APPENDIX I

National Marine Fisheries Service

Response Letter of October 25, 2018

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

October 25, 2018 F/SER47 AR/pw

(Sent via Electronic Mail)

Colonel Andrew Kelly, Commander
Jacksonville District Corps of Engineers, Antilles Office
Fundacion Angel Ramos, Annex Building
383 Franklin Delano Roosevelt Avenue, Suite 202
San Juan, Puerto Rico, 00918

Attention: José A. Cedeño-Maldonado

Dear Colonel Kelly:

NOAA's National Marine Fisheries Service (NMFS) reviewed the letter dated July 12, 2018, from the Jacksonville District regarding public notice SAJ-2004-12518 (SP-JCM). The Summer's End Group, LLC, requests authorization from the Department of the Army to construct a private commercial marina in Coral Harbor, Estate Carolina, Coral Bay, St. John, U.S. Virgin Islands. The marina design, as currently proposed, would consist of 144-slips constructed from 960 piles to accommodate vessels up to 160 feet long, along with 12 permanent moorings, a dinghy dock, fuel pump, and redevelopment of upland areas. The project would result in the loss of a significant amount of seagrass, identified as essential fish habitat (EFH) for federally managed species under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). As part of the ongoing EFH consultation, the District requested the NMFS review the additional information provided by the applicant:

- *Environmental Assessment Report [EAR] for the Development of the St. John Marina, Coral Bay, St. John USVI*, dated April 2014
- The applicant's response to NMFS-Habitat Conservation Division submitted to the District on August 15, 2017
- *Marina Site Suitability Analysis – Wind and Wave Analysis* (Suitability Analysis), dated December 9, 2017
- *Compensatory Mitigation Plan for Development of the St. John Marina* (Mitigation Plan), revised February 2018
- Coral Bay Community Council and Save Coral Bay comments to the District on the project, dated May 4, 2018
- A description of the proposed action and action area, a description and analysis of potential routes of effect or the manner in which the action may affect EFH, and a summary of the District's determination of effect pursuant to the provisions of the Magnuson-Stevens Act prepared by the District.

Consultation History
By letter dated February 5, 2015, the NMFS responded to the public notice dated January 7, 2015, providing EFH conservation recommendations and objections pursuant to Section 404(q) of the Clean Water Act and concluding the proposed project would adversely affect EFH designated by the Caribbean Fishery Management Council. Specifically, the proposed project design had the potential to affect 12 acres of the sea bottom, including an estimated 9.12 acres of seagrass. The proposed mitigation activities,

including planting mangroves and removing debris, did not quantify the seagrass habitat restored by these actions; therefore, the NMFS did not have sufficient information to determine if mitigation activities would sufficiently offset the impacts to seagrass habitat. Under the EFH provisions of the Magnuson-Stevens Act, the NMFS recommended the Department of the Army not authorize the project as proposed. Furthermore, by letter dated March 2, 2015, the NMFS determined the project may result in substantial and unacceptable impacts to aquatic resources of national importance (ARNI) pursuant to Part IV 3(b) of the Memorandum of Agreement between the Department of Commerce and the Department of the Army dated August 11, 1992.

On July 9, 2015, the District issued a revised public notice listing the same applicant and SAJ number and requested continued consultation with the NMFS Habitat Conservation Division. By email dated September 11, 2015, the NMFS informed the District the alterations did not change the project substantively and, therefore, warranted no changes to the previous letters.

By letter dated July 12, 2018, the District provided the applicant's response to the comments from the NMFS and other agencies along with steps and measures to avoid and minimize the potential impacts of the proposed project on EFH, should the District permit the project. These steps and measures include:

- Analysis of an alternative location and design
- Completion of comprehensive benthic assessments
- Use of grated decking on the proposed docking structures, walkways, and finger piers
- Design of the marina to avoid dredging; positioning of larger vessels and slips in deeper waters
- Inclusion of pump out and waste collection facilities in the marina design
- Implementation of a boaters education program as part of operations of the marina
- Implementation of the Clean Marina Action Plan
- Implementation of acoustic impact attenuation measures during the proposed pile driving activities
- Use of erosion and sediment control measures during upland construction and floating silt curtains during in-water work; implementation of water quality and environmental monitoring plans
- A plan to transplant to a safe location seagrass harvested from within the footprint of proposed piles
- Implementation of the Mitigation Plan, including removal of debris, repair of corals throughout Coral Bay, mangrove planting, and long-term management and maintenance of stormwater control structures throughout the Coral Bay watershed.

Essential Fish Habitat within the Project Area

The District has defined the action area to include approximately 114 acres of navigable waters subject to the potential direct and indirect impacts of the proposed project. The docks, moorings, slips, and navigation ways of the marina would occupy approximately 25.5 percent (nearly 26 acres) of the approximate 97 acres of marine bottom within Coral Harbor. Within this action area, approximately 0.80 acres of coral colonized hardbottom is located 1,100 feet south of the project site, and 2.15 acres of coral colonized hardbottom is located 2,100 feet to the southeast of the project site.

The proposed marina site is on the eastern side of Coral Harbor. On August 2, 2018, the NMFS (Habitat Conservation and Protected Resources Divisions) visited the action area with representatives of USVI Department of Planning and Natural Resources. The purpose of the visit was to characterize the seagrass, coral, and hardbottom communities and compare the characterization to observations collected in January and February 2014 and February 2018 by agents for the applicant. Notably, Hurricane Irma directly hit St. John in September 2017, and the purpose of the site visit was to assess changes to the area form the hurricane. The observations the NMFS made on-site are consistent with the findings of the applicant's post-hurricane assessment.

The harbor bottom contains a mosaic of sandy bottom, live/hardbottom with coral, macroalgal beds, and seagrass. Native turtle grass (*Thalassia testudinum*) remains the dominant seagrass throughout the bay, some areas with 100 percent cover, followed by manatee grass (*Syringodium filiforme*) and lesser shoal grass (*Halodule wrightii*). Throughout the seagrass beds within the project footprint, the NMFS observed a high abundance of juveniles from commercially important fish species, including gray snapper (*Lutjanus apodus*) and schoolmaster (*Lutjanus griseus*), relatively large colonies of smooth star coral (*Solenastrea bournoni*), and several small colonies of lesser starlet coral (*Siderastrea radians*). Prior to Hurricane Irma, dense mangroves, primarily red mangroves (*Rhizophora mangle*), dominated the Coral Harbor shoreline. Post-hurricane observations include bare and mangled mangroves along the shoreline, various types of debris scattered throughout the bay, seagrass scouring due to vessel groundings, and the presence of the non-native seagrass *Halophila stipulacea,* primarily in disturbed bottom areas.

According to the benthic assessments provided by the applicant, the proposed project footprint does not include hardbottom or coral colonized hardbottom; however, two shallow hardbottom areas colonized by corals occur approximately 1,100 feet south and 2,100 feet southwest of the proposed project footprint, on both sides of the mouth of Coral Harbor. These hardbottom areas are within the District-defined 114-acre action area. At these sites, the NMFS observed colonies of coral species listed as threatened under the Endangered Species Act (ESA) and identified by the applicant, including elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), and mountainous star coral (*O. faveolata*). The NMFS observed nearly twice as many Orbicellid colonies along the eastern mouth of the bay than the ten colonies reported by the applicant. However, the NMFS was not able to locate the single colony of ESA-listed pillar coral (*Dendrogyra cylindrus*) reported by the applicant at the eastern mouth of the harbor.

Impacts to Essential Fish Habitat

The impacts to seagrass from the proposed marina remain unclear, and the NMFS believes a meeting with the District and applicant would clarify these impacts. The bullets below provide our understanding to the seagrass impacts:

- The installation of 960 piles would permanently affect 0.03 acres of seagrass.
- Relocating 12 moorings would permanently affect 0.094 acres of seagrass.
- Spudding by barges during construction would directly affect about 0.023 acres of seagrass. These impacts may not be permanent depending upon the success of best management practices taken.
- Dock structures would shade seagrass habitat, likely diminishing its fishery support value. The area of the dock structures is 1.68 acres. The severity of these impacts will vary based on the amount of shading and density of seagrass. The NMFS does not have sufficient information to assess the severity of the shading within these 1.68 acres.
- Vessels moored at the docks also will shade seagrass habitat, similarly diminishing its fishery support value. The NMFS estimates up to 5.65 acres of seagrass habitat would be shaded by the vessels. As noted above, the severity of these impacts will vary based on the amount of shading and density of seagrass. The NMFS does not have sufficient information to assess the severity of the shading within these 5.65 acres.
- Areas adjacent to the dock and vessel footprints often exhibit shading impacts due to shadow extensions. The NMFS estimates up to 1.41 acres of seagrass habitat would be shaded in this manner. As noted above, the severity of these impacts will vary based on the amount of shading and density of seagrass. The NMFS does not have sufficient information to assess the severity of the shading within these 1.41 acres.

- Operation of marinas commonly leads to loss of seagrass from prop wash, bottom scour, and other activities despite the great care of vessel operators. The extent of these impacts varies considerably within project documentation, ranging from 0.337 acres to 6.5 acres. The NMFS would like additional discussion with the District and applicant on these impacts.

Minimization of Impacts to Essential Fish Habitat
The applicant reduced the footprint of the marina by reducing the number of slips from 145 to 144 and the number of pilings from 1,333 to 960. The dock size was reduced by 0.01 acres, which would reduce the area of direct impact by 0.03 acres and the area of shading by 0.04 acres. Although we appreciate inclusion of these additional project minimization measures, they fall short of expectations for a project of this scale. The NMFS recommends additional avoidance and minimization of impacts by reducing the number of slips in shallow areas where there would be little clearance between the seabottom and moored vessels. Such adaptations could include the use of single pilings in place of finger piers and a significant reduction in the number of slips and vessel sizes the applicant aims to accommodate.

Additional Information Needed to Evaluate Impacts to Essential Fish Habitat
The NMFS believes the applicant did not adequately consider relocating the marina or reducing its size in response to local conditions that trigger the need for additional infrastructure. As described in the Suitability Analysis, the winds at Coral Harbor as typically come from the east/southeast, which means the proposed marina would be exposed often to offshore waves. The Suitability Analysis concluded the estimated one-year return wave heights at the project site would exceed established industry guidelines for berthing operations conditions. The analysis also concluded additional infrastructure, such as a floating wave attenuator, is necessary to ensure operations criteria are not exceeded and additional coastal infrastructure, such as a rubble mound breakwater, is necessary to mitigate the effects of a 50-year wave event. In-situ measurement data would be required to strengthen this analysis, and would be required to determine the potential impacts from the additional infrastructure.

The NMFS agrees with the District that a geotechnical study would aid evaluation of impacts from pile installation. The applicant estimates an average of 300 strikes to install each pile (960 total). At six piles installed per day, the pile driving requires 166 days under the assumption that the sediments within the project footprint are composed of a mix of fine, silty sand, and clay throughout the 25-foot embedment depth. The District requested a geotechnical study from the applicant to identify the sediments within the marina footprint that would support these assumptions; however, the study was not provided. If harder substrates are present within the embedment depth, pile installation may require additional strikes, longer installation times, or additional equipment. Any of these actions could increase impacts of sedimentation and shading on seagrass during construction activities.

