distant to reasonably reflect any impacts of the small size of the proposed project (~250 m length and ~7000 cubic meters fill), relative to ambient background changes along the broader shoreline.

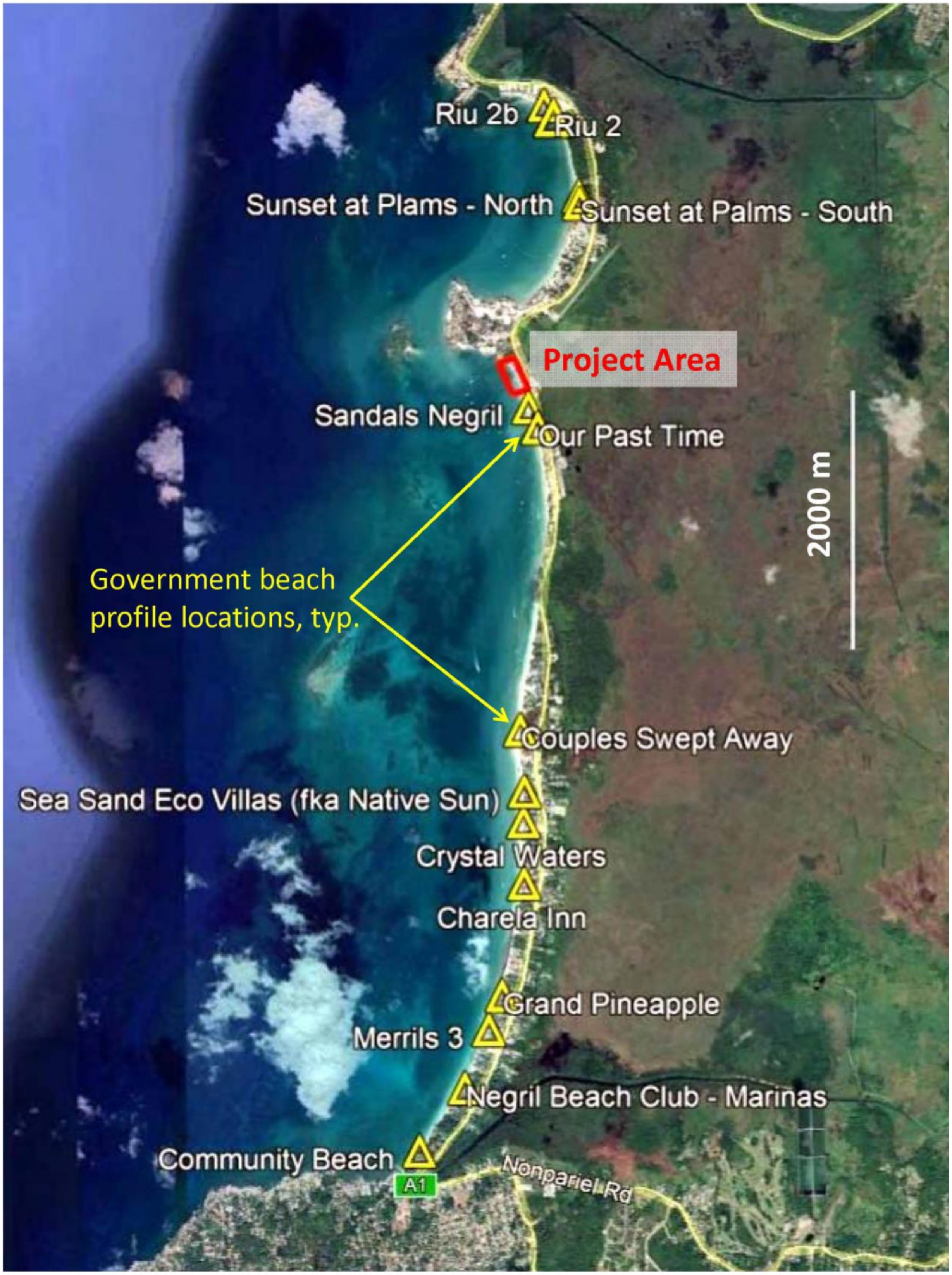

Figure B: Government's existing beach monitoring locations along Negril Beach.

Beach profile change data at profiles #8 and #10 will be compared to the Government's longer-term beach profile data at these locations ("Sandals Negril" and "Our Past Time") to assess contemporary post-project beach behavior relative to the prior record. **Figure C** illustrates changes in the beach profile width from the Government database at these two locations. Here, the *average* (4-year) trend indicates erosion of -1.2 m/yr at "Sandals Negril" and -0.4 m/yr at "Our Past Time", located about 140 m and 315 m south of the project area, respectively. The annual variations (erosion versus accretion) are noteworthy. Accordingly, the monitoring program shall necessarily assess short-term (survey-to-survey) changes relative to longer-term (multi-year) trends.

