

ENVIRONMENTAL ASSESSMENT REPORT

FOR THE INSTALLATION OF AN ARTIFICIAL reef-breakwater STRUCTURE ON SCOTCH BANK ST. CROIX, U. S. VIRGIN ISLANDS

SUBMITTED TO

THE OFFICE OF COASTAL ZONE MANAGEMENT DEPARTMENT OF PLANNING AND NATURAL RESOURCES GOVERNMENT OF THE VIRGIN ISLANDS

AND

U.S. ARMY CORPS OF ENGINEERS ANTILLES REGULATORY DIVISION

SUBMITTED BY

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APPENDICES

Appendix A

Qualifications of Preparers

ACRONYMS

ADCP	Acoustic Dopler Current Profiler
BA	Biological Assessment
CEM	Coastal Engineering Manual
CFMC	Caribbean Fisheries Management Council
CFD	computational fluid dynamics
Cm	centimeter
CRF	Coral Restoration Foundation
DPNR	Department of Planning and Natural Resources
EAR	Environmental Assessment Report
EFH	Essential Fish Habitat
ESA	Endangered Species Act
HAPC	Habitat Areas of Particular Concern
in	inches
km	kilometer
m	meter
mm	millimeters
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS CCMA	National Ocean Service Center for Coastal Monitoring and Assessment
MMPA	Marine Mammal Protection Act
PRD	Protected Resources Division of the National Marine Fisheries Service
RPL	Route Position List
SAG	spur and grove
SCUBA	self-contained breathing apparatus
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USVI	U.S. Virgin Islands

1.0 NAME AND ADDRESS OF APPLICANT

ReefStarter, Inc

1317 Edgewater Dr. 5316

Orlando, FL 32804

2.00 LOCATION OF PROJECT

The proposed modular reef-breakwater system will be located on Scotch Bank adjacent to the Coral Restoration Foundation (CRF)'s coral nursery, Figure 1. The structure will be in a large open sand plain to the east of the Christiansted Harbor Entrance Channel, Figure 2.

Structure:

- NE Corner: 17.76466944 N, 64.69312778 W
- SE Corner: 17.76434167 N, 64.69279722 W
- SW Corner: 17.76391111 N, 64.69331389 W
- NW Corner: 17.76423333 N, 64.69363611 W



Figure 1. Location of the modular reef-breakwater structure and CRF's Coral Nursery.

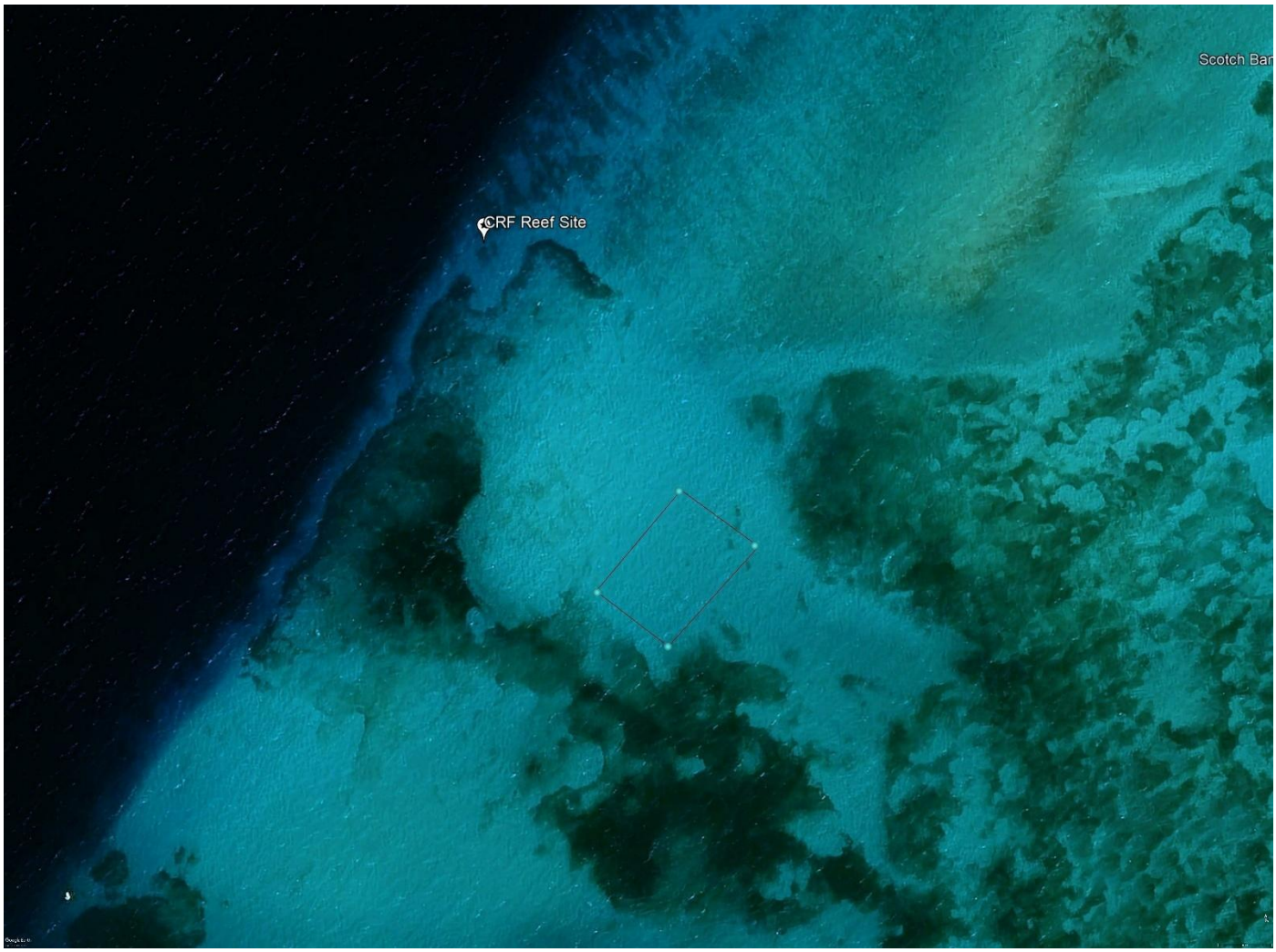


Figure 2. Closeup of the reef structure site in relation to the CRF nursery site.

3.00 ABSTRACT

ReefStarter, Inc is proposing to construct their modular reef-breakwater system as part of a National Coastal Resiliency grant through the National Fish and Wildlife Foundation. The purpose of the reef-breakwater structure is to address coastal erosion by reducing wave energy while creating a habitat suitable for coral colonization and creating a habitat for fish and invertebrates.

Those familiar with Scotch Bank are aware of the waves and currents created by the deep-water waves intersecting the shallow bank to the east of Christiansted Channel. The area is usually subject to large swells and pronounced wave shoaling caused by the rapid depth change.

This site will be an ideal location to show the capabilities of ReefStarter's structure. Sea conditions and wave dynamics will be monitored prior to installation, and the structure has been designed based upon the existing wave climate. Once installed, detailed monitoring will occur to evaluate the success of the structure in dampening the wave effects as well as its suitability as an artificial reef.

The reef-breakwater structure is to be constructed in a sand patch located in the Great Middle Grounds, just west of Scotch Bank and east of the Christiansted Harbor Channel. The location of the structure will be within: NE Corner: 17.76466944 N, 64.69312778 W; SE Corner: 17.76434167 N, 64.69279722 W; SW Corner: 17.76391111 N, 64.69331389 W; NW Corner: 17.76423333 N, 64.69363611 W. The water depth is between 3.66 m and 4.28 m (12ft to 14 ft). This is a multi-function structure designed to reduce wave energy and provide habitat creation.

The structure will showcase the two primary functions of the ReefStarter concept: wave energy reduction and habitat. The project is part of a larger scale restoration plan to restore the functionality of the Long Reef system. The deterioration of Long Reef, the fringing reef protecting Christiansted Harbor, has reduced its ability to provide the wave protection that it has done historically. Once the concept has been tested in the Great Middle Grounds, which is located to the east of Long Reef, design work will begin on how ReefStarter can fortify the deteriorated sections of Long Reef and restore protection for Christiansted's shoreline, including the Seaplane Base, Christiansted boardwalk, and its waterfront restaurants, Hotel on the Cay, the VI Water and Power Authority, and Condo row.

4.00 STATEMENT OF OBJECTIVES SOUGHT BY THE PROPOSED PROJECT

ReefStarter, Inc. is proposing to install a modular reef-breakwater system to demonstrate that their innovative approach to breakwater design can reduce the wave energy that causes coastal erosion while simultaneously accelerating ecosystem recovery through the creation of habitat for coral, fish and invertebrates.

5.00 DESCRIPTION OF PROJECT

ReefStarter developed a modular system of ecologically integrated concrete blocks designed to mimic the structure and benefits of mature reefs. The structures create a range of micro-, meso-, and macroenvironments for marine organisms while protecting the shoreline from destructive storm wave energy.

The structure has been designed to be stable under the impact of depth limited breaking waves. The maximum wave height at the site is dependent on the depth of water. The design wave condition was determined by first obtaining the 50 year and 100-year return interval wave height, 11.5 m and 13.0 m respectively, from the USACE WIS Station 61022, Figure 19. These waves were then used to model conditions at the project site. Due to the shallow seafloor at the project site, the design wave will be breaking before it reaches the proposed reef site. Therefore, the design wave is taken as the depth limited breaking wave. A conservative value of 1.0 for the breaking criteria is used in the calculation of the depth limited wave height.(In the calculation of the depth limited wave height conservative figures are utilized so that the reef is designed for the largest wave that could occur.) Stability and wave attenuation testing is performed using a design wave height of 4 meters in front of the structure and a design period of 10 seconds. The structure is engineered to reduce wave energy by up to 90% and to support a diversity of marine life.

The 5.7 to 6.1-ton interlocking reef blocks will be assembled to mimic a spur and grove formation. The mass of each block is designed such that when interlocked with neighboring blocks, the block will be stable against the force of the design depth limited breaking wave. The USACE Coastal Engineering Manuel (CEM) design manual was used to estimate the mass needed for stability using the Hudson equation:

$$W_{50} = \rho_s g H^3 / (K_D (\rho_s / \rho_w - 1)^3 cot(\alpha)) \qquad (1)$$

Where W_{50} is weight of the block needed to armor the structure against the design wave, H is the design wave, ρ_s and ρ_w are the densities of the stone or concrete and water respectively, K_D is the stability coefficient (e.g. larger stability coefficients require less weight to remain stable against a given design wave), α is the slope of the face of the structure.

Since this is the first time the novel ReefStarter design is being deployed, a range of stability coefficients, K_D, values were considered (2.0, 7.0, and 10.0). Based on Shore Protection Manual Table 7-8, a K_D of 2.0 corresponds to rough angular quarry stone and represents the least stable material, a structure built from tetrapods or quadrapods placed randomly has a K_D of 7.0, and parallelepipeds have associated stability coefficients ranging from 7.0 - 20.0. Recognizing that the ReefStarter blocks will interlock more securely than randomly placed tetrapods, a stability coefficient of 7.0 is considered to be conservative. Using $K_D = 7.0$ in the Hudson equation, the ReefStarter blocks are stable against the design wave with a factor of safety or 1.875 - 2.0. It is anticipated that the actual stability coefficient associated with the ReefStarter blocks will be greater than 7.0 indicating they are more stable than tetrapods and result in a factor of safety greater than 2.5. Physical 1:10 scale model testing in the Florida Tech Wave channel and numerical computational fluid dynamics (CFD) studies using FLOW3D confirm the stability of individual blocks and block groups to forces from the scaled design wave.

<u>Reef Design</u>

-
    - Nominal Reef Dimensions: 50m x 30m x 3.5m (l x w x h), Figure 3
        - 4 Spurs
        - Range of habitat features
            - Micro
            - Meso
            - Macro
            - Reef scale
    - Constructed using 964 reef-blocks:
        - 672 standard reef-block modules
            - Nominal Module dimensions: 1.25m x 2.5m x 1m (l x w x h), Figure 4
            - Nominal Module weight: 5.7 tons
        - 292 short reef-block modules (Pancakes)
            - Nominal Module dimensions: 2.5m x 2.5m x 0.5m (l x w x h), Figure 5
            - Nominal Module weight: 6.1 tons
    - Depth Range:
        - Structure base will be 3 -5 m below sea level (depending on site conditions)
        - Structure crest designed to be constructed to -0.30 m MLLW and be at -0.40m MLLW after post construction settling
    - Module Spacing: As per approved design

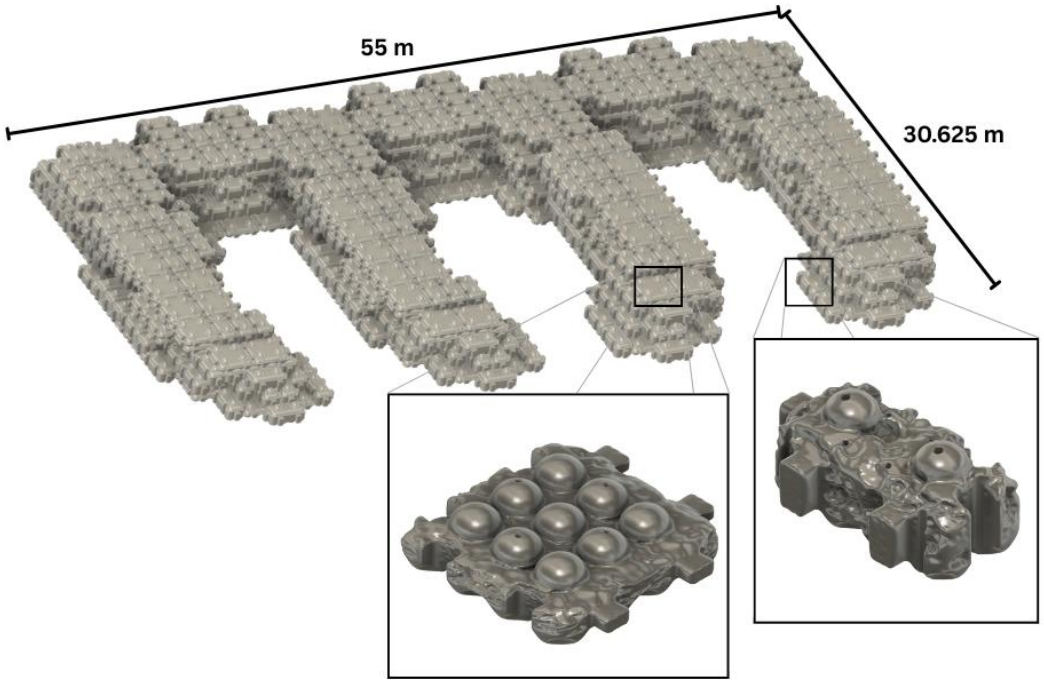


Figure 3. ReefStarter full assembly spur and groove reef breakwater rendering. Nominal dimensions (L,W,H) 55m x 30.625m x 3.5m. The reef structure is composed of 672 reef-blocks and 292 short reef-blocks.

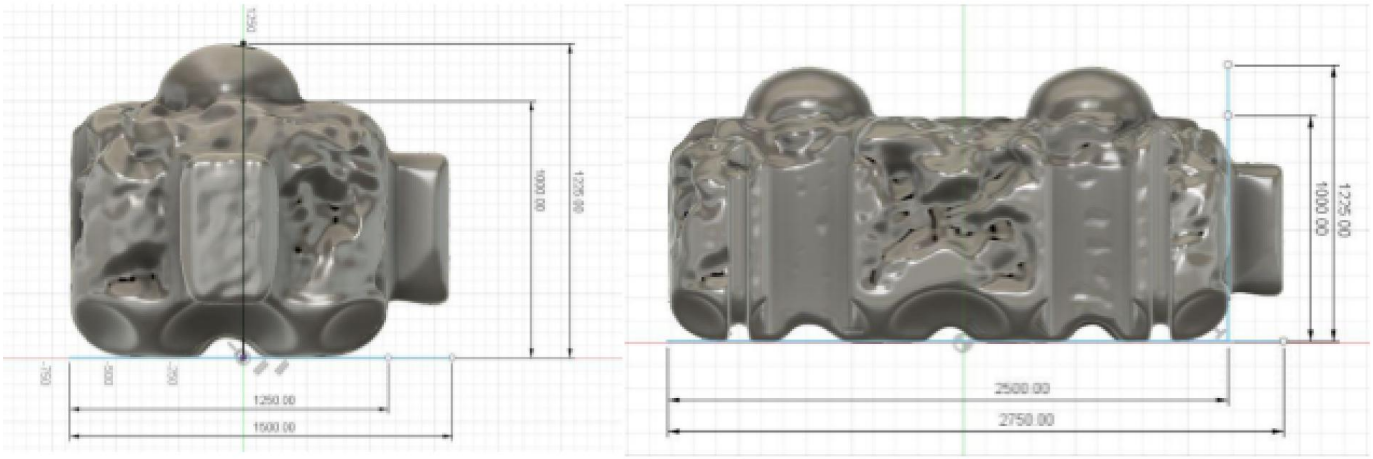


Figure 4. ReefStarter reef-block design. Nominal dimensions(L,W,H) 2.5m x 1.25m x 1.00m. Weight: 5.7 tons.

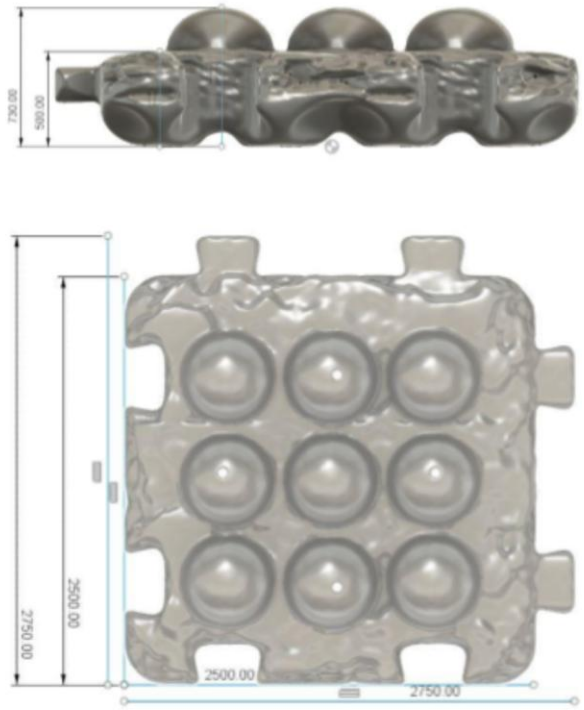


Figure 5. ReefStarter short reef-block (pancake) design. Nominal dimensions (L,W,H): 2.5m x 2.5m x 0.5m. Weight: 6.1 ton.

Bedding/Filter layer

The bedding layer is designed using guidance from the USACE CEM. The Hudson equation, Eq (1), for rubble mound breakwater was adapted to provide guidance on bedding layer stone size. The structures will be built on top of a prepared substrate to minimize erosion of the base. The sand bottom will first be leveled by dragging approximately 688m^3 of sand from the shallow eastern side and placing that same volume on the deeper western side. A minimum 0.30 m (1 ft) thick bedding layer will be placed on the leveled sand bottom (as per CEM design guidance). This layer will consist of approximately 800m^3 of 0.45 kg (6.40 cm) stone. The bedding layer will level out the bed onto which the structures will be constructed and prevent the structure from burying into the bed. To maintain water quality during construction and reduce the silt, the bedding stones will be rinsed before placement. Turbidity booms will be deployed and turbidity monitored during placement.

Scour protection

A toe, designed using guidance from the USACE CEM, will be constructed to provide scour protection. The Hudson equation for rubble mound breakwater, Eq (1), was adapted to provide guidance on toe stone size. The toe will require approximately 50m^3 stones with a nominal size (D50) of 0.138 m (4.54 kg) and will be placed in a layer at least two stones thick and at least three stones wide around the base of the structure where the structure meets the bedding layer. These stones will form a toe and provide protection from scour. As the sand scours away from the bedding layer, the bedding layer and then the toe stones will fill that hole preventing further progression of the scour. In order to maintain water quality during construction and reduce the silt, the toe stones will be washed before placement. Turbidity booms will be deployed and turbidity monitored during placement.

5.01 Summary of Proposed Activity

Prior to any work wave height data collection equipment will be deployed for a period of 6-12 months to gather data on the site. Once all the necessary data has been collected, turbidity barriers will be placed around the area of work, and the sand will be leveled using a jack up barge mounted excavator and a drag beam and a bedding layer of stone/gravel will be placed to ensure the blocks are level. Next, a barge with special installation equipment will be carefully spudded down into position. Divers will locate spud positions so that the barge can spud down without impacting any marine resources. The first level of blocks will be placed such that they interlock together. Divers will assist to ensure correct attachment occurs. The subsequent layers of blocks will be installed carefully, interlocking each block. Divers will inspect each block as it goes in to ensure proper stability is achieved. The last step is to construct the toe around the base of the structure.

Once the reef-breakwater is complete, wave sensor monitoring equipment (wave pressure sensors, Acoustic Doppler Current Profilers (ACDP)) will be installed and monitoring of the sea conditions and use and colonization by marine organisms will begin. This data will be compared to the pre-installation data to determine the structure's impact on the wave conditions in the area.

The reef system is designed so that it can be modified or disassembled in the event that negative impacts are observed.

5.01a Performance benefit and Long-Term Monitoring

The performance of the reef-breakwater structure will be measured by the following metrics:

Wave attenuation

Wave energy attenuation is a main point of function designed into the ReefStarter structures. Laboratory modeling (both physical and numerical computational fluid dynamics (CFD) models) was used to provide design guidance. The ability of a low crested structure to reduce wave energy is a function of reef submergence, as shown in Figure 6. Based on testing results, we expect the designed structure to reduce the wave energy of the design wave by over 90%.

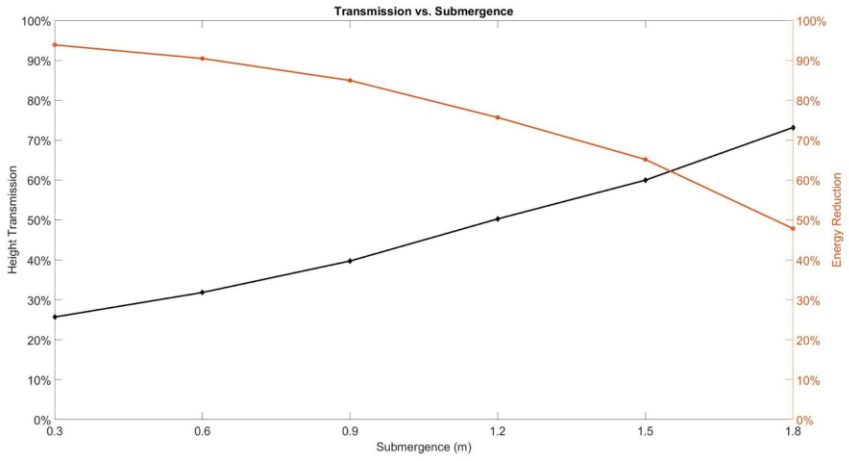


Figure 6: Wave transmission (left axis) and Energy reduction (right axis) vs submergence curve

Wave gauges (SOFAR Spotter wave buoys) will be deployed both seaward and shoreward of the reef-

breakwater. The buoys will provide real-time data for the duration of the project (Both pre- and post-construction). These gauges will allow the ReefStarter team to validate wave attenuation and provide future guidance on design parameters.



SOFAR Pressure Sensor



Teledyne ACDP

Stability

Stability will be monitored through regular visual inspections of the structure will be recorded. Post construction surveys will be conducted to measure the degree of settling and extent of any scour. Structure crest elevation will be surveyed quarterly. Particular attention will be focused on the progression of scour around the structure. Locations and extent of scour will be documented. Mitigation plans are in place, should scour threaten to undermine the base reef-blocks. If the bedding layer and the toe are insufficient to mitigate scour at any location along the structure, additional material will be placed by barge to fill in the scour hole and prevent further progression. Siltation control will be deployed during all material placements. Agencies will be informed of the volume of material that will be placed, and placement will be documented and monitored, and a report will be filed. ReefStarter anticipates that no more than 100 m^3 of additional 6.40 cm stone and no more than 50 m^3 of 0.138 m stone will be needed to mitigate any scour.

Ability to generate currents that induce circulation patterns similar to those found on natural spur and grove (SAG) reef systems.

A feature of the ReefStarter design is that the structure will recreate the circulation patterns seen on a natural spur and grove (SAG) reef. To monitor and document this feature, two Acoustic Doppler Current Profilers (ADCPs) will be placed around the structure. Because the ADCP provides a profile of currents at a particular location, we will need to deploy both instruments in a variety of locations to obtain a complete understanding of the induced currents. A post construction field experiment will be conducted deploying both fixed and towed instruments to fully capture the flow fields. The current data will allow the ReefStarter team to validate the CFD modeling and confirm the constructed reef creates similar circulation patterns as found on natural SAG reefs. Should it be found that the structure is not performing as predicted, blocks can be added or removed to tune structure performance.

The post construction monitoring will not only serve as a measure of success of the project, but the data will also be used to confirm and validate the physical and CFD modeling, Figure. 7, performed during the design phase. Future projects will benefit from a clear understanding of the accuracy of the CFD models to predict wave attenuation, flow, and scour. The lessons learned from the project will make it easier to design for mitigation reef-breakwaters placed on Long Reef.

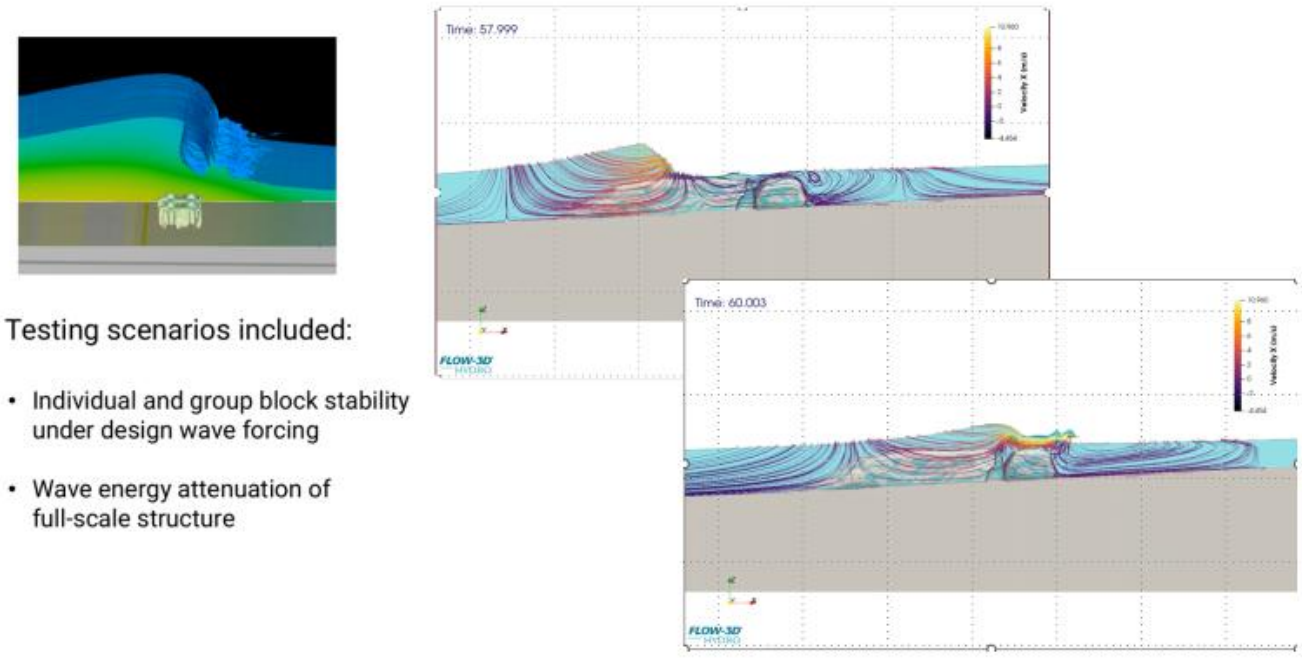


Figure 7. Computational Fluid Dynamics (CFD modeling)

Long term monitoring

Long term monitoring will include instrumentation and tech attached to the ReefStarter reef-blocks. The suite of instruments proposed will allow for ReefStarter, in collaboration with its conservation partners, to monitor the recruitment and growth of organisms on the reef. Fixed underwater cameras and hydrophones will record the sights and sounds on the reef over time, documenting any changes in heterogeneity. Temperature, turbidity, and light loggers will provide insight into the influence the structure has on temperatures, particle suspension, and light.

- Instrumentation and measurement
    - Cameras
    - Temperature
    - Light
    - Turbidity
    - Sound
    - eDNA

5.01b Presence and Location of Any Critical Areas and Possible Trouble Spots

The design and location of the modular reef has been chosen to avoid and, where avoidance is impossible, to minimize impact on environmental resources. The footprint of the modular reef has been selected to avoid all coral reefs, critical habitat and hardbottom, and seagrass beds. There are coral reefs and exposed hardbottom to the north and there are dense *Thalassia* and *Syringodium* beds to the west, east, and south of the proposed reef. To protect these resources, monitoring will occur during all in-water work. Both water quality and environmental monitoring will be implemented throughout the installation. Because barges and marine equipment will be used during construction, the applicant will comply with the National Marine Fisheries Service's "Protected Species Construction

Conditions, NOAA Fisheries Southeast Regional Office" dated May 2021.

a.	The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles. All construction personnel are responsible for observing water-related activities for the presence of these species.
b.	The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.
c.	Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.
d.	All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.
e.	If a sea turtle is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.
f.	Any collision with and/or injury to a sea turtle or small tooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.
g.	Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Figure 8. Protected Species Construction Conditions, NOAA Fisheries Southeast Regional Office

ReefStarter and the Marine Contractor Partners, PCCI, will comply with the "Vessel Strike Avoidance Measures and Reporting for Mariners," revised May 2021, for marine turtles and marine mammals. All work will occur during daylight hours and be conducted with barge-mounted equipment.

ReefStarter and the Marine Contractor Partners, PCCI, will follow the Pre-construction survey protocol outlined in the most up to date "NMFS Queen Conch Survey Construction Conditions and Relocation Guidelines" and they will report the survey results prior to placing the turbidity barriers. The applicant will monitor for queen conch throughout the in-water construction following the "Projects with no turbidity curtain or floating turbidity curtains" section on page 5 of the NMFS Queen Conch Guidelines. The surveys will follow the guidelines for the initial survey and then the subsequent repeated surveys. If conch are found, they will be permanently relocated according to the protocol and all report guidelines, including the Endangered Species Take Report Form, will be observed.