The applicant provided water current measurements showing water movement in Coral Harbor is sluggish with circulation and currents influenced by tides and wind. Turbidity levels are consistently high within Coral Harbor, especially compared to areas throughout the rest of Coral Bay, resulting from limited exchange and flushing in and out of the bay. The applicant's analysis of water current measurements acknowledges that under such conditions, re-suspended fine sediments would remain in the water column of Coral Harbor for an extended period potentially resulting in long-term increases in turbidity and associated detrimental effects to the benthic community, potentially worsening the already compromised water quality of Coral Harbor. In order to assess fully impacts on seagrass due to prop wash, the District requested a study of water circulation from the applicant to assess the potential impacts with respect to sedimentation, water quality, and turbidity. Some of the proposed slips that would accommodate large vessels 100 feet or longer, which typically draft between five to nine feet, would be located in water depths of eight to nine feet, which could result in vessels frequently stirring-up and re-suspending sediments during the operation of the marina. Because the applicant did not provide this study, the agencies do not have enough information to fully assess or quantify the potential loss of seagrass due to prop wash scouring.

Compensatory Mitigation

To minimize the direct impact of pilings to seagrass, the applicant plans to relocate 0.03 acres of seagrass within the piling footprints to a recipient site in the northwest corner of Coral Harbor, where the Spring Gut discharges into the harbor. The applicant would also relocate any seagrass impacted by the installation of 12 permanent moorings for vessels, however, the Mitigation Plan does not estimate the area of seagrass relocated. The NMFS views the transplanting of seagrass within the direct project footprint as a minimization measure rather than mitigation. Additionally, 0.03 acres of seagrass makes up less than one percent of the minimum estimated potential loss of seagrass due to marina construction and operation. Furthermore, Coral Harbor is highly impacted by the input of terrestrial sediment due to runoff, most of which comes from Spring Gut. The seagrass recipient site in northwest Coral Harbor once had thriving seagrass, but no longer can sustain seagrass habitat due to sediment deposition from Spring Gut. Accordingly, the NMFS does not recommend relocating seagrass to this site and offers to work with the District to find locations that restore ecosystem services by repairing damage from blowouts and prop scars.

The applicant proposes to clean (through debris removal), repair, and assume the long-term maintenance of stormwater management structures located throughout the Coral Bay watershed in an effort to enhance the seagrass habitat. The District cannot fully assess or quantify the beneficial effects of the proposed debris removal and maintenance of stormwater structures on the condition and extent of seagrass beds within Coral Harbor. The NMFS believes this effort could help minimize additional impacts to EFH and agrees with the District that the applicant has not provided enough information to assess the potential beneficial effects on EFH. The NMFS offers to work with the District to quantify the ecological lift this type of mitigation would provide assuming the District believes there is a mechanism for enforcing this permit requirement.

In the Mitigation Plan, the applicant proposes to compensate for impacts to seagrass by collecting a minimum of 0.03 acres of debris from the seagrass beds within Coral Harbor, collecting a minimum of 0.23 acres of debris throughout 750 acres of greater Coral Bay, re-attaching an unspecified number of corals that have been dislodged post-hurricane in greater Coral Bay reef areas, and planting and monitoring 300 red mangrove propagules along 850 feet of shoreline in Coral Harbor. The NMFS generally supports the proposed concepts of debris removal; however, the seagrass habitat restored by these actions needs quantification. While the NMFS normally recommends against out-of-kind mitigation for seagrass impacts, the NMFS acknowledges the severity of the degradation of mangroves from Hurricane Irma along the shoreline and supports restoration of this area as compensatory mitigation. The NMFS acknowledges the Mitigation Plan includes other mitigation activities, including providing signage and information to promote the protection of natural resources and safe boating practices and providing a pump out and waste disposal facility to all boaters in the facility. While the NMFS views the activities as beneficial, the NMFS cannot accept these activities as mitigation for the loss of seagrass habitat. The Mitigation Plan also describes coral re-attachment but does not clearly link the activity to offsetting the direct or indirect impacts to corals and hardbottom resulting from marina construction and operation.

Conclusion

The NMFS believes operation of the marina would result in increased and potentially chronic turbidity within the harbor, which could outweigh the benefits of the proposed compensatory measures. Furthermore, the NMFS believes the mitigation plan proposed by the applicant would not provide sufficient compensation for the potential impacts of the marina on seagrass beds.

Thank you for the opportunity to provide comments. Please direct related correspondence to the attention of Ms. Ashley Ruffo at 3013 Estate Golden Rock, Almeric Christian Federal Building, Building Box 4, Christiansted, USVI, 00820. She may also be reached by telephone at 340-718-1236 or by e-mail at Ashley.Ruffo@noaa.gov.

Sincerely,

/ for

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

cc: COE, Jose.Cedeno-Maldonado@usace.army.mil
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APPENDIX II

Summer's End Group LLC

Response Letter of December 13, 2019

Kelly Egan, Project Manager
Project Manager, Biologist
Regulatory Office
US Army Corps of Engineers
4400 PGA Blvd Suite 500
Palm Beach Gardens, FL 33410

Re: SAJ-2004-12518 (SP-JCM)
St. John Marina

Dear Ms. Egan:

Please accept this letter as The Summer's End Group, LLC's (Applicant) response to the National Marine Fisheries Service (NMFS) requests for additional information by email correspondence dated September 26, 2018 from Protected Resources Division (PRD) and by letter dated October 25, 2018 from the Habitat Conservation Division (HCD) regarding the above referenced application. The Applicant sought clarification and assistance in responding to these requests with several conference calls with Jose Cedeno-Maldonado and NMFS staff from both divisions. The Applicant responds as follows.

1. ***Action Area*** *Pursuant to 50 C.F.R. 402.02, the term Action Area is defined as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." Accordingly, the Action Area typically includes the affected jurisdictional waters and other areas affected by the authorized work or structures within a reasonable distance.*

Applicant Response:

The US Army Corps of Engineers (USACE) and NMFS requested a comprehensive circulation study be completed by the Applicant to accurately assess the area of potential impacts and thereby define an appropriate action area. A defined action area is necessary to assess reasonable potential impacts and appropriately quantify the compensatory mitigation required to offset those impacts. NMFS-PRD provided the following comment on the scoping draft for the requested circulation study from Sea Diversified, Inc. dated April 26, 2019:

> **"For example, if modeling were to show turbidity would stay within 100 ft of the project footprint, then the benthic survey logically would not be needed over the entire ~100 acres of Coral"**

Please see Exhibit 1, Attachment A, Sea Diversified scoping document mark-up, June 10, 2019.

The USACE references the law pursuant to 50 C.F.R. 402.02., and defines "action area" as "all areas to be affected directly or indirectly by the federal action...", "...areas affected by the authorized work or structures within a reasonable distance."

The Applicant has completed the requested comprehensive circulation study. The results of the circulation study, inclusive of the numerical modeling analysis, defines the areas to be affected directly or indirectly as approximately 120 meters around the proposed marina (approx. 45 acres). Based on the modeling results and data, Humiston & Moore Engineers recommend the action area for potential impacts be established within 120 meters of the proposed marina.

Please see Exhibit 2, Attachment A, St. John Marina Numerical Modeling Analysis prepared for Sea Diversified, Inc. by Humiston & Moore Engineers.

Based on the modeling analysis, Applicant states that the 114 acres of action area previously proposed by staff is not reasonable based on the area of impacts identified by the studies performed. Further, "the benthic survey logically would not be needed" based on data provided, the Applicant requests that the action area defined by the District as the area within 120 meters around the proposed marina (approx. 45 acres) based on the data and analysis provided.

The USACE and NMFS reviewed and commented on the scope of work developed for the circulation study, including the specific methods needed to generate the data and analysis sought by NMFS in its review of this application. NMFS was quite specific as to the information sought and recognized the impact that the information generated would have on the defined action area as the comment on the draft scope shows.

Based on the Applicant's and USACE's discussions with NMFS, the action area should be limited to the areas of anticipated direct and indirect impacts which is identified by the studies provided to be the area within 120 meters around the proposed marina.

2. ***Essential Fish Habitat within the Project Area.*** *NMFS believes that corals listed under the Endangered Species Act (ESA-listed corals) may be affected by the proposed action. USACE's consultation request letter indicates that there are shallow reef and hardbottom areas to the south and southeast of the proposed marina footprint, immediately adjacent to the mouth of the harbor on both sides. The letter states that there is approximately 0.8 acre of shallow reef/hardbottom located on the west side of the mouth of Coral Harbor, about 1,100 feet (ft) from the project site and approximately 2.15 acres of shallow reef and hardbottom located on the east side of the mouth of Coral Harbor, about 2,100 ft from the project site. Please provide a comprehensive survey of ESA-listed corals in the action area. The detailed survey methodology should be*

developed in concert with NMFS in order to ensure that it is capable of detecting and identifying any ESA-listed coral species that may be present.

Applicant Response:

The Applicant consulted Sea Diversified, Inc. and Humiston & Moore Engineers (H&M) to provide a comprehensive circulation study in order to determine the possibility of impacts to ESA-listed corals. Based on the results of the circulation study, H&M determined that the action area should be approximately 120 meters around the proposed marina (approx. 45 acres) based on the results of the study.

According to the circulation study, the 45-acre area around the marina has a potential for impact from sediment deposition to a depth of two meters (most natural resources are above two meters in depth) as a result of boating activities. The overall analysis provides reasonable assurances that the proposed marina will not adversely impact the ESA-listed corals located at the west and east mouth of the harbor, due to both the depth of those resources and the distance from the marina.

Humiston & Moore Engineers state in their circulation study that the results show that Harbor Point reef will not be affected by the marina operation. Harbor Point is the area noted above in the NMFS RAI as the reef/hardbottom located on the west side of the mouth of Coral Harbor. The results of the circulation study show that there is an 8% possibility of the sediment reaching Pen Point but only at a depth below three meters where there are no corals or areas of significance. Sea Diversified, Inc. preformed both side scan sonar and multibeam sonar on 100% of Harbor Point and Pen Point reefs. The results of the side scan sonar indicate no coral or area of concern below 2 meters depth.

Humiston & Moore engineers recommended that the action area be identified as the area within roughly 120 meters of the proposed marina, this identified area also corresponds to wave and current conditions 92% of the time. This area would cover the area with potential for sediment deposition down to 2-meters in depth (most natural resources are above 2-meter depth) could occur from marina activities. Accordingly, this is the area of concern for both mitigation and monitoring.

Neither Harbor Point nor Pen Point reefs are located within the recommended action area. The Applicant is not required to mitigate for areas that are not impacted directly or indirectly by the proposed project. Based on the studies performed, no further benthic surveys are required at the reef areas at the mouth of the harbor as they are not within the area that will be directly or indirectly impacted by the proposed project.

Please see Exhibit 2, Attachment A, St. John Marina Numerical Modeling Analysis prepared for Sea Diversified, Inc. by Humiston & Moore Engineers.

The Summer's End (SE) Harbor Management Docking and Mooring Plan (HDMP) was developed by Marine Management and Consulting, (MMC) President and Managing director Jeff Boyd. The HDMP is designed to protect of the coral colonies and hardbottom areas noted by Sea Diversified, Inc. and Humiston & Moore Engineers (H&M) in their work. The HDMP requires a clearly marked navigational channel directing vessel ingress to and egress from Coral Harbor, provides for enforcement and security of harbor activities by a United States Virgin Islands Department of Planning and Natural Resources (DPNR) officer and a pilot vessel to escort vessels into and out of Coral Harbor as necessary. The clear delineation of the channel, together with the other proposed actions, will provide assurances that the reefs, including all ESA listed corals, will be protected from direct impacts.