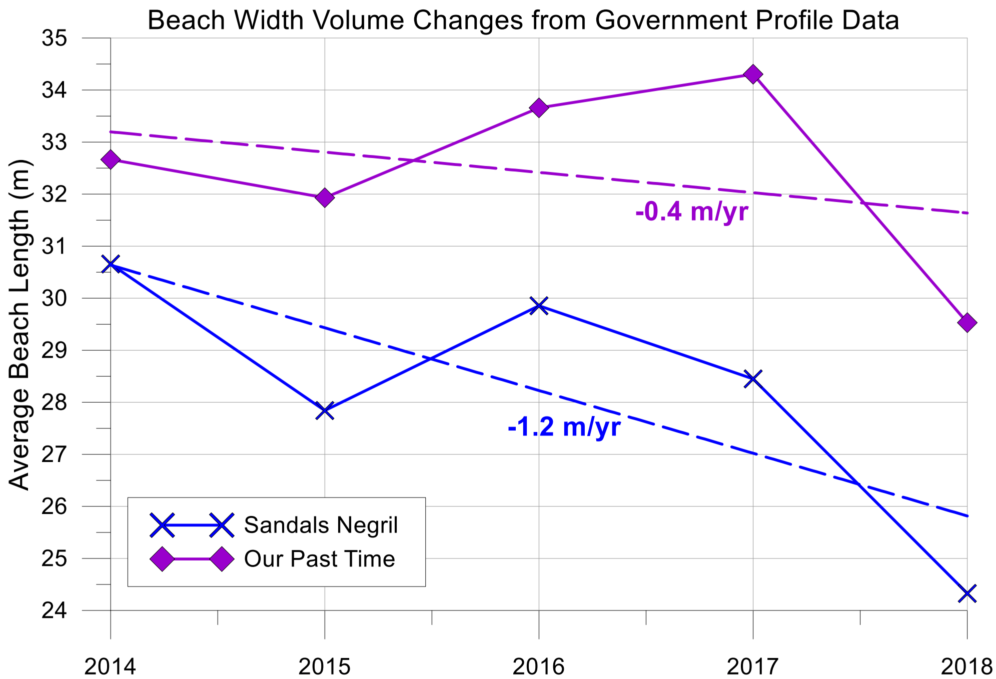

Figure C: Beach width ("length") changes at the Government's two Negril Beach profile locations nearest to the project area, 2014-2018. The dashed lines represent the best-fit regression trend of these data.

12.10 Wider Negril Beach Restoration (WNBR) Project

A PROJECT BRIEF FOR THE **WIDER NEGRIL BEACH RESTORATION (WNBR) PROJECT**

Amended: January 18, 2019

BACKGROUND

Over the last 4 decades, the Negril Long Bay and Bloody Bay region in Westmoreland and Hanover has been undergoing a gradual and steady erosion trend with rates ranging between 0.5 and 1.0 metre annually. This has resulted in most sections of the shoreline losing between 22 and 55 metres of beach while other sections have lost up to 70 metres. During this period, several studies committed to identifying the causes accompanied by several attempts at solutions have been executed by various institutions, but with very little or no positive long-term and sustainable response to the growing problem.

The Smith Warner International Preliminary Engineering Report done in 2007 for example concluded that, the primary source of sand for the Negril beach is as a result of coralline algae within the nearshore seagrass beds; that over the past 15 years, the Negril shoreline appears to have retreated at a rate of 1–2 metres per year; and that over the past five (5) years, the actual volume of sand on the beach has reduced[7]. Whilst the acquisition of the services of CEAC Solutions Limited by the National Works Agency (NWA) in 2013 to execute the overall activities relating to the construction of breakwaters[8], and the 2014 Environmental Impact Assessment (EIA) conducted by CL Environmental Limited[9], are the most recent efforts which did not achieve their intended purposes.

The community and stakeholders of Negril remain under threat of future adverse effects from the erosion issue, but the negative impacts thus far have also created an even stronger basis for a holistic solution as a matter of national importance.

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[7] Smith Warner International (2007). Preliminary engineering report for beach restoration works at Negril
[8] CEAC Solutions Limited BCA Beach Licence application for encroachment on the foreshore and floor of the sea… (2013) to NEPA
[9] CL Environmental Limited (2014). Environmental impact assessment: construction of two breakwaters at Long Bay Negril, Westmoreland.

NATIONAL IMPORTANCE OF NEGRIL

Negril is a highly diverse community with varying stakeholders who are heavily dependent on several industries, with the main one being tourism. Possessing the longest stretch of white sand beach in the Island, tourism in Negril accounts for some of Jamaica's highest stop over arrival figures, and provides amongst the highest number of direct jobs and a number of indirect services within the industry. From time to time, the tourist industry in Jamaica, has recorded higher rates of direct employment than in several other sectors including the financial services, education, communication services, and chemicals manufacturing sectors. Negril has been a major contributor to this ongoing national achievement, thereby emphasizing the national importance of the area, and the corresponding need for a holistic and stakeholder driven approach; that serves to meet the needs of all- current and future.

VISION 2030 ALIGNMENT

The WNBR Project is strategically aligned to the Vision 2030 Jamaica: National Development Plan, specifically with National Outcome # 13: *Sustainable Management and Use of Environmental and Natural Resources*. Under National Outcome #13, the Medium-Term Socio-Economic Policy Framework (MTF) 2015-2018, list the *"Reverse loss of environmental resources through restoration initiatives"* as a sector strategy to rehabilitate eight local beaches as a priority action for that period[10]. The current 2018-2021 MTF, which awaits final sign-off by Cabinet, has since included under the Tourism sector strategy the continuation of the rehabilitation exercise of several local beaches. This is to be spearheaded by the Tourism Product Development Company (TPDCo), with funding through the Tourism Enhance Fund (TEF). The MTF is Vision 2030's 3-year operational framework for the implementation of the National plan up to the year 2030.

TOWARDS A WIDER NEGRIL SOLUTION

The Negril community, which spans the Long Bay-Bloody Bay area along the Normal Manley Boulevard between the Parishes of Hanover and Westmoreland, has committed to working towards a holistic solution. This solution is set within the context of other national and local actions led by government in partnership with stakeholders to reverse the beach erosion problem that has plagued the region. As such, the impact of this ***Wider Negril*** solution is intended to contribute to an overall reversal effect that will serve to benefit not just stakeholders at the local level but also nationally. Some of the major initiatives held within the context of this project are the Integrated Water, Land, and Ecosystem Management in Caribbean SIDS (IWECo Project) which would focus on the rehabilitation of wetlands in Negril; the ongoing Enforcement Strategy by NEPA; and the New Negril Master Plan to be rolled out by the Government of Jamaica with focus on beaches.

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[10] PIOJ website. Medium Term Socio-Economic Policy Framework 2015-2018 http://www.vision2030.gov.jm/Portals/0/MTF/MTF%202015%20-%202018%20(final).pdf accessed October 23, 2018.

PARTNERSHIP APPROACH

This project has been conceptualized under a Public-Private Partnership (PPP) principle which is perceived by the Negril stakeholders as the best approach that should be adopted for the successful achievement of the project goals and objectives. It is therefore instructive that all efforts to establish the Wider Negril Beach Restoration (WNBR) Project move towards a PPP solution for its implementation, which requires the willingness of the relevant government, bilateral and multilateral agencies to support the initiative. It is also prudent to take the PPP approach because the Negril beach erosion issue is far-reaching and covers a wide cross section of linked issues that fall under the mandate of several of these agencies. It is therefore perceived that the success of this project will serve to benefit the short-term and long-term goals of all those who has a stake in Negril's sustained environmental health, and its social and economic development.