If any other ESA-listed species is seen in any of the proposed areas of activity, work will not occur within 150 ft of that area for 20 minutes after the animal has left of its own volition. Environmental monitors would be present during project activities to ensure water quality conservation measures are implemented, and standards are maintained, and to watch for and stop work if a listed species is observed in the project area. Environmental monitors will regularly check the turbidity barriers for entangled or entrapped animals. To ensure that water quality is maintained, a water quality monitoring program would be implemented during leveling and block placement. This plan will

monitor turbidity and the effectiveness of the sedimentation control. If any degradation of water quality is detected immediate corrective measures will be taken to abate the impact. The applicant will not conduct the leveling activity during coral and queen conch spawning season (June- October 16th).

5.01c Provisions to Limit Site Disturbance

The reef structures will be placed in areas of open sand with sparse resources. Divers will assist with installation to ensure that no impact occurs during installation. Divers will assist with all spudding and anchoring to ensure impacts do not occur during spudding and will monitor the queen conch during block installation.

5.01d Sediment Control Methods to be Implemented

The seafloor within the footprint of the structures will need to be leveled prior to placement of the blocks to ensure stability and a bedding material will be placed. The leveling of the area will be done with a drag bar and this will create turbidity. Because of the nature of the activity and the size of the area over which the drag bar will be drug, it will be extremely difficult to deploy turbidity barriers around the entire area, especially with the sea conditions in open water. This will be a short process, and the area should be leveled over a couple of days; therefore, turbidity will be short lived, especially since the sand within the area is a coarse carbonate sand with 70% of the sand in the 0.5 to 2.0mm range. The leveling will be done when seas come from the NE or E and will carry turbidity away from the nearby reefs and coral nursery. If turbidity is found to move towards the reef, work will stop until the plume settles and then it will resume more slowly to minimize the size of the plume. It may require the grading to start and stop several times to minimize turbidity.

Turbidity barriers will be deployed when deposition of material begins.

The bedding material will be washed before placement and will be deployed within turbidity barriers, which can be secured to the barge. A crane will be used to place the material, and the material will be lowered to the seafloor and spread using the drag bar. Once the material is level, the placement of the blocks will begin.

Turbidity barriers should not be necessary during the deployment of individual reef blocks.

5.01e Schedule for Construction Activities and Implementation of Siltation Control Measures

The leveling of the site will only occur when the currents and winds come from the north or northeast which is the prevailing wind and wave direction. The area is too large to surround with turbidity barriers during leveling to function well due to the existing wave action. Any turbidity will be carried towards the sandy colonized areas. Monitoring will occur and anytime turbidity is above 3NTU work will be paused until it returns to appropriate limits.

Turbidity barriers will be installed during the installation of all bedding material (they can be attached to the barge), and bedding materials will be released near the seafloor with a crane. Barriers will be maintained throughout all bedding placement.

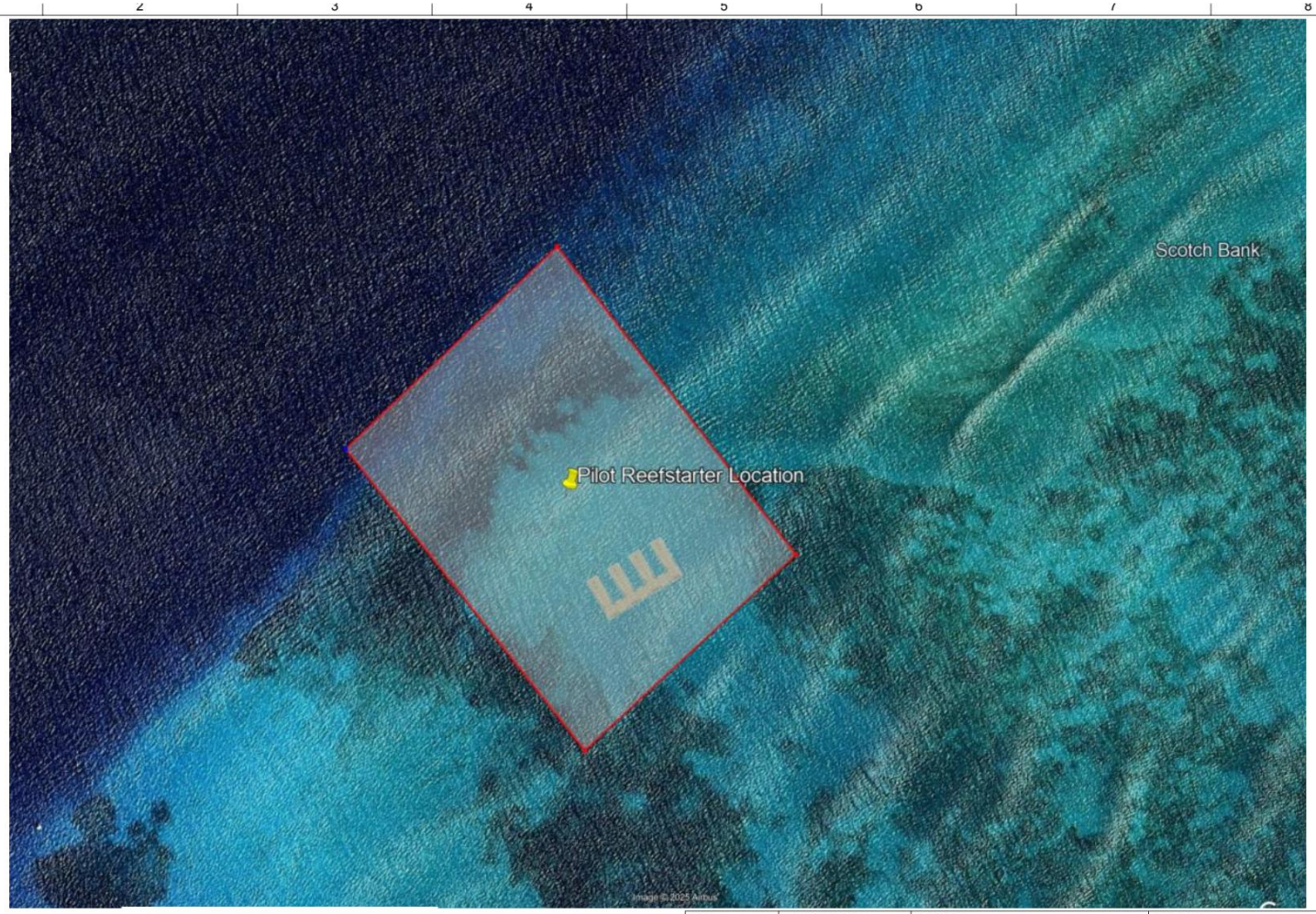
The reef blocks will not create turbidity, and barriers will not be necessary.

5.01f Maintenance of Sediment and Siltation Control Measures

Barriers will be inspected during all fill placement and will be repaired immediately when inadequacies are noted.

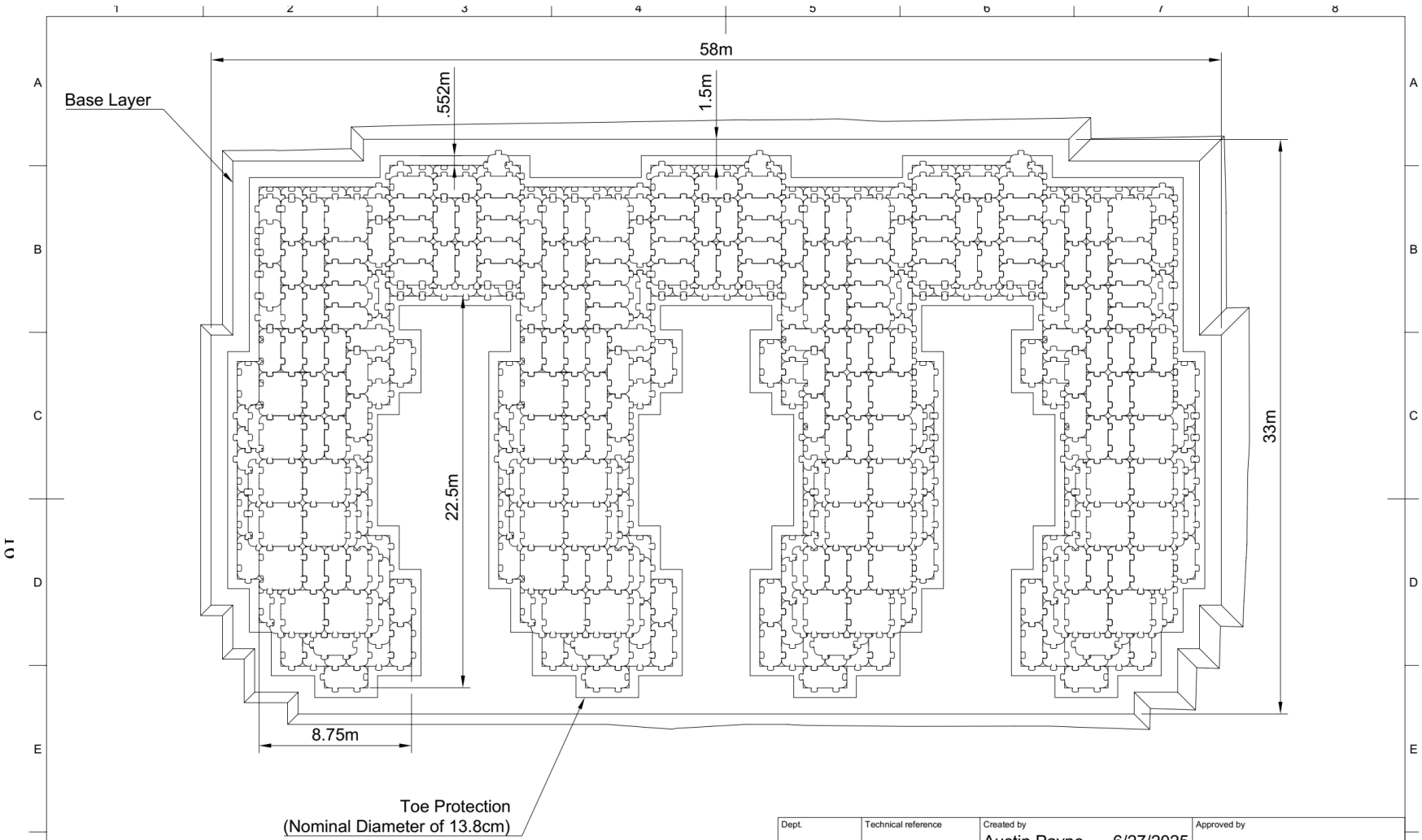
5.02 Project Work Plans

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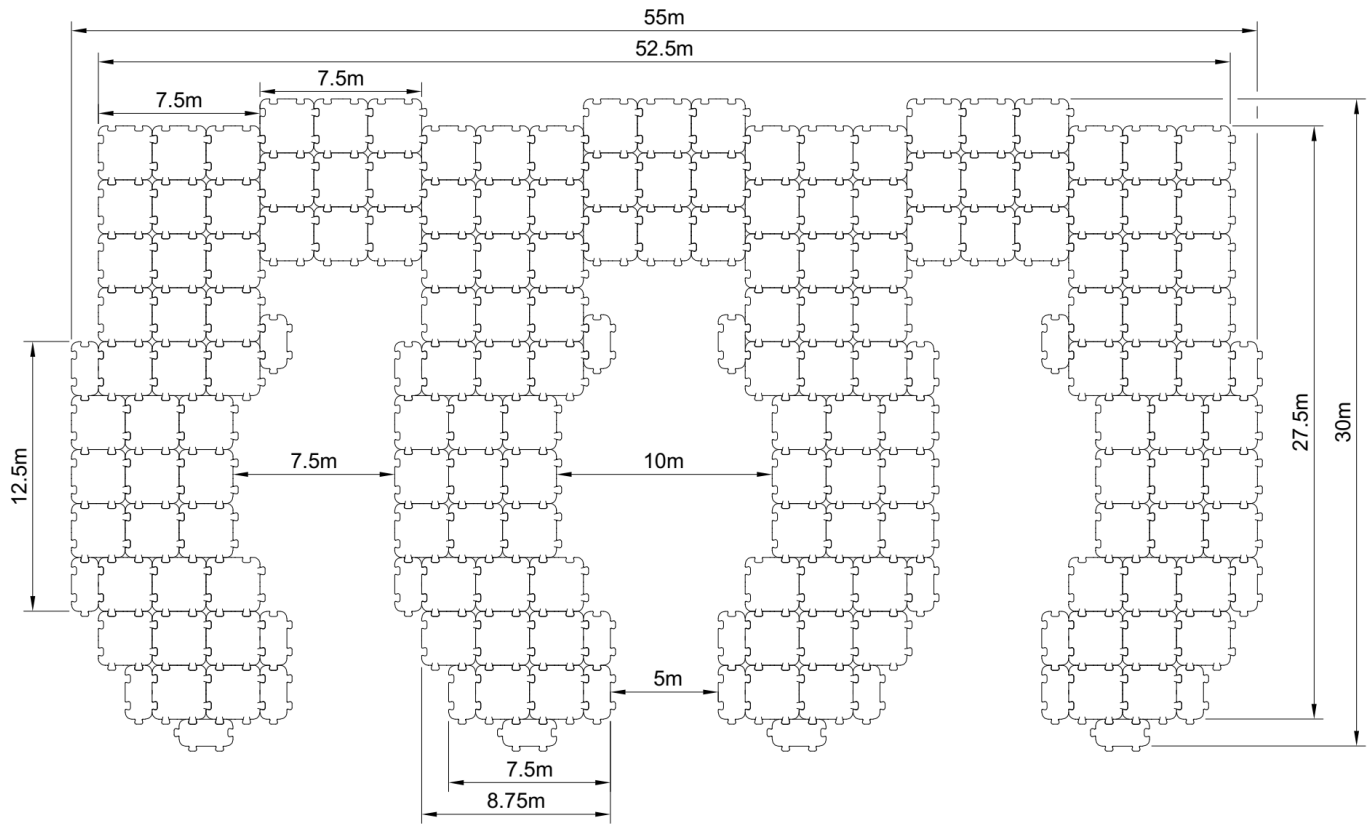


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NW Corner: 17.76423333 N, 64.69363611 W

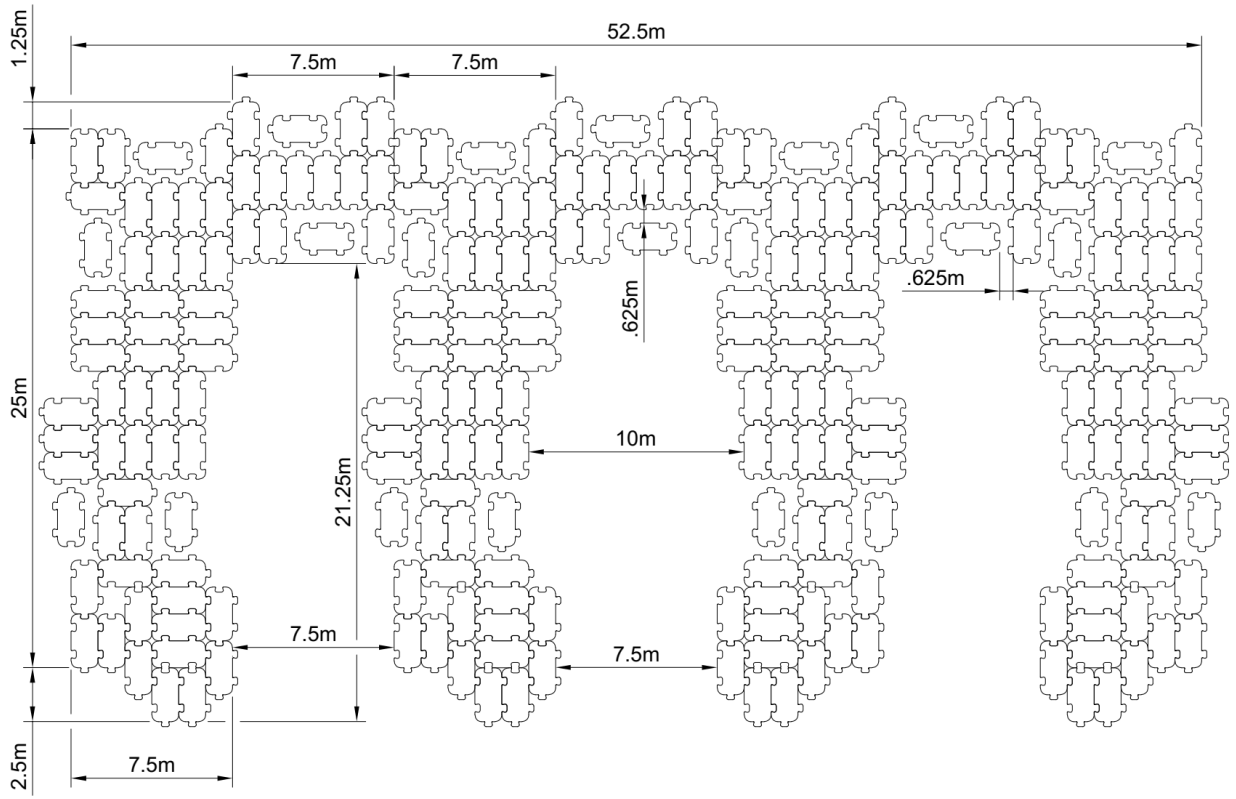
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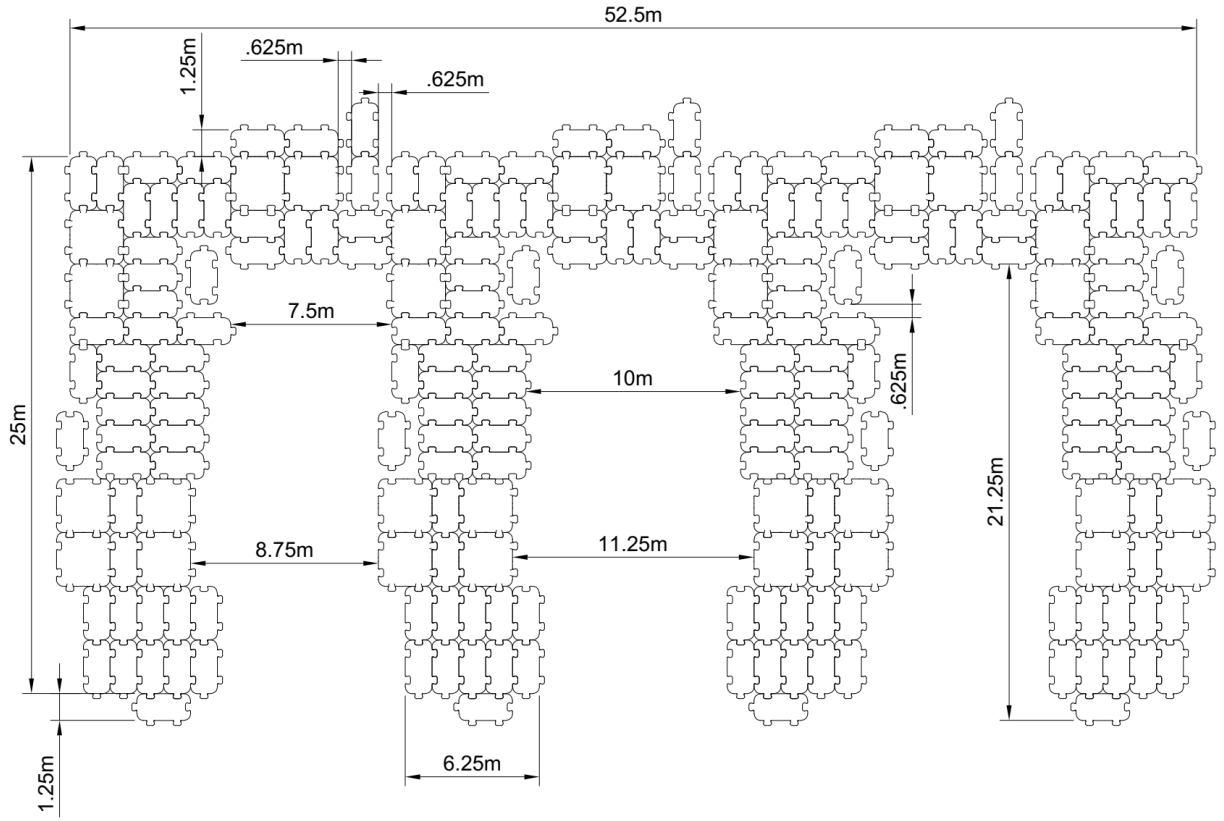
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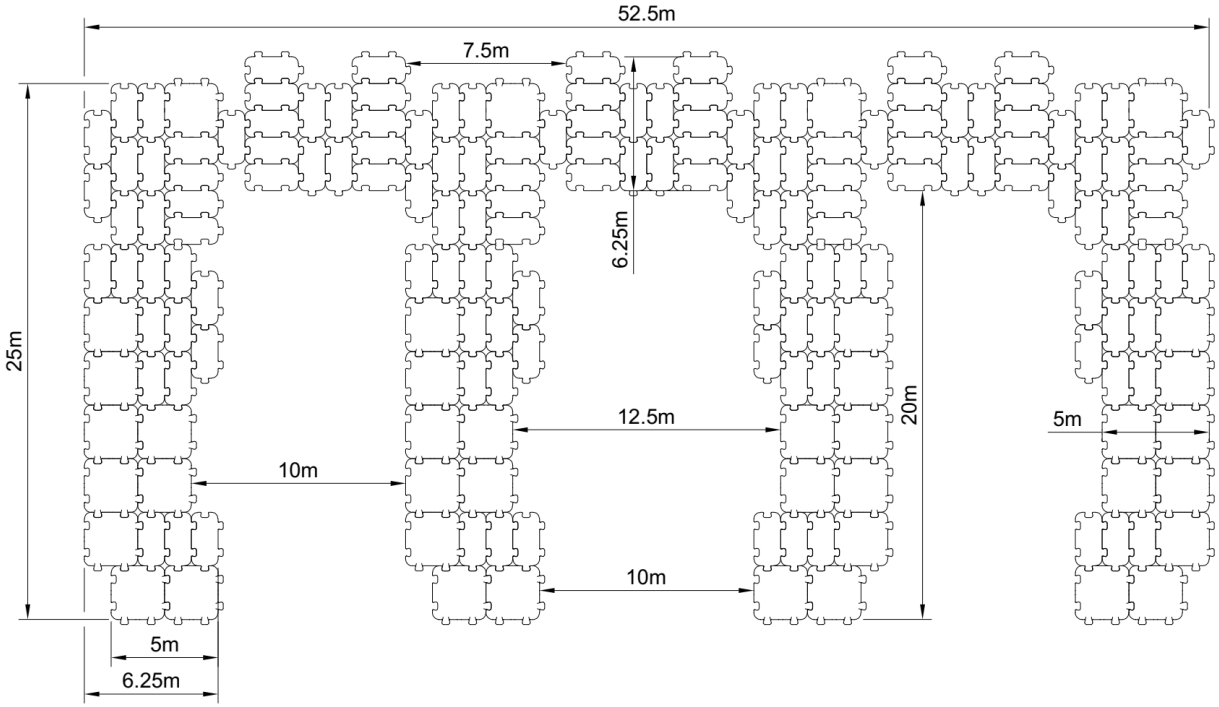
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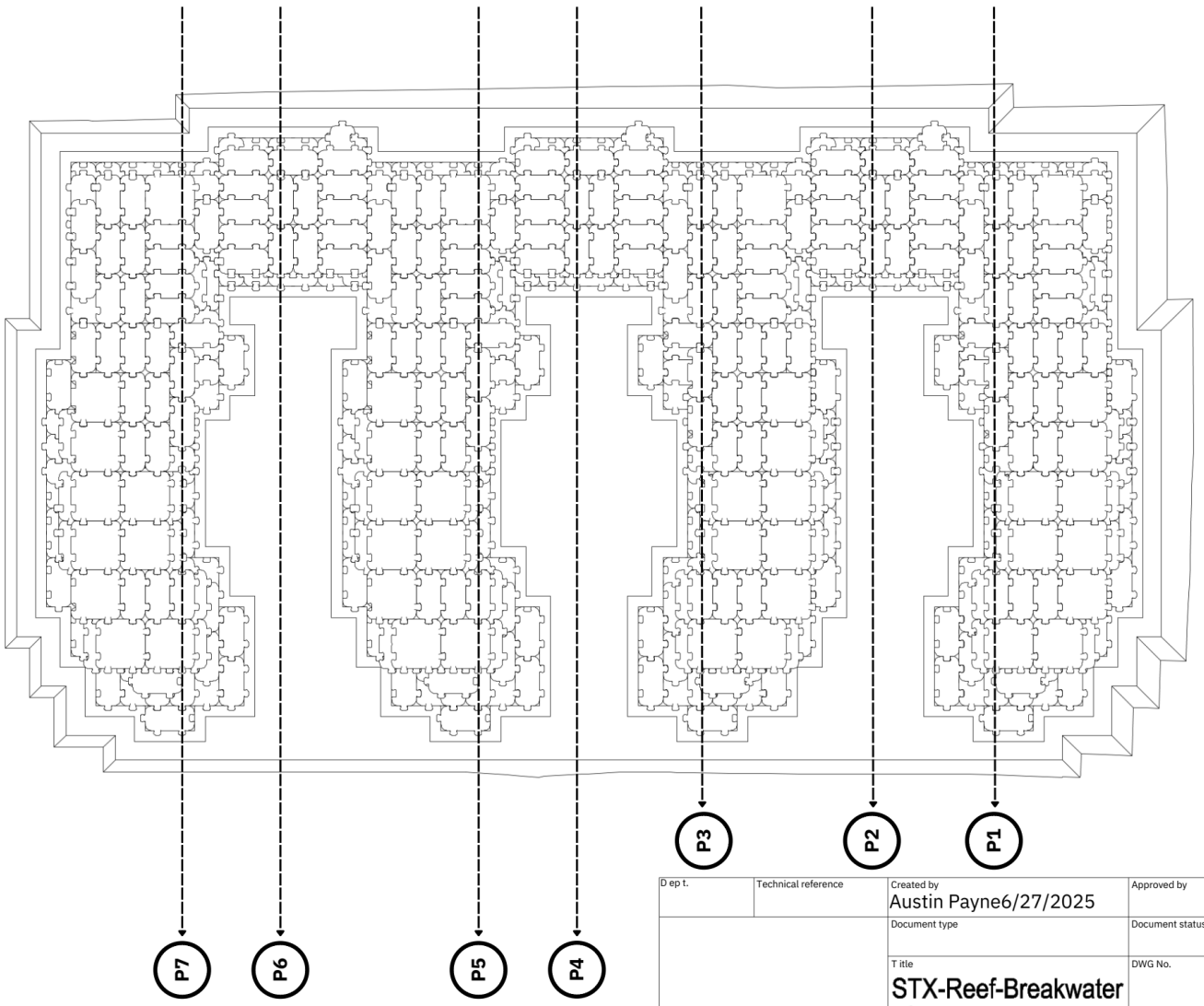
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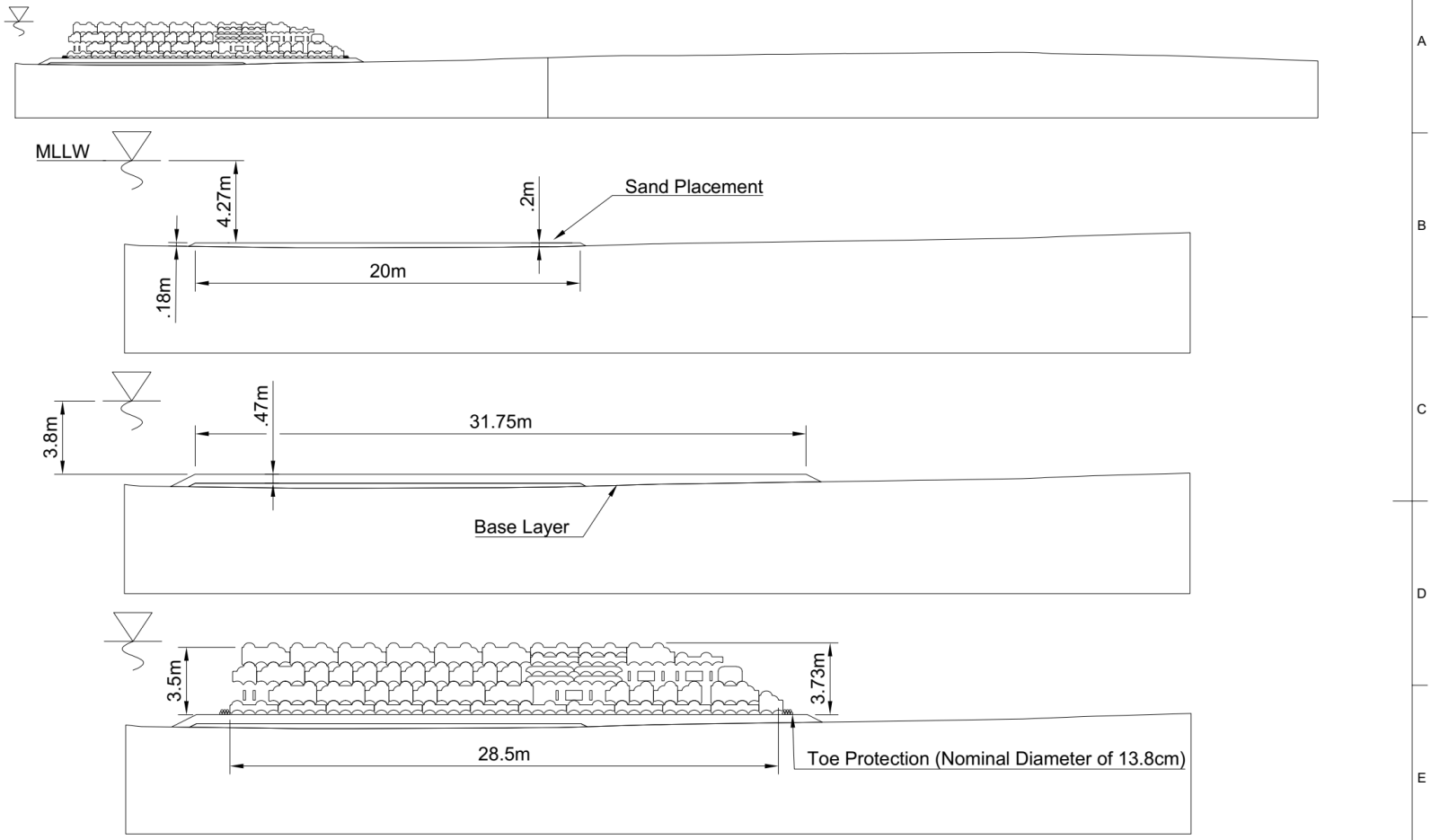
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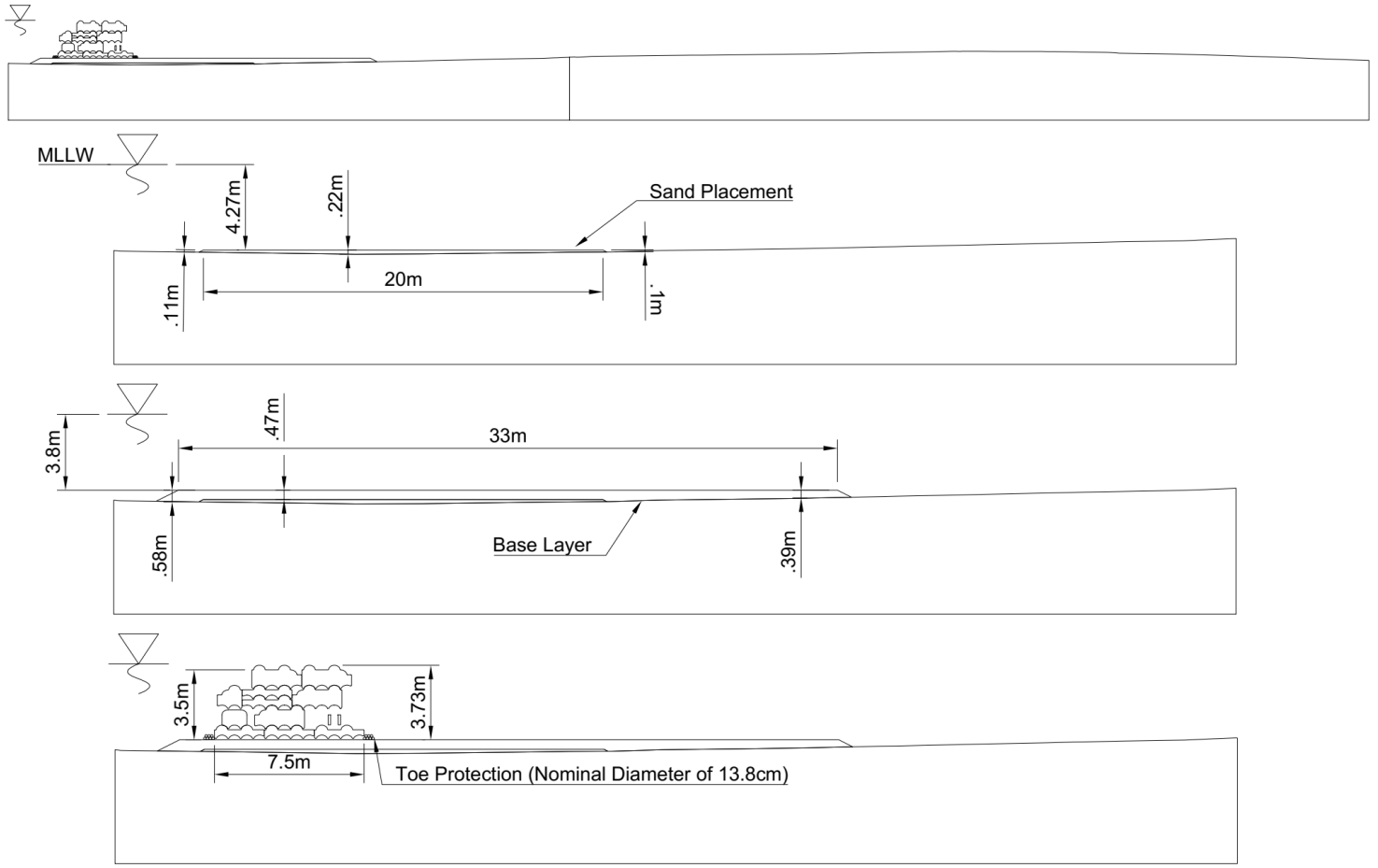