As a result of the Circulation Study completed by Sea Diversified, and the HDMP prepared by MMC, the Applicant states that the marina development and operations will not directly or indirectly impact the 0.80 acres of coral colonized hardbottom located 1,100 feet south of the project site, or the 2.15 acres of coral colonized hardbottom located 2,100 feet to the southeast of the project site.

Please see the Summer's End Harbor Management Docking and Mooring Plan, by Marina Management and Consulting, attached as Exhibit 3, Attachment A.

3. ***Minimization of Impacts to Essential Fish Habitat*** *- The Applicant reduced the footprint of the marina by reducing the number of slips from 145 to 144 and the number of pilings from 1,333 to 960. The dock size was reduced by 0.01 acres, which would reduce the area of direct impact by 0.03 acres and the area of shading by 0.04 acres. Although we appreciate inclusion of these additional project minimization measures, they fall short of expectations for a project of this scale. The NMFS recommends additional avoidance and minimization of impacts by reducing the number of slips in shallow areas where there would be little clearance between the sea bottom and moored vessels. Such adaptations could include the use of single pilings in place of finger piers and a significant reduction in the number of slips and vessel sizes the Applicant aims to accommodate.*

Applicant Response:

In order to minimize impacts that could result from prop-wash or bottom scour in the slips located at south section of the marina dock with water depths ranging from 6 – 7 feet, the Applicant will limit the draft for vessels allowed to dock in these slips The draft and operational limitations for vessels allowed to use these slips have been incorporated into the Summer's End HDMP.

NMFS acknowledged the reduction of piles for the marina and the slips in the marina. The pile reduction are Applicant's most recent efforts at minimization of impacts and does not acknowledge Applicant's previous efforts to minimize impacts. To assist staff in reviewing minimization, Applicant has prepared a list of modifications to the project made thus far to minimize project impacts in response to comments in the federal and territorial review process of its pending applications. Applicant has demonstrated compliance with the requirements to avoid impacts by previously submitting a substantive and dispositive "alternatives analysis" as required by the Section 404(b)(1) Guidelines. The alternatives analysis outlined the Project purpose and analyzed multiple sites with the region. The analysis supports the conclusion that there were no practicable alternatives that satisfy the project purpose with less adverse environmental impacts that are available and capable of being acquired and developed taking costs, existing technology and logistics into account in light of the overall project purpose. See also response to Question 4.

Applicant has implemented the following minimization efforts including:

- Relocating docks further away from shore to remove the need for a dredge permit. By not dredging and, instead shifting, slips and vessels into deeper water, Applicant has minimized project impacts by eliminating impacts from re-suspended sediments that would have been caused by dredging within the project footprint. Please refer to the analysis submitted by Applicant regarding the defined action area for further information.

- Locating docks within the harbor at deeper depths to minimize the risk of potential prop wash and scouring.

- Modifying the original plans by replacing floating docks with solid composite decking with fixed docks with solid composite decking installed at a minimum of 4' above the mean high-water line in response to comments from USACE and NMFS.

- Substituting grated decking on the fixed docks throughout the facility to provide additional light exposure to submerged aquatic vegetation. These modifications to the marina provided substantially reduced (near-shore) and or eliminated deeper water impacts to seagrasses at the marina dock locations.

- Adding boat lifts to A Dock greatly reducing the shading impacts on seagrasses.

- Imposing operational and draft limitations for vessels docking at F Dock slip section I, where there are water depths of 6 – 7 feet to minimize and prevent prop-wash and scouring and limit suspension of sediment, thereby minimizing impacts to benthic habitat.

- Fund a grant that provides for a full time DPNR enforcement officer for Coral Harbor and the island of John. A full-time enforcement officer for St. John helps to dramatically improve the marine environment from long term damages caused by non-compliant boaters and others. Added enforcement helps to ensure the monitoring of boating activities and moorings and enforce compliance with existing regulations and permits to protect sea grass beds and corals from prop dredge and anchor damage.

- Reducing the time needed for pile installation by 25% as a result of the geotechnical study and subsequent engineering re-evaluation,

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Please see Avoidance and Minimization document attached as Exhibit 4, Attachment A.

The Applicant performed a break-even analysis to establish the vessel size and number of slips necessary for a marina to achieve economic sustainability on St. John. This project is specifically designed to both meet the project purpose and comply with the requirements for permitting, including avoidance, minimization and mitigation in accordance with regulations. The 144-slip mix of slips that accommodate both small and large vessels within the marina is based on that analysis and constitutes the alternative that meets the overall project purpose, providing a viable facility in this market and location while also complying with regulatory protections for the environment. The model runs for the economic analysis tested not only the existing design, but also several alternate scenarios. The study concluded that any reduction of the size of the marina below 144 slips or reducing the size range of vessels the marina could accommodate substantially impairs the financial viability of the project. Most significantly, such reductions in the marina greatly increase the economic risk of the project, and substantially increases the losses in the first several years, pushing the break-even point out into the future to an extent that capital funding at reasonable rates is imperiled or impossible to obtain.

A practicable alternative is defined in 40 C.F.R. Section 230.10(a)(2) as an alternative that is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purpose. Alternatives that do not satisfy the project purpose are not feasible. In the analysis of feasibility, issues of costs, existing technologies, and logistics must be considered. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense.

Applicant has worked with the USACE and NMFS from the initial concept to the current proposal. Applicant has responded to agency requests for additional information with a great deal of complex study and scientific analysis to establish that avoidance requirements have been met and further engaged in substantial minimization of the proposed project in its efforts to satisfy the regulatory requirements. What remains are unavoidable impacts resulting from a water dependent project. Accordingly, Applicant is submitting detailed mitigation to offset any unavoidable impacts. Applicant has meticulously analyzed the current environmental conditions in the harbor, the lack of enforcement of existing rules related to mooring and boat operations, illegal boating activity in Coral Harbor, the condition of publicly funded watershed projects that are failing mostly due to lack of maintenance, and the continuing impact of insufficiently treated stormwater carrying sediments into the harbor, to design its compensatory mitigation for this project to provide long-term ecological improvement in Coral Harbor and subsequently Coral Bay .

Applicant's proposal provides sufficient mitigation to result in a net improvement for water quality within Coral Harbor. Applicant further asserts it has provided sufficient data and analysis to the agencies to support the conclusion that Applicant has met the requirements for avoidance, minimized the project to the extent economically and reasonably feasible given the overall project purpose and provided sufficient mitigation to offset the project's unavoidable impacts.

4. ***Additional Information Needed to Evaluate Impacts to Essential Fish Habitat***
   The NMFS asserts Applicant did not adequately consider relocating the marina or reducing its size in response to local conditions that trigger the need for additional infrastructure. As described in the Suitability Analysis previously submitted, the winds at Coral Harbor as typically come from the east/southeast, which means the proposed marina would be exposed often to offshore waves. The Suitability Analysis concluded the estimated one-year return wave heights at the project site would exceed established industry guidelines for berthing operations conditions. The analysis also concluded additional infrastructure, such as a floating wave attenuator, is necessary to ensure operations criteria are not exceeded and additional coastal infrastructure, such as a rubble mound breakwater, is necessary to mitigate the effects of a 50-year wave event. In-situ measurement data would be required to strengthen this analysis, and would be required to determine the potential impacts from the additional infrastructure.

Applicant Response:

As previously noted in the response to Question 3, Applicant asserts that they have provided sufficient data and analysis in support of its avoidance analysis for the project site and no further analysis is required. In support of which Applicant states that Bioimpact, Inc. was retained to provide a comprehensive Alternative Site Analysis report that considered 10 sites where a marine could be developed on St. John. The analysis evaluated the sites for: compatibility with existing land uses and landscape; potential effects to existing business and local economy; compatibility with existing infrastructure; potential conflicts and adverse effects related to navigation; quantification of potential impacts to benthic habitats; and potential effects to protected or sensitive resources within or in the vicinity resulting from construction and operation of the marina; and, what avoidance and minimization measures could be undertaken at locations that would still satisfy the project purpose . The results of the alternative site analysis identified that the location proposed for St. John Marina provides the best practicable alternative on the island for a marina serving varying sizes of vessels and providing needed services and amenities to boaters in and around St. John. A practicable alternative is defined in 40 C.F.R. Section 230.10(a)(2) as an alternative that is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purpose. Property that the Applicant cannot reasonably obtain, utilize, or manage to fulfill the project purpose is not a practicable alternative. 40 C.F.R. Section 230.10(a)(2).

Please see Exhibit 5, Attachment A, Alternative Analysis.

NMFS staff also asserts that additional infrastructure will be required based on wave heights analysis. The Applicant asserts that additional infrastructure will not be necessary for the operation of the marina based on recommendations from Water Environment Consultants and Marina Management & Consultants as well as an additional review completed by Marina Management & Consultants who is also the designer of Yacht Haven Grand on St. Thomas which has been successfully operated for more than a decade.

The Applicant asserts a correction to the comment above from NMFS that *"The analysis also concluded additional infrastructure, such as a floating wave attenuator, is necessary to ensure operations criteria..."*

The letter from Matt Goodrich, P.E., Water Environment Consultants dated February 20, 2018 clarifies by stating the following:

"As noted by the Corps in the January 28, 2018 letter, the WEC report explains that additional infrastructure to attenuate waves is one of the methods..."

"...the WEC report also explains that there are other alternatives to address the wave events that exceed the criteria. The proposed project will employ alternative approaches other than wave attenuation infrastructure (e.g., breakwaters)."

"...there are no regulator requirement to satisfy these specific criteria."

"...vessels will be evacuated from the marina in advance of hurricane conditions. Therefore, the only wave height consideration is in regard to structure design and survivability."

"The fixed docks used for the marina are designed for wave conditions that exceed the ASCE's harbor tranquility criteria. This is accomplished by using a decking that allow water to pass through) thereby reducing wave uplift forces) and by using a heavy duty dock system."

"...the WEC report concludes that the site is expected to provide safe berthing for recreational boats during operational conditions except for a small fraction of the time."

"The smallest vessels in the marina will be on boat lifts and safe moorings of these vessels is not a concern during conditions when waves exceed the operational criteria."

The letter from Jeff, Boyd, President, Marine Management & Consulting RE: SAJ-2004-12518 (SP-JCM) further clarifies design components and operational protocols that offset the need for any additional attenuation.

"The proposed marina plan arranges berths so that the largest vessels are positioned towards the seaward and windward-end of the marina plan, the smallest vessels are positioned towards the landward-end of the marina plan in the lee of the mega yachts which effectively attenuate the incident waves and reduce wave conditions towards the leeward-end of the marina where smaller boats are docked."

In addition to the foregoing, HDMP provides for additional operational measures that are commonly seen in marinas within the USVI.   MMC will implement the HDMP operational measures for the St. John Marina as the alternative to additional infrastructure.

"Tiedowns for boats in the marina that will be adjusted by marina staff address changes in wind and wave as needed."

"The smallest berths in the marina, 36 feet, will use boat lifts to remove smaller boats from the water."

"This marina will require pre-authorization to enter or leave the marina based on size, draft, and wind conditions as warranted. When conditions warrant, tenders will escort large vessels into and out of the marina."