PROJECT COMPONENT

Component 1: Project Coordination

- This component would involve general project start-up and close-out activities, but mainly the recruiting of a Project Manager who would act as a "champion" to lead the project towards success through partnership with key stakeholders.

Component 2: Project Implementation:

- The project implementation will be carried out in three (3) phases as follows:

  1. Phase 1: Sand Study – This study is to consist of Beach Profile and Sand Sourcing Investigation. It will lead to the confirmation of an area where sand can be retrieved, the submission of information/data required for the permit applications, and the design of the beach line.

  2. Phase 2: Beach Nourishment – This phase will consist of the actual nourishment work along the beach.

  3. Phase 3: Reef and Beach Protection – This will involve the design and execution of a solution to ensure that the beach is protected on a long-term basis following the nourishment work.

Component 3: Project Sustainability Programme

- This component will focus on establishing an effective governance framework and overarching financial mechanism to safeguard the maintenance and wider sustainable operations of the WNBRP and its outputs (see outcome 2 below).

PROJECT OUTCOMES AND OBJECTIVES

The following outlines the outcomes and related objectives of the project:

A. Outcome 1: Successful implementation of an overarching solution to the beach erosion problem along the Negril, Long Bay and Bloody Bay region
   a. Objectives
      i. Conduct Beach Profile and Sand Sourcing Study to determine viability and feasibility of the beach nourishment exercise as the main activity
      ii. Implement Beach Nourishment exercise along the Negril beach stretch to include all areas between Long Bay and Bloody Bay
      iii. Implement Reef and Beach Protection mechanism

B. Outcome 2: Establishment of an effective governance framework and overarching financial mechanism to safeguard the maintenance and wider sustainable operations of the WNBR Project
   a. Objectives
      i. Put in place a governance framework to oversee all coordinated efforts to develop and implement strategies to support the maintenance of the project outcomes
      ii. Set up a financial mechanism to fully support the maintenance of the project outcomes to enhance sustainability

PROJECT PROFILE

Title of Project: Wider Negril Beach Restoration (WNBR) Project

Project Owners: Negril (Hanover and Westmoreland) stakeholders represented by established stakeholder organizations, captured in a Memorandum of Understanding (MOA) or a Memorandum of Agreement (MOA).

Project Implementer: The NCC Limited will be the implementing entity; however a joint Project Steering Committee will be selected to oversee project implementation.

Project Beneficiaries: Business and residential community of the resort town of Negril, and the Government of Jamaica through the tourism sector

Duration: Project Start-up – 2 months

Project Implementation – 22 months
- Phase 1: 6 months
- Phase 2: 9 months
- Phase 3: 7 months

Project Sustainability Programme – 4 months

Project Close-out – 2 months

Total Duration - 30 months (2.5 years)

Project Outputs:
1. Beach Profile and Sand Sourcing Study
2. Executed Beach Nourishment
3. Reef and Beach Protection Mechanism
4. Established Governance Framework
5. Established Financial Mechanism

Project Goal: Restoration of the Negril 7-mile beach stretch

Project Impact: Contributory reversal effect of the beach erosion along the Negril 7-mile beach stretch

Project Donors:
1. Tourism Enhance Fund (TEF)
2. International Donor Agencies
3. Others to be identified/determined

Project Cost: Total Project cost is estimated to be $13,571,250 USD
The preliminary estimate/budget provides further details and breakdown of this cost.

PROJECT PRELIMINARY ESTIMATE/BUDGET

The table outlines details of a preliminary estimate for the WNBRP

PROJECT COMPONENTS	ACTIVITIES	COSTS (USD)	SOURCES / DONORS	COMMENTS
Component 1: Project Coordination	Project Start-up	10,000	Tourism Enhance Fund (TEF)	Supported by NCC
	Project Manager Compensation	110,000	Tourism Enhance Fund (TEF)	Compensation covers Component 1 and 2 only (24 months). Further funding needed for component 3. To include gratuity and motor vehicle upkeep

PROJECT COMPONENTS	ACTIVITIES	COSTS (USD)	SOURCES / DONORS	COMMENTS
	Project close-out	5,000	Tourism Enhance Fund (TEF)	Supported by NCC
Component 2: Project Implementation	Phase 1 *(Sand Study)*	260,000 100,000	Tourism Enhance Fund (TEF)	Includes cost for sand investigation, EIA study and attaining government approvals
	Phase 2 *(Beach Nourishment)*	9,990,000 1,500,000 500,000	TBD	Includes estimated cost for monitoring / supervision fees, contingency fees
	Phase 3 *(Reef and Beach Protection Design and Study)*	300,000	TBD	Reef solution design, EIA study
	Phase 3a *(Reef and Beach Protection work)*	0	TBD	An extension phase for which additional funding will be sought once cost is established from phase 3
Component 3: Project Sustainability Programme	Governance framework	150,000	TBD	Cess to be proposed to supplement funding.
	Financial mechanism			Includes beach nourishment maintenance
Project Contingency (5%)		***646,250***		
Total Project Cost		**1,096,2501,096,250**		

Notes on preliminary estimate/budget

1. ***Not included in budget:***
    - *Cost of money (interest on loans)*
    - *Legal fees*

2. ***Additional Funding***
    - *Van Ord have indicated their interest and intention to provide funding on a conditional basis (loan)*
    - *The Dutch Government also has indicated in previous engagements with them that they have interest in supporting the project financially.*

3. ***Component 1***
    - *Additional project coordination cost is to be incurred by the Project Owner/Implementer (NCC). This is to include cost for office space and support services.*

4. ***Reef and Beach Protection Work (Phase 3a)***
    - *The project's implementation (component 2) focuses on Beach Nourishment as the main solution to be employed; however there is recognition that to sustain the nourishment of the beach, additional solutions (restoration/protection of the reef) must be included as part of the overall fix to prevent a reversal of the effort. As such, the **Reef and Beach Protection Work under** Phase 3a will be an extension phase which will also need funding). The costings for this work will be established once the design and study is completed under phase 3.*

12.11 Olsen Associates Inc. – Recommended Plan for Beach Improvement

RECOMMENDED PLAN FOR BEACH IMPROVEMENT AT SANDALS NEGRIL, HANOVER

Prepared by

Kevin R. Bodge, Ph.D., P.E.
N. Zachary Bedell, E.I.T.
Olsen Associates, Inc.