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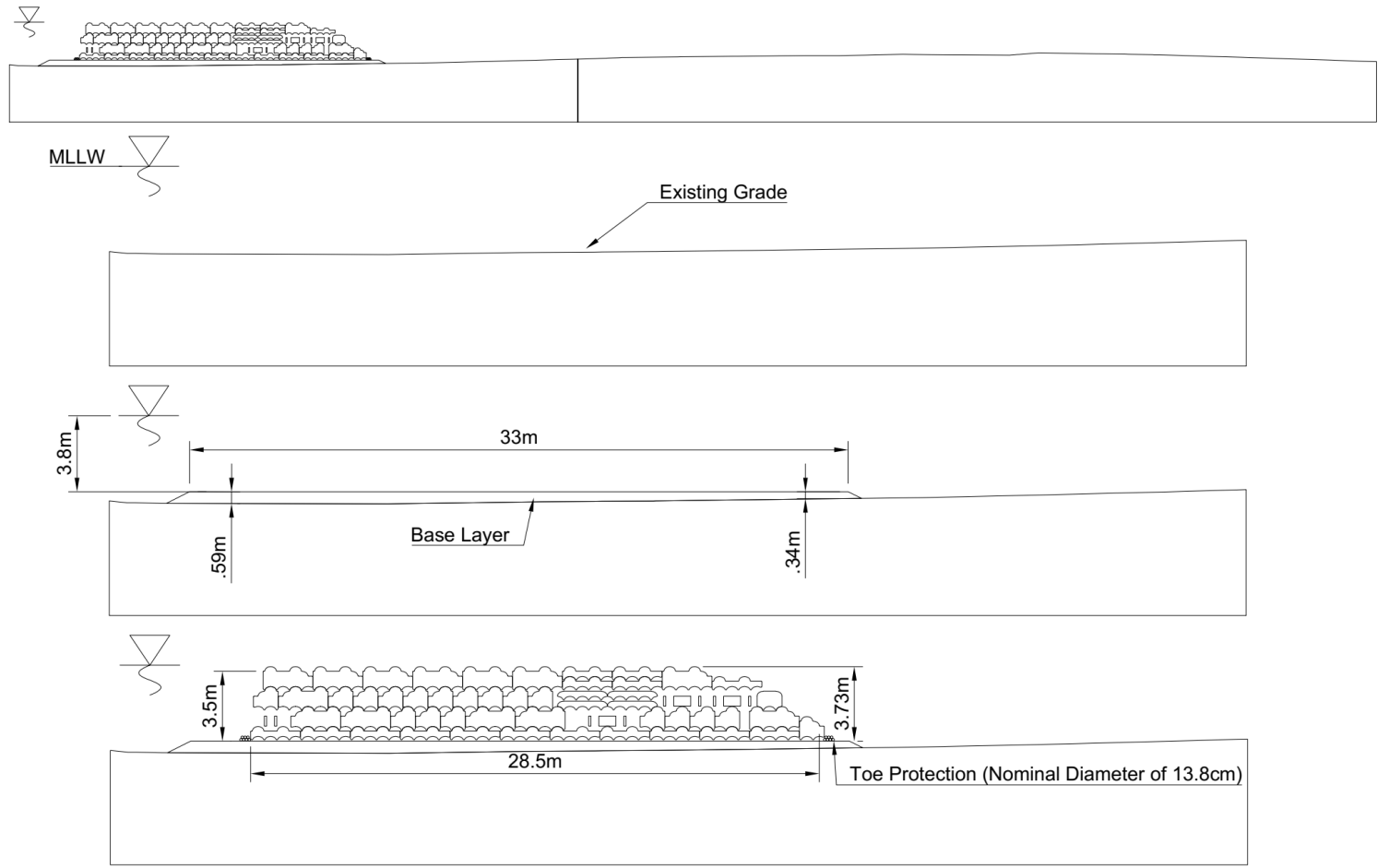


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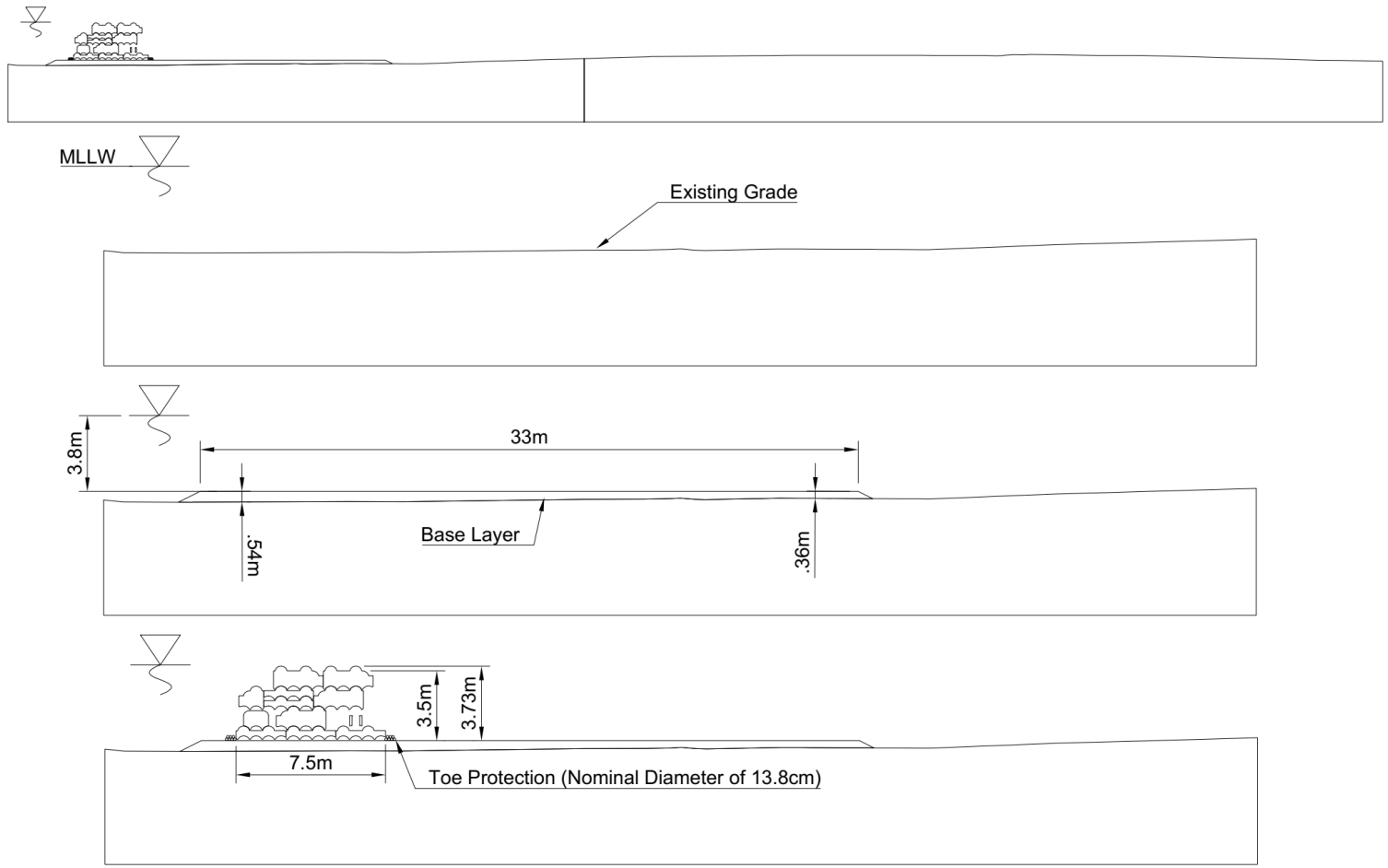
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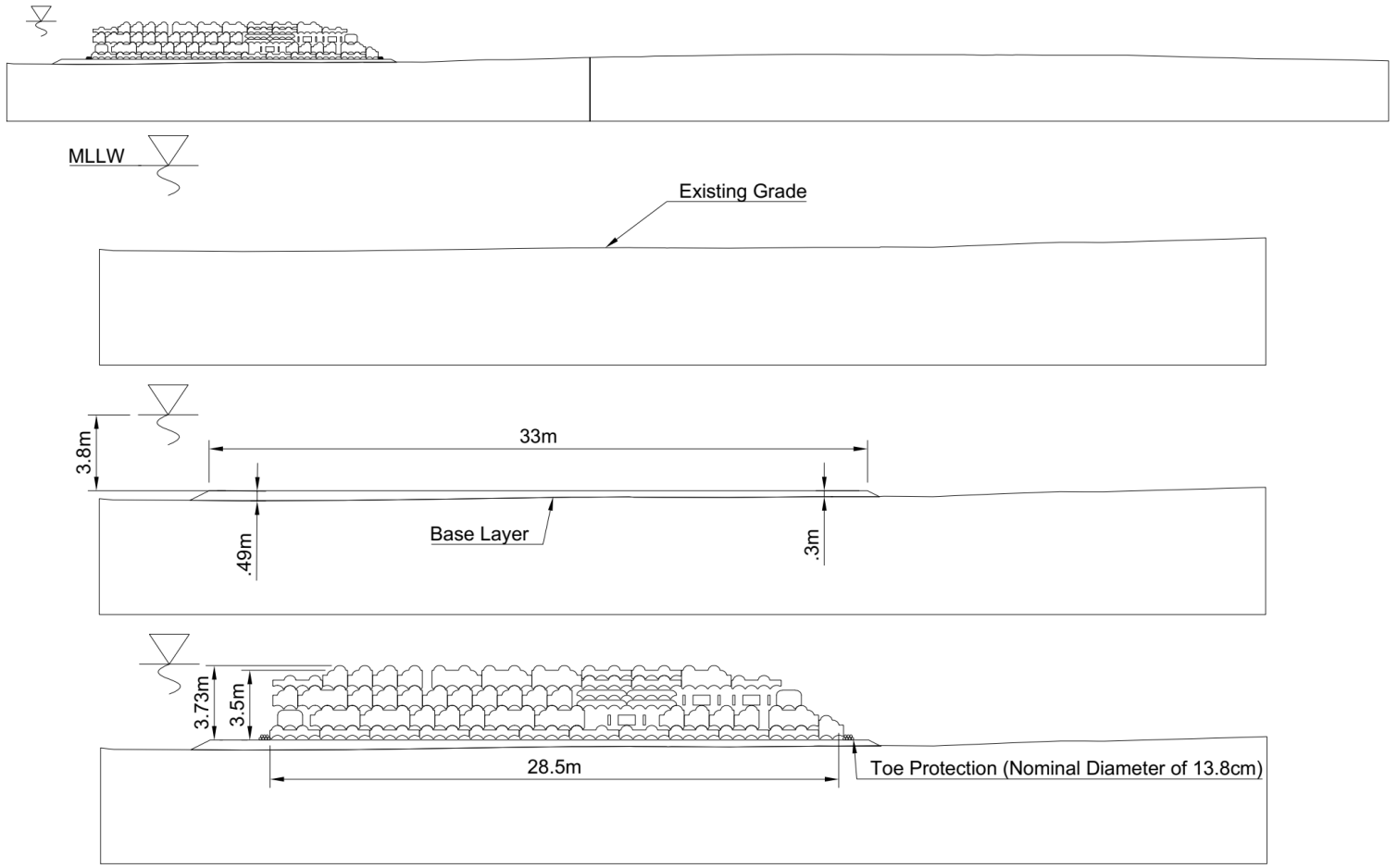
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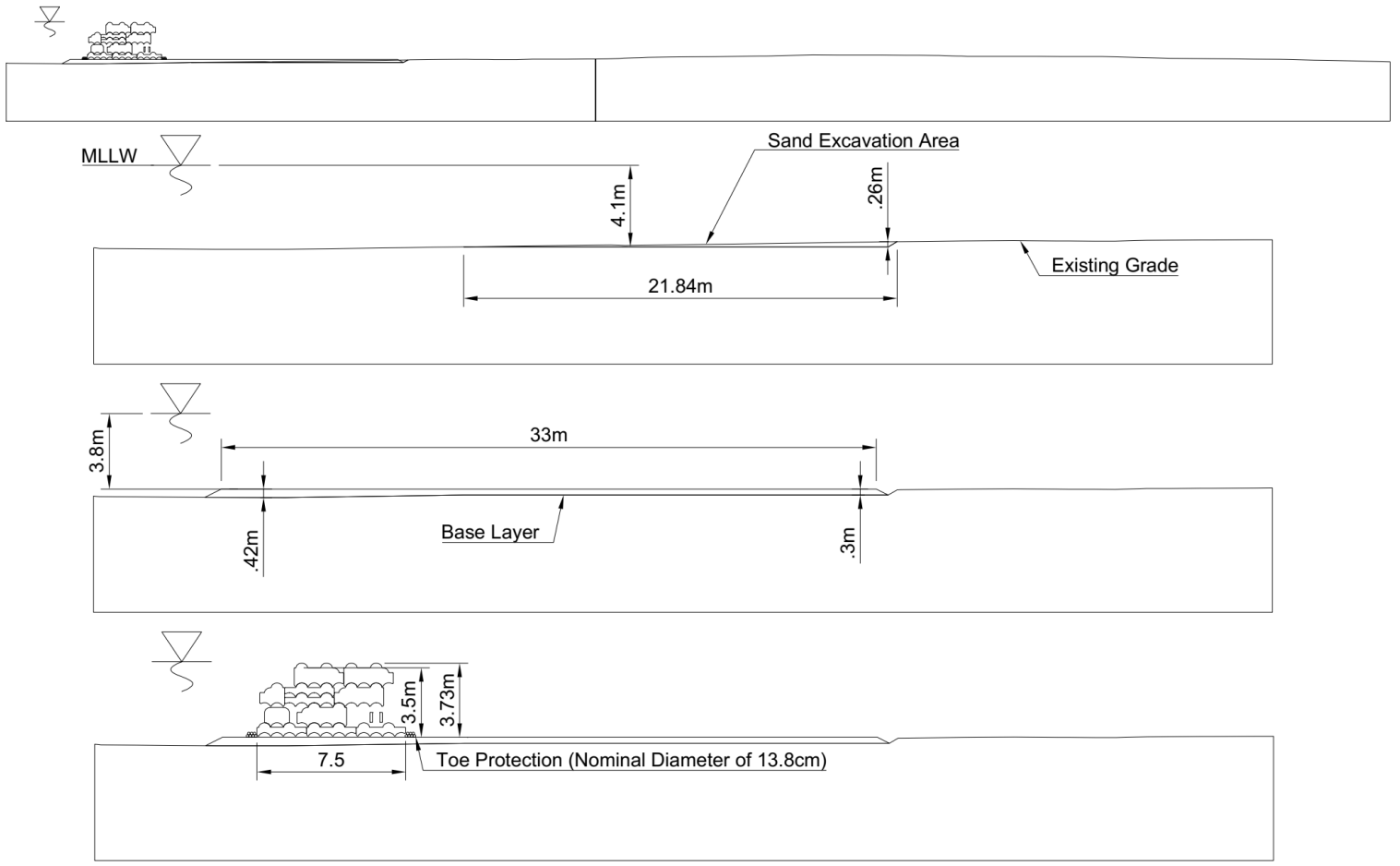
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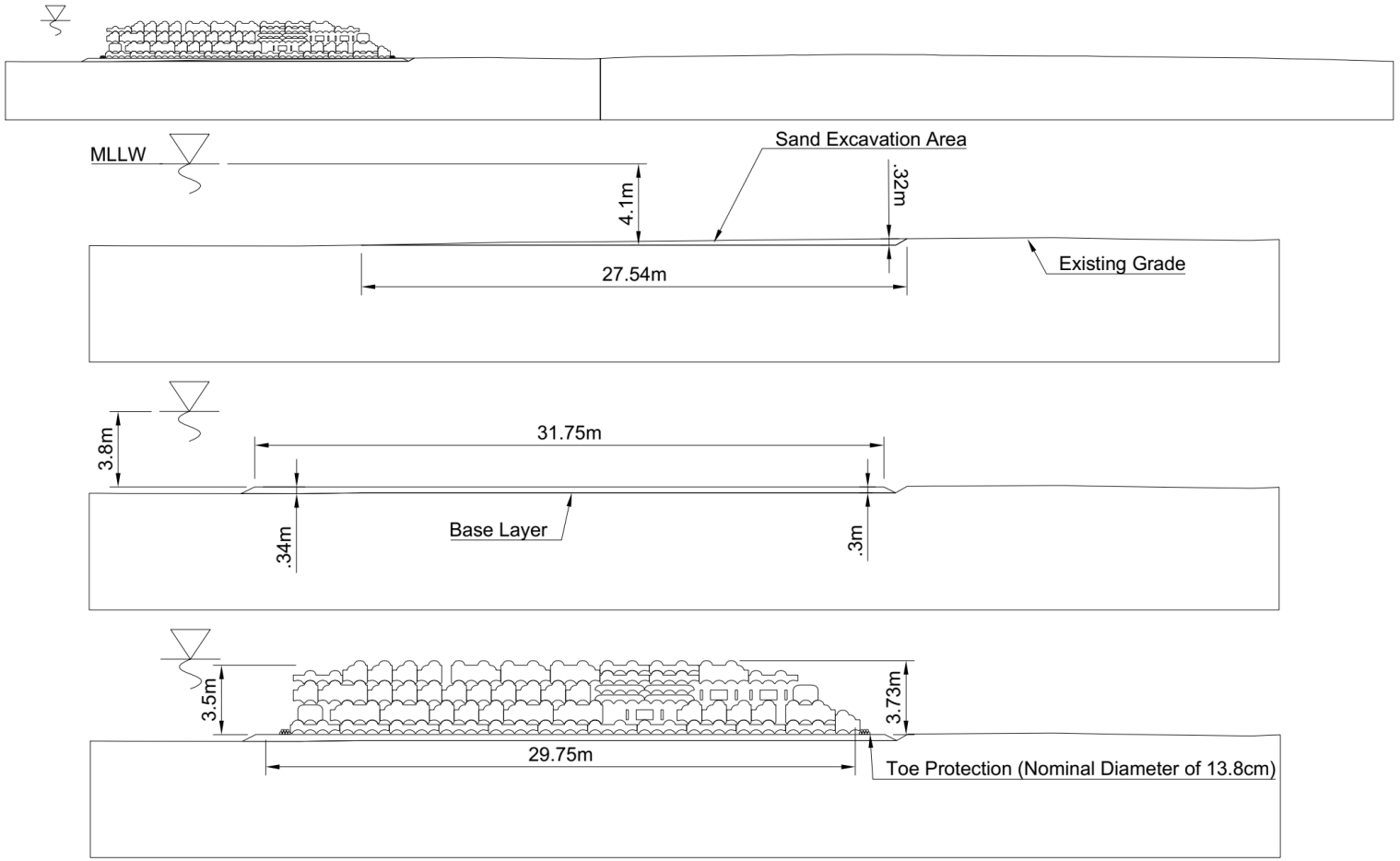
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6.00 ENVIRONMENTAL SETTING AND PROBABLE PROJECT MODIFICATIONS

6.01 Climate and Weather

Prevailing Winds

The Virgin Islands lie in the "Easterlies" or "Trade Winds" that traverse the southern part of the "Bermuda High" pressure area, thus the predominant winds are usually from the east-northeast and east, which created the reliable winds that allowed sailing ships to travel to the new world. These trade winds vary seasonally and are broadly divided into 4 seasonal modes: 1) December to February; 2) March to May; 3) June to August; and 4) September to November.

December - February

During the winter, the trade winds reach a maximum and blow with great regularity from the northeast. Wind speeds range from eleven to twenty-one knots about sixty percent of the time in January. This is a period when the Bermuda High is intensified with only nominal compensation pressure changes in the Equatorial Trough. “Northerners” or “Christmas Winds”, which blow more than twenty knots from a northerly direction in gusts from one to three days, interrupts the trade winds during this period. Such outbreaks average about thirty each year. They are created by strengthening of high-pressure cells over the North American continent, which, in turn, allows weak cold fronts to move southeastward over the entire Caribbean region. These storms are accompanied by intermittent rains and by clouds and low visibility for mariners.

March - May

During the spring, the trade winds are reduced in speed and blow mainly from the east. Winds exceed twenty knots only thirteen percent of the time in April. The change in speed and direction is the result of a decrease of the Equatorial Trough.

June - August

Trade winds reach a secondary maximum during this period and blow predominantly from the east to east-southeast. Speeds exceed twenty knots twenty-three percent of the time during July. The trend for increasing winds results from the strengthening of the Bermuda High and a concurrent lowering of the pressure in the Equatorial Trough. Trade winds during this period are interrupted by occasional hurricanes.

September - November

During the fall, winds blow mainly from the east or southeast and speeds reach an annual minimum. Only seven percent of the winds exceed twenty knots in October. The low speeds result from a decrease in the Equatorial Trough. During this period, especially during late August through mid-October, the normal trade wind regime is often broken down by easterly waves, tropical storms and hurricanes.

Storm and Hurricanes

There are numerous disturbances during the year, especially squalls and thunderstorms. These occur most frequently during the late summer and early fall, lasting only a few hours and causing no pronounced change in the trade winds.

Tropical cyclones whose winds exceed 74 miles per hour are termed hurricanes in the northern hemisphere and have significant impacts on the area. These hurricanes occur most frequently between August and mid-October with their peak activity occurring in September. The annual probability of a cyclone is one in sixteen years.

Climate

The climate is maritime tropical and is characterized by generally fair weather, steady winds, and slight but regular annual, seasonal, and diurnal ranges in temperature. Rain-producing weather systems generally move into the Virgin Islands from the east in summer and from the northwest in winter.

Major rainfall events are associated with weather systems that enhance the uplift of moist air in the region. Orographic lifting of moist air over hilly terrain is the most common cause of rainfall in the Virgin Islands. The amount of rainfall increases with increasing elevation. The total annual rainfall differs substantially at various locations throughout the island. In St. Croix the total annual rainfall is more than 50 inches in the northwestern part of the island, about 25 to 35 inches on the southwestern coast, about 40 to 50 inches on the south-central coast, and about 20 to 30 inches in the eastern part of the island. Leeward aspects receive greater amounts of rain because clouds develop over the slopes on a daily basis. In general, days have a higher incidence of rainfall than nights. The Virgin Island's wettest period generally is from September to November, and the driest period is from January to June. Occasionally, intense rainfall occurs during the drier period.

The absence of strong trade winds allows Sahara dust to linger in the atmosphere during the wet seasons (Xsitaaz 2014).

The difference between the mean temperatures of the coolest and warmest month is only 7 degrees F. The highest temperatures occur between August and October and the lowest are in January or February. The highest average daytime temperature in the warmest months is about 88 degrees F, and in the coolest months it is in the low 80's. Nighttime lows are usually in the mid 70's during the warmer months and in the high 60's during the cooler months. In general, air temperature in the Virgin Islands ranges between 75 degrees and 88 degrees.

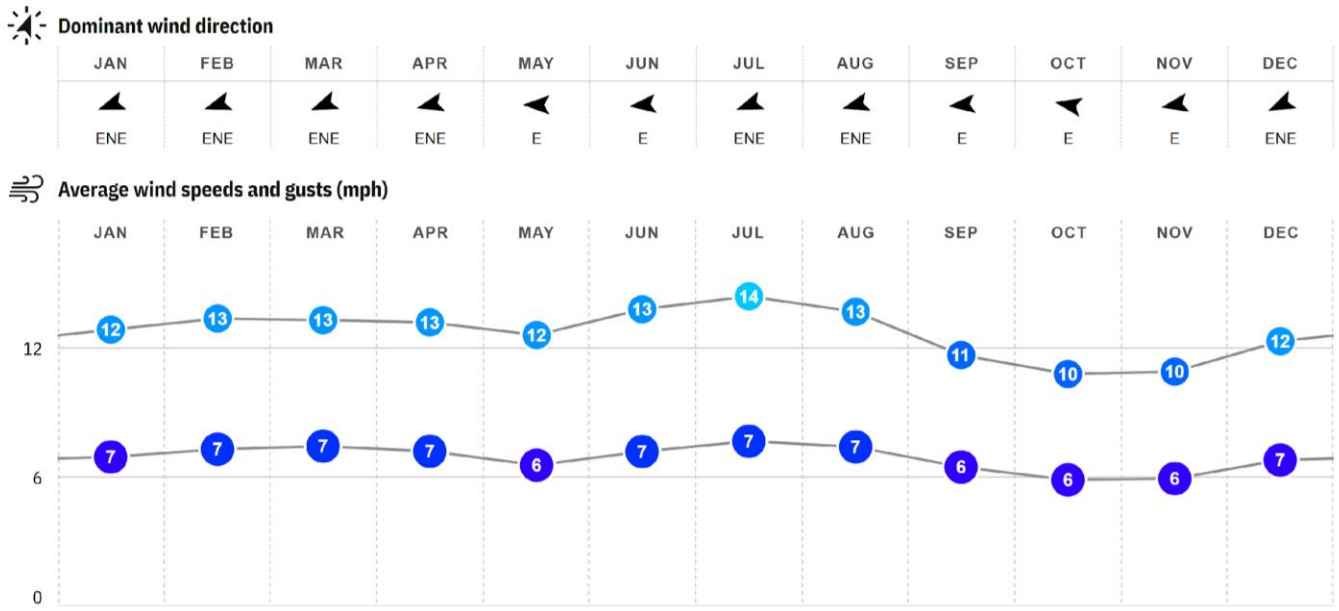


Figure 9. Monthly wind speed statistics and direction for Christiansted Harbor (https://www.windfinder.com/windstatistics/christiansted_harbor)

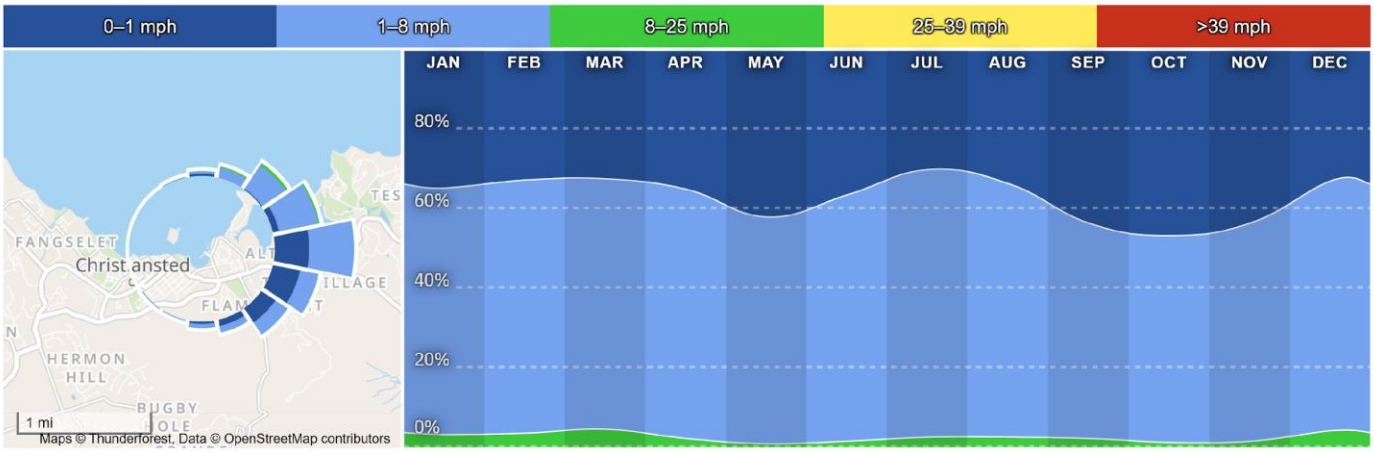


Figure 10 Monthly wind direction and strength distribution. (https://www.windfinder.com/windstatistics/christiansted_harbor)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Highest measured temperature (°F)	88	88	93	99	99	99	93	93	99	99	93	90
Average daytime temperature (°F)	80	80	81	82	85	86	85	86	86	86	83	81
Average nighttime temperature (°F)	77	77	77	78	81	82	82	82	82	82	80	78
Lowest measured temperature (°F)	66	70	70	70	72	73	72	72	72	73	32	70

Figure 11. Temperature statistics for Christiansted Harbor. . (https://www.windfinder.com/windstatistics/christiansted_harbor)

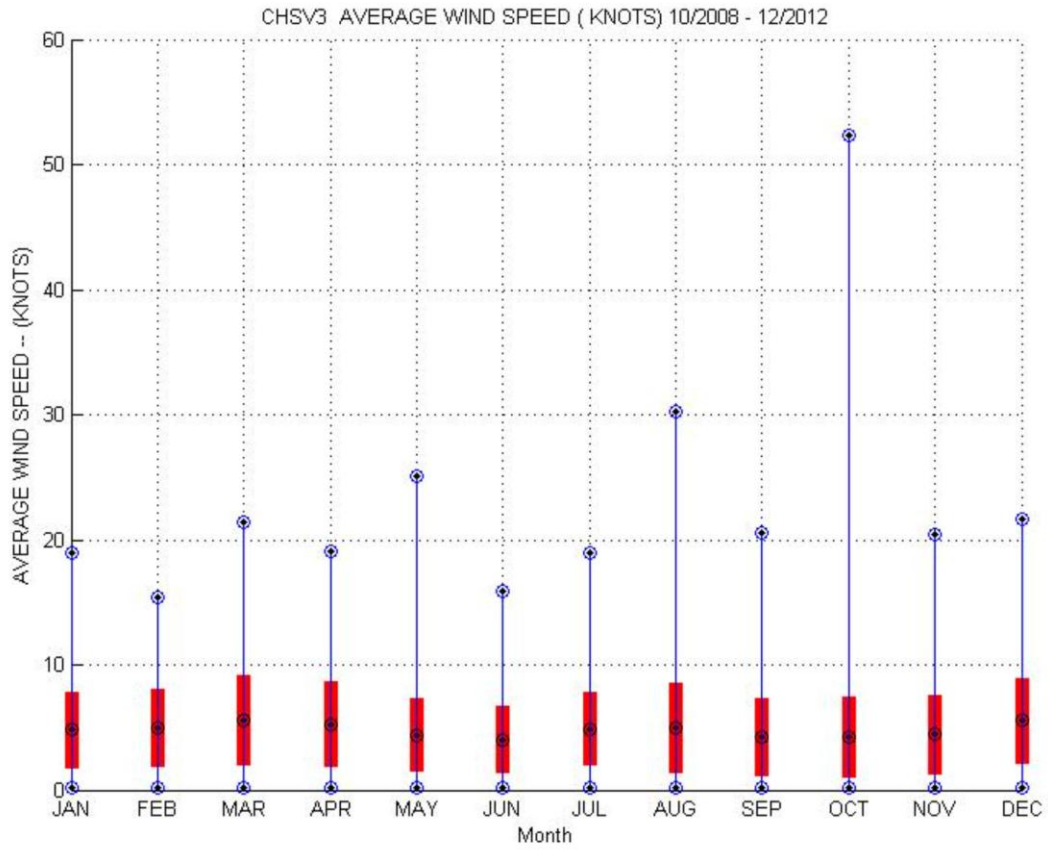


Figure 12. Station CHSV3 - Climatic Summary Plots for wind speed Mean and Standard Deviation Plot.