On a per vessel size and location analysis "Long term berths will also include expandable elastic shock chords inserted within the mooring lines thus mitigating the surge and or fetch and slowing the movement periods of the vessels."

MMC evaluated several other marina facilities in close proximity to the proposed St. John Marina in Coral Harbor. Wind data was submitted as a comparison to other existing and successful marinas in close proximity. MMC concluded that that the proposed marina location is on par with or better than other facilities in the region in regard to impacts resulting from wind and wave action within in the action area.

Please see referenced supporting documents:
Exhibit 6, Attachment A, Letter from Matt Goodrich, P.E., Principal, Water Environment Consultants
Exhibit 6, Attachment B, Letter from Jeff Boyd, President, Marine Management & Consulting
Exhibit 6, Attachment C, Wave Graphics from Marine Management & Consulting

Based on the foregoing, Applicant asserts that the HDMP submitted together with the explanation of alternative methods provided by Water Environment Consultants are sufficient to refute staff concern that the wind and wave action require additional infrastructure, and supports Applicant' determination that a wave attenuator, is unnecessary for the successful operation of the project. Consequently, Applicant's request for authorization will not be modified to include any additional infrastructure and there will be no additional impacts to Essential Fish Habitat.

5. ***Additional Information Needed to Evaluate Impacts to Essential Fish Habitat Continued:***
   The NMFS agrees with the USACE that a geotechnical study would aid evaluation of impacts from pile installation. The Applicant estimates an average of 300 strikes to install each pile (960 total). At six piles installed per day, the pile driving requires 166 days under the assumption that the sediments within the project footprint are composed of a mix of fine, silty sand, and clay throughout the 25-foot embedment depth. The District requested a geotechnical study from the Applicant to identify the sediments within the marina footprint that would support these assumptions; however, the study was not provided. If harder substrates are present within the embedment depth, pile installation may require additional strikes, longer installation times, or additional equipment. Any of these actions could increase impacts of sedimentation and shading on seagrass during construction activities.

Applicant Response:

Applicant retained Sea Diversified, Inc. to conduct the requested geotechnical study and the work has been completed. The scope and method of the study conducted was reviewed and discussed with the USACE and NMFS prior to field activities to assure the data collected would generate the information sought by USACE and NMFS to evaluate the application for possible impacts to Essential Fish Habitat.

The results of the geotechnical study indicate that no hard substrates are present within the embedment depth for the piles. Further, the study shows that the vibra-hammer method for pile installation originally proposed by the Applicant is a viable and effective installation method throughout the marina footprint.

TechnoMarine Manufacturing has reevaluated the marina design and engineering based on the geotechnical study produced by Sea Diversified, Inc. and has updated the project's pile driving summary. The pile driving summary states that the Applicant will be able to drive 8 piles per day using a vibra-hammer for a duration of 120 days. As a result of the geotechnical study and subsequent engineering re-evaluation, Applicant modifies its request to seek authorization for the installation of up to 8 piles per day for a duration of approximately 120 days. The proposed modification to the installation process results in a 25% reduction in the time required for piling installation compared to that originally proposed by Applicant. Further, the proposal, as revised to allow the use of vibrahammer, results in significant reductions in impacts to the environment by reducing the time needed for installation and reducing the noise generated by installation of individual piles and the duration of the noise for the installation of all the piles. Applicant states that based on the results of the geotechnical analysis and the circulation study, NMFS concern of increased impacts to seagrasses caused by sedimentation and shading during construction activities are not supported by the data generated. Applicant further states that NMFS have sufficient information at this time to complete its evaluation of impacts to Essential Fish Habitat.

Please see attached:
Exhibit 9, Attachment A, Survey Report Geophysical Investigation and Bathymetric Survey Summer's End Marina by Sea Diversified, Inc.

Exhibit 7, Attachment A, Letter from Olivier Bigler, P.E., Technomarine Manufacturing, Inc. dated September 17, 2019.

6. ***Additional Information Needed to Evaluate Impacts to essential Fish Habitat Continued:***
   The Applicant provided water current measurements showing water movement within Coral Harbor is sluggish with circulation and currents influenced by tides and wind. Turbidity levels are consistently high within Coral Harbor, especially compared to areas throughout the rest of Coral Bay, resulting from limited exchange and flushing in and out of the bay. The Applicant's analysis of water current measurements acknowledges that under such conditions, re-suspended fine sediments would remain in the water column of Coral Harbor for an extended period potentially resulting in long-term increases in turbidity and associated detrimental effects to the benthic community, potentially worsening the already compromised water quality of Coral Harbor. In order to assess fully impacts on seagrass due to prop wash, the District requested a study of water circulation from the Applicant to assess the potential impacts with respect to sedimentation, water quality, and turbidity. Some of the proposed slips that would accommodate large vessels 100 feet or longer, which typically draft between five to nine feet, would be located in water depths of eight to nine feet, which could result in vessels frequently stirring-up and re-suspending sediments during the operation of the marina. Because the Applicant did not provide this study, the 4 agencies do not have enough information to fully assess or quantify the potential loss of seagrass due to prop wash scouring.

Applicant Response:

Response: In response to the Districts request, the Applicant has provided a comprehensive and detailed circulation study. The Applicant consulted Sea Diversified, Inc. and Humiston & Moore Engineers to complete the circulation study and provide the District and NMFS the requested analysis. The extensive scope for this study was discussed and revised with USACE and NMFS staff prior to initiation in order to provide the data needed to accurately assess impacts related to sedimentation, water quality, and turbidity and provide the analysis to address NMFS concerns.

The results of the study conclude that finer particles (silt), once displaced tend to deposit in deeper water within the bay where they are not likely to be disturbed. Based on the circulation study results, it appears that ESA-listed corals, elkhorn and staghorn coral critical habitat will not be impacted during construction or by the operation of the project.

There will be some impact to seagrass within the action area, including the marina and the adjacent area within 120 meters of the project. This analysis is complete and will be submitted under separate cover.

Please see St. John Marina Numerical Modeling Analysis, by Humiston & Moore Engineers attached as Exhibit 2, Attachment A.

7. ESA-Listed Coral Relocation

1. *Please provide the number, species, and size of ESA-listed corals that are going to be reattached in the 750-acre action area.*

2. *Who will be doing the coral repair work, and what are their qualifications to collect, handle, and reattach ESA-listed corals (if listed corals are to be reattached)?*

Applicant Response:

ESA-Listed Coral Relocation is no longer proposed based on the results of the circulation study. Based on discussions with NMFS and the USACE as well as the results of the circulation report, the Applicant states the proposed compensatory mitigation to improve water quality in Coral Harbor will be more than sufficient to offset any impacts.

Please see St. John Marina Numerical Modeling Analysis, by Humiston & Moore Engineers attached as Exhibit 2, Attachment A.

8. **Upland Permitting**

1. *(Partially Addressed) We will need to analyze the impacts from construction and operations of the marina to water quality in the bay, and then their effects to ESA species and critical habitat. Will the Applicant need to obtain a multi-sector general permit? Construction general permit? If the answer to either of these questions is yes, please identify each permit and its specific requirements with regard to sediment/erosion control and monitoring requirements (i.e., number and types of*

discharges, measurable monitoring requirements like water volume and concentration of contaminants expected in discharges, visual monitoring requirements, the stormwater pollution prevention plan, etc.). If no multi-sector general permit or construction general permit will be obtained, please explain why.

USACE explained that its purview is in-water work, and these permits are outside its purview (multi-section general permits and construction general permits are delegated to USVI from USEPA). However, NMFS needs this information in order to assess whether effluent will impact listed species. NMFS understands that USACE is limited in its ability to enforce monitoring at upland outfalls.

Applicant Response:

Applicant will obtain and comply with any and all permits delegated to USVI from USEPA relative to the protection of water bodies from stormwater impacts related to construction and operation of the project. Control of stormwater from construction site requires the installation of silt fence and siltation barriers to prevent discharges during storm events. Applicant will maintain the silt fencing and siltation barriers until construction is complete. Further, Applicant has proposed as part of its mitigation to provide rehabilitation and long term maintenance for portions of the stormwater system within the drainage basin which are presently unmaintained.

(Partially Addressed) What impact will stormwater discharge entering Coral Harbor from proposed upland development outfall(s) have on listed species (i.e., corals, sea turtles, fish)? [note: DVD Enclosure 6A diagrams erosion and sediment control plan] Impact considerations should include and specify all water quality contaminants. Similar to 15, above, USACE explained that its purview is in-water work; however, NMFS needs this information to assess whether effluent will impact listed species.

Applicant Response:

Applicant's upland development is a very small proportion of the uplands within the drainage basin. Applicant will comply with the delegated program for protection of water quality to USVI from USEPA for the operation and maintenance of its project. As discussed above, Applicant will rehabilitate and provide long term maintenance for portions of the stormwater system presently installed in the drainage basin, but not maintained, that is adversely impacting Coral Harbor which will thereby provide a net improvement in stormwater quality entering the Harbor. Presently there are no funds available to provide for long term maintenance and operation of the stormwater system installed in the drainage basin as the grants which paid for the stormwater improvements did not include funds for maintenance. As staff will doubtless agree, surface water management systems fail to protect water quality when such systems are not regularly and timely maintained, and may actually cause impairment to the water body.

.

9. **Vessel Docking and Mooring**

1. *Are there expectations to expand the marina in the future?*

Applicant Response: The Applicant has no plans to expand the marina in the future. In regard to the additional questions raised by Staff, the Applicant has addressed all concerns expressed by staff in the marina's Harbor Management Plan, including the reorganization of existing noncompliant vessels, and the comparison of current vessel traffic to anticipated vessel traffic when the marina is complete.

Please see attached Harbor Management Plan by Jeff Boyd, President of Marine Management and Consulting attached as Exhibit 3, Attachment A.

2. *What is the process for removal and installation of existing moorings? What impact will the proposed move of existing moorings have on listed species?*

Applicant Response:

As per Applicant's *Harbor Management Vessel Docking and Mooring Plan*: *"….in cooperation and coordination with USVI DPNR, the St. John Marina developers have agreed to professionally install, have inspected and maintain up to 75 public moorings throughout Coral Harbor, whose locations will be noted in the plan. The existing moorings that do not meet the standards set for the new moorings, or are a navigational hazard when presently located within the overall mooring plan area may be totally professionally removed with no impacts to listed species."*

3. *Will the proposed marina result in a redistribution of existing vessels? (in order to conduct a vessel strike analysis, I need to compare the number of new vessels to be docked and new vessels to be moored under the proposal to existing vessels moored in Coral Harbor)*

Applicant Response:

Applicant's *Harbor Management Vessel Docking and Mooring Plan states*:

> *"It is estimated that there are currently 55 +/- vessels moored and anchored throughout Coral Harbor, of which approximately 95% are non-compliant with the Rules and Regulations for Mooring and Anchoring Vessels in the U.S. Virgin Islands, as identified in Title 25, Chapter 16 of VIRR."*
>
> *Because of the pervasiveness of habitually non-compliant boats in the harbor, it is estimated that less than half of its current occupants would be willing to come into compliance and be relocated to a new mooring, and thus are expected to vacate Coral Harbor to places unknown.*

While combined long-term and short-term slip rental sales will average 90%+, marina occupancy will average annually at approximately 30%+/-, due to insurance regulations and other hurricane season related concerns, and seasonal tourist fluctuations."