15 February 2019

Overview.

This document presents the recommended plan for beach nourishment with hard structures for the Sandals Negril Beach Resort. The plan features beach nourishment that is stabilized by six (6) short, low profile, linear rock groynes along the 240-m long project shorefront, as illustrated in ***Figure A***, below. The groynes are spaced about 40 m apart, almost wholly buried in sand. In conjunction with the proposed groynes, the existing groyne spur at the north-end headland will be reshaped and lowered to below the waterline. Sand placement for this project will be roughly 7,000 cubic meters, more or less – sourced from the uplands of the Sandals owned property in Bloody Bay – increasing the post-nourishment, equilibrated beach width by about 8 to 10 m.

Figure A: Proposed plan with beach nourishment and six groynes.

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Sandals Negril Beach – Olsen Groyne Alternative

The proposed groynes are between 16 and 25 m in overall length, of which over half the length is completely buried below the sand. The visible, exposed portions of each groyne are limited to less than 30 cm height (<12") across the intertidal beach face – from the berm to about the low water shoreline. Based on the existing grade of the beach, local wave climate, and associated low-level of sediment transport, the post-nourishment, equilibrated[1] beach is expected to resemble the current profile – but will be located between 8 to 10 m seaward thereof. As such, only about 8 m length of each groyne, and less than about 2.5 m wide and 0.3 m high, would be visually exposed above the sand – this is inclusive of the submerged portion of each groyne (see *Figure F*). The groynes would be spaced between 37 and 47 m from tip to tip, based on standard best-practices for groyne fields (USACE, 2008). The recommended groyne field plan is the most-practicable alternative for structural stabilization of the required beach fill and was designed on the premise of avoiding and minimizing potential adverse impacts to the local shoreline and environment. Groyne design development and concept explanation will be discussed in the later section: **Proposed Six-Groyne Alternative**.

Discussion of Principal Available Alternatives.

As described in the project's Environmental Impact Assessment (EIA), there are three principal action alternatives for beach improvements at Sandals Negril Beach:

(1) no-action,
(2) beach nourishment only,
(3) beach nourishment with hard structures.

(1) Given the site's contemporary condition and shoreline history, the no-action alternative is not viable. The existing narrow beach width is functionally compromised; there is little or no practical opportunity for the upland beach profile to retreat; and the beach will continue to narrow through acute and chronic erosion given its crenulate shape.

(2) Inspection and prior experience demonstrate that "beach nourishment only" will erode at an unacceptably high rate. Unrecoverable loss of beach fill is particularly problematic, given the scarcity of beach-quality sand fill resources. The natural tendency of the contemporary shoreline location along the property is to erode towards a weak, crenulate embayment shape within about 240 m south of the existing headland. This is contrary to a "straight" shoreline. See *Figure B*, following page. An attempt to "straighten" the shoreline – simply widening it with beach fill (without stabilization) – conflicts with the natural tendency of the shoreline to create this weak embayment shape. Accordingly, some level of structural stabilization is practically necessary to keep the beach fill mostly in place, that is, to provide reasonable longevity. Else, in the absence of structures, the beach fill will rapidly erode to create the "indented" embayment shape that is otherwise favored by the contemporary, natural shoreline.

[1] The "equilibrated" beach profile refers to the condition the beach is expected to attain in the period after project completion.

Sandals Negril Beach – Olsen Groyne Alternative

Extending the existing headland further seaward (see ***Figure B***) – to "pull" the embayment shoreline further seaward – is an option, but this introduces more structure into the open sea and could further reduce water flow and circulation on the leeward, south side of the headland along the project shoreline. Accordingly, adding further structure at the headland is not recommended. (In fact, the preferred alternative is to reduce the elevation of the existing headland groyne spur, to improve water flow and circulation along the project shoreline.)

Figure B: The existing shoreline exhibits a weak crenulate shape south of the local headlands. In such shape, the shoreline is "indented" landward by some minor width (W) that is a function of the open shoreline length (G) down-wave of the headland. Filling the indention with sand to straighten the shoreline (without stabilizing structures) results in rapid loss of the sand fill as the beach seeks to recover its embayment shape. For this reason, some modest level of structures is warranted at the site.

(3) In the case of Negril Beach, the effect of shore-perpendicular groynes upon the beach is more certain to predict than other forms of hard, coastal structures. Additionally, prevailing wave direction and the low-energy characteristics of this shoreline support the anticipated beach response to the proposed groynes. This is particularly true for the proposed short, low-profile groynes, which have a finite ability to impound sand; that is, their maximum influence on the beach can be no greater than the groyne's profile. The primary function of shore-perpendicular groynes is to impound (i.e. retain) sand to the point of capacity on the updrift direction of sediment transport. As the beach equilibrates in response to construction of the groynes and corresponding beach fill placement, there will be a resulting rotation of the shoreline between each groyne towards the direction of incident waves, irrespective of wave size (***Figure C***). As a result of the low-energy wave environment of Negril Beach, it is anticipated that it will take between 6 and 12 months for the shoreline to fully equilibrate, after nourishment and groyne construction.

<u>Sandals Negril Beach – Olsen Groyne Alternative</u>

Other classes of shoreline structures include "cribs" or rock sills or permeable structures placed along the beach or beach toe; i.e., parallel to the shoreline. These are inappropriate and not consistent with the resort requirements of the site, as they are duly not considered herein.

Given that some level of structural stabilization of the beach fill is warranted, and given that short, low-profile groynes allow for greater predictability in shoreline behavior and smaller impacts to the seabed and water-circulation, the present renourishment plan proposes a field of six minimum sized low-profile groynes.

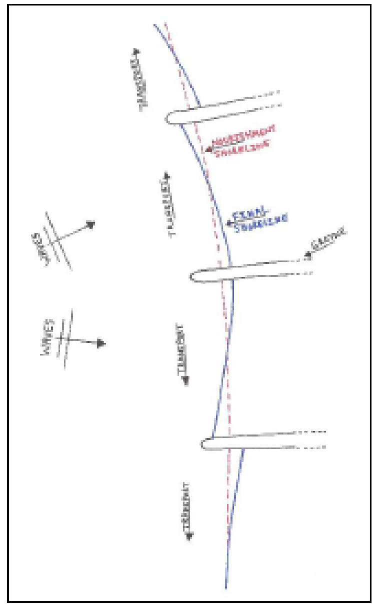

Figure C: Anticipated shoreline response to groynes. The post-nourishment shoreline is expected to equilibrate by rotating to face the direction of incident waves.