(https://www.ndbc.noaa.gov/view_climplot.php?station=chsv3&meas=ws)

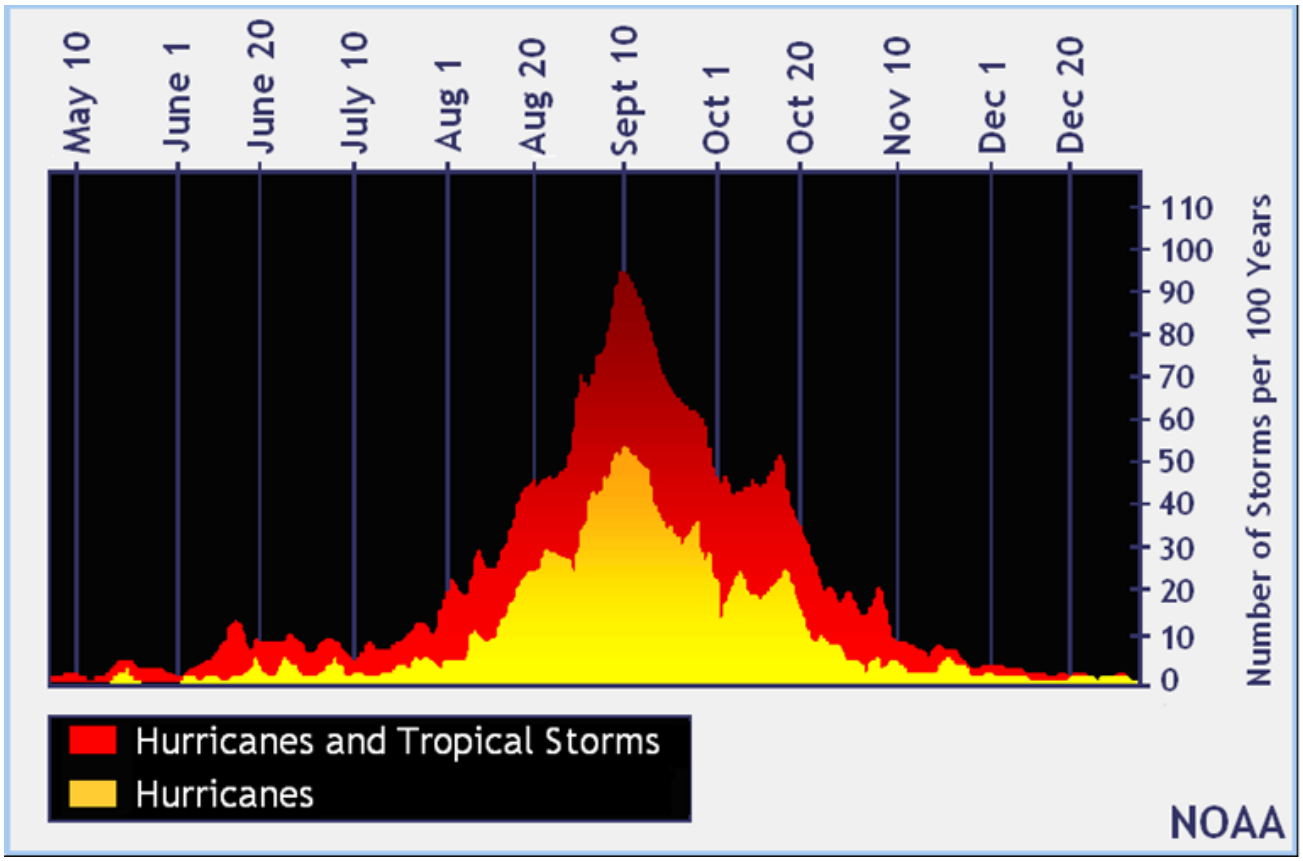


Figure 13. Tropical Storm and Hurricane Occurrences in the Atlantic (National Weather Service)

6.02 Landforms, Geology, Soils, and Historic Use

GEOLOGY OF ST. CROIX

The Virgin Islands are near the northeastern corner of the present Caribbean Plate, a relatively small trapezoidal-shaped plate which is moving eastward relative to the North and South American continents carried on the American plate. The arc of the Lesser Antilles is an active volcanic arc above a subduction zone in which the Atlantic oceanic crust of the American Plate is carried downward under the Caribbean Plate. The closest volcano to the Virgin Islands, which is still active, is Saba, about 160 km to the east.

The island of St. Croix consists geologically of two predominant mountainous areas (the North side and the East End ranges), with a central sediment filled valley in between. The oldest rock underlying both ranges, and probably in the valley as well, is from the Cretaceous period, 80 million years ago. These sedimentary rocks which were formed from the erosion of volcanic ash and debris, and are

beset with igneous intrusions, underwent a period of orogeny lifting them up from the ocean floor and forming two islands with a channel in between. Oligocene clay and mud were deposited in this channel forming what is known as the Jealousy formation. Next, tertiary limestone was deposited when this channel area became a lagoon encircled by coral reef. The limestone and marls that overlay the Jealousy formation are known as the Kingshill formation. After these formations were deposited, the area underwent another period of uplifting, the two islands became connected by the newly emergent filled-in area, and the island of St. Croix was formed. Since that time, geologic activity has been limited primarily to the erosion of sediments and the formation of ponds, beaches, reefs, and beach rock coast.

Two large basins, the Virgin Islands Basin and the St. Croix Basin, separate St. Croix from the other Virgin Islands. Within the distance between St. Croix and St. Thomas, about 40 nautical miles, hydrographic charts show that the ascent from the sea floor north of St. Croix is as much as a 70º. Frasetto and Northrop (1957) indicate that this northern topographic slope extends downward to the Virgin Islands Basin at a gradient up to 43º. There is an ascent of 13,656 feet within a horizontal distance of 25,800 feet, terminating with the steep north coast in the vicinity of Hams Bluff. The area has been described as the south side of the Anegada Trough and its related fault scarp (Taber 1922). Meyerhoff (1927) suggested that this block faulting took place during the late Pliocene or early Pleistocene, prior to which St. Croix was physically attached to the northern Virgin Islands. The southern and eastern portions of the St. Croix Platform, differing greatly from the northern and western regions, have a gradient of much less amplitude and therefore a wider shelf area.

GEOLOGY OF THE PROPOSED REEF SITE

The ReefStarter structure is proposed to be in a wide sandy plain which extends more than 914.4m (3000 ft.) offshore to a steep drop off. The sand plain becomes as shallow as 3.048m (10 ft.) in some areas near the drop off. There is reef and exposed rock at the edge of the drop off to the north and east of the proposed reef. The depth of the upper edge of the drop off is approximately 9.14m (30ft.) The drop off is nearly vertical.

The seafloor of the Virgin Islands Basin is more than 3700 m (12,139.11ft) before ascending the basin's southern margin to the narrow shelf of St. Croix. The channeled and irregular walls of the basin are steep, exceeding 25° on the southern side. At approximately 50m (164.04ft) much of the shelf ledge is sharp protruding rock. The shelf slopes more gently to approximately 30ft, and the area is a series of grottos with sand channels.

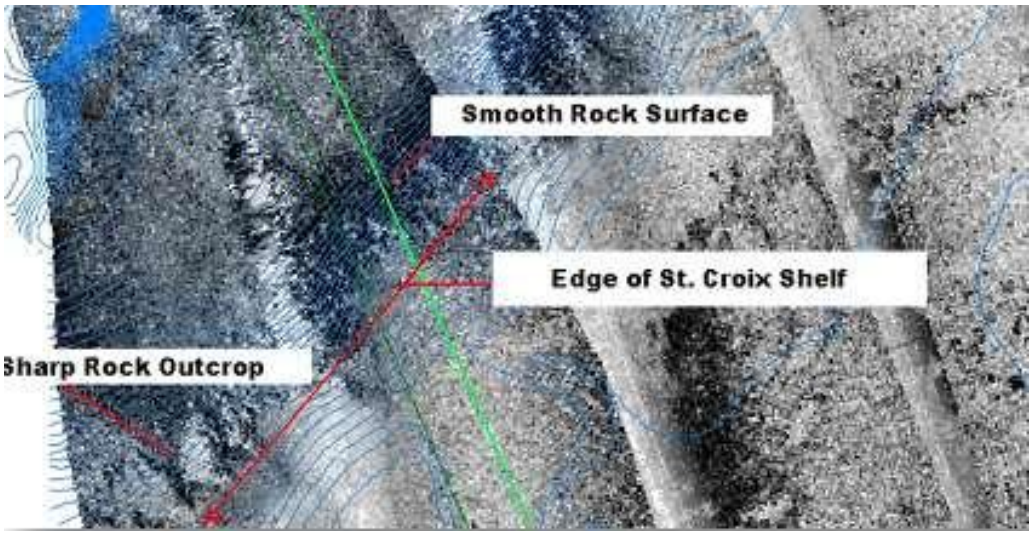


Figure 14. Side scan data of St. Croix Shelf Edge encompassing project site.

ADVERSE SITE CONDITIONS

The shoreline areas adjacent to the proposed reef sites are in Christiansted Harbor is in Zone VE13, areas of the coastal flood zone with velocity hazards (wave action), which have been determined to be 13 ft. (3.9624m) (Flood Insurance Rate Map, Panel 24 of 94, revised April 16, 2007).

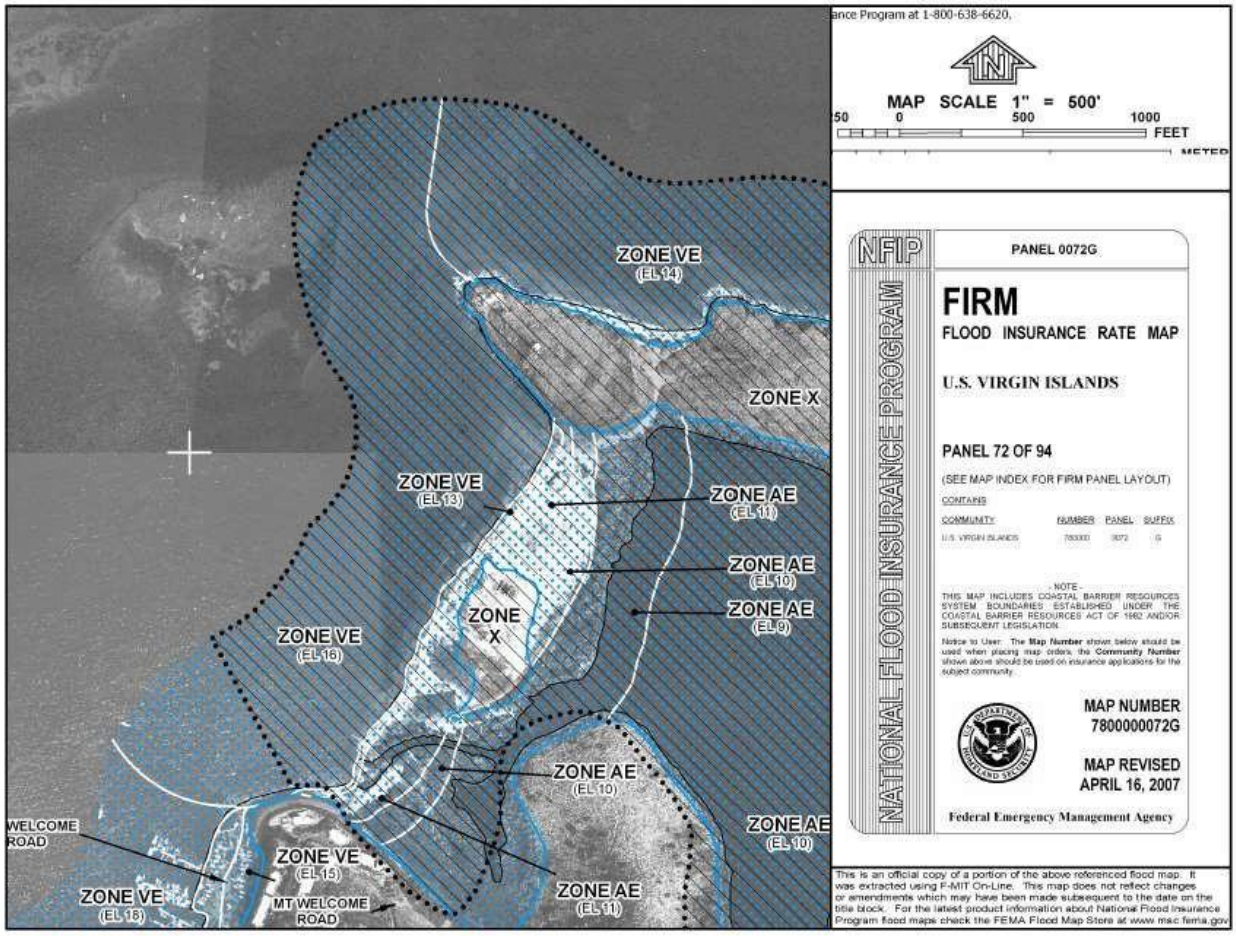


Figure 15. FEMA FIRM Map

Puerto Rico and U.S. Virgin Islands lie in one of the most earthquake prone areas of the world, and are susceptible to ground shaking, earthquake-induced ground failures, surface fault ruptures and tsunamis (tidal waves) (Hays, 1984). The activity is mostly associated with large-scale tectonic activity or faulting, originating in the Anegada Trough to the northeast of the islands.

The trough and its related scarp apparently were thrown up by block faulting during the late Pliocene or early Pleistocene. It is oriented generally northeast to southwest, separating St. Croix from Puerto Rico and the other Virgin Islands. Based on shallow focus earthquakes, the Anegada Fault Trough is estimated to be more than 400 miles in length. There are indications that strike slip movement is occurring, with St. Croix shifting northeast relative to Puerto Rico (Puerto Rico Water Authority 1970).

The year 2025 marks the 158th anniversary of the last major earthquake in the Virgin Islands. This quake, which occurred on November 18, 1867, had an identified intensity of VIII on the Modified Mercalli Scale. Earthquakes of this magnitude have generally been associated with epicentral ground accelerations of between 0.05 and 0.35 gravities. Since the 1867 quake, there has been continuous low intensity activity, all below 6.0 Mercalli Scale. The last destructive shock in Puerto Rico was in 1918 (7.5 Mercalli Scale), did not occur along the main seismic zone, but rather on an intraplate fault near Mona Canyon off the northwest coast. A possible great earthquake in 1787 (8 to 8.25 Mercalli

Scale) appears to have occurred along the main seismic zone near the Puerto Rico Trench to the north of the island, but data for the event are scarce. Thousands of tiny earthquakes are encountered every year in the islands. This activity is associated with the volcanic eruptions that have been occurring to the southeast on the island of Montserrat.

SOILS

The reef site has moderate to coarse calcium carbonate sand. There are scattered coral fragments and an occasional coral boulder. Probes were made up to 12" and no underlying rock was encountered in the proposed footprint.

IMPACT OF DEVELOPMENT

The proposed project is the placement of a hard substrate where one currently does not exist. The reef is proposed to abate wave action and should result in some accretion of material downstream of the reef and should result in damping of wave action on the adjacent shoreline.

6.03 Drainage, Flooding and Erosion Control

6.03a Impact of Terrestrial and Shoreline Erosion

The project is set well offshore and will have no impact on terrestrial erosion. The project is proposed to help minimize shoreline erosion by damping offshore wave action.

6.03b Relationship of the Project to the Coastal Flood Plain

The shoreline inshore from the reef structure are in flood zones ranging from VE 7 to VE 17 where flooding with velocity (wave action) has been determined to be between 7 ft. (2.134m) and 17 ft. (5.1816m) during the 100-year storm event.

6.04 Fresh Water Resources

The proposed reef structure will be located offshore and therefore there is no potential for it to impact groundwater resources. The reef blocks will be built by a local contractor on St. Croix, who will use a nominal amount of water for casting the blocks.

6.05 Oceanography

6.05a Seabed Alteration

The project involves the installation of an artificial reef-breakwater. What is currently low-lying sandy flats will be engineered into rugose spur and groove reef systems. The reef structure will occupy 1250m^2 (13455ft^2 or 0.31ac)

6.05b Tides and Currents

The Virgin Islands coastal areas are not subject to significant tidal ranges or tidal currents. Due to their size, the sea flows around the islands cause an average tidal height of only a few inches and a maximum change of only a little over one foot. Only very narrow intertidal zones are found because of this lack of tidal amplitudes and the steepness of the islands rising out of the sea. Normal tidal ranges may be greatly exceeded during storm conditions, when a combination of lower barometric pressure at the ocean surface and storm winds amplifies the tidal crest.

The tides on the north coast of St. Croix's are primarily diurnal in nature. There is a slight secondary cycle (semi-diurnal), but this is almost indistinguishable and is reduced to very small ebbs and floods. The mean tides range from 0.8 ft. to 1.0 ft. and the spring tidal ranges reach up to 1.3 ft.

The Christiansted tide station has a mean Mean Range of 0.69 ft. and a Diurnal Range of 0.74 ft.

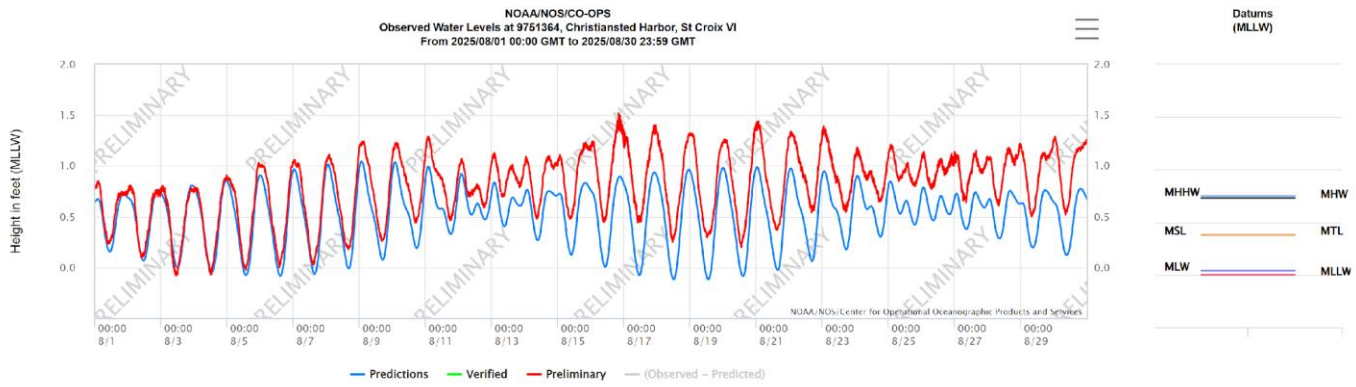
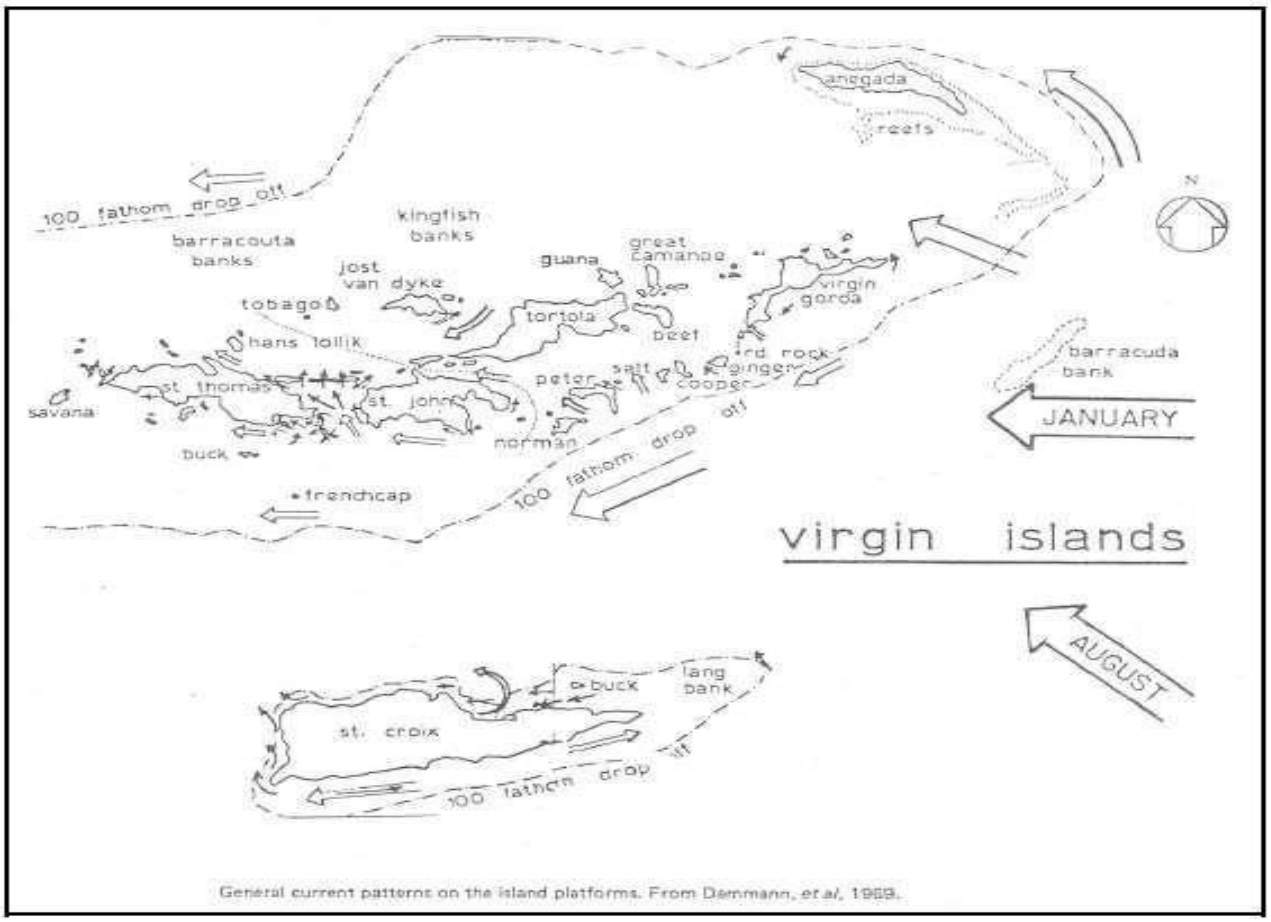


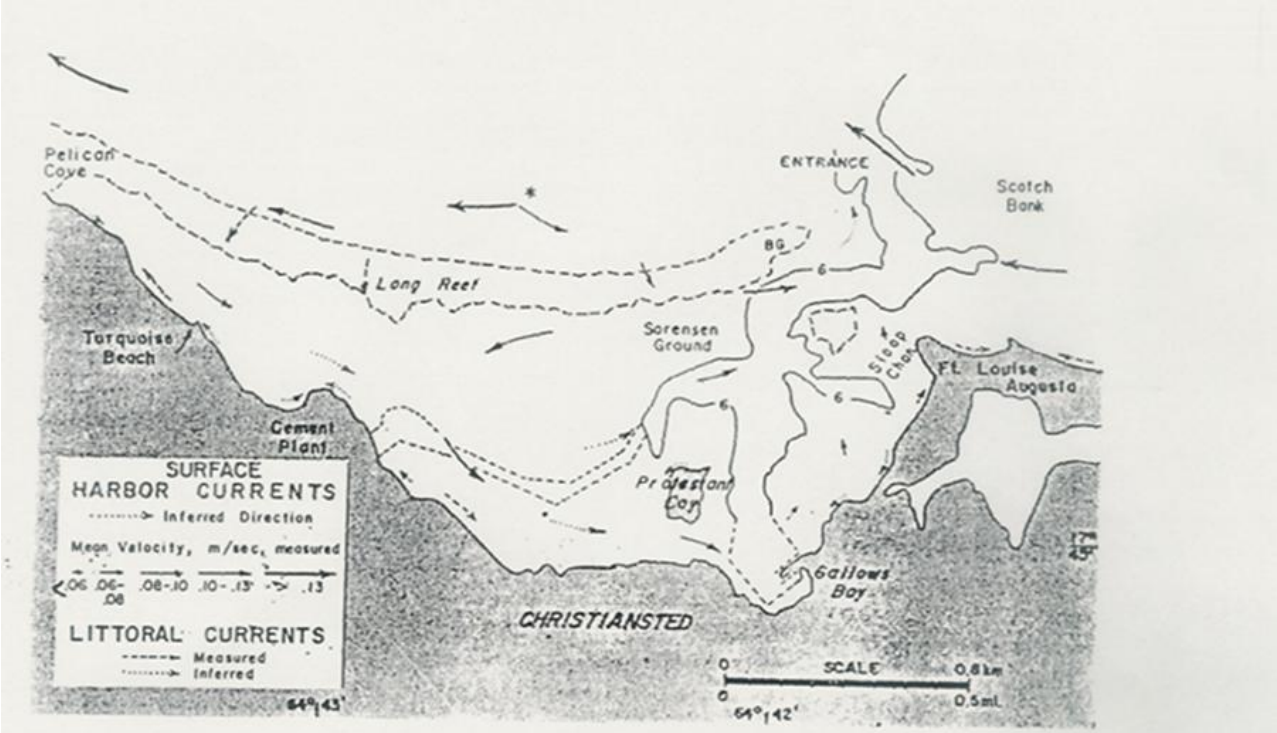
Figure 16. Tides in Christiansted Harbor in August 2025 (https://tidesandcurrents.noaa.gov/)

The surface currents throughout the Caribbean are driven by the North Equatorial Current which runs through the islands west northwest and then joins the Gulf Stream. These currents change very little from season to season with the currents originating more from the south during the summer months.



General current patterns on the island platforms. From Denmann, *et al*, 1959.

Figure 17. Currents within the Virgin Islands



Mean surface current, speed and direction for harbor currents and for littoral currents, August, 1971. Length and width of arrow indicates speed in meters per second. Harbor currents based on anchor station measurements; littoral currents on dye patch measurements. * indicates two alternating predominate directions. From Nichols, *et al*, 1972.

Figure 18. Harbor Currents from Nichols et. al 1972

The currents offshore of St. Croix average around 0.7 knots. The current movements in Christiansted Harbor have been well documented. Waves approaching from the northeast break on Long Reef and drive water into the harbor. The water mass then moves to the east and flows out of the harbor on either side of Round Reef. Out flow velocities have been measured between 5 and 18 cm/sec under normal conditions. Point Louise Augusta tends to protect the channel mouth and allows for outward flow even during periods of high wave action.