4. *What is the vessel size class for each of the 12 new moorings, and what is the respective depth at each mooring?*

Applicant Response:

Applicant's *Harbor Management Vessel Docking and Mooring Plan states*: *"Twelve (12) moorings directly associated with the marina will be available for boats from approximately 30-60'. Depth for each mooring will be a minimum of 10' and a maximum of 17'."*

5. *Please compare the current vessel traffic (i.e., number and size of boats moored in Coral Harbor) to the number and size of boats proposed to be docked (in the marina) and moored in Coral Harbor.*

Applicant Response:

Applicant's *Harbor Management Vessel Docking and Mooring Plan* states:

> *"It is estimated that there are currently 55 +/- vessels moored and anchored throughout Coral Harbor, of which approximately 95% are non-compliant with the Rules and Regulations for Mooring and Anchoring Vessels in the U.S. Virgin Islands, as identified in Title 25, Chapter 16 of VIRR.*
>
> *Because of the pervasiveness of habitually non-compliant boats in the harbor, it is estimated that less than half of its current occupants would be willing to come into compliance and be relocated to a new mooring, and thus are expected to vacate Coral Harbor to places unknown.*
>
> *While combined long-term and short-term slip rental sales will average 90%+, marina occupancy will average annually at approximately 30%+/-, due to insurance regulations and other hurricane season related concerns, and seasonal tourist fluctuations.*
>
> *Boats presently moored or anchored in Coral Harbor range in size from approximately 35' +/- sail and power boats to a 100'+ schooner. Vessels at the St. John Marina will be similar in size but will additionally include vessels of 150'+/-. An increase in ingress and egress to Coral Harbor is anticipated, whether for use of marina facilities or DPNR designated moorings. Currently approximately 12 boats per day enter and leave Coral Harbor.*
>
> *When harbor improvements, channel markings, and mooring relocations have been completed and the St. John Marina is operational it is estimated that boat traffic in and out of the harbor to be 20 +/- per day on average, although marina boat traffic and occupancy fluctuate seasonally. While combined long-term and short-term slip rental sales will average 90%+, marina occupancy will average annually at approximately 30%+/- occupancy, due to insurance regulations and other hurricane season related concerns, and seasonal tourist fluctuations."*

Without the professional harbor management provided by marina personnel, reorganization, professional installation of proper mooring tackle & maintenance offered by the project, and mobile and fixed wastewater pump out, Coral Harbor is destined to return to its pre-Irma state of over 115 non-compliant boats committing consistent, long term damage to seagrass and the unabated discharge of untreated wastewater into the harbor.

To summarize, Applicant has no plans to expand the marina in the future. Further, the Applicant has fully addressed all concerns expressed by staff in the marina's Harbor Management Plan, including the reorganization of existing vessels, and the comparison of current vessel traffic to anticipated vessel traffic when the marina is complete.

Please see attached Harbor Management Plan by Jeff Boyd, President of Marine Management and Construction attached as Exhibit 3, Attachment A.

10. **Miscellaneous**

a. *What is the approximate proportion of seagrass estimated to be lost due to the proposed project to total seagrass (available for ESA-listed species foraging and refuge) in Coral Harbor?*

Applicant response:

In total it is estimated that 3.75 acres of seagrass may be lost.

b. *What assurances can the Applicant provide that the turtle grass transplanted to the northwest corner of Coral Bay will survive? Based upon information provided, no seagrass currently grows there.*

Applicant response:

Applicant no longer proposes to transplant sea grass as part of its mitigation proposal.

c. *Please confirm that both an air bubble curtain and wood block cushions would be used simultaneously to attenuate noise -- and protect juvenile Nassau grouper that may be present in the action area -- during installation of all piles.*

Applicant response:

Based on the geotechnical results produced by Sea Diversified, Inc. and the pile driving summary produced by TechnoMarine Manufacturing, the pile installation will be accomplished by vibra-hammer which would not require either a bubble curtain or wood block cushions to attenuate noise. In the unlikely event that an impact hammer would be required in pile driving for any reason, an air bubble curtain and wood block cushion would be used simultaneously to attenuate noise as originally proposed.

APPENDIX III

St John Marina Numerical Modeling Analysis

Sea Diversified Ind.

St. John Marina
Numerical Modeling Analysis

November, 2019

Prepared for
Sea Diversified, Inc.

Prepared by

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ST. JOHN MARINA

NUMERICAL MODELING ANALYSIS

01 GENERAL

This report provides a summary of the numerical modeling analysis conducted for the proposed St. John Marina in Coral Harbor, St John, Virgin Islands. The purpose of this analysis is to evaluate the potential effects of the marina on two reefs in its vicinity: the Pen Point and Harbor Point Reefs. More specifically, the analysis evaluates the potential for the proposed marina to result in increased sediment deposition at the reef locations. Background information reviewed consisted in data collected by Sea Diversified Inc. including ADCP current measurements, bathymetric survey, turbidity measurements and sediment samples sieve analysis. A circulation model was prepared to assess the flow patterns and characterize conditions that could potentially affect the reefs.

02 BACKGROUND DATA COLLECTION

02.01 TURBIDITY MEASUREMENTS

Turbidity measurements were collected by Bio-Impact Inc. on July 20th, 2019. Six locations within Coral Harbor were selected including the proposed marina location. The measurements were conducted once in the morning and once in the afternoon at all 6 locations and at three water depth: surface, mid-depth and 0.5m from bottom. The results and location of point measurements are presented in Figure 1. Overall the turbidity levels ranged around 2 NTU and lower. Location 3 and 1 showed the highest turbidity levels around 2 NTUs, while all other locations had levels lower than 1. Underwater photos from divers however, showed poor visibility within the proposed marina location (1), but this did not seem to affect turbidity readings significantly.

02.02 SEDIMENT SAMPLES

Several sediment samples were collected by Sea Diversified within the footprint of the proposed marina and at the location of the deployed ADCPs. For each location, 2 samples were collected and analyzed. The main factor likely to affect turbidity is the amount of silt present at any

	MORNING			AFTERNOON		
Sample ID	surface	middle	1/2m	surface	middle	1/2m
1	0.47	0.5	0.7	1.65	1.61	2.19
2	0.24	0.15	1.31	0.48	0.51	0.78
3	1.89	1.92	2.18	1.87	1.67	1.78
Open TM	0.53	0.42	0.93	0.52	0.5	0.34
Harbor pt	0.22	0.16	0.52	0.26	0.22	0.27
6	0.29	0.26	0.18	0.29	0.28	0.1

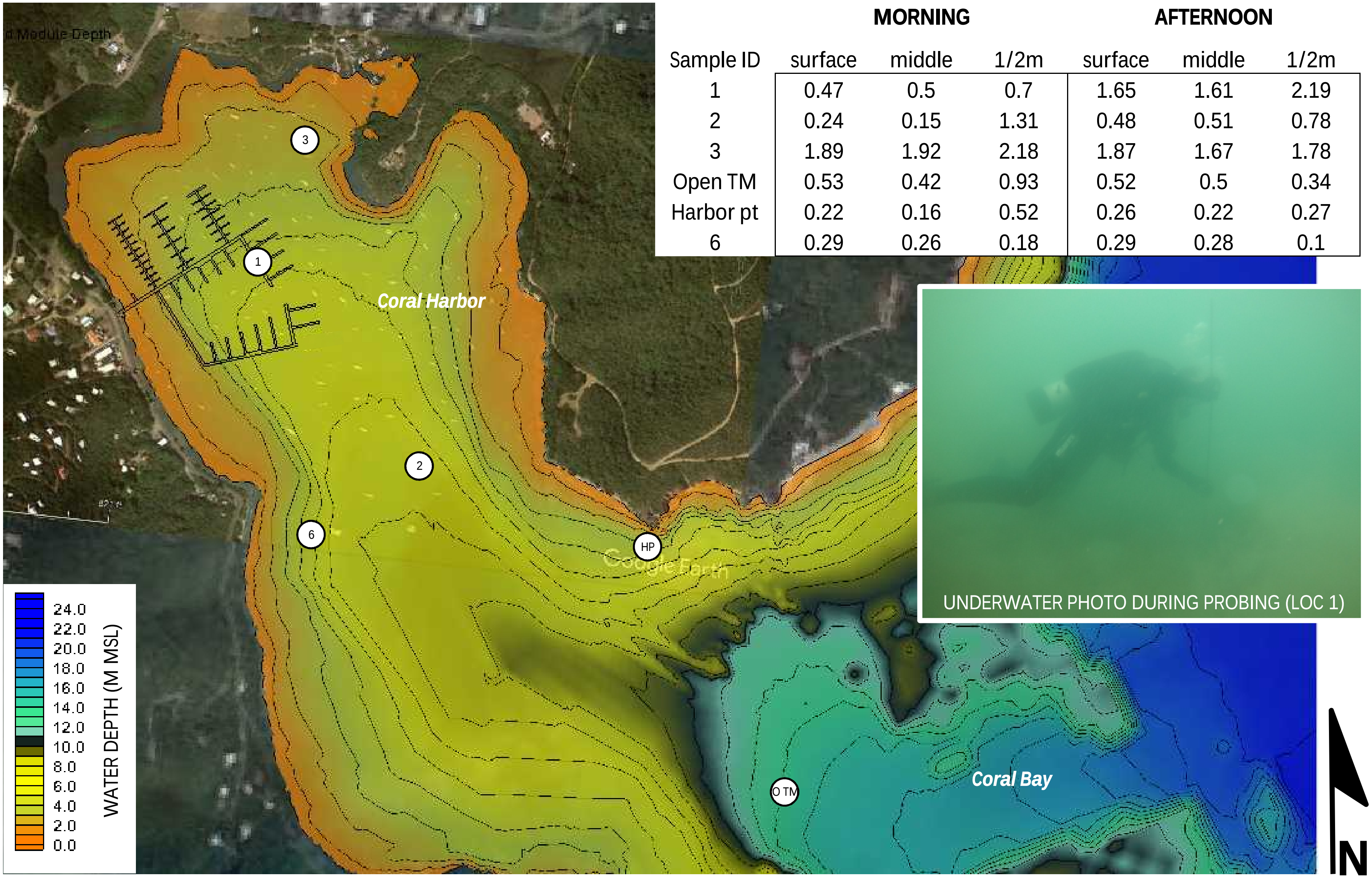


Figure 1: Coral Harbor - Turbidity Measurements

location because finer sediments, once disturbed will stay in suspension for a longer period of time, and thus could be carried away over longer distances. Figure 2 presents the results for the sieve analysis performed on all samples collected. The grain size distributions are presented in two ways (bar chart and log curves) in the exhibit, on the lower graph the percent passing sieve size #230 represents the amount of silt present within each sample (Yellow). The results indicate that the samples collected along the shoreline in shallower water contain the least amount of silt with levels ranging from 0 and 0.3% (NW and SW). Samples collected in deeper water contained silts levels ranging from 3% to 18% with sample SE containing the most. This indicates that finer particles (silt), once displaced tend to deposit in deeper water within the bay where they are less likely to be disturbed.