Proposed Six-Groyne Alternative.

The proposed plan includes placement of beach nourishment sand (approximately 7,000 m^3) from a Sandals upland property near Bloody Bay and the concurrent construction of six (6) rock groynes along the 240-m shoreline south of the existing headland, along with re-orienting and lowering (submerging) the existing rock spur-groyne at the seaward end of the existing headland. See ***Figures D, E, and F***, (i.e., Sheets 1, 2, 3) following pages.

The groynes are spaced approximately 40 m apart alongshore (***Figure E***). This is about 2.5 to 3.0 times their "active" length[2], and is considered the "standard of care" for maximum spacing (particularly for short structures). They would be constructed of 0.75 to 1.3 m diameter boulders, two rows wide and thick, with foundation dug into the existing beach (***Figure F***). The maximum crest elevation is +0.75 m along the backshore (buried below the beach fill elevation of +0.85 m or greater), and thence slopes downward at about 1(v):13(h) to elevation -0.15 or -0.2 m at the seaward end (that is, at about low water). Each groyne's width is 2.1 m across the crest (two boulders wide), and up to about 3 m wide at the sand surface where it is exposed above the sand across the intertidal beach. It is estimated that approximately 600 m^3 of the existing beach grade will need to be excavated in order to place the groyne boulders. Excavated beach grade will be placed as beach fill immediately adjacent to each groyne, assuming that the sediment is beach-compatible. Non-beach-compatible sediment excavated will be removed from the project site and disposed of at an approved upland location.

[2] The active length is the portion of the groyne that is exposed above the sand.

Sandals Negril Beach – Olsen Groyne Alternative

For northern groynes G1-G5, the total groyne length is up to about 25 m, of which the landward half is wholly buried within the sand (*Figure E*). Per design, the only visually exposed portion of each groyne is the crest (less than 30 cm height above the sand) across the inter-tidal beach face from the edge of the berm (about +0.5 to +0.75 m) to the low tide shoreline (about -0.2 m, *Figure F*). This is equivalent to about 12 m, of which the seaward 5 m is below mean sea level. The southern groyne, G6, is shorter (about 15 m overall), of which roughly 8 m of crest is marginally exposed above the sand, and of which the seaward 2.5 m is below mean sea level. Groyne G6 is intentionally shorter and permeable to facilitate the transition from the beach fill area to the south shoreline. The landward ends of all groynes, above the high-tide water/wave limit, are wholly buried below the sand berm, such that there is no obstruction to lateral access along the shoreline over the groynes.

The length and elevation of the groynes is the least, minimum-profile groyne design. The six groynes are designed as a "template" that replicates the beach profile associated with a nominal 12-m advance of the existing shoreline (vis-à-vis beach fill). The groynes purposefully do not extend across the entire width of the beach fill to the "toe". Instead, they terminate within about 5 meters of the post-nourishment shoreline (or 2.5 m at structure G6), in depth of -0.5 m or shallower. At such short length and low profile, the groynes are designed to hold only the initial beach fill placed immediately adjacent to the groynes, and not to entrap or hold additional beach width. It is expected that the beach between groynes will equilibrate and erode – losing nourishment sand to the adjacent shorelines – and ultimately yielding a net anticipated residual beach width of 8 to 10 m beyond the existing shoreline. (See *Figure A*.) The groynes could be lengthened to reduce losses and retain a greater percentage of the beach fill; but this is not the intent of the design. The intent is to augment the fill stability with minimum evident structure.

The seaward end (and overall length) of each groyne at the sand-structure interface is designed to terminate at about -0.3 m elevation – which is about a depth of about one (1) vertical tide range below mean sea level. This depth is consistent with the stable beach seabed elevation observed adjacent to short profile groynes along a low-energy environment (Bodge, 2003).

The proposed beach fill berm elevation is +0.85 m. This is consistent with the backshore elevation of the existing beach (+0.9 to +1.2 m); and, it is lower than the shorefront sidewalk (+1.0 to +1.3 m). The design beach fill slopes at 1(v):10(h) from the berm, between elevations +0.85 and -0.5 m, thence slopes 1(v):25(h) to intersection with the existing seabed (between -0.8 and -1.5 m).

The existing (native) beach sand is very fine-grained, with both median and mean grain sizes of about 0.16 mm. In contrast, the median grain size of the proposed fill sand from the upland Bloody Bay site is reported to be approximately 0.28 to 0.31 mm – which is amply coarse and stable relative to the native beach sand.

Sandals Negril Beach – Olsen Groyne Alternative

The plan includes re-configuring and lowering the existing spur-groyne at the end of the north headland. This is to improve water flow and circulation from the north, without de-stabilizing the shoreline at the north end of the beach.

The six rock groynes would require approximately 3730 metric tons (4100 US tons) of boulders to construct, of which a minor portion (<500 metric tons) may come from re-working the existing spur-groyne at the north headland. About ~7,000 m^3 of beach fill is required. Beach-quality sand excavated to establish the groyne's foundations (approx. 600 m^3) will be placed on the beach adjacent to each groyne.

The rock groynes would be constructed from land. No boat or barge work is required. No impacts to the nearshore seabed are anticipated except immediately proximate to the six rock groynes (and re-working the existing groyne at the headland) – and all of this work would be within less than about 15 m of the existing mean low water shoreline. Site work construction is anticipated to take approximately 60 days, including beach fill placement which would typically occur immediately after and adjacent to construction of the groynes.