6.05c Waves

The deep-water waves off the Virgin Islands are primarily driven by the northeast trade winds, which blow most of the year and waves average from 1 to 3 ft. from the east, 42% of the time throughout the year. For 0.6% of the time, easterly waves reach 12 ft. in height. The southeasterly swells, with waves one to twelve feet high, become significant in late summer and fall when the trade winds blow from the east or when tropical storms and hurricanes pass the islands at a distance to the south. During the winter months, long length, long period, northern swells develop to a height of 1 to 5 feet. The roughest sea conditions prevail between June and August, and the second highest seas occur from December through February. September through November is the calmest period for waves

Wave Information Studies

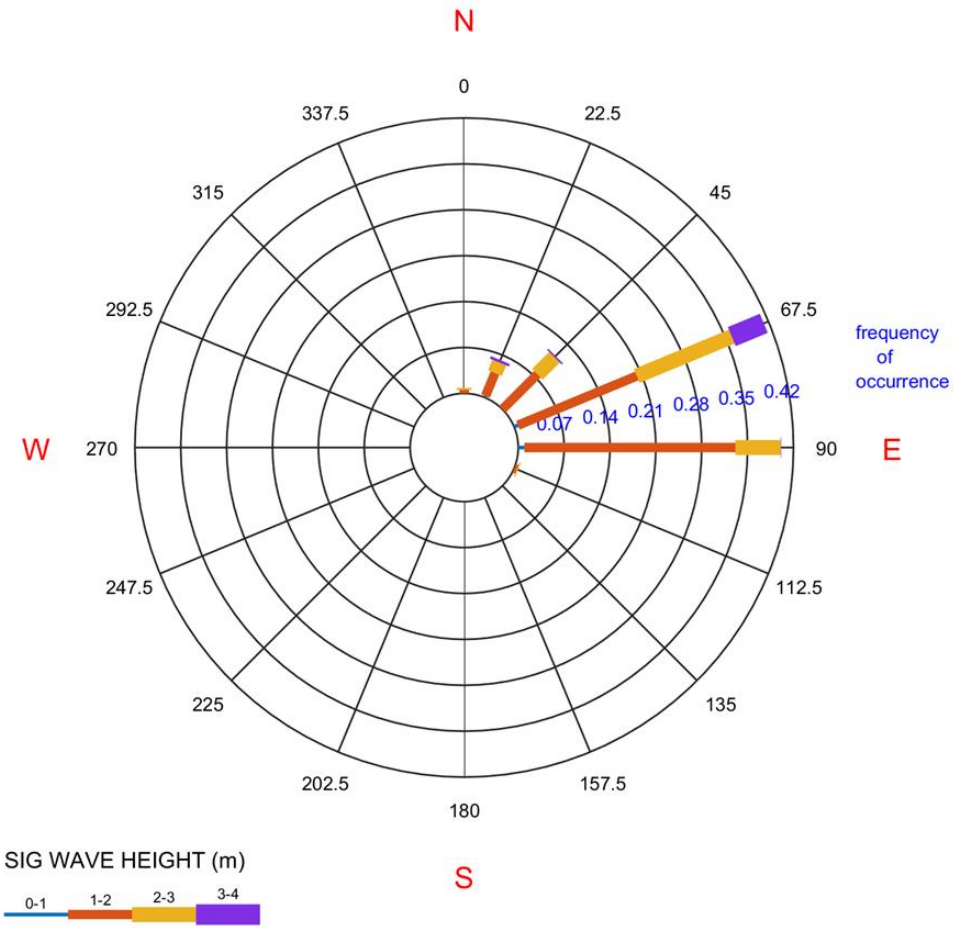
Atlantic WIS Station 61022

ANNUAL 2014

Long: -64° Lat: 18° Depth: 2730 m

Total Obs : 8756

WAVE ROSE



US Army Engineer Research & Development Center ST61022_v03

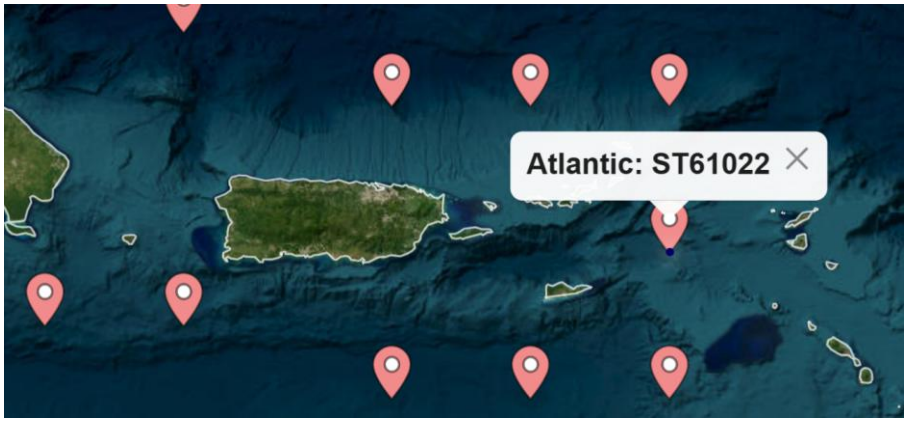


Figure 19. Data from the USACE WIS showing wave condition ST61022..

6.05d Marine Water Quality

The Virgin Islands has excellent water quality, and the proposed breakwater site is Class B waters. The regulatory limits for class B waters are as follows.

Table of Definitions of water quality classes on St. Croix.

Pollutant	Class B	Class C
Dissolved Oxygen	Not less than 5.5 mg/l from other than natural sources	Not less than 5.0 mg/l
pH	<8.3 Tolerable Limit>7.0	<8.5 Tolerable Limit>6.7
Temperature	Less than 32° Celsius	Same as Class B
Bacteria	Not to exceed 70 fecal coliforms per 100 ml by MF or MPN count. Not to exceed a geometric mean of 35 enterococci per 100 ml., not to exceed a single sample maximum of 104 per 100 ml at any time	Not to exceed 200 fecal coliforms per 100 ml by MF or MPN count. Not to exceed a geometric mean of 35 enterococci per 100 ml., not to exceed a single sample maximum of 104 per 100 ml at any time
Phosphorus	Not to exceed 50 mg/l in any coastal waters	Same as Class B
Nitrogen	Nitrogen as total N shall note exceed concentrations of 207µg/L in more than 10 percent of samples over a three- year period in estuarine, marine and coastal waters.	Same as Class B
Chlorine	4-day average concentration of Chlorine not to exceed 7.5 ug/l. The 1-hour average concentration of Chlorine not to exceed 13ug/l.	Same as Class B
Suspended, colloidal or settleable solids	None from waste water which would cause deposition or be otherwise deleterious.	Same as Class B
Oil and Floating substances	No residue attributable to waste water. No visible film; no globules f grease	Same as Class B
Radioactivity	**Gross Beta:** 1000 picocuries per liter, in the absence of Sr 90 and alpha emitters. **Radium- 226:** 3 picocuries per liter. **Strontium-90:** 10 picocuries per liter	Same as Class B

Taste and Odor	None in amounts to interfere with use for primary contact recreation, potable water supply or to render undesirable taste or odor to edible aquatic life	Same as Class B
Color and Turbidity	**A.** A secchi disc shall be visible at a minimum depth of one meter. For waters where the depth does not exceed one (1) meter, the bottom must be visible. **B.** A maximum nephelometric turbidity unit reading of three (3) shall be permissible	A Secchi disc shall be visible at a minimum depth of one (1) meter.

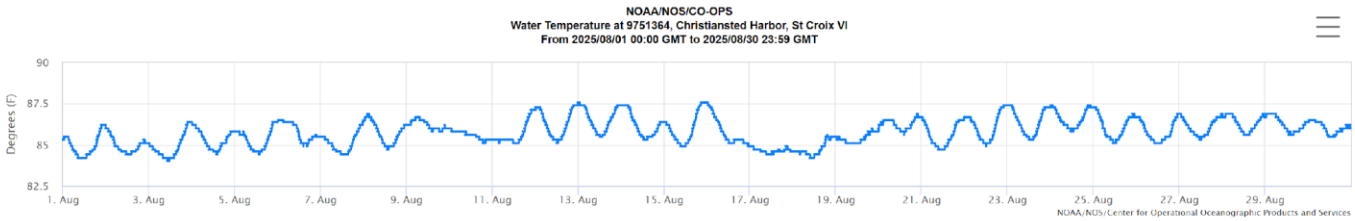


Figure 20. Water temperatures as recorded at the Christiansted Tides Station in August 2025 (https://tidesandcurrents.noaa.gov/)

The USVI's U.S. Virgin Islands Basic Water Quality Monitoring (USVI BWQM) Program takes water samples on a quarterly basis, and the two closest stations are STC 36 located offshore of Long Reef on the Western side of the Channel and STC 38 located within the Channel.



Figure 21. Location of Closest Monitoring Stations

The water quality shown in the following table shows sites with excellent water quality.

Table 1. Water Quality Data from STC 36 and STC 38

Date	Station ID	Time (hh:mm)	Total Depth (m) xx.x	Sample Depth (m) xx.x		Temp (°C) xx.xx	Salinity (ppt) xx.xx	DO (mg/L) xx.xx	pH (s.u.) xx.xx	Turbidity (NTU) xx.x	Secchi (m) xx.x
1.25.21	STC-36	11:00	3.0	Surface	0.5	26.67	35.30	6.55	8.01	0.0	3.0
				Bottom	2.5	26.66	35.30	6.58	8.01	0.0	
1.25.21	STC-38	11:08	6.2	Surface	0.5	26.19	35.34	6.28	8.02	0.2	6.2
				Bottom	5.7	26.18	35.34	6.24	8.03	0.2	
5.25.21	STC-36	11:28	11.0	Surface	0.5	27.75	34.80	8.33	8.23	0.3	11.0
				Bottom	10.5	27.75	34.79	8.37	8.23	0.5	
5.25.21	STC-38	11:37	9.0	Surface	0.5	27.92	34.81	7.37	8.24	0.7	9.0
				Bottom	8.5	27.70	34.86	7.48	8.22	0.4	
8.3.21	STC-36	11:28	7.9	Surface	0.5	28.55	35.50	6.40	8.21	0.2	7.9
				Bottom	7.4	28.57	35.46	6.37	8.21	0.3	
8.3.21	STC-38	11:37	8.6	Surface	0.5	28.59	35.78	5.60	8.16	0.5	8.6
				Bottom	8.1	28.74	35.64	5.30	8.14	0.5	
11.9.2021	STC-36	10:50	6.9	Surface	0.5	29.10	34.71	6.51	8.31	0.3	6.9
				Bottom	6.4	29.19	34.52	6.46	8.31	0.3	
11.9.21	STC-38	10:54	6.8	Surface	0.5	29.22	34.50	5.96	8.25	0.4	6.8
				Bottom	6.3	29.22	34.50	5.99	8.25	0.3	
1.23.23	STC-36	15:25	8.0	Surface	0.5	26.56	35.23	7.24	8.46	0.3	8.0
				Bottom	7.5	26.56	35.15	7.19	8.45	0.3	
1.23.23	STC-38	15:35	8.5	Surface	0.5	26.51	35.19	7.19	8.45	0.4	8.5
				Bottom	8.0	26.49	35.19	7.23	8.45	0.3	
5.8.23	STC-36	14:36	7.6	Surface	0.5	28.61	35.12	6.15	8.32	0.3	7.6
				Bottom	7.1	28.58	35.10	6.21	8.32	0.3	
5.8.23	STC-38	14:44	8.1	Surface	0.5	28.49	35.06	6.40	8.33	0.2	8.1
				Bottom	7.6	28.46	35.05	6.39	8.33	0.3	
9.4.23	STC-36	15:33	7.8	Surface	0.5	30.44	34.98	6.08	8.88	1.6	
				Bottom	7.3	30.34	34.95	6.04	8.89	1.9	
9.4.23	STC-38	15:40	8.0	Surface	0.5	30.61	34.99	6.32	8.89	1.7	
				Bottom	7.5	30.59	35.06	6.50	8.90	1.9	
11.14.23	STC-38	10:53	6.0	Surface	0.5	28.92	35.18	5.40	7.94	0.5	6.0
				Bottom	5.5	28.93	35.19	5.42	7.95	0.5	
11.14.23	STC-36	11:10	8.5	Surface	0.5	28.77	35.93	6.63	8.02	0.3	8.5
				Bottom	8.0	28.84	35.22	5.68	7.97	0.2	
2.17.25	STC-36	13:15	7.2	Surface	0.5	27.16	35.34	7.39	8.27	0.1	7.2
				Bottom	6.7	27.25	35.25	7.52	8.28	0.1	
2.17.25	STC-38	13:22	7.3	Surface	0.5	27.21	35.29	7.31	8.26	0.1	7.3
				Bottom	6.8	27.25	35.25	7.41	8.37	0.1	
5.21.25	STC-36	10:11	7.1	Surface	0.5	31.74	35.22	5.56	8.24	0.5	7.2
				Bottom	6.6	31.71	35.24	5.52	8.24	0.5	
5.21.25	STC-38	10:20	7.1	Surface	0.5	31.01	35.46	5.58	8.25	0.3	7.3
				Bottom	6.6	30.87	35.53	5.57	8.25	0.4	
7.30.25	STC-36	9:55	7.3	Surface	0.5	29.42	34.90	5.71	8.06	0.9	7.3
				Bottom	6.8	29.44	34.93	5.62	8.07	0.9	
7.30.25	STC-38	10:01	7.0	Surface	0.5	29.31	35.18	5.41	8.01	0.6	7.0
				Bottom	6.5	29.19	35.06	5.56	8.00	0.6	

IMPACT OF PROPOSED PROJECT

The placement of the reef blocks will have minimal potential impact on turbidity, each reef block will be washed prior to loading on the barge for installation to remove any fines or materials from the forming process, and the blocks will be completely cured before installation thereby limiting any fines (bleeding) which are released from the blocks. Twenty-eight days is the standard cure time and allows concrete to reach its maximum strength, and wear resistance. The time may vary depending on add mixtures. The complete curing will also limit the amount of heat released from the concrete and allows immediate colonization of the structure. The most significant heat release occurs in the first 48hours and then diminishes over time usually with 14 days, and no residual heating or release should occur after 28 days.

Concrete structures may also have a minor impact on pH; concrete is alkaline and can raise pH. Marine waters tend to equalize these effects, thus the heavy colonization of marine structures.

The seafloor within the footprint of the structures will need to be leveled prior to placement of the blocks to ensure stability and a bedding material will be placed. The leveling of the area will be done with an excavator and drag bar and this will create turbidity. Because of the nature of the activity and area over which it will be drug it will be extremely difficult to deploy turbidity barriers around the entire area especially with the sea conditions in the open water. This will be a short process, and the area should be leveled over a couple of days therefore turbidity will be short lived. The leveling will be done when seas come from the NE or E and will carry turbidity away from the nearby reefs and coral nursery.

The bedding material will be washed before placement and will be deployed within turbidity barriers which can be secured to the barge. A crane will be used to place the material, and the material will be lowered to the seafloor and spread using the drag bar. Once the material is level the placement of the blocks will ensue.

One purpose of the structure is to alter wave patterns, reducing the wave height behind the structure during large wave events. One result of breaking waves on the structure will be to create current in and around the structure. A baseline data set will be collected before placement and then data will be collected post installation to assess the success of the structures in dampening wave action and the impact of local currents.

6.06 Marine Resources and Habitat Assessment

6.06a Benthic Survey Methods

Benthic surveys were conducted at the proposed reef sites during April, May, June, July and September of 2025. Surveys were conducted using belt transects. The first step in the survey was to identify large open sandy areas which would result in minimal impact when the structure is built. The surrounding habitats were mapped using handheld GPS on the surface and divers on the seafloor. The chosen location avoids all reef, hard bottom and continuous seagrass beds and has sparse algal and seagrass colonization. Seagrass and algal densities within the project areas were assessed per meter square within footprints and surrounding area.

6.06b Findings

The deep basin offshore at an almost vertical slope towards St. Croix and levels off at approximately 50m (164.04ft) transitioning over a sharp protruding rock ledge. At a depth of approximately 9m (25.93ft) the shelf transitions from near vertical to a steep sand slope and then at a depth of approximately 5m (16.4ft) it becomes an almost level sand plain with some areas shallowing to a depth of less than 3m (9.8425ft.). The proposed reef site ranges from 3.26m (10.7ft) to 5.03m (16.5ft), Figures 22 & 23.

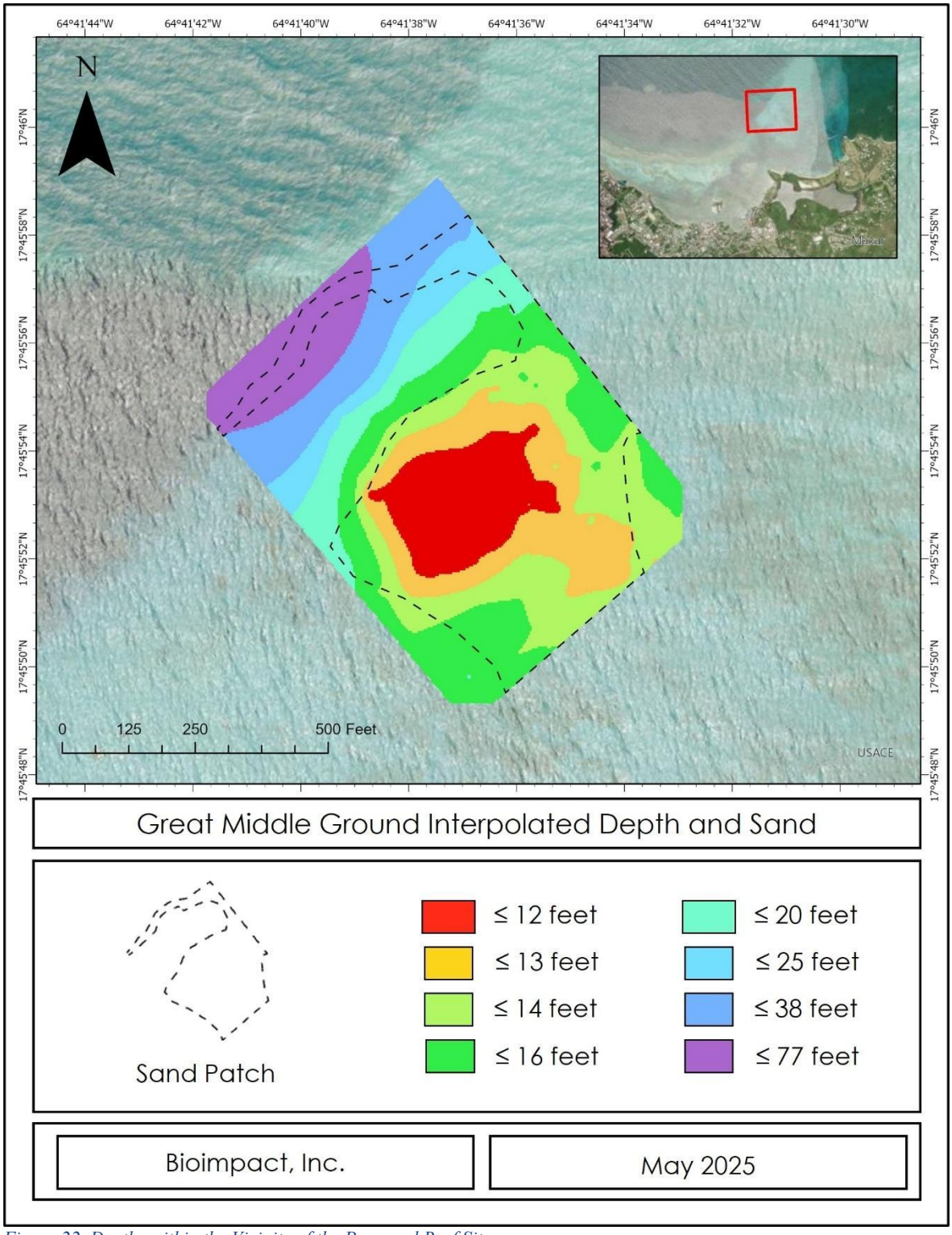


Figure 22, Depths within the Vicinity of the Proposed Reef Site

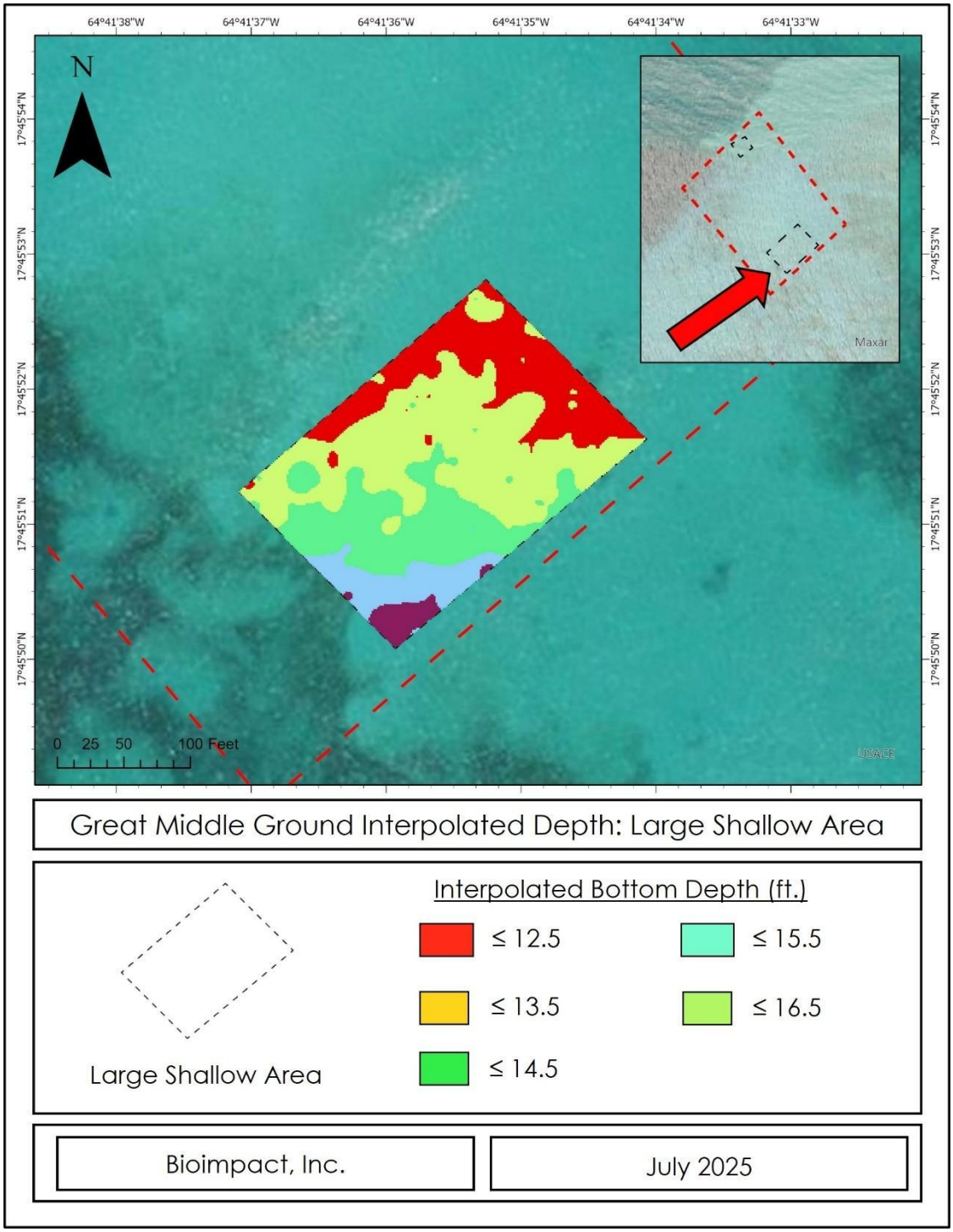


Figure 23. Depths within the reef footprint

General

The NOAA NOS Benthic Habitat map presented below shows the very narrow reef/rock area as the seafloor rises up to the shelf that transitions into a wide sandy plain.

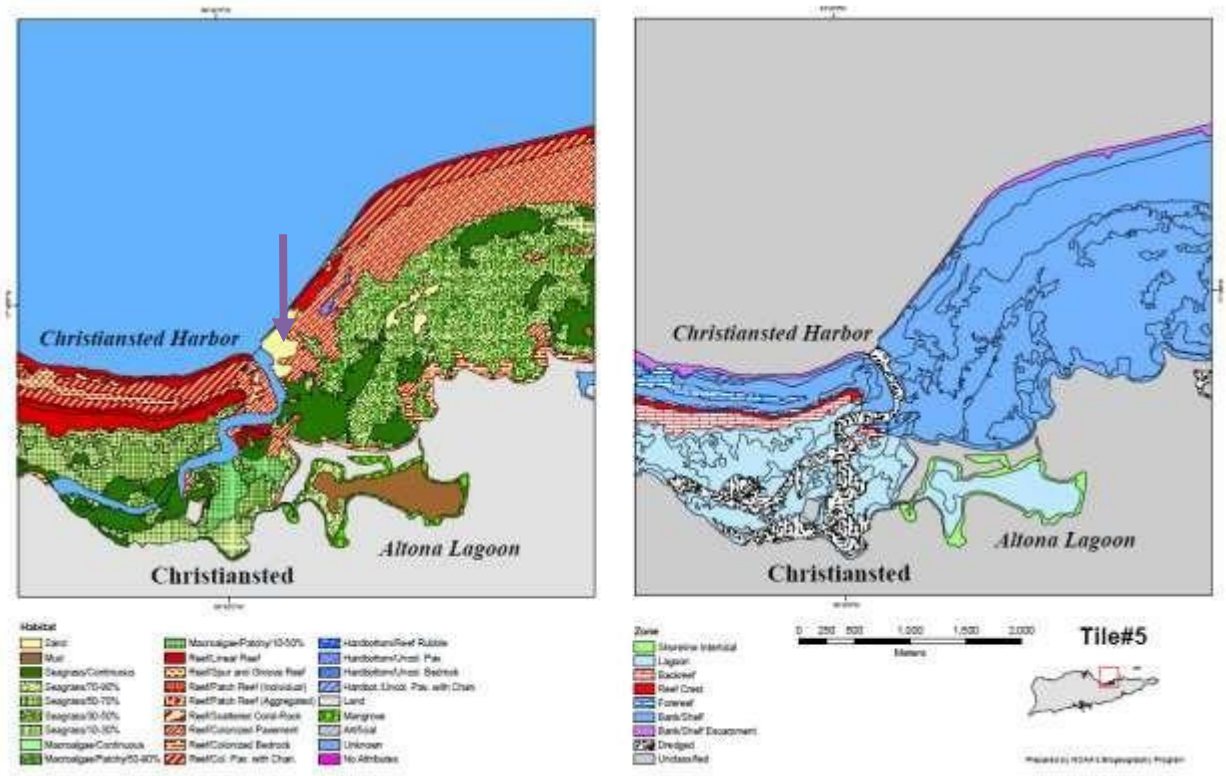


Figure 24: NOAA NOS Benthic Habitat Map for Christiansted Harbor

The shelf edge is very steep and is a vertical drop in many areas. There is an exposed rock at the shelf edge which is colonized by a variety of hard and soft corals as well as associated marine organisms. These are rock grotto formations with very steep sand slopes in between them. In some areas sand can be seen actively flowing down the slope.

Rock grottos on the shelf edge are colonized by a variety of corals and sponges, soft corals are especially abundant. Hard corals noted include: *Orbicella annularis, Montastrea cavernosa, Diploria labyrinthiformis, Agaricia fragilis, A agaricites, A. humilis, A. lamarcki, A. grahamae, Porites astreoides, Meandrina meandrites, Madracis decactis, Porites porites, Dendrogyra cylindrus*, *Montastrea franksi,* and *Siderastrea siderea*. Soft corals were primarily: *Muriceopsis, Pseudopterogorgia, Plexaura, Plexaurella* and *Pseudoplexaura. Xestospongia muta* are common as are *Agelas spp*., *Aiolochroia spp. Aplysina spp., Verongula spp., Callyspongia spp., Ircinia spp.,* and *Amphimedon spp*. There are areas where there are large accumulations of dead seagrass blades caught amid the coral grottos at the shelf edge.

Inshore, there is a very steep sand slope, which levels out at less than 6 m. This is a broad sand plain which spans close to 225m (738.189ft.) inshore. Seagrass beds begin closer to shore and the beds vary from being relatively sparse to very dense. The beds are a mixture of *Thalassia testudinum, Syringodium filiforme,* and to a lesser extent *Halodule beaudettei*. These beds are found all along the

eastern side of the Schooner Channel that leads into Christiansted Harbor. The beds have scattered large blowouts, and many of the blowouts are in the process of recolonizing. There are numerous algal species within these seagrass beds, including *Halimeda, Udotea, Dictyosphaeria, Penicillus, Caulerpa, Laurencia, Hypnea*, and *Dictyota*. Queen conch (*Aliger gigas* – now an ESA listed species), and urchins (*Tripneustes sp*.) were noted in the beds (outside the project area). In recent years *Halophila stipulacea* a invasive has become prevalent on the shelf. The following photographs provide an overview of the benthic environment on the shelf edge.



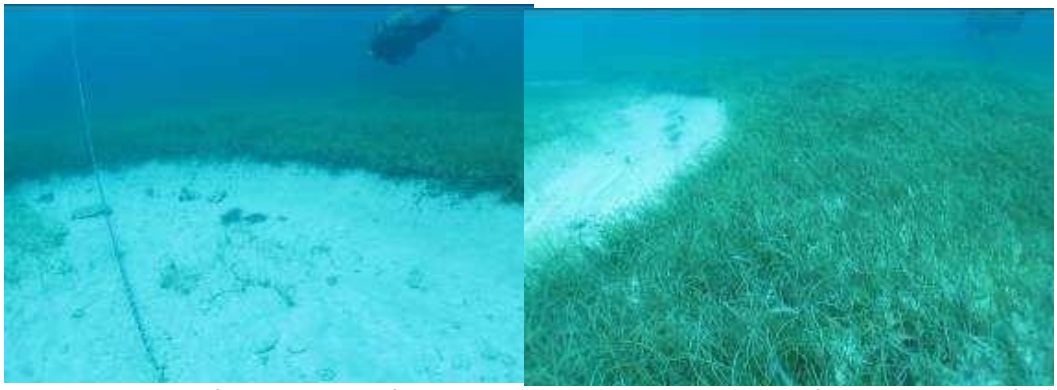
Deep reef near the shelf edge including hard and soft corals.



There are often large accumulations of dead seagrass blades on the shelf slope caught by the corals and grottos.



Scattered sponges and corals in the steep sand slope (left) and a large open grotto (right.)



Large blowouts are found in areas of dense seagrass, these blowouts are often as much as a foot deeper than the surrounding bed.

Project Footprint

The greater area was surveyed, and a large sand plain was identified as an excellent location to install the proposed structure.