02.03 ADCP CURRENT METER

Sea Diversified Inc. deployed two Nortek ADCPs from July 16 to 20, 2019. The first gauge was located within the footprint of the proposed marina in approximately 4m of water depth and the second one towards the entrance of Coral Harbor in approximately 6m of water. The gauges collected current measurements at several depths (cells) along the water column and also measured wave heights.

Results from the instruments indicate that the cell located near the water surface measured higher current velocities than all the cells beneath which covered most of the water column. The measurements also show that peak current velocities correlated well with the incoming and outgoing tides. This suggests that the limited tidal prism in the harbor (approx. 0.3m) mostly affects the very top layer of the water column. In general, measured current velocities beneath the surface layer indicate that overall there is little current through the water column.

Figures 3 & 4 present the current measurement from the two gauges, a moving average was applied the data to highlight the main trend. The top graph represents the water level and each graph thereafter show the current velocity at increasing depth. Overall, when the current velocities are averaged over the depth at the gauge, the resulting current value was approximately 0.05 m/s for both gauges for the deployment duration. This indicates that there is no significant current in the bay in general.

03 NUMERICAL MODELING

03.01 MODEL DESCRIPTION & INPUTS

The Coastal Modeling System (CMS) suite of numerical models was used to perform detailed circulation modeling and help characterize flow patterns in Coral Harbor. CMS was developed by the US Army Corps of Engineers Coastal and Hydraulics Laboratory. The modeling system