Sandals Negril Beach – Olsen Groyne Alternative

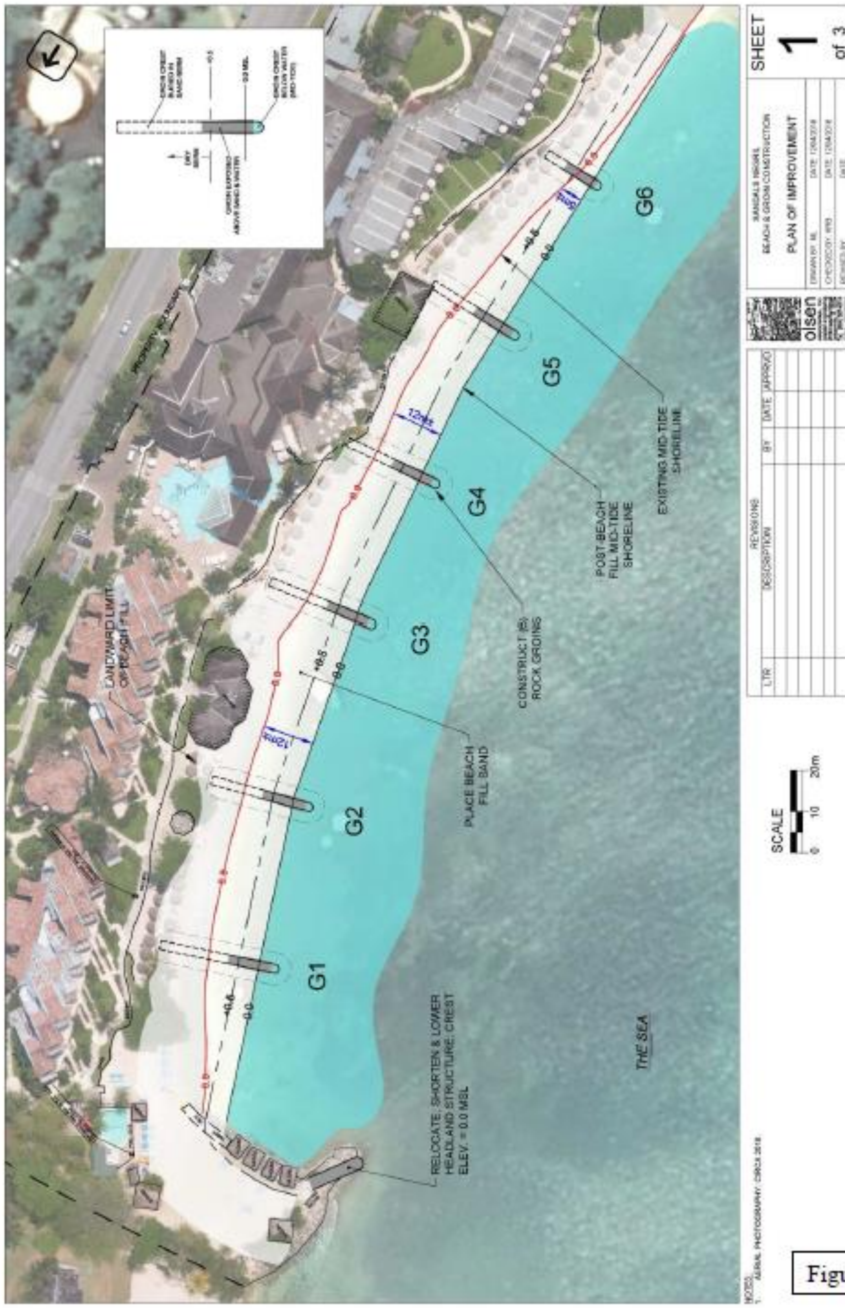

Figure D

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Sandals Negril Beach – Olsen Groyne Alternative

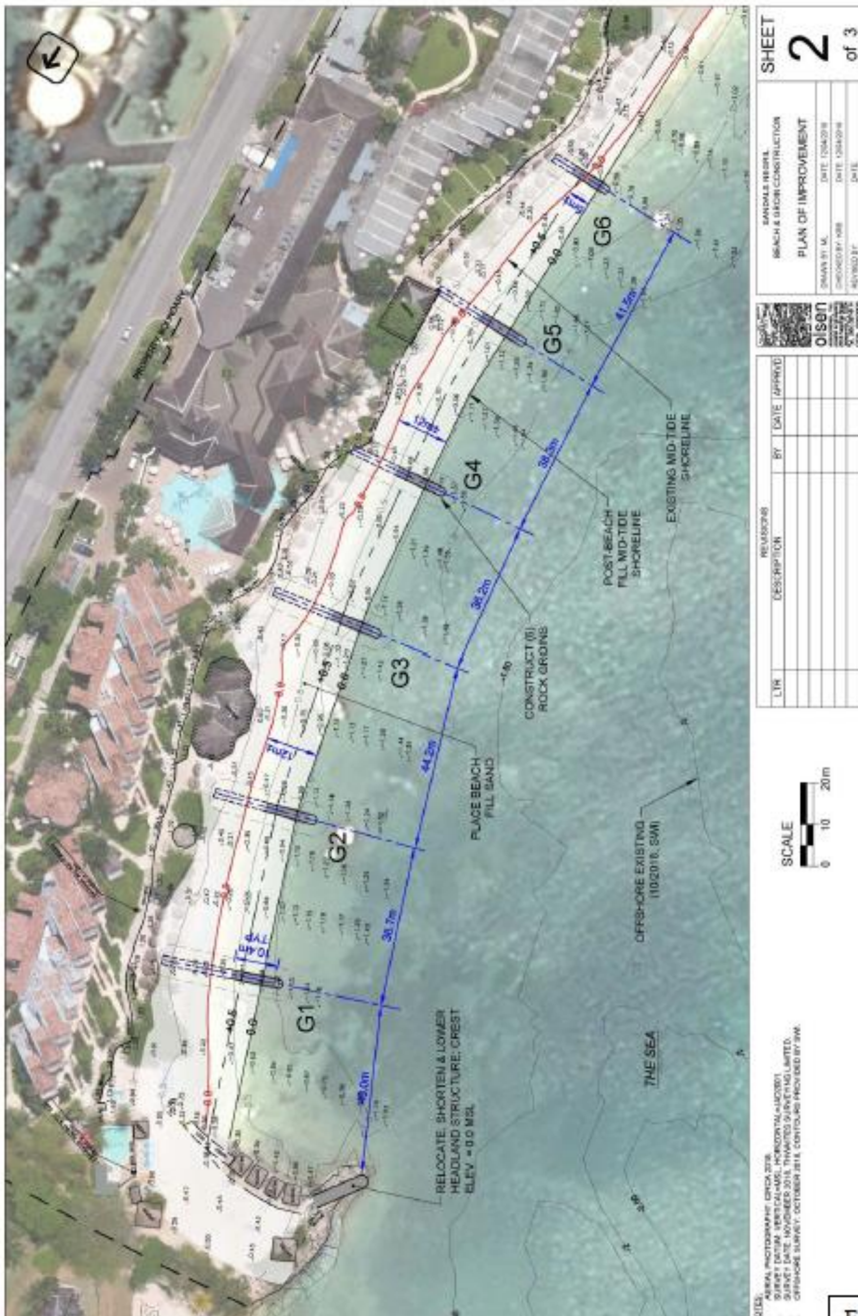

Figure E

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Sandals Negril Beach – Olsen Groyne Alternative