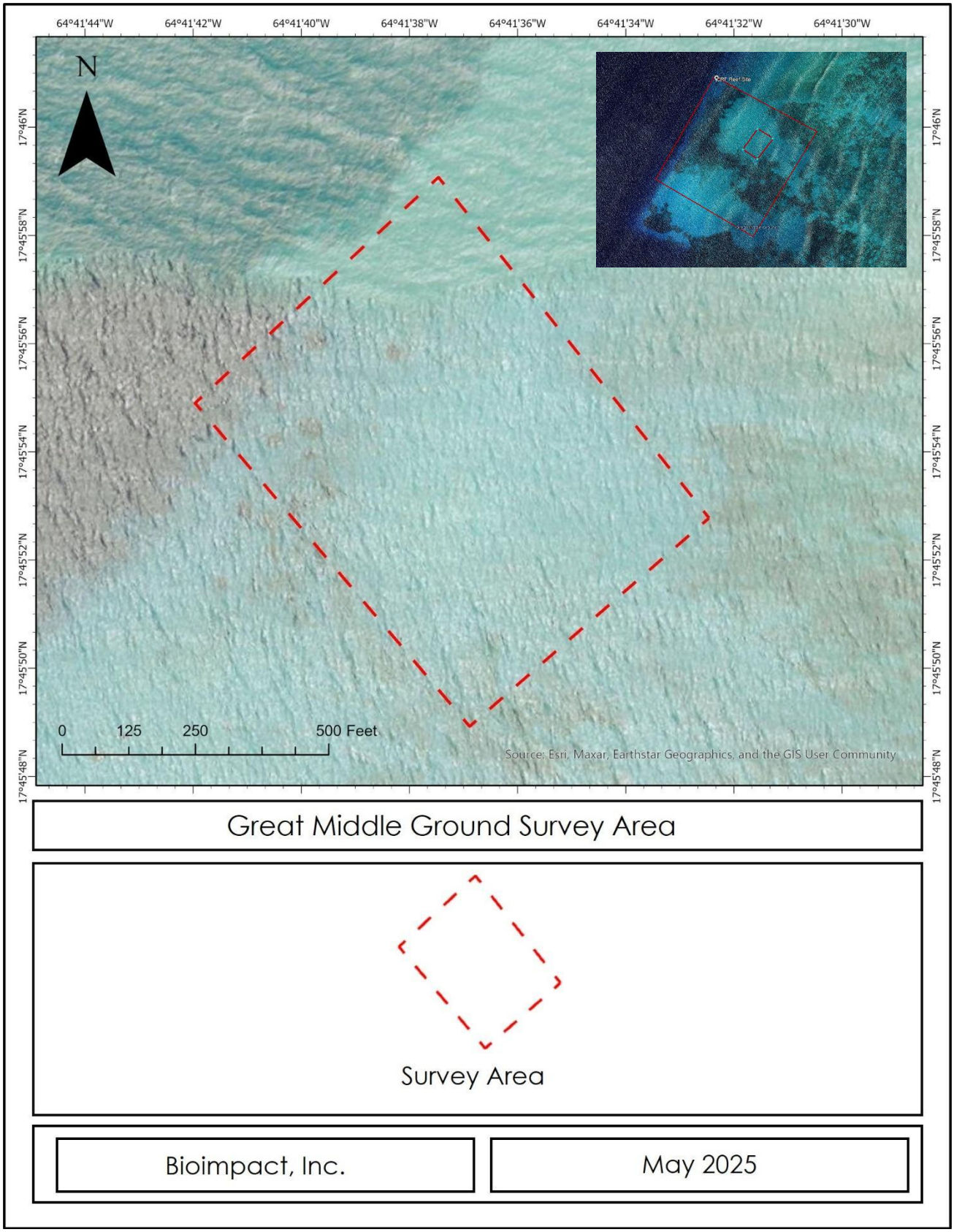


Figure 29. Location selected for the reef-breakwater placement

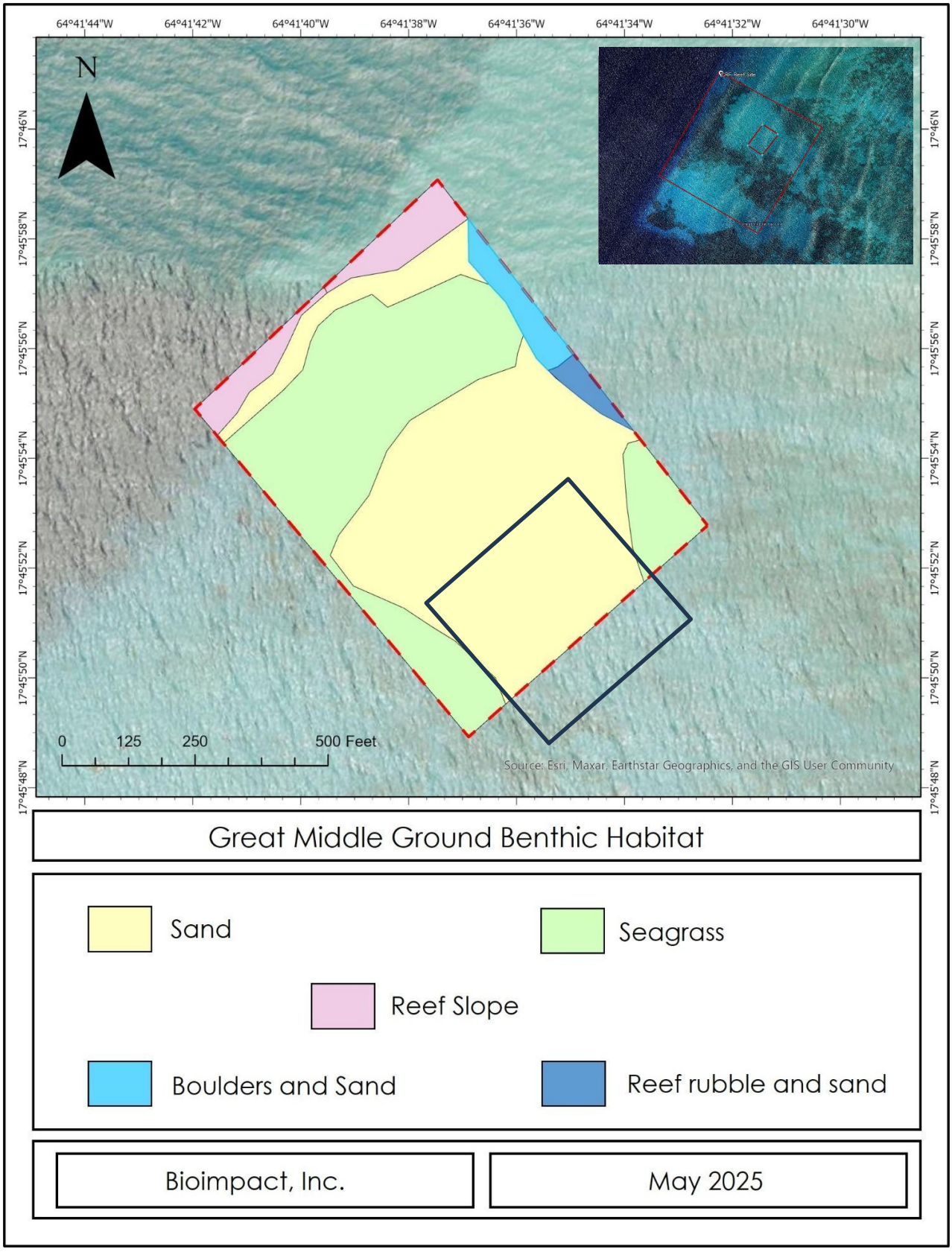
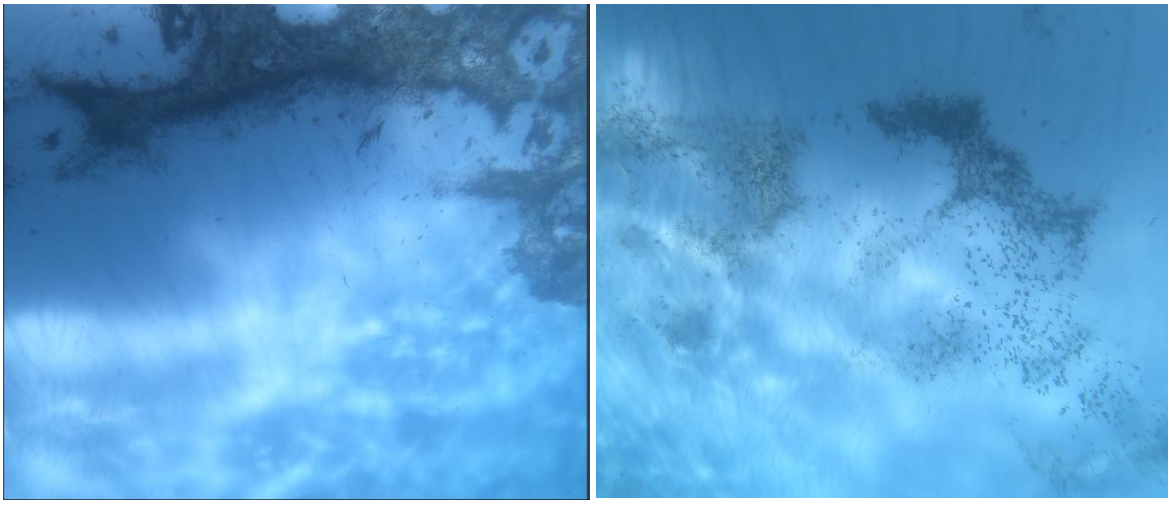


Figure 30. Benthic Habitat Map showing location selected for reef

This site has between 5-10% overall coverage of Submerge Aquatic Vegetation (SAV) and no hard bottom or coral habitat. The site is surrounded by seagrass beds that are a mix of *Thalassia testudinum* and *Syringodium filiforme* and beds composed of *Halophila stipulacea* with a few shoots of *T. testudinum*.



Halophila stipulacea makes up large areas of the SAV that surround the sand plain in which the reef will be located.



Where *T. testudinum* is adjacent to the sand plain they evidence the role their root system plays in stemming erosion, and the beds can be as much as 6" above the surrounding sand plain.

Macro algae are also present in small, scattered patches especially near the interface with the surrounding SAV beds, *Halimeda, Udotea, Penicillus, Caulerpa, Laurencia, Hypnea*, and *Dictyota* area all present, but in very limited abundance.



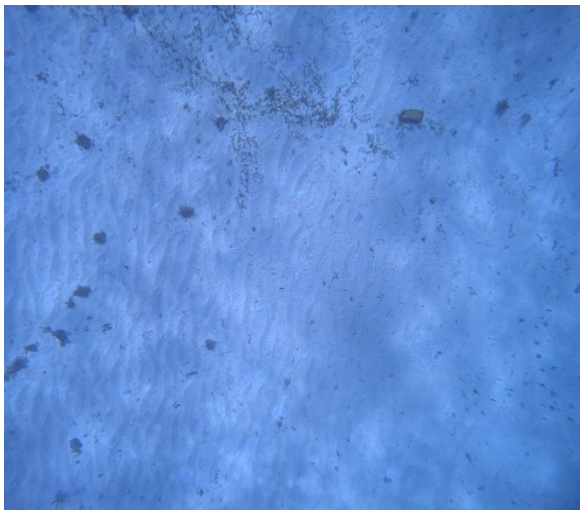
There are small patches of *H. stipulacea* in the sand plain but also *Halophila beaudettei* the native *Halophila.* Most of the H. beaudettei was found in the northern portion of the sand plain, not within the reef footprint.



Overall, within the sand plain, *H. stipulacea* makes up about 60% of the SAV present, *H. beautettei* about 15% and *Thalassia* about 10% and marco algae about 15%. But the SAV makes up only 5-10% of the proposed reef footprint.




Most of the site has 0-5% coverage

The footprint of the proposed structure has very limited colonization.

A total of 26 queen conch were seen following the current guidelines for large projects for queen conch within the project area including the 12m buffer. This includes both adults and juveniles.

IMPACT OF STRUCTURE INSTALLATION

The structure will be in an area that is minimally colonized. The nearest dense seagrass bed will be a minimum 10 m from the reef and there will be adequate area to work around the reef with the barge during placement of the reef blocks.

Divers will be assisting with all spudding and barge locations to ensure no seagrass beds are impacted.

At first consideration was given to place a reef near the coral nursery to facilitate outplanting. But because all potentially suitable locations were too close to the nursery and natural reef, it was determined that it would be better to work in a large sand plain without a potential to impact to coral

colonized hardbottoms.


CRF Coral Nursery

Divers will lay out the area to be leveled and will then do a final survey and will collect any organisms that may be in the footprint. If there are any small patches of seagrass in the footprint that appear to be transplantable, the seagrass will be collected and transplanted into a blowout in one of the surrounding beds of seagrass.

Divers will be conducting the required queen conch monitoring as works progress and will monitor the installation to ensure that all impacts are kept to a minimum. A conch survey will be done immediately prior to the start of the leveling of the site and will be repeated every day that is require for leveling the site, placing the base material and during the laying of the first layer of blocks. Divers will also survey to ensure no seagrass or other organisms including queen conch everything the barge is relocated,

The installation will impact approximately 0.015acre (650ft^2) of SAV, of which 0.009ac (390ft^2) is *H. stipulacea*, 0.002ac (90ft^2 is Macro-algae and 0.0015ac (65ft^2) is *T. testudinum* or *H. beaudettei.* Most of this is widely scattered and do not lend themselves to relocation but will be relocated if at the time of installation they have become denser or more suitable for relocating.

6.07 Terrestrial Resources

The proposed project consists of the development of an offshore reef-breakwater structure and has no terrestrial components. The project is intended to abate wave action and minimize coastal erosion, which may result in the protection of seaside vegetation.

This project is a good distance offshore, and while it is expected to result in dropping wave energy by up to 90%, due to the distance offshore and the openness of the area, coastal impact will be negligible.

6.08 Wetlands

The U.S. Army Corps of Engineers defines wetlands as "those areas that are periodically inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, bogs, marshes and similar areas." (U.S. Army Corps of Engineers, 1986).

The project is located offshore and has no upland components. No impacts on terrestrial wetland will occur.

The US Fish and Wildlife Service classifies offshore areas as deepwater wetlands. The Scotch Bank Reef site is M1UBL, as shown below. The site is a marine subtidal unconsolidated bottom.

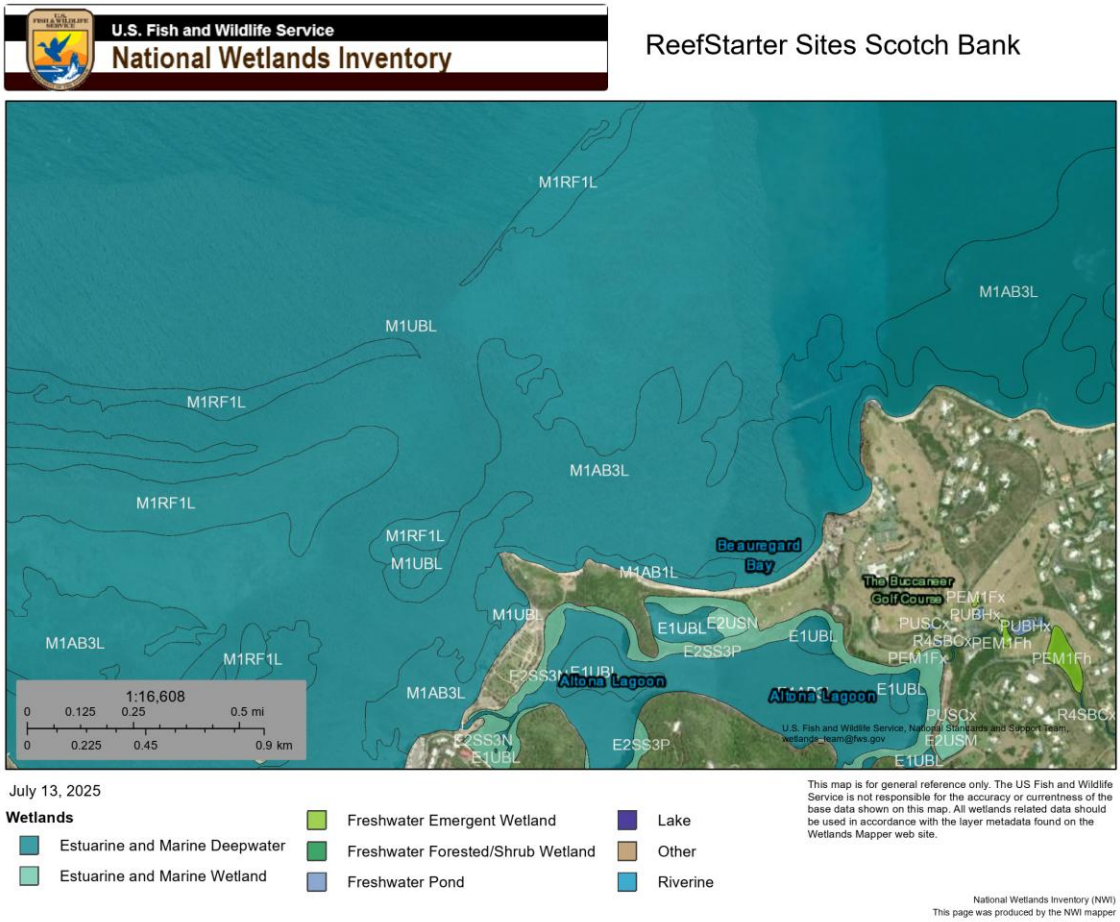


Figure 31. FWS Wetland Inventory, classification of ReefStarter Reef site

6.09 Rare and Endangered Species and Essential Fish Habitat

All four species of sea turtles that occur within the Virgin Islands are on the US Endangered Species list. These include hawksbills (*Eretmochelys imbricata*), leatherbacks (*Dermochelys coriacea*), loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*). These turtles occur and have all been seen during this and previous surveys at or near the proposed reef site. To ensure that no impact occurs to these endangered and threatened species the marine vessels used in the construction of the ramp will follow NOAA guidelines for marine vessels and will have wildlife observers during installation.

ESA-Listed corals Acropora palmata, A. cervicornis Dendrogyra cylindrus, Orbicella annularis, Orbicella faveolata, Orbicella franksi, Dichocoenia stokesii and *Mycetophyllia ferox* all occur, or historically have occurred, within and along the Christiansted Harbor and Scotch Bank reefs. However, the proposed reef site is in a large sand plain and should have no impact on these species.

Coastal waters and waters within the project area are frequented by whales *(Megaptera novaeangliae, Balaenoptera physalus*) during winter for mating and birthing and dolphins (*Tursiops truncates*) are year-round residents. Due to the shallowness of the project area whale species should not occur in the immediate project area. Dolphins have been seen in the immediate project area.

Queen conch (Aliger gigas) is listed as a threatened species and occur within the greater areas, and area present in the project area.

There are species and habitat within the vicinity that are considered Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act.

Species Managed by CFMC Occurring in the vicinity

Scientific Name	Common Name
Cnidarians	All corals
Strombus gigas	Queen conch
Panulirus argus	Spiny lobster
Epinephelus struiatus	Nassau grouper
E. guttatus	Red hind
E. fulvus	Coney
Ocyurus chrysurus	Yellowtail snapper
Lutjanus analis	Mutton snapper
L. apodus	Schoolmaster
L. gruiseus	Grey snapper
L. vivanus	Silk snapper
Chaetodon striatus	Butterflyfish
Holocentrus ascensionis	Squirrel fish
Haemulon plumieri	White grunt
Balistes vetula	Queen triggerfish
Malacanthus plumieri	Sand tilefish

Sparisoma chrysopterum	Redtail parrotfish
Lactophrys quadricornis	Trunkfish
-	Sharks and Tunas
-	Swordfish and Billfishes

The design and location of the proposed modular reef-breakwater structure has been chosen to avoid and, where avoidance is impossible, to minimize impact on environmental resources. The footprint of the modular reef has been selected to avoid all coral reefs, critical habitat and hardbottom as well as seagrass beds. There are coral reefs and exposed hardbottom to the north and there are dense *Thalassia* and *Syringodium* beds to the west, east, and south of the proposed reef-breakwater. To protect these resources monitoring will occur during all in-water work. Both water quality and environmental monitoring will be implemented throughout the installation.

ESA-Listed Coral Species

Elkhorn (*Acropora palmata*) Staghorn (*Acropora cervicornis*)

ESA-listed coral species, *Acropora palmata* and *A. cervicornis* were observed in the general vicinity in the past but are not present in the project footprint or in any area where they could be impacted by the installation. Critical habitat for these corals is defined as habitat in depths up to 98 feet with natural consolidated hard substrate or dead coral skeleton that is free from fleshy and turf macroalgae cover and sediment cover to maximize the potential for successful recruitment and population growth. The reef-breakwater structure should have No Effect on acropoid corals or there critical habitat.

Agaricia lamarcki, Dendrogyra cylindrus, Orbicella annularis, Orbicella faveolata, Orbicella franksi, Dichocoenia stokesii* and *Mycetophyllia ferox

These species all occur on the hardbottom on the edge of the shelf and along Long Reef. The proposed reef structure is within a sandy plain, well away from any hardbottom and should have no impact on these corals. The elimination of a second deep water reef, which was originally part of the project plan, was done in part to move away from hardbottom that could be potentially impacted. The proposed reef-breakwater should have No Effect on listed coral species or their critical habitat.

ESA-Listed Sea Turtles

Hawksbill (*Eretmochelys imbricata*), Leatherbacks (*Dermochelys coriacea*), *Loggerhead (Caretta caretta)* and Green turtles (*Chelonia mydas*)

All four species have been seen at some point in the last 10 years in the vicinity of the proposed reef structure. The project will implement the measures discussed on pages 16-17 of this document. The project May affect by is Not Likely to Adversely Affect the listed sea turtle species.

Queen Conch – *Aliger gigas*

ReefStarter and affiliated marine contractors will follow the Pre-construction survey protocol outlined in the most up to date "NMFS Queen Conch Survey Construction Conditions and Relocation Guidelines" and they will report the survey results prior to placing the turbidity barriers. The applicant will monitor for queen conch throughout the in-water construction following the "Projects with no turbidity curtain or floating turbidity curtains" section on page 5 of the NMFS Queen Conch Guidelines. The surveys will follow the guidelines for the initial survey and then the subsequent repeated surveys. If conch are found, they will be permanently relocated according to the protocol and all report guidelines, including the Endangered Species Take Report Form, will be undertaken.

If any other ESA-listed species is seen in any of the proposed areas of activity, work would not occur within 150 ft of that area for 20 minutes after the animal has left of its own volition. Environmental monitors would be present during project activities to ensure water quality conservation measures are implemented, and standards are maintained, and to watch for and stop working if a listed species is in the project area. Environmental monitors will regularly check the turbidity barriers for entangled or entrapped animals. To ensure that water quality is maintained, a water quality monitoring program would be implemented during leveling and block placement. This plan would monitor turbidity and the effectiveness of the sedimentation control. If any degradation of water quality is detected immediate corrective measures would be taken to abate the impact. The applicant will not conduct the leveling activity during coral and queen conch spawning season (June- October 16th).

The proposed reef-breakwater project May Affect but will Not Likely Adversely Affect the queen conch.

Marine Mammals - Whales and Dolphins

Coastal waters and waters within the project area are frequented by Humpback (*Megaptera novaeangliae*) and Finback whales *(Balaenoptera physalus)* during winter for mating and birthing, and dolphins *(Tursiops truncates)* are year-round residents and are frequently seen offshore. At present, a total of 17 species of whales and dolphins have been reported from Puerto Rican and U.S. and British Virgin Island waters (Mignucci-Giannoni 1998). There are four baleen whales (blue, fin sei, and humpback), and one toothed whale (sperm) species with occurrence in the Caribbean that are federally listed as endangered. The sperm whale *(Physeter macrocephalus)* has been reported by NOAA to inhabit the coastal shelf and oceanic waters (NOAA 2010). The site is too shallow for these species thesefore the project will have No Effect on whale species.

Sperm whales have reportedly been sighted within the vicinity of the proposed reef in the past. Dolphins (*Tursiops truncates*) were seen within the vicinity of the project site during previous surveys within the area. The project May Affect but is Not Likely to Adversely Affect dolphin species.

Essential Fish Habitat

The reefs and seagrass beds within the proposed project vicinity are all considered Essential Fish Habitat (EFH). The proposed location of the ReefStarter structure was strategically chosen to avoid direct impacts to either seagrass or reefs. However, limited amounts of seagrass can be found within the proposed project footprint. The reef installation may impact up to 90sqft of native seagrass. The loss of 90sqft of seagrass will have a negligible impact on any managed species. The creation of the reef structure will create habitat for many of the species managed by NMFS's Habitat Conservation Division.

The reef-breakwater will May Affect but will Not likely Adversely Affect essential fish habitat.

IMPACT OF REEF INSTALLATION

The reef-breakwater structure is intended to have two purposes: Abate waves and create habitat. It is probable that the ESA listed coral species being grown by CRF will be outplanted onto this structure. The structure will also create a habitat for many of the CFMC managed species and will be suitable habitat for the listed Nassau Grouper (*Epinephelus striatus*).

6.10Air Quality

All of St. Croix is designated Class II by the Environmental Protection Agency in compliance with National Ambient Air Quality Standards. In Class II air quality regions, the following air pollutants are regulated: open burning, visible air contaminants, particulate matter emissions, volatile petroleum products, sulfur compounds, and internal combustion engine exhaust (Virgin Islands Code Rules and Regulations).

The proposed reef-breakwater installation will require the use of heavy equipment during installation and therefore will result in short-term localized increases in combustion engine emissions. The air quality will return to ambient immediately following the completion of the installation. The reef-breakwater itself, once installed, will have no impact on air quality.

7.00 IMPACTS ON THE HUMAN ENVIRONMENT

7.01 Land and Water Use Plans

The proposed reef will be placed offshore to the east of the Schooner Channel. The area is near to the viNGN cable Segment 2 which runs from Altona Lagoon to Great Bay. The Route Position List (RPL) for the cable was used and at the closest point the breakwater-reef is more than 700ft to the south-southwest. The artificial reef is near CRF's coral nursery and is intended to be the recipient of some of the outplanting of corals grown at that nursery. The area is one that frequently has larger swells and is offshore of the navigation routes of most fishermen and tour boats heading for Buck Island. The artificial reef will not have a negative impact on navigation and should result in the calming of seas at the channel edge. Buoys will be placed on the reef to ensure boaters are aware of the reef's presence.

7.02 Visual Impact

The project is the development of a modular reef-breakwater, and it will be underwater and will not be visible from the island of St. Croix. The structure will be visible to boaters who come to the site and marker buoys will be deployed to ensure that no vessels with extremely deep drafts (the shallowest portion of the reef is 1ft below the surface) do not hit the reef. Over time the reefs will become colonized and will become attractive dive sites. As part of the project, moorings for boat use during monitoring and for recreational diving will be placed near the reef-breakwater.

7.03 Impact on Public Services

7.03a Water

The reef-breakwater will have no impact on public potable water.

7.03b Sewage Treatment and Disposal

The reef-breakwater will not create any sewerage and will have no impact on the public sewer system.

7.03c Roads, Traffic and Parking

The reef-breakwater will create minor traffic during the transport of the reef blocks to the port for loading on the barge, but this will be only a few large trucks a day scattered over several months.

7.03d Electricity

The reef has no electrical demand.

7.03e Schools

One of the purposes of the project is to show that the system will dampen wave and current action, provide coastal protection, and provide habitat to marine organisms, basically helping offset the loss of natural reefs. The project will actively seek community involvement, and as a part of this, CRF and ReefStarter, Inc will be reaching out to schools to talk about the project and show students the importance of coastal engineering and how it can make a difference, especially in island environments.

7.03f Fire and Police Protection

The reef-breakwater will have no impact on fire protection or police protection in the Virgin Islands.

7.03g Health

The reef-breakwater will have no impact on public health facilities in the Virgin Islands. ReefStarter will be using local contractors who are already serviced by the territory's health facilities. Visiting scientists and researchers may use health facilities for emergency care but would return to their home for long-term treatment.

7.04 Social Impacts

The project is being funded by a National Fish and Wildlife Foundation (NFWF) grant. Part of the grant includes community outreach and involvement. ReefStarter, Inc will engage with Diving with a Purpose (DWP), Underwater Adventure Seekers Foundation (UASF) and the Virgin Islands Restoration of Coral Squad (VIRoCS) to help monitor the project.

7.05 Economic Impact

The project is using local contractors, engineering firms and local concrete manufacturers and pre-casters, thereby keeping the money received from the grant in the VI territory.

7.06 Impacts on Historical and Archeological Resources

The reef site is open sand, and no archeological resources were noted in the diver surveys of the footprint.

The area was surveyed as part of the cable landing study for the viNGN cable, and no artifacts were highlighted within the area.

7.07 Recreational Use

The installation of the reef-breakwater should have no negative impact on the recreational use of the area. The site is used by some divers for recreation and/or fishing. The reef-breakwater will only occupy a small part of this wide open area and should have negligible impact on the use of the area. The placement of the proposed reef-breakwater will provide another reef to dive and/or fish on.

7.08 Waste Disposal

The reef-breakwater will not create solid waste.

7.09 Accidental Spills

The reef-breakwater does not have the potential to create spills of hazardous materials. All vessels associated with the installation will have U.S. Coast Guard approved spill contingency plans.

7.10 Potential Adverse Effects Which Cannot Be Avoided

The artificial reef-breakwater will be situated so it does not impact hardbottom or existing natural reefs and does not impact continuous seagrass beds.

The placement of the artificial reef-breakwater will result in the loss of small amounts of very sparse *Halodule beaudettei, Thalassia testudinum,* and *Halophila decipiens.* Most of the footprint is uncolonized sand, but there are some patches and runners of both the *H. beaudettei* and the *H. decipiens*. These are small runners of both grasses or small patches which represent less than 5 % of the area impacted. The rhizomes on both species are so fine and delicate that transplanting would not be successful.

The artificial reef-breakwater is being placed in large open sandy area and the presence of the reef should result in wave dampening. With this reduction in wave energy, seagrasses should spread in the area. There may be some minor scouring around the structure but this should not affect any of the nearby habitats.

8.00 MITIGATION PLANS

A monitoring plan will be implemented for the installation to minimize impact on water quality or to any benthic organism. Divers will be diving the site prior to the placement of the blocks and after the placement of the blocks to ensure that animals are not impacted or impinged.

8.01 Water Quality Monitoring

WATER QUALITY MONITORING PLAN
FOR THE INSTALLATION OF THE REEFSTARTER REEFS ON SCOTCH BANK
ST. CROIX, U.S. VIRGIN ISLANDS

INTRODUCTION

The following is the proposed monitoring program for the placement of a ReefStarter reef on Scotch Bay St. Croix. The purpose of this plan is to minimize impacts to water quality and to document any impacts that do occur because of the project. Through the monitoring proposed in this plan, impacts can be kept to a minimum by identifying water quality problems and ensuring that immediate solutions are sought.