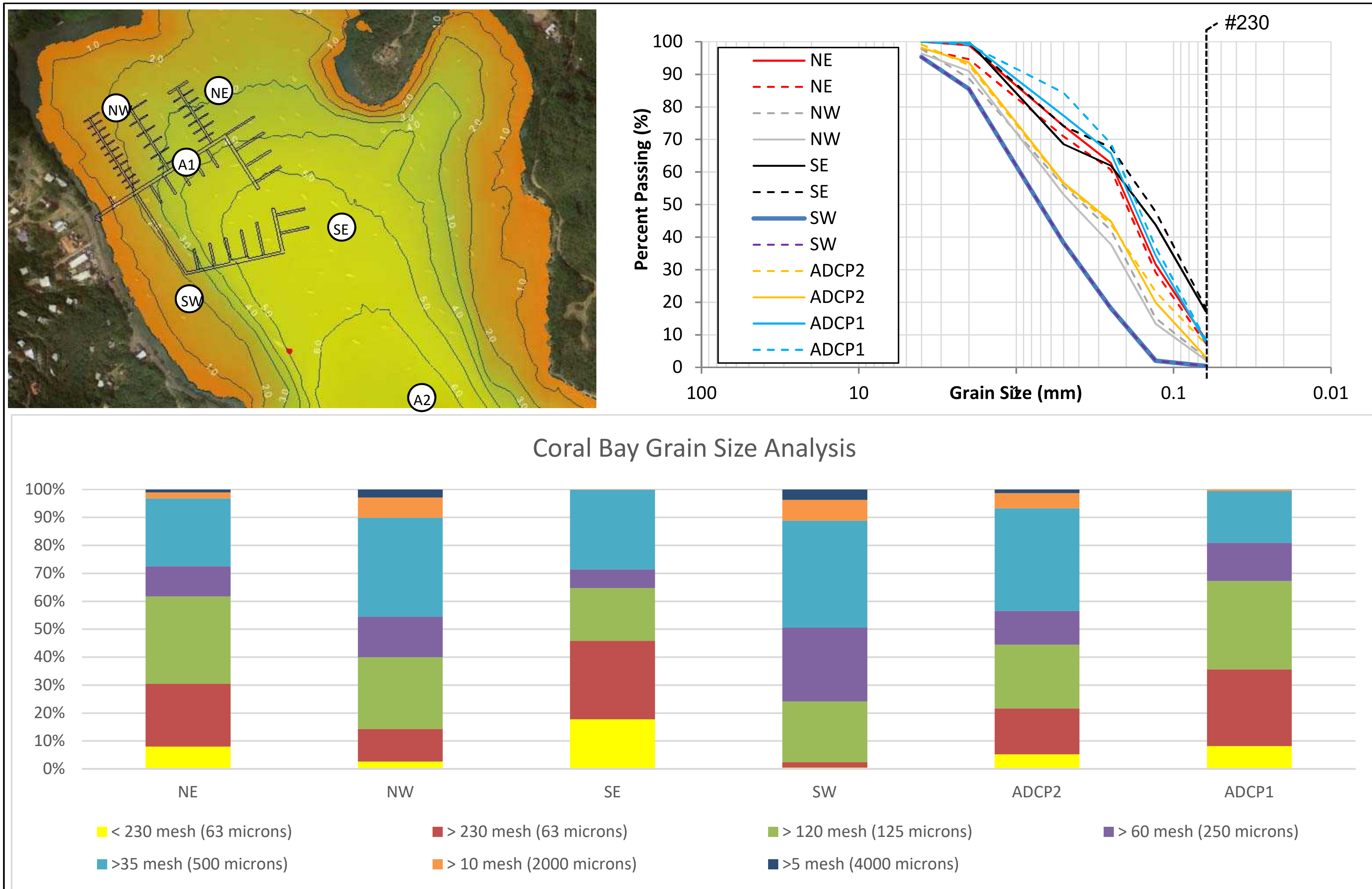


Figure 2: Coral Harbor – Sediment Samples Grain Size Distribution

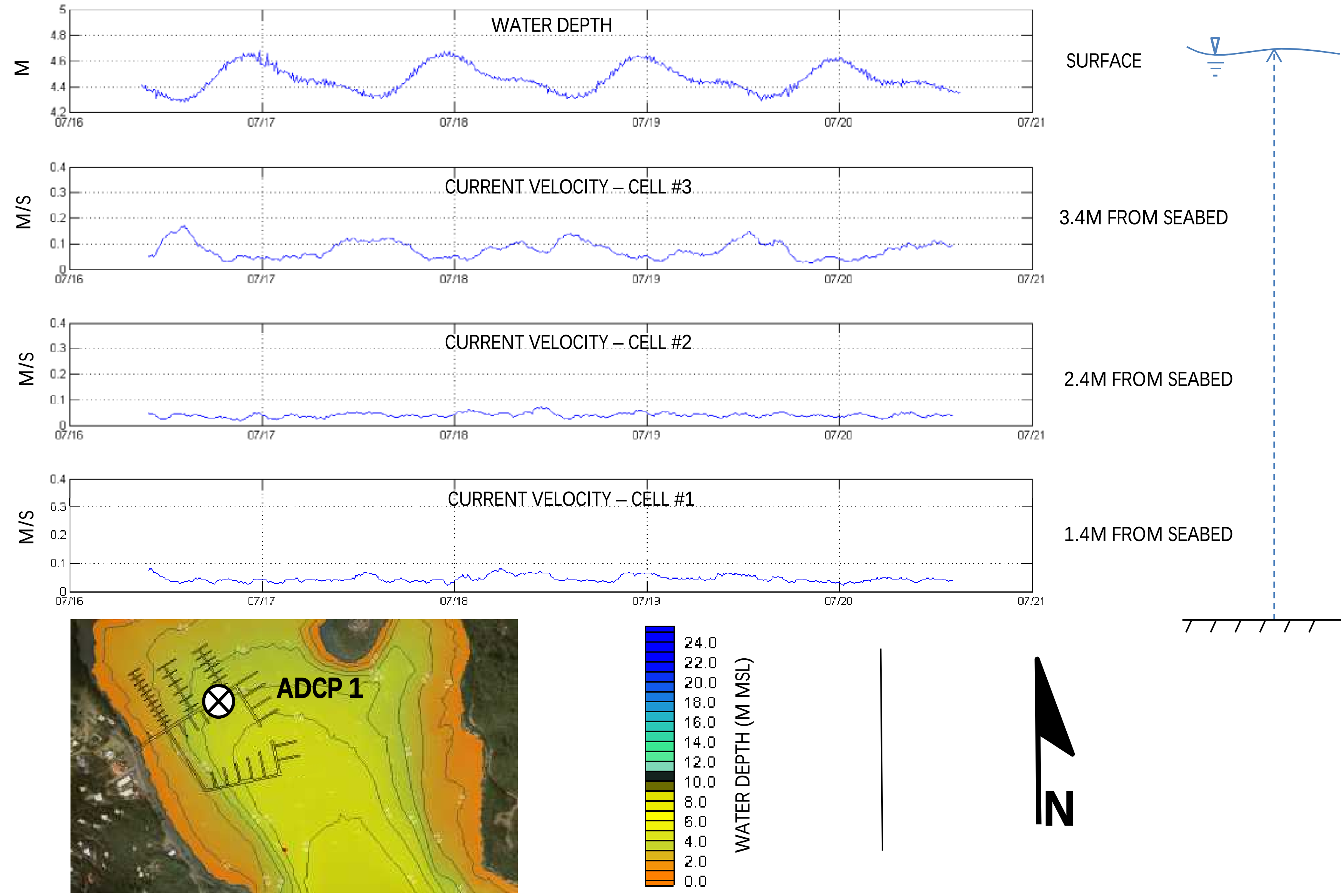


Figure 3: Coral Harbor – ADCP 1 Current Measurements

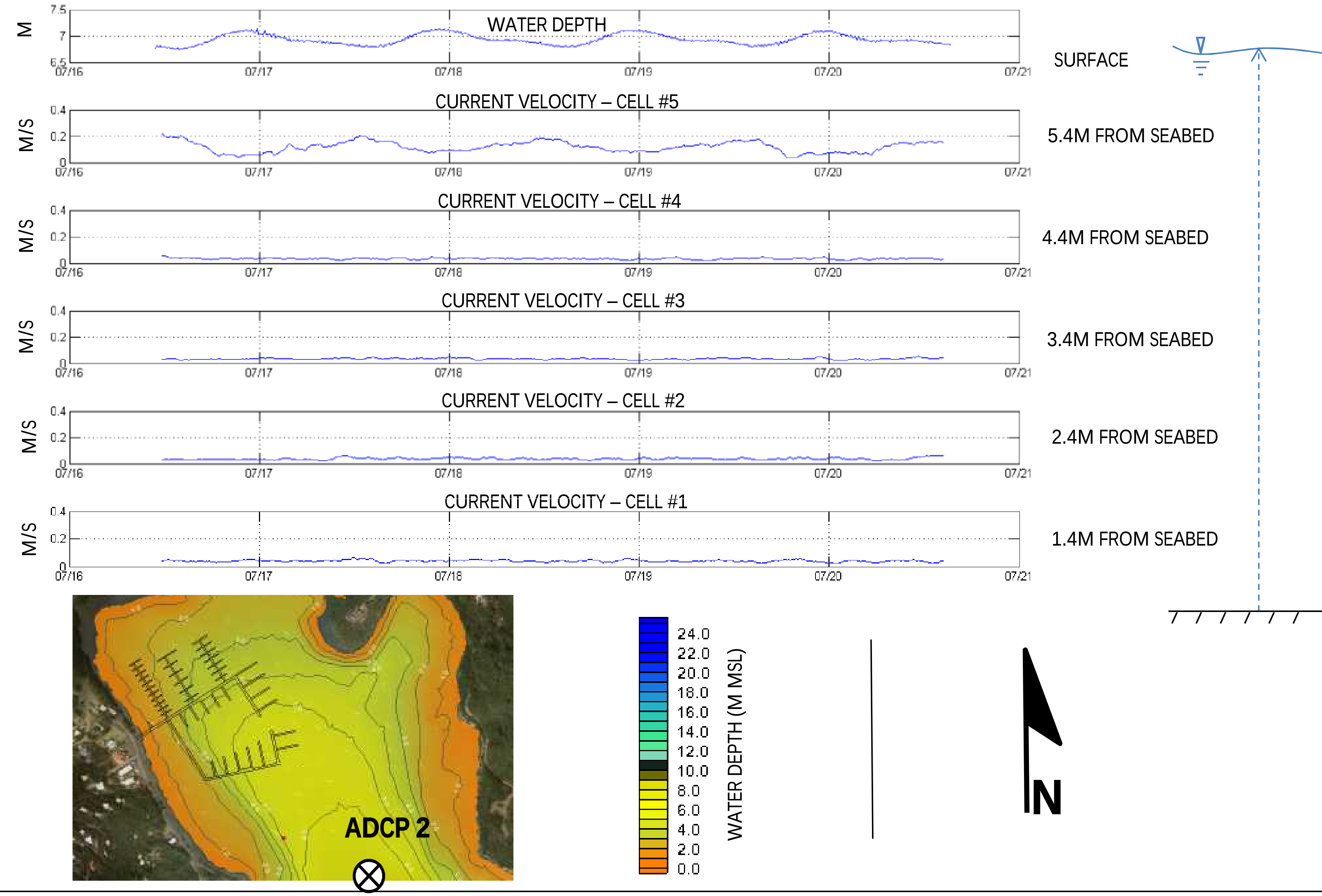


Figure 4: Coral Harbor – ADCP 2 Current Measurements

includes a 2-D wave spectral transformation phase averaged model suitable for coastal area modeling coupled with two dimensional, finite-difference numerical simulation of the flow, sediment transport and morphology. The model program allows for the creation of nested grids of varying resolution to allow higher definition in areas of interest. The model domain covered all Coral Bay with increased resolution for Coral Harbor and the proposed marina area. Figure 5 shows the CMS-Flow model grid with the nested cells varying in size from 8m in Coral Harbor to 64m for Coral Bay. This allows time dependent simulations of actual wave records while maintaining practical run time for long term simulations.

The numerical model inputs consisted in the recent bathymetric survey collected by Sea Diversified Inc. in July 2019 within the proposed marina area, bathymetry for the remainder of Coral Harbor was obtained from the most recent NOAA LIDAR data from 2011. Figure 6 shows the model domain with the input bathymetry. A full tidal cycle obtained from the nearest tide gauge in Lameshur Bay was used at the model open boundary as forcing, and several model runs were prepared with wave height input ranging from 0.5m to 2m.

03.02 MODEL RESULTS & VERIFICATION

The CMS model was initially setup to simulate waves only and then both waves and tide were used to help characterize the hydrodynamic patterns resulting from the combined forcing. Appendix A shows the model results for the waves only. In the figures, the lower quadrant shows a regional view of Coral Harbor and the main exhibit is a more detailed view of the proposed marina location for the corresponding simulated wave condition. Overall, the model results show that the marina location is fairly well sheltered from offshore waves. Additionally, the 1.5m offshore wave simulation resulted in wave heights similar to wave measured at the two ADCPs location (approx. 0.2-0.3m).

Appendix B presents the current model results for combined wave and tide simulations. The model simulates depth average current velocities, so velocities are representative of the whole water column. The results indicate that simulated current at the marina location are overall small in the order of magnitude between 0.01m/s to 0.08m/s for respective offshore waves of 0.5m and 2m. When comparing the depth averaged currents from the ADCPs to the simulated currents, the conditions for which the offshore waves were 1.5m result is the closest match. A review of the actual wave conditions for the nearest wave NOAA gauge (Station 41052 - South of St. John) shows that the offshore waves were on average close to 1.3 meters during the same time frame as the ADCP deployment. This suggests that the model could verify the current velocities with similar offshore wave conditions as simulated. Table 1 below presents a summary of the model results for wave and current velocity.

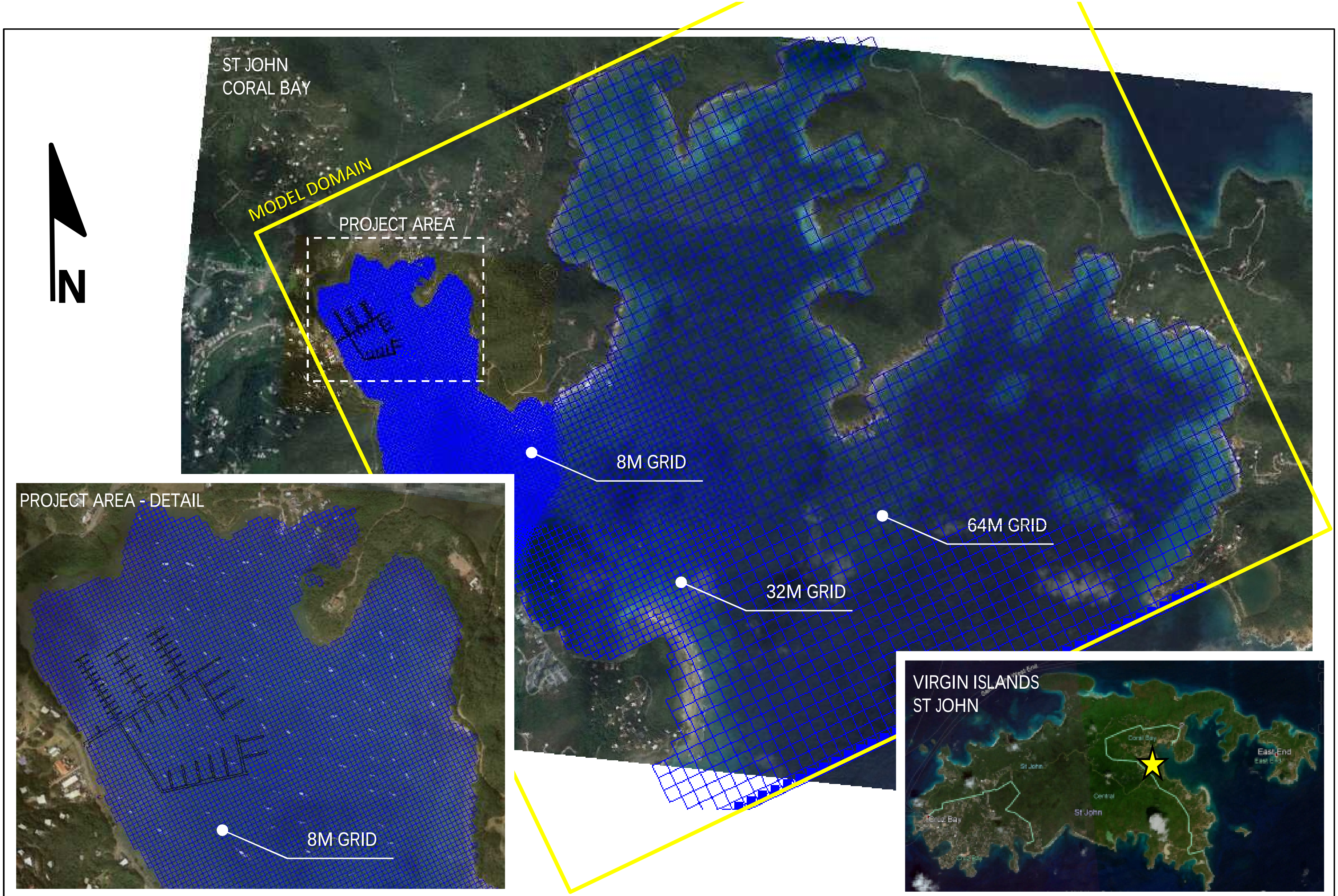


Figure 5: Coral Harbor – CMS Model Domain & Grid

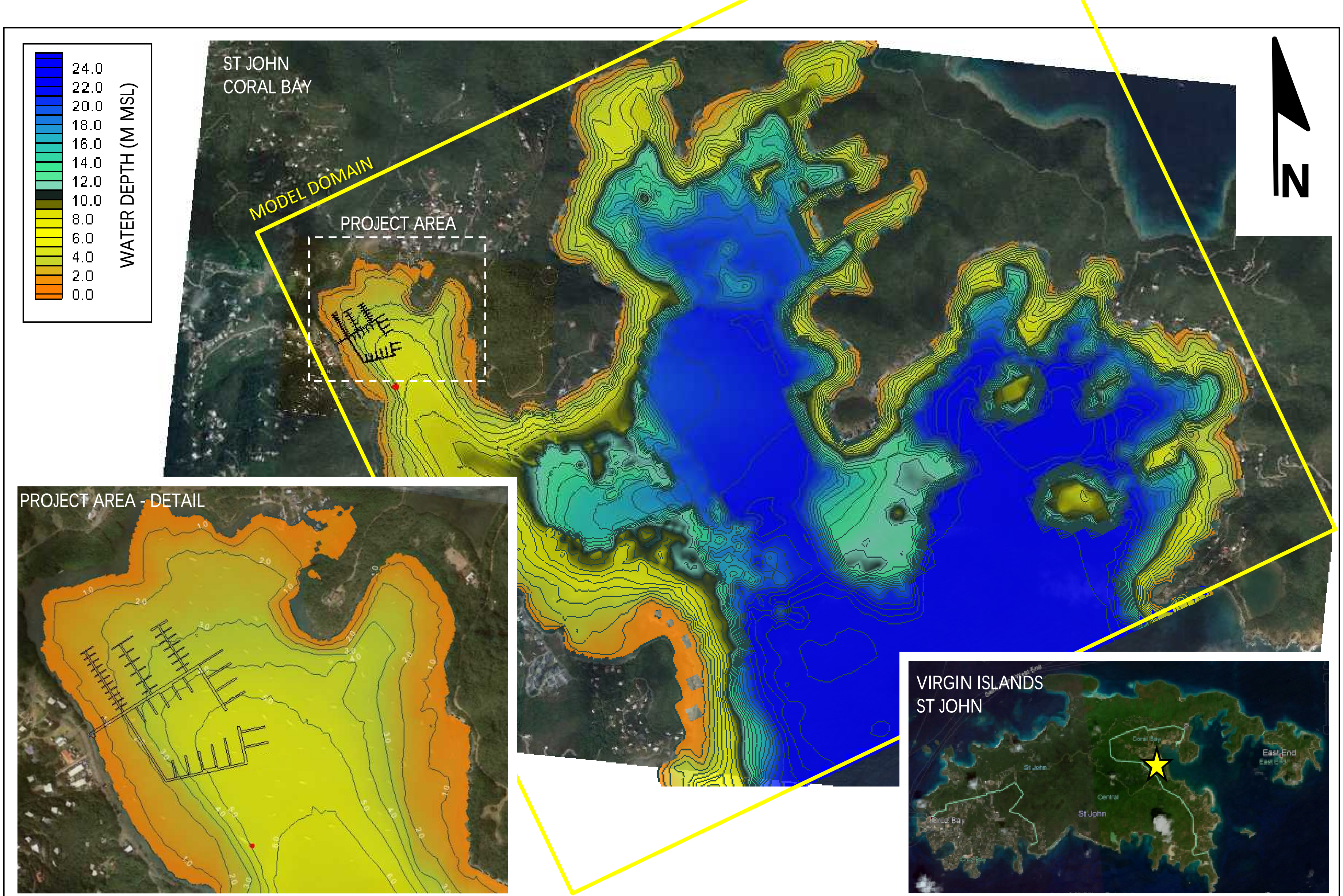


Figure 6: Coral Harbor – CMS Model Bathymetry

Table 1 – CMS - Model Results

	Offshore Wave Height	Wave Height @ Marina [m]	Current @ Marina [m/s]
	0.5m	0.1	0.01
	1m	0.2	0.03
ADCP measurement	1.3m	0.3	0.05
	1.5m	0.3	0.06
	2m	0.4	0.08

The model results seem to indicate that in addition to tidal fluctuations, wave heights may also affect the current magnitudes in the bay. The results suggests that incoming waves could generate a flow that follows the shorelines on either sides of Harbor Bay, and then returns offshore following the path along the higher depth in the center of the bay. While this assumption cannot be completely verified with the limited measurements, the similarity in magnitude between current simulated and measured provides reasonable level of validation for the model.