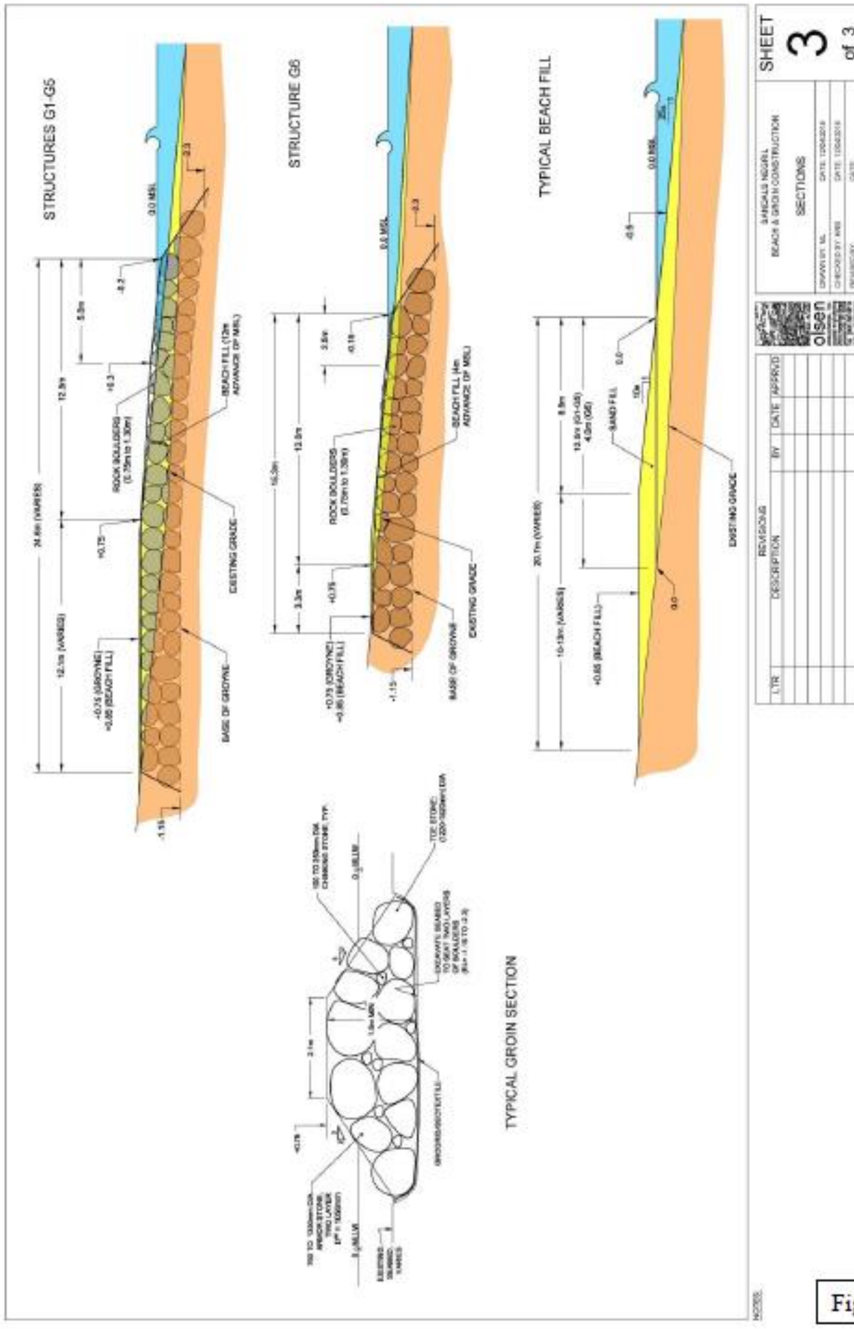

Figure F

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Sandals Negril Beach – Olsen Groyne Alternative

Predicted Project Performance and Impacts.

The proposed groyne design presents the minimum amount of total and visually exposed structure in order to physically yield the objective of providing augmented stability to the beach fill. As noted above, the low, short profile of the proposed six groynes approximately matches the profile of the adjacent beach fill, terminating at or about the post-nourishment low tide shoreline. As such, the groynes will not impound additional sand beyond that which is placed. Loss of beach fill between groynes is anticipated, and the lost sand will be transported to the adjacent (downdrift) shorelines. Accordingly, adverse downdrift impact to the adjacent (southern) beaches is not predicted; and instead, some minor gains to adjacent shores may result from the anticipated losses of the beach fill that shall occur between the groynes.

However, for conservatism in impact and to optimally reduce the visual (physical) aesthetic of the structures, the shorter groyne length proposed in the plan described herein is recommended. The presently proposed plan with short groynes acknowledges the loss of beach fill – but seeks to balance this greater anticipated potential loss in long-term beach fill with the community interest for minimization of structural presence and potential downdrift littoral impact.

The effect of short, low profile groynes upon the beach, with accompanying placement of beach fill that is of the similar elevation profile as the groynes, has greatest certainty of predicted performance. The groynes cannot physically retain more sand than their elevation profile (unless they are completely buried by sand, in which case the groynes become inactive). Broadly, the effect of groynes from various wave heights is also fairly consistent; their effect more or less scales with wave height. Small waves produce the least effect compared to high waves, but both produce the same general expected signature (performance) for waves of semi-uniform direction, such as at this site. Accordingly, there is high confidence in the ability to predict the probable performance and effect of the proposed six low, short groynes.