The project involves the installation of modular reef structures, constructed of large interlocking blocks. The placement of the reef blocks will have minimal potential impact on turbidity, each reef block will be washed prior to loading on the barge for installation to remove any fines or materials from the forming process, and the blocks will be completely cured before installation thereby limiting any fines (bleeding) which are released from the blocks. Twenty-eight days is the standard cure time and allows concrete to reach its maximum strength, and wear resistance. The time may vary depending on add mixtures. The complete curing will also limit the amount of heat released from the concrete and allows immediate colonization of the structure. The most significant heat release occurs in the first 48 hours and then diminishes over time usually with 14 days, and no residual heating or release should occur after 28 days.

Concrete structures may also have a minor impact on pH; concrete is alkaline and can raise pH. Marine waters tend to equalize these effects, thus the heavy colonization of marine structures.

The seafloor within the footprint of the structures will need to be leveled prior to placement of the blocks to ensure stability and a bedding material will be placed. The leveling of the area will be done with a drag bar and this will create turbidity. Because of the nature of the activity and area over which it will be dragged it will be extremely difficult to deploy turbidity barriers around the entire area especially with the sea conditions in the open water. This will be a short process, and the area should be leveled over a couple of days therefore turbidity will be short lived. The leveling will be done when seas come from the NE or E and will carry turbidity away from the nearby reefs and coral nursery.

The bedding material will be washed before placement and will be deployed within turbidity barriers, which can be secured to the barge. A crane will be used to place the material, and the material will be lowered to the seafloor and spread using the drag bar. Once the material is level the placement of the blocks will begin.

In any marine construction project, the potential for turbidity increases. When sediments are suspended in the water column, these suspended sediments add to the turbidity of the water, decreasing its transparency. The lowering of the transparency of seawater can greatly affect sessile marine organisms that rely on the transmission of light for their existence. Settling

sediments can also smother coral colonies and marine plants and prevent larval sediment of reef organisms. Through careful planning and monitoring, such potential impacts can be minimized and abated.

WATER QUALITY MONITORING

Prior to construction, one round of water samples (parameters listed below) will be taken one week before the start of construction at each site to establish a baseline. Five samples will be taken radiating out 10 m from the center of the construction site. Two control samples will also be taken, one across the channel on the western side and one approximately 100 m along the reef edge to the east. Samples will be taken once a day during the construction activity.

Visual depth visibility readings (Secchi disk measurements) and turbidity expressed, as Nephelometric Turbidity Units (NTU) will be measured in the field both 1 meter from the surface as well as 1 meter from the seafloor. The field turbidity will be measured with a calibrated YSI Exo Sonde or an Aqua-Troll Sonde.

Once the baseline samples are collected, determinations can be made as to whether limits different than those established in Subchapter 186 Title 12 of the VI Code should be established. According to this subchapter in 186-11 Legal limits; the reef site is class B, and a secchi disk must be visible at 1 meter and turbidity maintained at less than 3 NTU.

A report of the baseline readings and suggested limits will be delivered to DPNR prior to the start of construction and a determination will be requested of the allowable limits for the installation project.

During the preparation and installation, water samples will be taken twice a day on all days when water works occur that could potentially impact water quality. The five water quality samples will be taken 10 meters from the point of “in-water activity”. These samples will be spread approximately 72 degrees apart surrounding the area of activity. Two control sites will also be sampled at the locations outside the area of influence of the activity.



Figure 1. Location of Water Quality Monitoring Stations. Blue stations are monitoring sites, green stations are controls.

Ambient control samples will be used to determine if elevated readings are the result of ambient sea conditions. Wind speed and direction, wave height and direction, and daily rainfall will be recorded each day and will be presented in the weekly reports.

During construction, if the water samples show secchi disk, or NTU's readings more than the allowable limits, DPNR, DEP, USACE, the contractor and ReefStarter will be immediately notified by email. Control samples will be used to determine whether the elevated turbidity is a result of ambient conditions. If the problem does not appear to be the result of natural phenomena, the source of the problem will be identified and, if it is a result of the construction practices, methods will be worked out to reduce the turbidity. Someone with the authority to implement changes or halt construction must always be on hand at the construction site.

In the event of any emergency or noted increase in turbidity, ReefStarter, DPNR, USACE and DEP will be immediately notified by email or phone. Weekly reports will be prepared and delivered to the agencies.

Prior to the startup of construction, the contractor must deliver a schedule for installation, including the approximate duration of the project and approximate time when the construction will start and end each day.

9.00 ALTERNATIVES TO PROPOSED ACTION

The grant was received for planning a pilot ReefStarter structure in the vicinity of the CRF nursery for the ease of outplanting the corals being grown at the site. Environmental surveys were done of the entire area covering a large swath of Scott Bay and several areas with minimal colonization were identified. Once the site was found, it was evaluated for its being suitable for the installation of the reef-breakwater and how the reef structure would need to be designed for the site. The reef-breakwater location proposed in this application is the optimal location for the development of the reef to meet the grant requirements.

10.00 Relationship Between Short Term and Long-Term Uses of Man's Environment

The reef-breakwater has been designed so that it avoids and minimizes environmental impacts. The impacts that will occur will be extremely short term and the structures will become incorporated into the marine environment. The reef-breakwater will provide a long-term benefit to Virgin Islanders, by providing coastal protection and replacing habitats which are quickly being lost due to ocean warming and worsening weather.

11.00 REFERENCES

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APPENDIX A

ReefStarter

A scalable reef habitat solution

ReefStarter is a hybrid coastal infrastructure and coral-restoration platform designed to protect shorelines while restoring marine ecosystems and driving local economic opportunity. Our modular concrete reef units are engineered to reduce wave energy, prevent beach erosion, and create ideal substrate for coral growth and biodiversity recovery. Unlike traditional hard armoring, ReefStarter installations are designed to enhance rather than displace marine habitats, supporting fisheries, tourism, and long-term ecosystem services.

For regulators and resource managers in the USVI, ReefStarter offers a scalable, science-based solution that aligns with coastal resilience mandates, coral restoration goals, and marine conservation policies. The structures can be paired with active coral outplanting, monitoring, and data collection, creating new opportunities for research partnerships and adaptive management.

Local communities stand to benefit through jobs in fabrication, deployment, monitoring, tourism services, and reef stewardship. ReefStarter projects can be locally manufactured and maintained, leveraging existing marine construction capacity while building new skills in restoration, fabrication, and blue-economy technologies. By protecting beaches, enhancing fisheries habitat, and attracting eco-tourism, ReefStarter installations help sustain the economic engines of the USVI while reducing future storm-related losses.

The result is a permitting-friendly, nature-positive alternative to breakwaters and seawalls that delivers ecological restoration, stakeholder value, and durable economic development across the territory.

Our Solution

ReefStarter mimics the structure and complex habitat of mature natural reefs across multiple scales to promote ecosystem recovery.

Inspired by nature

The size, shape, and surface properties of ReefStarter units are designed to replicate mature reefs (such as spur-and-groove formations.) This can accelerate reef recovery from decades or centuries to a matter of years.

Easy-to-install

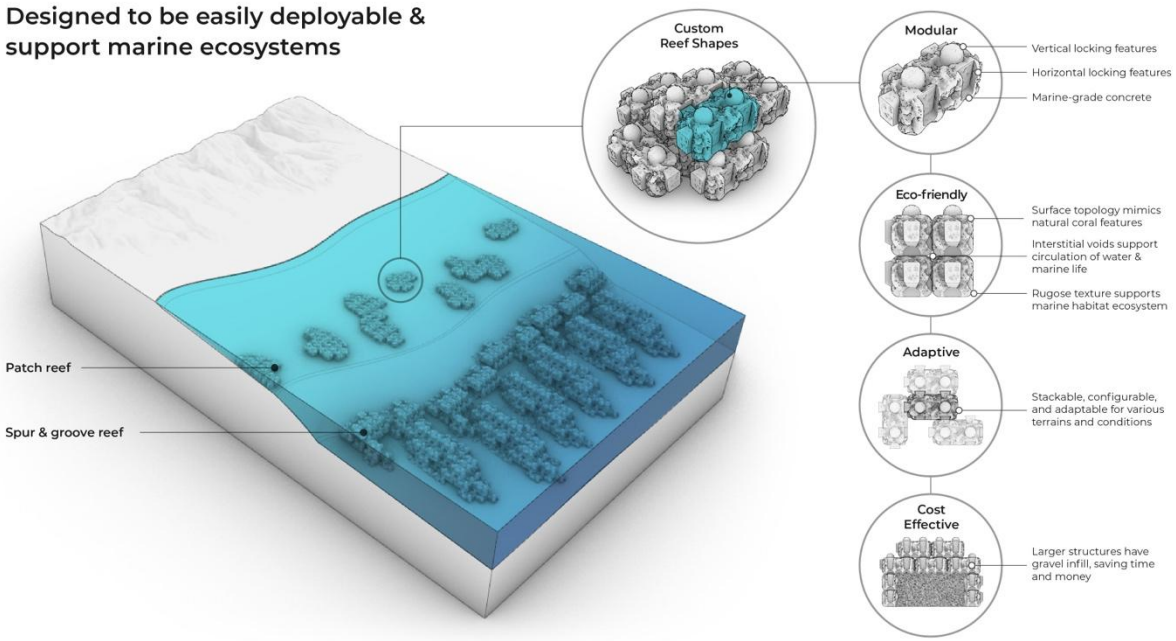
To hasten the succession and recovery to a functional reef ecosystem, ReefStarter units can immediately be used for coral outplanting, as well as grazer crabs and urchins restocking projects.

Shore-protecting

The surface of ReefStarter is designed to reinforce the barrier function of reef ecosystems, protecting coastal infrastructure from damaging waves and coastal flooding.

Customizable
ReefStarter habitats use modular building blocks that can be arranged in custom patterns. It's simple to mix and match our modules to suit the installation site and/or the desired reef community.

Self-sustaining
ReefStarter structures are built to encourage natural recruitment of fish, sponges, and a wide variety of fast- and slow-growing corals, paving the way for mature, self-sustaining reef ecosystems to self-organize and mature.



Recovery on multiple scales

Macro: The size and shape of ReefStarter structures are designed to support organisms like corals, oysters, sponges, and grazing organisms. The structure also interacts with local wave conditions, leading to wave attenuation and the formation of microenvironments. This can influence conditions like temperature gradients and sediment distribution, further encouraging biodiversity to thrive.

Meso: Reefstarter structures provide cavities and solution holes to support the developmental stages of reef organisms, including juvenile fish and crustaceans.

Micro: ReefStarter structures have a microstructure that supports a healthy microbiome community and larval settlement of marine organisms.
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Who We Are

ReefStarter is a collaboration between The Keys Marine Laboratory (KML), the University of South Florida, Florida Institute of Technology.

Bridget Baumgartner, co-founder & CEO

Bridget's career has spanned academic biomedical research, government-led biotechnology development, and nonprofit work at the intersection of biotechnology and conservation. As the CEO, Bridget approaches the field of ecosystem restoration with a commitment to advancing innovative solutions that serve humans as well as wildlife. She is responsible for overseeing the development of the ReefStarter vision from the lab to a viable commercial product.

Robert Weaver, co-founder & CTO

Robert is an Associate Professor in the Department of Ocean Engineering and Marine Sciences at Florida Institute of Technology. His research includes real-time coastal modeling of waves and water levels, coastal flooding and transport, living shoreline/living dock design, and coastal eco-engineering. He is the inventor of the ReefStarter breakwater structure and leads all prototype design and testing for specific ReefStarter installations.

Pete Miraglia, co-founder & COO

Prior to joining ReefStarter, Pete served as Deputy Director at Revive & Restore, where he led initiatives to advance cutting-edge biotechnologies for conservation and ecosystem restoration. Pete's specialty is program management and business development for first-of-its-kind advanced technologies, particularly those aimed at addressing national and global energy challenges.

Cindy Lewis, Restoration Advisor

Cindy Lewis is the Director of FIO's Keys Marine Lab and has been a lead Staff Scientist since 2008. She has a Ph.D. from Florida International University, where she studied coral stress, bleaching, and disease. Cindy is an active member of the marine science community, serving on various advisory councils and committees. She is also a certified dive master and a dedicated community leader. Cindy advises all ecological studies on ReefStarter structures and leads associated ecosystem restoration activities.

Stephen Wood, Engineering Advisor

Stephen is a Professor in the Department of Ocean Engineer and Marine Sciences at Florida Institute of Technology, and is a licensed mechanical engineer specializing in design. He has worked in physical oceanography conducting deep-sea mooring deployments and data analysis. He advises on offshore construction planning and execution for ReefStarter installation projects.

Tom Frazer, Science Advisor

Tom is a Professor and Dean of the College of Marine Science at the University of South Florida. Prior to his arrival at USF, he was Director of the School of Natural Resources and Environment at the University of Florida and served also as Chief Science Officer for the State of Florida. Tom helps design and supervises all ecology research related to the development of ReefStarter as a replacement reef habitat.

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QUALIFICATION STATEMENT

Bioimpact, Inc. is a Virgin Islands corporation that has been licensed to do business in the USVI since 1986.

Bioimpact, Inc. is qualified to conduct and prepare both terrestrial and marine Environmental Assessment Reports required by the U.S. Virgin Islands Department of Planning and Natural Resources (DPNR), Division of Coastal Zone Management (CZM), and the U.S. Army Corps of Engineers (USACE).

Bioimpact, Inc. has wetland delineators certified by the National Wetland Science Training Cooperative to establish wetland jurisdictional limits for the USACE.

Bioimpact, Inc. is experienced in the creation and implementation of wetland mitigation programs.

Bioimpact, **Inc.** is experienced in developing and implementing marine water quality monitoring programs and long-term monitoring of the benthic environment.

Bioimpact, Inc. has water samplers and analysts certified by the DPNR Division of Environmental Protection (DEP).

Bioimpact, Inc. has successfully designed and implemented large scale coral and seagrass transplant programs.

Bioimpact, Inc. is experienced in cable landfall studies and the establishment of routes for undersea cables and monitoring of cable installations to minimize impact.

Bioimpact, Inc. is experienced in conducting endangered species surveys including corals listed under the Endangered Species Act (ESA) and terrestrial flora and fauna species surveys.

Bioimpact, Inc. is experienced in preparing Biological Assessments for the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS).

Bioimpact, Inc. is experienced in the transplant and monitoring of ESA-listed corals, as authorized under "Take Permits" from NMFS.

Bioimpact, Inc. is experienced in preparing Environmental Assessments for federal permitting and for federal issuance of a Finding of No Significant Impact (FONSI).

Bioimpact, Inc. is experienced in conducting Phase I Environmental Site Assessments as set forth in the ASTM International Standard Practice Designation E1527-21 and All Appropriate Inquires and Phase II Environmental Site Assessments as set for in ASTM E1903-11.

Bioimpact, Inc. is experienced in the development and implementation of sampling plans to detect and delineation hazardous materials and petroleum products.

Bioimpact, Inc. is experienced in conducting deep water remotely operated vehicle (ROV) surveys up to 1,250 feet and has all the necessary equipment to undertake these studies.

Bioimpact, Inc. has conducted environmental studies in the U.S. Virgin Islands, Puerto Rico, British Virgin Islands, as well as other parts of the Caribbean and in the Florida Keys.

PARTIAL JOB LIST
Updated March 31, 2022

MONITORING LARGE SCALE PROGRAMS

2021 – Present Watershed and Stormwater Sampling on St. Croix and St. Thomas as a Subcontractor to Watershed Consulting Associates LLC.

2021 – Present Development and Implementation of a Water Quality and Environmental Monitoring Plan for Construction of a Private Dock in Chocolate Hole, St. John.

2021 – Present Development and Implementation of a Water Quality Monitoring Plan for the Reconstruction of the Marriott Frenchman's Reef Dock and Minor Dredging.

2020 – Present Monitoring for the Virgin Islands Tree Boa at the Donoe Housing Redevelopment Site.

2019 – Present Development and Implementation of the Water Quality and Environmental Monitoring Plan for the Installation of a Single Point Mooring at Limetree Marine Terminals, St. Croix.

2013 – Present U.S. Virgin Islands Ambient Water Quality Monitoring Program, Sampling for St. Croix.

2018 – 2021 Development and Implementation of the Water Quality and Environmental Monitoring Plan for the Construction of the Veterans Drive Project on St. Thomas for the U.S. Virgin Islands Department of Public Works (VIDPW).

2016 Development and Implementation of the Water Quality Monitoring Plan for the West Indian Company Limited (WICO) Emergency Bulkhead Replacement on St. Thomas.

2014 – 2018 Development and Implementation of the Environmental Monitoring Plans for the Conversion of U.S. Virgin Islands Water and Power Authority (VIWAPA) to Liquid Petroleum Gas (LPG) for Vitol on St. Croix and St. Thomas.

2014 – 2018 Development and Implementation of the Environmental Monitoring Plans for the Creation of a Dolphin Exhibit at Coral World (VI), Inc. on St. Thomas.

2013 – 2018 Development and Implementation of the Water Quality and Environmental Monitoring Related to the Dredging of the Crown Bay Marine Terminal and Turning Basin on St. Thomas.

2013 – Present Development and Implementation of the Monitoring Plans for the VIDPW's Improvements to Veterans Drive on St. Thomas.

2013 – 2018 Development and Implementation of the Monitoring Plans for the U.S. Virgin Islands Port Authority's (VIPA) Maintenance Dredging of Crown Bay Marina on St. Thomas.

2013 – 2018 Development and Implementation of Monitoring Plans for the Westin Resort's Dock Permit and Improvements of Stormwater Drainage on St. John.

2013 – 2015 Implementation and Monitoring of a Wetland Created as Mitigation for the Development of the U.S. Virgin Islands Waste Management Authority's (VIWMA) Transfer Station on St. Croix.

2012 – 2018 Development and Implementation of the Monitoring Plans for the Virgin Islands Next Generation Network's (viNGN) Fiber Optic Cable System in the USVI.

2011 – 2019 Development and Implementation of a Water Quality and Environmental Monitoring Plan to Assess Impacts of an Increase in Discharge from the Marriott Frenchman's Reef Hotel on St. Thomas.

2010 – 2012 Development of the Water Quality and Environmental Monitoring Program for the Development of Thatch Cay with a Special Emphasis on ESA-listed Corals.

2009 – 2015 Environmental Monitoring for the Development of Oil Nut Bay and the Yacht Club Costa Smeralda (YCCS) for Victor International on Virgin Gorda, British Virgin Islands (BVI).

2009 – 2010 Development and Implementation of a Water Quality Monitoring Plan for the Construction of the Dock at Frenchman's Cove for Marriott Vacation Club, Inc on St. Thomas.

2009 Establishment of the Baseline for the Dredging of Charlotte Amalie Harbor and Entrance Channel, and the and the Disposal of Dredged Materials in the Historic Dredging Hole in Lindbergh Bay, St. Thomas for WICO.

2008 – 2009 Environmental Monitoring of the Development of Scrub Island in the BVI for Mainsail Lodging and Development.

2007 – 2010 Water Quality Monitoring for the Development of the Calabash Boom Affordable Housing Complex for Reliance Housing in Estate Calabash Boom on St. John.

2007 – 2009 Water Quality and Environmental Monitoring for Flamboyant Real Estate of a Subdivision of Seventy-seven Acres in Hansen Bay, St. John.

2006 – 2008 Water Quality Monitoring for the Dredging of a Sand Channel in St. Croix for VIWAPA.

2006 – 2007 Water Quality Monitoring for the Renovations of the Ritz-Carlton Hotel on St. Thomas for the Ritz-Carlton.

2006 – 2010 Environmental Monitoring for the Placement of Undersea Cables at the Global Crossing Cable Station in St. Croix for Global Crossing Network, Alcatel, and Tyco Electronics Subsea Communications (now SubCom).

2005 – 2007 Water Quality Monitoring for the Dredging of Crown Bay, St. Thomas for VIPA.

2005 – 2006 Water Quality and Environmental Monitoring for Improvements to the Redhook Marine Terminal for VIPA.

2004 – 2011 Water Quality and Environmental Monitoring for the Construction of the Pond Bay Resort for First American Development Group on St. John.

2004 Benthic Habitat Survey of Crown Bay and Gregerie Channel to Supplement the USACE Feasibility Report for VIPA.

2003 – 2006 Water Quality Monitoring for the Construction of the Enighed Pond Marine Terminal on St. John for VIPA.

2003 – 2004 Water Quality Monitoring for the Development of the Crown Bay Marine Terminal on St. Thomas for VIPA.

2002 – 2008 Water Quality and Environmental Monitoring for the Development of Marine Amenities on the Island of Lovango for the Joseph Markus Trust.

2002 – 2005 Water Quality Monitoring for the Improvements to the Gallows Bay Marine Terminal on St. Croix for VIPA.

2001 – 2008 Coral Transplant Monitoring for the Enighed Pond Marine Terminal on St. John for VIPA.

2001 – 2006 Coral Transplant Monitoring for the Mangrove Lagoon Sewage Treatment Plant Outfall on St. Thomas for VIDPW.

2001 – 2002 Water Quality Monitoring for Improvements to the Tropical Shipping Dock in Crown Bay, St. Thomas for Meisner Marine.

2000 – 2006 Seagrass Transplant Monitoring of the Seagrass Transplanted for the Dredging of Charlotte Amalie Harbor on St. Thomas for VIPA.

2000 – 2003 Water Quality Monitoring for the Dredging of Charlotte Amalie Harbor on St. Thomas for VIPA.

1999 – 2006 Water Quality Monitoring for Repairs to the Frederiksted Pier on St. Croix for VIPA.

1999 – 2002 Water Quality Monitoring for the Construction of Cable Stations at Estate Northside on St. Croix for Global Crossings.

1997 – 2005 Development of a Water Quality Monitoring Program for the Construction of the Christiansted Boardwalk on St. Croix Prepared for the Government of the U.S. Virgin Islands.

1997 – 2005 Wetland Monitoring of the Tren Urbano, Puerto Rico (PR) 5 and PR 22 Mitigation Sites under Subcontract to Nutter & Associates, Inc. for the Puerto Rico Highway Authority.

1997 – 2002 Wetland Monitoring of the Airport Mitigation Site at the Henry E. Rohlsen Airport on St. Croix for VIPA.

1997 – 2002 Wetland Monitoring for the Fairplains Mitigation Site at the Henry E. Rohlsen Airport on St. Croix for VIPA.

1996 – 1998 Water Quality Monitoring for the Expansion of the Molasses Pier at the Third Port on St. Croix for the VIPA.

1996 Development and Implementation of a Water Quality Monitoring Program for the Expansion of, and Improvements to, the Redhook Marine Terminal on St. Thomas for VIPA.

1996 Development and Implementation of a Water Quality Monitoring Program for the Creation of the Enighed Pond Marine Terminal on St. John Prepared for the Maguire Group, Inc. and VIPA.

1995 Water Quality Monitoring for the Construction of the AT&T Cable Landing Facility in Estate Northside, St. Croix for AT&T Submarine Systems.

1992 – 1994 Development and Implementation of a Water Quality Monitoring Program for the Reconstruction of the Frederiksted Pier on St. Croix for VIPA.

1992 – 1993 Conducted a Baseline Assessment and Developed a Long-term Monitoring Plan for VIWAPA of the Benthic Community Potentially Impacted the Outfall from the Richmond Power Plant on St. Croix

1992 – 1993 Development and Implementation of a Monitoring Plan to Study Algal Blooms within the Alumina Cooling Pond Discharge and Strategies to Alleviate Runoff for V.I. Alumina Corporation LLC (VIALCO) on St. Croix.

1990 – 1992 Water Quality Monitoring for Dredging Christiansted Harbor on St. Croix for VIPA.

1989 Development and Implementation of a Turtle Monitoring Program for Manchineel Beach on St. Croix.

LARGE SCALE MITIGATION PROGRAMS

2021 – Present Removal and Relocation of 209 Corals for the U.S. Coast Guard Aids to Navigation (ATON) Replacement Project on St. Croix and Routine Monitoring of a Subset of Corals.

2020 – Present Development and Implementation of the Compensatory Mitigation Plan for the Transplant of 1,700 corals, the Repair of 500 Corals of Opportunity, and the Outplanting of 3,000 ESA-listed corals for Limetree Bay Terminal's Single Point Mooring on St. Croix.

2018 – Present Development and Implementation of a Compensatory Mitigation Plan for the Relocation of 1.25 Acres of Seagrass and 631 Corals from the Impact Footprint of the Veterans Drive Project on St. Thomas, and the Repair of Damaged Corals on Triangle Reef for VIDPW.

2016 – 2020 Development and Implementation of a 190-Coral Transplant for the Stabilization of the Seawater Intake Line for the Marriott Frenchman's Reef Hotel on St. Thomas.

2016 – 2020 Development and Implementation of a Coral Transplant to Minimize the Impacts of Construction for LPG Improvements at VIWAPA Facilities on St. Croix and St. Thomas.

2015 – 2021 Development and Implementation of the Mitigation Plan for the Relocation of 10,000 Corals Off the WICO Bulkhead in Havensight for WICO on St. Thomas.

2014 – Present Development and Implementation of a Coral and Seagrass Transplant for Coral World (VI), Inc. in Association with the Development of the Dolphin Exhibit on St. Thomas; 250 Corals were Transplanted and More Than 500 Corals were Repaired after the 2017 North Atlantic Hurricane Season.

2014 – 2019 Development and Implementation of the Mitigation Plans for VIPA's Maintenance Dredging of Crown Bay Marina on St. Thomas.

2013 – 2018 Development and Implementation of the Mitigation Plans for the Westin Resort's Dock Permit and Improvements of Stormwater Drainage on St. John.

2013 – 2015 Creation of a Herbaceous Wetland for VIWMA as Mitigation for the Construction of the Transfer Station at the Anguilla Landfill on St. Croix.

2009 Transplantation of 300 Corals for Victor International Coral for Impacts Associated with the Development of an Access Ramp and Dock at Oil Nut Bay in the BVI.

2008 – 2009 Transplantation of 3,000 Corals for Mainsail Lodging and Development for Impacts Associated with the Development of the Scrub Island Resort in the BVI.

2006 – 2011 Planting of 1 Acre of Mangrove Wetland for VIDPW as Mitigation for the Construction of the Mangrove Lagoon Sewage Treatment Plant on St. Thomas.

2003 – 2008 Planting of 2.8 Acres of Mangrove Wetland for VIPA as Compensatory Mitigation for the construction of the Enighed Pond Terminal on St. John.

2003 – 2008 Removal and Relocation of 3,000 Corals Outside the Area of Impact for the Development of the Crown Bay Marine Terminal on St. Thomas for VIPA.

2002 – 2007 Development and Implementation of the Mitigation Plans for VIPA's Dredging of Crown Bay Marine Terminal and Turning Basin on St. Thomas.

2002 – 2007 Transplantation of 50,000 Corals for VIPA Outside the Area of Impact for the Enighed Pond Marine Terminal Project on St. John.

2002 Creation of Artificial Coral Reefs and *Acropora spp.* Thickets for Joseph Markus Trust as Mitigation for the Construction of a Barge Landing Facility on the Island of Lovango.

2000 – 2005 Transplantation of 2 Acres of Seagrass for VIPA to an Area Outside the Dredging Footprint of the Charlotte Amalie Harbor on St. Thomas.

2000 – 2001 Transplantation of 7,000 Corals for VIDPW Outside of the Area of Impact for the Placement of the Mangrove Lagoon Sewage Treatment Plant Outfall on St. Thomas.

1999 – 2004 Transplantation of 300 Corals for VIPA Outside the Area of Impact for the Mooring Improvements to the Frederiksted Pier on St. Croix.

1997 – 2003 Planting of ½ Acres of Mangroves for VIPA/VIDPW as a Mitigation Project for the Construction of the Molasses Dock Road on St. Croix.

1997 – 2002 Creation of a 1-Acre Herbaceous Wetland for VIPA as Mitigation for Henry E. Rohlsen Airport Construction on St. Croix.

1997 – 2002 Development of a Mitigation Plan for VIPA for the Creation of a 16,000-square Foot Wetland at Manning Bay to Address the Impact Incurred in Fairplains Gut on St. Croix.

1996 Development of a Mitigation Plan for VIPA for the Creation of 4.1 Acres of Wetland as Mitigation of the South Shore Power Plant, Third Port on St. Croix.

1994 Development of a Mitigation Plan for Green Cay Resort for the 12 Acres of Wetland Impacted by the Construction of the Resort on St. Croix.

ENVIRONMENTAL PLANNING AND STUDIES

A Foundational Blueprint For The Development Of A Comprehensive Pelagic Sargassum Management Plan For The United States Virgin Islands. The U.S. Virgin Islands Department of Planning and Natural Resources Division of Coastal Zone Management. (2023)

Ecosystem Risk Assessment Framework for the Caribbean Marine Fisheries Management Council (in progress).

ENVIRONMENTAL ASSESSMENT REPORTS
2020– PRESENT

Water quality, monitoring and/or compensatory mitigation plans were developed to supplement most of the environmental assessment reports listed.

Water Island Development, Water Island Development Corporation, Environmental Assessment Report for the Development of a Resort and Marina, Water Island

Villa Olga Shoreline Revetment, Olga's Fancy, Environmental Assessment Report for the Restoration and Revetment of the Shoreline, St. Thomas

Expansion of Yacht Haven Grande Marina, IGY, Environmental Assessment Report for the Expansion of the Existing Yacht Haven Grande Marina, St. Thomas

Sapphire Bay Marina Dredging and Installation of Sargassum Barriers and Shoreline Revetment, SBMCOA, LLC, Environmental Assessment Report for Dredging of the Marina, Revetment of the Shoreline, and Installation of Sargassum Barriers, St. Thomas

Ritz-Carlton Shoreline Preservation Plan, Ritz-Carlton Club, Assessment Report for the Installation of Sargassum Barriers and Geotubes, St. Thomas

St. Croix Yacht Club, St. Croix Yacht Club, Environmental Assessment Report to Permit the Existing Facility and to Allow for Repair and Maintenance, St. Croix

Container Port, Golden Grove and Midland Road Underground Projects, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of Underground Power Systems to Improve Resiliency, St. Croix.

Flamingo Bay Eco-Resort, BBK Development, Environmental Assessment Report for the Development of the Small Eco-Resort, Water Island.

Pearl Landfill and Recycling Facility, V.I. Waste Management Authority, Environmental

Assessment Report for the Development of a Solid Waste Facility in Estate Pearl, St. Croix.

Charlotte Amalie Harbor Dredging, V.I. Port Authority, Environmental Assessment Report and HUD Environmental Assessment for the Dredging of the Charlotte Amalie Harbor Channel, Turning Basin, and WICO Inner Berth, St. Thomas.