The prototype performance of similar groynes constructed at Sandals Whitehouse in 2016 and 2017 – in very similar conditions to Sandals Negril Beach – favorably support the anticipated performance of the proposed groyne field described herein. There, ten rock groynes were constructed to stabilize beach fill placement amidst a highly erosional background condition, with daily conditions of very low typical wave-height and high uniform shoreline angle – very similar to the subject site. Despite their physical geometric differences (i.e. Sandals Negril groynes will be less noticeable), the proposed groynes at Sandals Negril are expected to perform as well as, if not better than, those at Sandals Whitehouse. To-date, the structures have retained the beach fill improvements with no discernible impacts to the adjacent (downdrift) shorelines and with minimal requisite maintenance adjustments within each beach cell between groynes. The groynes and beach fill restored, and have maintained, lateral access along the entire sandy beach shoreline. Little or no mechanical movement of sand has been required within, or between, beach cells in order to maintain a quasi-uniform beach width amongst the groyne field, as is expected to be the same case for the proposed groynes. Given the otherwise erosional history of Sandals Whitehouse, the result of the works has been unexpectedly better than anticipated. It indicates a favorable beach response to the groynes amidst the site's typical daily conditions of low wave heights and fairly high oblique shoreline incidence – very similar to the conditions at Sandals Negril. (See *Figure F.*) After construction of the groynes and beach fill, there shall be full lateral access along the entire sand beach shoreline. Like Whitehouse, the entirety of each groyne above the wave zone will be completely buried by sand.

Figure F: Rock groynes at Sandals Whitehouse constructed in 2016-17 to stabilize beach fill amidst a highly eroded shoreline in similar low-energy conditions as Sandals Negril Beach. These groynes are much longer and higher than those proposed at Negril Beach. (The long groyne at lower left was pre-existing prior to the works). Despite highly oblique waves & westerly-directed transport (toward the left in the photographs), little alongshore differential in shoreline location has been observed, and little maintenance has been required.

Sand Quality. The placement of coarser beach fill sand from the upland Bloody Bay site relative to the existing beach (~0.3 mm fill versus ~0.16 mm native) lends additional significant confidence to the predicted performance of the proposed activity. The coarser nourishment sand will be significantly more stable (less prone to erosion) and highly likely to conform to the beach profile and planform geometry predicted in the proposed plan.

Water Circulation. The proposed groyne field is reasonably predicted to have no significant impact upon nearshore water circulation or currents. The rock groynes project less than about 5 to 6 m length into the sea, beyond the nourished beach fill, in water depths of about 0 to 0.5 m. This is a minor fraction of the active wave and nearshore current zone. The structures' projection is insufficient to create embayment cells or otherwise significantly interrupt the natural longshore current by waves or wind.

Stormwater Runoff. To the maximum extent practicable, existing storm water runoff will be routed to and within the proposed six groynes, discharging flow from near the seaward ends of the groynes. This will reduce storm water discharge and resultant erosion that otherwise occurs across the beach, thus reducing beach erosion from storm water runoff.

Maintenance Beach Renourishment. Typical renourishment required for a project of this scale is on the order of 6 to 8 years. The actual timing and requirement for renourishment are more dependent on storm impacts to the project area. Sand sources for future renourishment will be determined by and at the time of project need.

Future Beach Renourishment. If or when the overall beach is additionally nourished (widened) by, say, 15 to 30 meters through a large-scale Negril Beach nourishment project, the proposed groyne field will be wholly buried by the sand fill. In that instance, the groynes will be wholly inactive and will not affect that beach nourishment, nor will they be visible.

Historical Objections to Rock Groyne Structures.

An understandable and historically justified objection to rock groynes is their visual impact and physical obstruction to the beach. Traditional rock groynes were constructed to "trap" sand – impounding sand upon the updrift side of the beach and resulting in erosion along the downdrift side of the beach – ultimately disrupting the natural beach and interfering with alongshore littoral transport and public lateral access. In contrast, in this plan, the proposed structures are of minimal elevation and length; that is, not greater than the profile of the beach nourishment fill, with minimum protrusion above the beach, and no obstruction to lateral access. The potential for adverse downdrift impact is minimized or negated by the low, short profile of the groynes. This profile is capable of quasi-stabilizing only the placed beach fill, or actually less. It features an overall elevation that is generally at or below the beach profile to ensure minimal visual impact and no obstruction to alongshore lateral access.

In short, the proposed rock groyne structures are far less significant in size than "conventional" groyne structures. The proposed plan is premised upon the principal that, when structures are warranted in a low-energy condition such as Sandals Negril, a field of six very short low buried groynes is the preferred and recommended plan.

Physical Modeling.

Physical (laboratory) modeling of various alternatives at this site would be of limited value – particularly in regard to assessment of large-scale downdrift impacts – owing to the very large size of the subject project area, and relative to the very shallow depths and typically very low wave heights that characterize this site. Even with specially formulated "faux" sand particles, and with distorted vertical scales, the ability to accurately model the dominant physical processes of this shallow, low-energy site in a laboratory wave tank – in a manner that would meaningfully inform the probable outcome of various project alternatives – is suspect. Such an endeavor would likely be a waste of time and expense – relative to simply building the actual field prototype, monitoring its outcome, and adapting to the result.

Summary.

A beach improvement plan proposed of six (6) low-profile, short groynes to stabilize approximately 7,000 cubic meters of beach fill placement along the northern 240-m of shoreline of Sandals Negril, along with re-shaping and lowering of the existing rock spur-groyne at the north headland of this shoreline, is presented and recommended for beach improvements, per the drawings presented herein. The proposed plan presents a feasible solution for acceptable project performance with the least potential repercussions for environmental impact to the nearshore seabed, water circulation and quality, downdrift beach effects, obstruction of lateral beach access, and visual or aesthetic impacts to the overall beach environment. The plan is simple to construct and most readily modified or adjusted to reflect requirements of observed project performance.

References.

Bodge, K. R., 2003. *Design Aspects of Groins and Jetties*. In: Advances in Coastal Structure Design. Ed. R. Mohan, O. Magoon, M. Pirrello. American Society of Civil Engineers (ASCE). Reston, VA. ISBN 0-7844-0689-8. Pp. 181-199.

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