Crown Bay and East Gregory Channel Dredging, V.I. Port Authority, Environmental Assessment Report and HUD Environmental Assessment for the Dredging of Portions of Crown Bay and East Gregory Channel, St. Thomas.

Frenchman's Reef and Morningstar, Beach Enhancement and Shoreline Stabilization, CREF3 (Formerly Diamond Rock), Environmental Assessment Report for the Revetement of the Shoreline, the Installation of Offshore Breakwaters and Sand Renourishment, St. Thomas.

Emergency Response Dock and Shoreline Revetment at the Harley Plant, V.I. Water and Power Authority, Environmental Assessment Report for the Construction of an Emergency Fuel Spill Response Dock and the Revetment of the Eroded Shoreline, St. Thomas.

Consolidated Permit for Randolph E. Harley Power Plant, V.I. Water and Power Authority, Environmental Assessment Report to Bring All Components into Compliance including those Pre-dating CZM, St. Thomas.

Underwater Memorial Park, Virgin Islands Underwater Memorial Park, Environmental Assessment Report for the Creation of an Underwater Park to Intern Ashes into Reef Building Structures, St. Thomas.

Mooring and Operation of a Bar and Restaurant in the Pillsbury Sound, Cowgirl Bebop, LLP, Environmental Assessment Report for the Installation of Moorings for Vessels and Patrons in the Pillsbury Sound, St. John.

Cruz Bay Underground, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of an Underground Power Cable System in Cruz Bay Feeder 7E, St. John.

Tropical Marine Expansion, Tropical Marine, Environmental Assessment Report to Combine Docks at Mangrove Marine and Off Plot 28 and the Expansion of the Existing Dock, St. Thomas.

Limetree Resort, Wyndham Bluebeard's Beach Club, Environmental Assessment Report for the Renovation and Expansion of the Existing Limetree Resort, St. Thomas.

Repair to Cruz Bay Visitor Center, Docks, and Surrounding Grounds Impacted by Hurricanes Irma and Maria, Croft Engineering/National Park Service, Environmental Assessment Report for Dredging the Basin and Repairs to the Bulkhead and Renovation and Upgrades to the Existing Visitor Center, St. John.

Latitude 18 Marina, Jack Rock EA-C LLC, Environmental Assessment Report for the Development of a Marina and Management of a Mooring Field and Dry Storage for Vessels, St. Thomas.

Green Cay Marina, St. Croix Financial Center, Environmental Assessment Report for the Expansion of the Existing Marina, Maintenance Dredging, and Beach and Shoreline Improvements, St. Croix.

King Christian Dock, USVI Opportunity Fund LLC, Environmental Assessment Report for the Reconstruction and Expansion of a Hurricane-Damaged Dock, St. Croix.
Renovations and Expansion of an Existing Dock, Inter-Island Ferry Service, Environmental Assessment Report for the Expansion and Extension of an Existing Dock to Better Accommodate Vessel Dockage, St. Thomas.

Repair of a Hurricane Damaged Dock, Margaritaville, Environmental Assessment Report for the Reconstruction of the Damaged Dock (modified to include a reverse osmosis line extension), St. Thomas.

Boat Building Facility and Dock, Gold Coast Yacht, Inc., Environmental Assessment Report for a Boat Building Warehouse and a Launch and Outfitting Dock, St. Croix.

Turquoise Bay Resort, VIPM LLC, Environmental Assessment Report for a Glamping Resort and Restaurant, St. Croix.

Christiansted National Historic Site Existing Wharf Replacement, HDR, Inc. and National Park Service, Environmental Assessment Report for the Replacement of the Failing Sheet Pile Wall and Bulkhead (and Acoustic Monitoring Plans), St. Croix.

Lovango Cay Beach Club and Resort, Lovango Island Holdings LLP, Environmental Assessment Report to Permit the Development of a Beach Club and Resort and Mooring Installation, Lovango Island.

Wave Attenuation System, LSJ LLC, Environmental Assessment Report for the Installation of Wave Attenuation Systems, Little St. James.

Installation of Access Docks, and Barge Landing Facility, Great St. James, Great St. Jim LLC. Environmental Assessment Report for the Development of a New Dock, the Renovation of an Existing Dock, and the Construction of a Barge Landing, Great St. James.

Installation of a Single Point Mooring at the Limetree Bay Terminal on St. Croix, Limetree Bay Terminals LLC, Environmental Assessment Report for the Installation of an Undersea Pipeline, Pipeline End Manifold (PLEM), and Buoy System at a Depth of 650 Feet, St. Croix.

St. Croix Sports Complex, Coastal Systems, Environmental Assessment Report for the Construction of the Paul. E. Joseph Stadium, Wetland Delineations, and Endangered Terrestrial and Marine Species Assessments (and Development of a Sea Turtle Lighting Mitigation Plan), St. Croix.

Installation of a Submarine Cable System, V.I. Water and Power Authority, Environmental Assessment Report for Submarine Cable Routing and Beach Landfall, St. Thomas.

Maintenance Dredging of Krause Lagoon Channel, V.I. Port Authority, Environmental Assessment Report for the Dredging of the Cross-Channel into the Container Port and Molasses Dock, St. Croix.
Installation of New Reverse Osmosis Discharge and Intake Line, Westin Resort, Environmental Assessment Report for the Installation of a Saltwater Intake Line Over 2000 Feet Offshore, St. John.

Shoreline Stabilization Project for Buccaneer Hotel, The Buccaneer, Environmental Assessment Report for the Placement of a Shoreline Stabilization Structure to Protect the Eroding Shoreline, St. Croix.

VIWAPA's Conversion to LPG, VITOL and V.I. Water and Power Authority, Environmental Assessment Report for the Installation of LPG conversion Equipment and Fuel Dock Expansion (and Offshore Deep-Water Buoy Permit for LPG Ships), St. Croix and St. Thomas.

ENVIRONMENTAL ASSESSMENT REPORTS
2014 – 2019

Water quality, monitoring and/or compensatory mitigation plans were developed to supplement many of the environmental assessment reports listed.

viNGN Submarine Cable Network, Alcatel-Lucent for viNGN, Environmental Assessment Report for the Installation of an Inter-Island Cable System (including a Cable Beach Routing and Landfall Study), U.S. Virgin Islands.

Improvements to the Frederiksted Pier, V.I. Port Authority, Environmental Assessment Report for the Installation of a New Tender Landing, St. Croix.

Improvements to the Red Hook Marine Terminal, V.I. Port Authority, Environmental Assessment Report for the Construction of a New Customs Building and Shoreline Improvements, St. Thomas.

Offshore Windmills, Ocean Energy, Inc., Environmental Assessment Report for the Installation of Offshore Turbines, a Submarine Cable, and Cable Landing (including a Bird Study), St.

Thomas.

St. John Marina, Summers End Group, Environmental Assessment Report for the Development of a Marina and Associated Upland Facilities, St. John.

Maintenance Dredging of the Schooner Channel, V.I. Port Authority and HUD/V.I. Housing and Finance Authority (VIHFA), Environmental Assessment Report for the Dredging of the Schooner Channel (including an Evaluation of Alternative Alignments), St. Croix.

Remediation of Hydrocarbon Contamination at the V.I. Seaplane Ramp, V.I. Port Authority, Environmental Assessment Report for the Installation of Restorative Sheet Piles to Restore (and the Containment of Hydrocarbon-contaminated Soil from a Leaking Underground Storage Tank [LUST]), St. Croix.

Maintenance of the Existing Bulkhead and Maintenance Dredging of Charlotte Amalie Harbor, CH2M Hill and WICO, Environmental Assessment Report for the Replacement of the Sheet Pile in the Inner Berth (including the Development of a Coral Transplant Mitigation Plan), St. Thomas.

ENVIRONMENTAL ASSESSMENT REPORTS
2009 – 2013

Water quality, monitoring and/or compensatory mitigation plans were developed to supplement each of the environmental assessment reports listed.

Dredging of Crown Bay Marine Terminal and Turning Basin, V.I. Port Authority, Environmental Assessment Report for the Dredging of the Crown Bay Marine Terminal and Basin, St. Thomas.

Maintenance Dredging of Crown Bay Marina, V.I. Port Authority, Environmental Assessment Report for the Dredging of Crown Bay Marina (including a Seagrass and Coral Mitigation Plan), St. Thomas.

Improvements to Bordeaux Road, V.I. Department of Public Works and Federal Highway Administration in Collaboration with Parsons Brinkerhoff, Environmental Assessment Report for a Finding of No Significant Impact, St. Thomas.

Improvement to Spring Gut Road, V.I. Department of Public Works and Federal Highways Administration in Collaboration with Stanley Engineer, Environmental Assessment Report for Improvements to Spring Gut Road for a Finding of No Significant Impact, St. Croix.

Coral World's Dolphin Exhibit, Coral World (VI), Inc., Environmental Assessment Report for the Construction of an Offshore Dolphin Pen and Viewing Dock (and ESA Corals Monitoring

and Mitigation Plan), St. Thomas.

Expansion of the Spratt Bay Homeowners Dock (SBHOA), Spratt Bay Homeowner's Association, Environment Assessment Report for the Expansion of the SBHOA Dock, Water Island.

Expansion of Veterans Drive, V.I. Department of Public Works and Federal Highway Administration in Collaboration with Parsons Brinckerhoff, Environmental Assessment Report for a Finding of No Significant Impact and Drafting the USACE Statement of Findings, St. Thomas.

Chiller Cooling System, BaHaMar and HDR, Inc., Environmental Assessment Report for the Placement of a Saltwater Intake Line at the BaHaMar Resort, Grand Bahama.

Reverse Osmosis Facility, V.I. Water and Power Authority, Environmental Assessment Report for the Installation a New Reverse Osmosis Facility at the St. Thomas Power Plant, St. Thomas.

Submarine Power Cable, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of a Submarine Power Cable between the Islands of St. Thomas and St. John, Pillsbury Sound, St. Thomas and St. John.

Chiller System and Dock Repairs at the Marriott Frenchman's Reef, Diamond Rock, Environmental Assessment Report for the Installation of Saltwater Intake Line and Dock Repairs (and Larval Study for Intake), St. Thomas.

Expansion of Heavy Materials Krum Bay Facility, Heavy Materials St. Thomas, Environmental Assessment Report for the Expansion of Heavy Materials Concrete Facility in Krum Bay, St. Thomas.

Thirty-three-Megawatt Waste-to-Energy Plant, Alpine Energy Group, Inc., Environmental Assessment Report for the Construction of a 33-Megawatt Waste-to-Energy Plant (including Conducting a Survey of Endangered V.I. Tree Boas in the Area), St. Thomas.

Eighteen-Megawatt Waste-to-Energy Plant, Alpine Energy Group, Inc., Environmental Assessment Report for the Construction of an 18-Megawatt Waste-to-Energy Plans (including a Wetland Delineation), St. Croix.

Reverse Osmosis Facility on St. John, V.I. Water and Power Authority, Environmental Assessment Report for the Construction of a Reverse Osmosis Facility, St. John.

Seven Hills Development, Robin Bay Partners, Environmental Assessment Report for the Development of Seven Hills Residential Community (including a Wetland Delineation), St. Croix.

Improvements to the Molasses Dock, V.I. Port Authority, Environmental Assessment Report for Dredging and Improvements to the Molasses Dock Roll-on Roll-off Facility (and Mitigation Plan for the Mangrove Shoreline), St. Croix.

Dredging of the Charlotte Amalie Harbor Channel and the Filling of Lindbergh Bay, The West Indian Company Limited, Environmental Assessment Report for the Dredging and Widening of the Charlotte Amalie Harbor to Accommodate Oasis Class Ships at WICO Docks and the Disposal of Dredged Materials in the Historic Dredging Hole in Lindbergh Bay, St. Thomas.

Fueling Station, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of a Vehicle Fueling Station in the Richmond Plant Terminal Facility License, St. Croix.

ENVIRONMENTAL ASSESSMENT REPORTS
2005 – 2008

Water quality, monitoring and/or compensatory mitigation plans were developed to supplement each of the environmental assessment reports listed.

Port of Mandahl, MSJ Realty, Environmental Assessment Report for the Development of the Marina and Resort in Estate Mandahl, St. Thomas.

North Sound Yacht Club, Victor International, Environmental Assessment Report for the Development of a Marina and Yacht Club in North South, Virgin Gorda, BVI.

Reconstruction of the Frenchman's Cove Dock, Marriott Vacation Club, Environmental Assessment Report for the Reconstruction and Expansion of a Damaged Dock in Charlotte Amalie Harbor, St. Thomas.

Thatch Cay Development, Thatch Cay LLC, Environmental Assessment Report for the Development of a Resort Community and Marine Infrastructure on Thatch Cay, St. Thomas.

Smith Bay Development, Smith Bay Developers, Inc., Environmental Assessment Report for a Condominium Complex, St. Thomas.

Subdivision of Great St. James, Christian Kejer, Environmental Assessment Report for The Development of a Residential Community on Great St. James including Marine Access Infrastructure, Great St. James Island, St. Thomas.

Subdivision of Inner Brass, Green Island Developers, Environmental Assessment Report for the Development of a Residential Community on Inner Brass including Marine Access

Infrastructure, Inner Brass Island, St. Thomas.

Subdivision of Inner Brass, Bryan Family, Environmental Assessment Report for the Subdivision of Lots for a Residential Community on Inner Brass and the Development of a Dock for Access. Inner Brass Island, St. Thomas.

Cabrita Point, Cabrita Point Partners and Lionstone LLC, Environmental Assessment Report for the Development of a Resort Community, a Mitigation and Monitoring Plan for the Endangered V.I. Tree Boa and a Monitoring Plan for a Reverse Osmosis Intake Line, Dock and Swimming Platform, St. Thomas.

Subdivision of 77 Acres in Hansen Bay, St. John Flamboyant Realty, Environmental Assessment Report for the Development of Roads and a Subdivision in Hansen Bay, St. John.

Subdivision of 14 Acres in Hansen Bay, St. John Hansen Bay Development Group, Environmental Assessment Report for the Development of Roads, and a Subdivision in Hansen Bay (including a Wetland Delineation), St. John.

Expansions and Improvements to the Ritz-Carlton Hotel, William Karr and Associates, Environmental Assessment Report for the Expansion and Renovation of the Ritz-Carlton Hotel, St. Thomas.

Modification to Carden Beach Condominiums, TK Properties, Inc., Environmental Assessment Report for the Development of Zero Lot Line Homes at the Carden Beach Property, St. Croix.

Development of Betty's Hope, V.I. Port Authority, Environmental Assessment Report and Wetland Delineations for the Development of the South Shore Property for Commercial and/or Residential Use, St. Croix.

Expansion of the Compass Point Marina, Margate Management, Environmental Assessment Report for the Addition of Docks at the Compass Point Marina in Benner Bay, St. Thomas.

Improvements, Expansions and Maintenance of HOVENSA Petroleum Refinery, HOVENSA LLC, Environmental Assessment Reports for the 1) Construction of Maintenance Buildings and Replacement of Existing Stacks, 2) Construction of a Low Sulfur Fuels (LSF) Facility, 3) Construction of Modular Buildings, and 4) Construction of Housing in Estate Blessing (including Permitting of an Existing Borrow Pit), St. Croix.

Installation of a Permanent Barge Landing Facility on Lovango Cay, Joseph Markus Trust, Environmental Assessment Report for the Development of a Permanent Barge Landing Facility (including a Compensatory Mitigation Plan for Endangered Coral Species), Lovango Cay.

Barge Landing, Swim Dock and Beach Enhancement on Little St. James, LSJ LLC, Environmental Assessment Report for the Relocation of the Existing Barge Landing and the

Construction of a Swim Dock and Beach Enhancing Devices, Little St. James.

Development of Affordable Housing in Calabash Boom, Reliance Housing, Environmental Assessment Report for the Development of Affordable Housing in Calabash Boom (and Territorial Pollutant Discharge Elimination System [TPDES] Permits), St. John.

Demineralized Water System and Storage Tank Upgrades, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of a New Storage Tank and Demineralizer, St. Croix.

Development of a Pizza Bar and Miniature Golf Course, Divi Carina Bay Resort, Environmental Assessment Report for the Development of Amenities at the Divi Carina Bay Resort and Casino, St. Croix.

Placement of Fuel Pipelines on the Ann E. Abramson Pier, Royal Caribbean Cruise Lines, V.I. Port Authority, Environmental Assessment Report for the Installation of Fuel Lines on the Frederiksted Pier, St. Croix.

Development of a Marina and Related Infrastructure, Coral Bay Marina LLC, Environmental Assessment Report for the Dredging and Development of a Marina in Coral Bay (including an Alternative Analysis to Reduce Impacts for the USACE), St. John

Development of a Marine Mammal Encountered Facility, Coral World (VI), Inc., Environmental Assessment Report for the Development of a Sealion Encounter Facility, St. Thomas.

Improvements to The Randall "Doc" James Racetrack, TRAXCO, Environmental Assessment Report for Improvements to the "Doc" James Racetrack Facility (including Wetland Delineations), St. Croix.

Maintenance Dredging and the Permitting of Permanent Moorings, Westin Resort, Environmental Assessment Report for Maintenance Dredging of the Existing Channel and around the Dock, and Mooring Installations, St. John.

ENVIRONMENTAL ASSESSMENT REPORTS
2000 – 2004

Water quality, monitoring and/or compensatory mitigation plans were developed to supplement each of the environmental assessment reports listed.

Compass Point Marina Expansion, Compass Point Marina in Collaboration with Springline Architects, Environmental Assessment Report for the Expansion of the Existing Compass Point Marina, St. Thomas.

Emergency Electrical Cable St. Thomas-St. John, V.I. Water and Power Authority, Environmental Assessment Report for the Placement of a New Submarine Power Cable between St. Thomas and St. John, St. Thomas.

Richmond Sand Channel Dredging, V.I. Water and Power Authority, Environmental Assessment Report for Maintenance Dredging of the Richmond Sand Channel, St. Croix.

Hassel Island Electrical Cable Replacement, V.I. Water and Power Authority Environmental Assessment Report for the Installation of a New Submarine Cable between St. Thomas and Hassel Island, St. Thomas.

Golden Resorts Golf Resort, Casino & Conference Center, Golden Resort, Environmental Assessment Report for the Development of Golden Resorts Golf Resort, Casino, and Conference Center (including a Wetland Delineation), St. Croix.

Crown Bay Marine Terminal Improvements, V.I. Port Authority in Collaboration with Adams, Inc., Environmental Assessment Report for Improvements to the Crown Bay Marine Terminal, St. Thomas.

Global Crossings Point of Presence, Global Crossings, Environmental Assessment Report for the Placement of a Point of Presence Communications Tower in Frederiksted, St. Croix.

Burial of Fiber Optic Cables, Innovative Telephone, Environmental Assessment Report for the Burial of Fiber Optic Cables on the North Shore, St. Croix.

Burial of Fiber Optic Cables on the West End of St. Croix, Innovative Telephone, Environmental Assessment Report for the Burial of Fiber Optic Cables on the West End, St. Croix.

Callaloo Club Blowing Point, Callaloo Club Peninsula, Environmental Assessment for the Development of a Marina on the Island of Anguilla, British West Indies.

Installation of a Waterline between St. Thomas and St. John, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of a Waterline between St. Thomas and St. John, St. Thomas.

Installation of a Submarine Cable to Little St. James, V.I. Water and Power Authority, Environmental Assessment Report for the Installation of a Utility Line between St. Thomas and Little St. James, Little St. James.

South American Crossing Cable Station, Global Crossing, Environmental Assessment Report for the Construction of the South American Crossing Cable Station at Estate Northside, St. Croix.

Water Island Ferry Dock, V.I. Department of Public Works, Environmental Assessment Report

for the Construction of a Ferry Dock on Water Island, Water Island.

CuisinArt Golf Resort & Spa Beach Enhancements, CuisinArt, Environmental Impact Assessment Report for Beach Renourishment, Anguilla, British West Indies.

Cinnamon Reef Resort, Cinnamon Reef, Environmental Impact Assessment Report for the Development of a Marine Facility, Anguilla, British West Indies.

Frederiksted Pier Improvements, V.I. Port Authority, Environmental Assessment Report for Improvements to the Existing Frederiksted Pier, St. Croix.

Construction of a Private Dock on Little St. James, LSJ LLC, Environmental Assessment Report for the Construction of a Private Dock on the Island of Little St. James, Little St. James.

Phase II of the Christiansted Boardwalk, Government of the Virgin Islands Environmental Assessment Report for Phase II of the Christiansted Boardwalk, St. Croix.

Construction of a Headquarters, Beal Aerospace, Environmental Assessment Report for the Construction of Beal Aerospace's World Headquarters in Estate Great Pond, St. Croix.

ENVIRONMENTAL ASSESSMENT REPORTS
1988 – 2000

Hurricane Damaged Dock Reconstruction, Divi Carina Bay Resort, Environmental Assessment Report for the Reconstruction of a Dock after Damage Associated with Hurricane Hugo at the Divi Carina Bay Resort and Casino, St. Croix.

Global Crossing Cable Terminal, Global Crossing, Environmental Assessment Report for the Construction of a Cable Terminal Building and Corridor for Eight Submarine Fiber Optic Cables (including a Landfall Study) in Frederiksted, St. Croix.

Construction of a Coker and Coker Dock at the HOVENSA Petroleum Refinery, HOVENSA LLC, Environmental Assessment Report for the Construction of a Coker and Coker Dock, St. Croix.

Frederiksted Pier Mooring Dolphin, V.I. Port Authority, Environmental Assessment Report for the Construction of a Mooring Dolphin at the Frederiksted Pier, St. Croix.

Seaplane Terminal, V.I. Port Authority, Environmental Assessment Report for the Development of a Seaplane Terminal at the Old Seaplane Ramp, St. Croix.

Forest Bay Marina, Forest Bay Group, Environmental Assessment Report for the Development

of a Marina and Related Facilities in Forest Bay, Anguilla, British West Indies.

Dolphin Lagoon, META Resorts, Environmental Assessment Report for the Development of a Dolphin Lagoon at Meads Bay, Anguilla, British West Indies.

Construction of the Christiansted Boardwalk, Government of the Virgin Islands, Environmental Assessment Report for the Construction of a Boardwalk in Christiansted, St. Croix.

Runway Extension of the Henry E. Rohlsen Airport, V.I. Port Authority in Collaboration with LPA Group, Environmental Assessment Report for the Runway Extension at the Henry E. Rohlsen Airport, St. Croix.

Red Hook Marine Terminal Expansion, V.I. Port Authority, Environmental Assessment Report for the Expansion of the Red Hook Marine Terminal (including the Development and Implementation of Mitigation and Monitoring Plans), St. Thomas.

Enighed Pond Marine Terminal, V.I. Port Authority, Environmental Assessment Report for the Creation of the Enighed Pond Marine Facility (including the Development and Implementation of Mitigation and Monitoring Plans), St. John.

Submerged Land Renewal, Coral World (VI), Inc., Environmental Assessment Report for the Renewal of the Submerged Land Lease for the Coral World Facility, St. Thomas.
Construction of a Seawall, Cowpet Bay, Environmental Assessment Report for the Modification of an Existing Permit to Construct a Seawall, St. Thomas.

Riprap Revetment Installation, Watergate East Villas, Environmental Assessment Report for the Construction of a Rip-Rap Revetment, St. Thomas.

Improvements to the Fuel Dock, V.I. Water and Power Authority, Environmental Assessment Report for Improvements to the Fuel Dock at the Power Generating Facility, St. Thomas.

Subdivision of Estate Misgunst, La Domaine, Environmental Assessment Report for the Subdivision of 40 Acres of Land in Estate Misgunst, St. Thomas.

Expansion of the Alexander Hamilton Airport and Highway 64 Relocation, V.I. Port Authority, Environmental Assessment Report for the Expansion of the Alexander Hamilton Airport Terminal and Highway 64 Relocation (including a Wetland Delineation, and Development and Implementation of a Wetland Mitigation Plan), St. Croix.

AT&T Cable Landing Facility, AT&T, Environmental Assessment Report for the Cable Landing Facility at Estate Northside (including a Beach Landfall Study, a Cable Routing Study, and the Development of a Water Quality and Environmental Monitoring and Mitigation Plan), St. Croix.

Dredging of the Sand Channel, DEVCON, Environmental Assessment Report for the Dredging

of the Christiansted Sand Channel, St. Croix.

Expansion of the Red Mud Storage Ponds, VIALCO, Environmental Assessment Report for the Expansion of the Red Mud Storage Ponds at the VIALCO Alumina Facility, St. Croix.

Stormwater Drainage System, VIALCO, Environmental Assessment Report for the Creation of a Stormwater Drainage System at the VIALCO Alumina Facility, St. Croix.

Permitting of a Caliche Mine, VIALCO, Environmental Assessment Report for the Mining of Caliche at the VIALCO Alumina Facility, St. Croix.

Molasses Dock Expansion, V.I. Port Authority Subcontracted by Frank Torrez, Environmental Assessment Report for the Molasses Dock Terminal at the Third Port Facility, St. Croix.

ENVIRONMENTAL ASSESSMENT REPORTS (SELECTED)
1988 – 1993

Beach Renourishment, St. Croix by the Sea, Environmental Assessment Report for a Beach Renourishment and Jetty Construction at St. Croix by the Sea, St. Croix.

Vieques Shrimp Farm, Vieques Shrimp Mariculture Project, Environmental Assessment Report for the Creation of a Shrimp Farm in Puerto Ferro, Vieques, Puerto Rico.

Marine Spill Response Corporation (MSRC) Dock, Hess Oil Virgin Islands (HOVIC) Petroleum Refinery, Environmental Assessment Report for the Construction of a Pier in the HOVIC West Turning Basin, St. Croix.

Construction of Eden Beach Hotel and Condominiums, Eden Beach, Environmental Assessment Report for the Proposed Construction of Eden Beach Hotel and Condominiums, St. Croix.

Expansion of the Tamarind Reef Hotel, Tamarind Reef, Environmental Assessment Report for the Proposed Reconstruction and Expansion of the Tamarind Reef Hotel, St. Croix.

Construction of Gas Turbines at the Third Port, V.I. Water and Power Authority, Environmental Assessment Report and USACE Application for the Construction of Two Gas Turbines at the Third Port Site, St. Croix.

Subdivision of Lovango Cay, Joseph Markus Trust, Environmental Assessment Report for the Creation of a Subdivision on Lovango Cay and Placement of a Private Dock, Lovango Cay.

Well Water Collection System, VIALCO, Environmental Assessment Report for the Construction of a Well Water Gathering System for Wells at the VIALCO Alumina Facility, St. Croix.

Crawl Cay, Monroe County, Environmental Assessment Report, Wetlands Delineation and Hammock Studies of Crawl Cay, Florida.

Jack's Bay Subdivision, Jack's Bay Development Company, Environmental Assessment Report for the Subdivision of Approximately 300 Acres into 64 Lots at Estate Jack Bay and Estate Isaac Bay, St. Croix.

Bauxite Building, VIALCO, Environmental Assessment Report for the Expansion of the Bauxite Building at the VIALCO Alumina Facility, St. Croix.

Carambola Beach Club Improvements, Danested, Environmental Assessment Report for the Repair and Improvement of the Carambola Beach Club Facilities, St. Croix.

Salt River National Park, National Park Service, Environmental Impact Statement for the Proposed National Park at Salt River, St. Croix.

Desalination Unit, V.I. Water and Power Authority, Environmental Assessment Report for the Construction of a Desalination Unit on St. John, St. John.

Construction of Estate Turner Hole Condominiums, Carmel by the Sea, Environmental Assessment Report for the Construction of a 95-unit Condominium at Estate Turner Hole, St. Croix.

Very Long Baseline Array (VLBA) Observation Station, NASA, Environmental Assessment Report and Landscaping Plan for the Construction of a VLBA, St. Croix.

Buccaneer Hotel Room Expansion, Buccaneer Hotel, Environmental Assessment Report for a 20-room Addition to the Buccaneer Hotel, St. Croix.

Construction of a Ritz-Carlton Hotel, Environmental Assessment Report and Zoning Application for a 350-room Ritz-Carlton Hotel in Estate Davis Bay, St. Croix.

Frederiksted Pier Expansion, V.I. Port Authority, Environmental Assessment Report for the Construction of a Second Pier in Frederiksted, St. Croix.

Construction of the Kingston Hotel, Kingston Hotel, Environmental Assessment Report for the Construction of a Hotel and Condominium in Kingston, Tortola, BVI.

Construction of an Airport Warehouse, V.I. Port Authority, Environmental Assessment Report for Construction of a Warehouse Facility at the Alexander Hamilton Airport, St. Croix.

Development of the Great Pond Resort, St. Croix, Environmental Assessment Report, for Golden Gaming, Zoning Application, and USACE Permit Application for a Hotel and Condominium Project at Estate Great Pond, St. Croix.

ENVIRONMENTAL ASSESSMENT REPORTS
1986 – 1988

St. Croix	St. Thomas	St. John
Columbus Landing, St. Croix	Blue Beards Beach, St. Thomas	Concordia, St. John
Grapetree Beach, St. Croix		
St. Croix by the Sea, St. Croix		
Ensenada, St. Croix		
Virgin Grand, St. Croix		
Sugar Bay, St. Croix		
Turtle Run, St. Croix		
Palm Shores, St. Croix		
Baobab, St. Croix		
Reflection Bay, St. Croix		
Coakley Bay, St. Croix		
Green Cay, St. Croix		
Turquoise Bay St. Croix		
Eagle Bay, St. Croix		
Granard, St. Croix		
Concordia, St. John		

Wider Caribbean

Southeast Peninsula, St. Kitts
Divi Dive Canal, Nassau, Bahamas

ENVIRONMENTAL CONTAMINATION ASSESSMENTS
1990 – PRESENT

2022 – Present Sampling for Heavy Metals Contamination of the Soil in Estate Donoe, St. Thomas.

2000 – Present Sampling for Chemical Contamination in Cisterns as a Result of a Hydrocarbon Release in the Air, St. Croix.

1994 – Present Periodic Sampling of the Leaking Underground Storage Tanks (LUSTs) at the V.I. Port Authority Seaplane Ramp, St. Croix.

2019 Sampling for Mold at the Renaissance Hotel, St. Thomas.

2016 – 2022 Sampling of Underground Storage Tanks (USTs) for Gasoline Service Stations on St. Thomas and St. Croix.

2012 – 2016 Sampling for Recognized Environmental Conditions in Estate Anna's Hope, St. Croix.

2006 – 2016 Sampling for Petroleum Product Contamination at Gasoline Stations and Industrial Sites, St. Croix.

1990 – 2002 Sampling of Residential and Commercial Properties on St. Croix, St. Thomas, St. John and Puerto Rico for Recognized Environmental Conditions.