04 SUMMARY

The analysis of data collected in Coral Harbor combined with the numerical simulation allowed characterization of the hydrodynamic processes and their potential effects on turbidity and fine sediment deposition. The project is located in Coral Harbor, which is approximately 0.3 mile wide at the entrance and approximately 0.4 mile long. The overall significant width of the bay compared to its length and the small tidal range in the region result in water levels that rise and fall almost simultaneously throughout the bay during tidal exchanges. This explains the small current velocities measured and simulated. In addition, the grain size analysis suggests that finer sediments subject to disturbance from boating activities tend to settle in deeper water where they are less likely to be disturbed.

The analysis highlighted a potential correlation between waves and current in the bay. Based on the model results, the percent occurrence of certain current magnitude could be assessed from the analysis of wave events. **Appendix C** presents the annual time series of wave heights between 2014 and 2018 at Station 41052 offshore of St John. The percentage occurrence of wave was computed per bins of 0.5m for the 4-year period. These were then associated with their corresponding modeled current velocity and potential distances traveled by sediments were then computed following several assumptions:

- Sediments are disturbed mostly within the marina layout during boat docking maneuvers
- Sediments of interest are mostly medium and coarse silt with fall velocities of 0.1cm/s (Wentworth scale USGS).
- Disturbed sediments are assumed to reach the surface of water column.
- Most of the reefs are above 2 and 3 meters depth.

Using the fall velocity and predicted current velocities, several ranges for sediment deposition were determined, each carrying a specific probability of occurrence. The computations were conducted for 2 and 3 meters of water depth, corresponding to the deeper points along the reefs (**Figure 9**). **Figures 7 & 8** present these results as color coded zones of probability for sediment deposition. The results suggest that sediments carried from the marina could reach Pen Point reef depth 8% of the time but only below 3m depth. The results show that Harbor Point reef would not be affected.

Overall, the analysis provides reasonable assurance that the proposed marina should not result in significant increase in turbidity at the two reef sites in its vicinity. For monitoring purpose, based on the modeling results, we suggest using an “Action Area” of approximately 120 meters around the proposed marina (see **Figure 7,** approx. 45 acres). This would cover the area where potential for sediment deposition down to 2 meter deep (most natural resources are above 2 meter depth) could occur from marina boating activities. The area also corresponds to wave and current conditions occurring 92% of the time.

Additionally the gauge results show current magnitude at the highest when the tide is descending, this means that currents occur mostly during flushing of Coral Harbor. This is

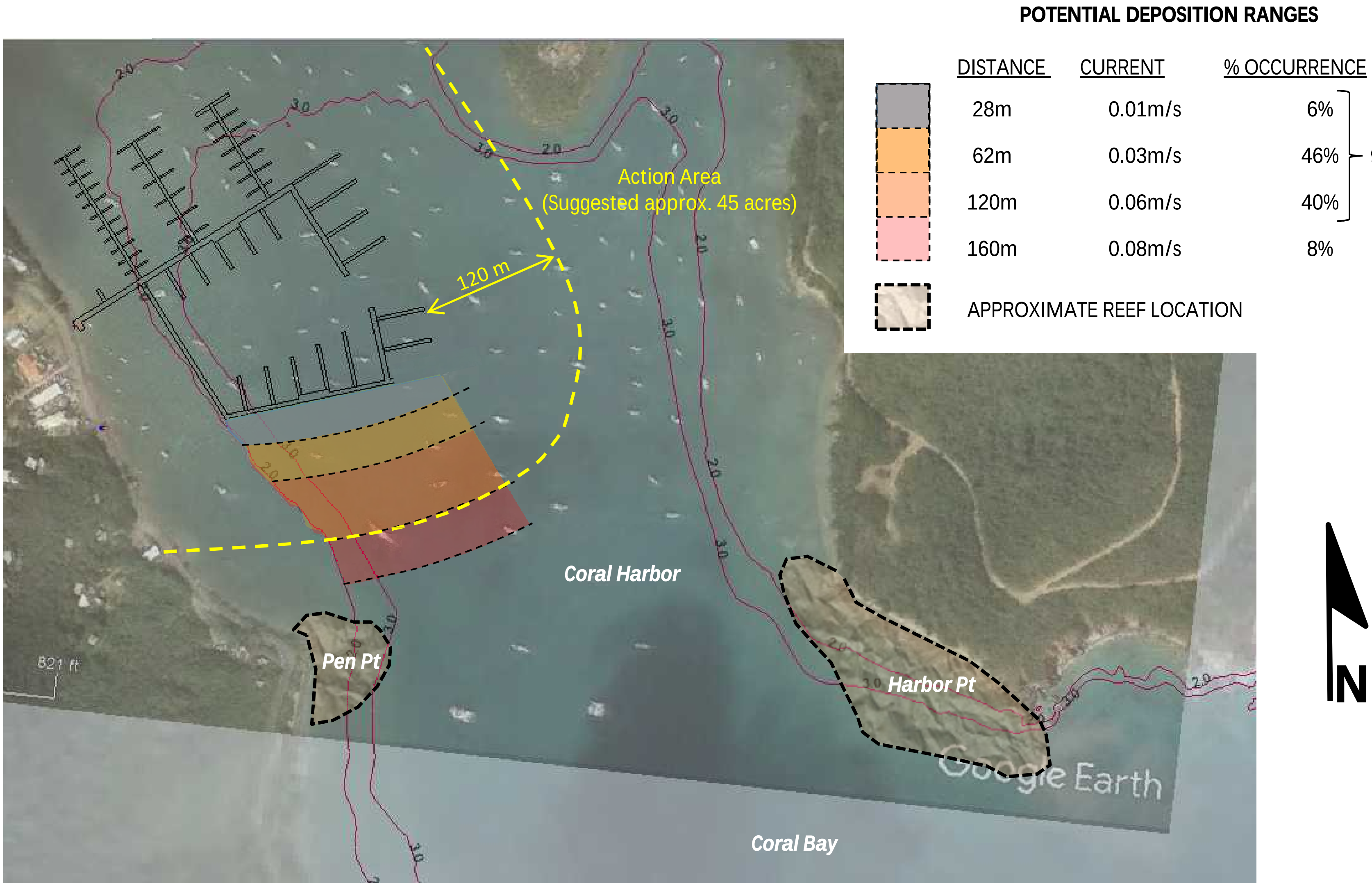


Figure 7: Coral Harbor – Potential Sediment Deposition Ranges to 2m depth

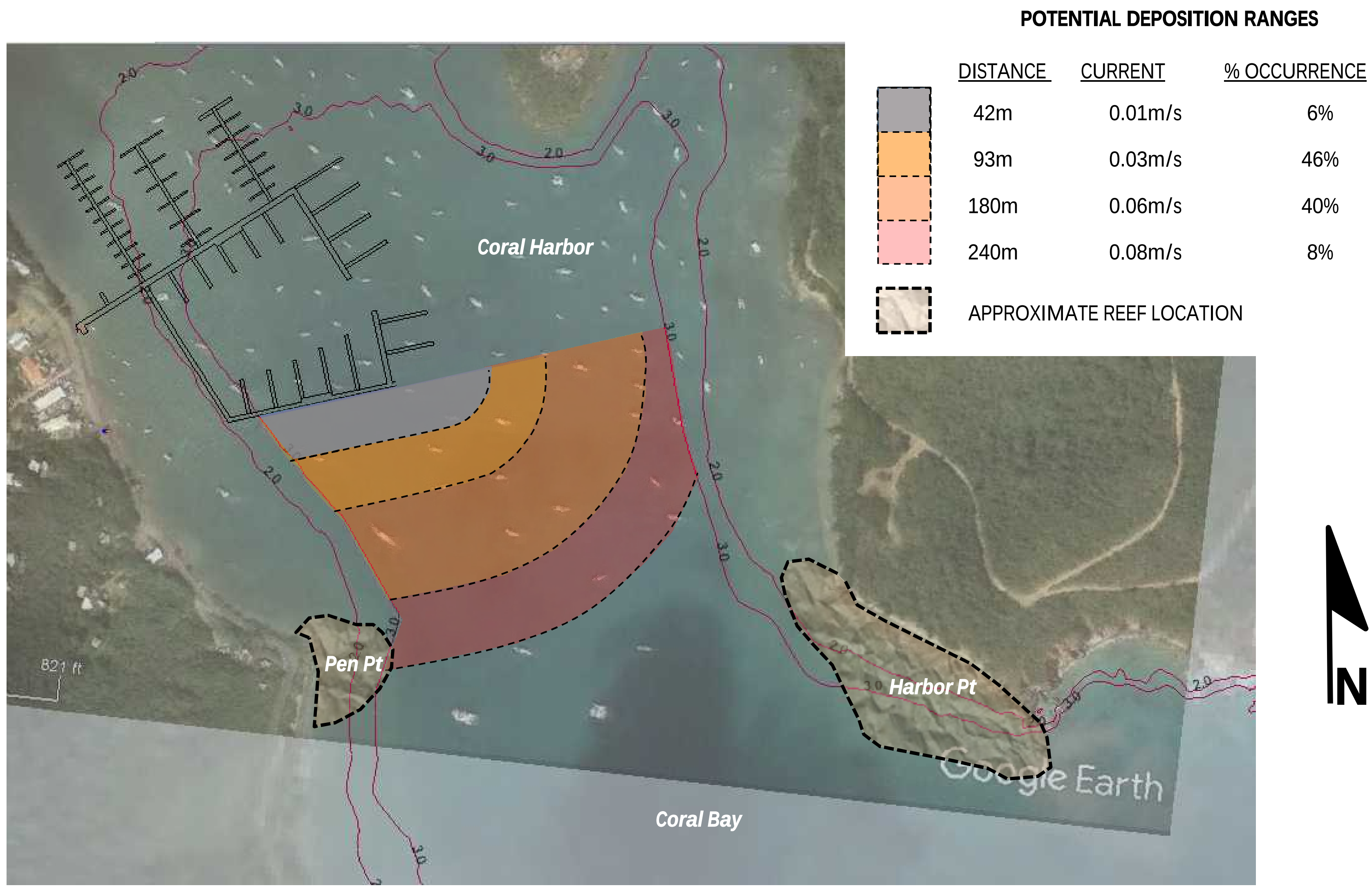


Figure 8: Coral Harbor – Potential Sediment Deposition Ranges to 3m depth

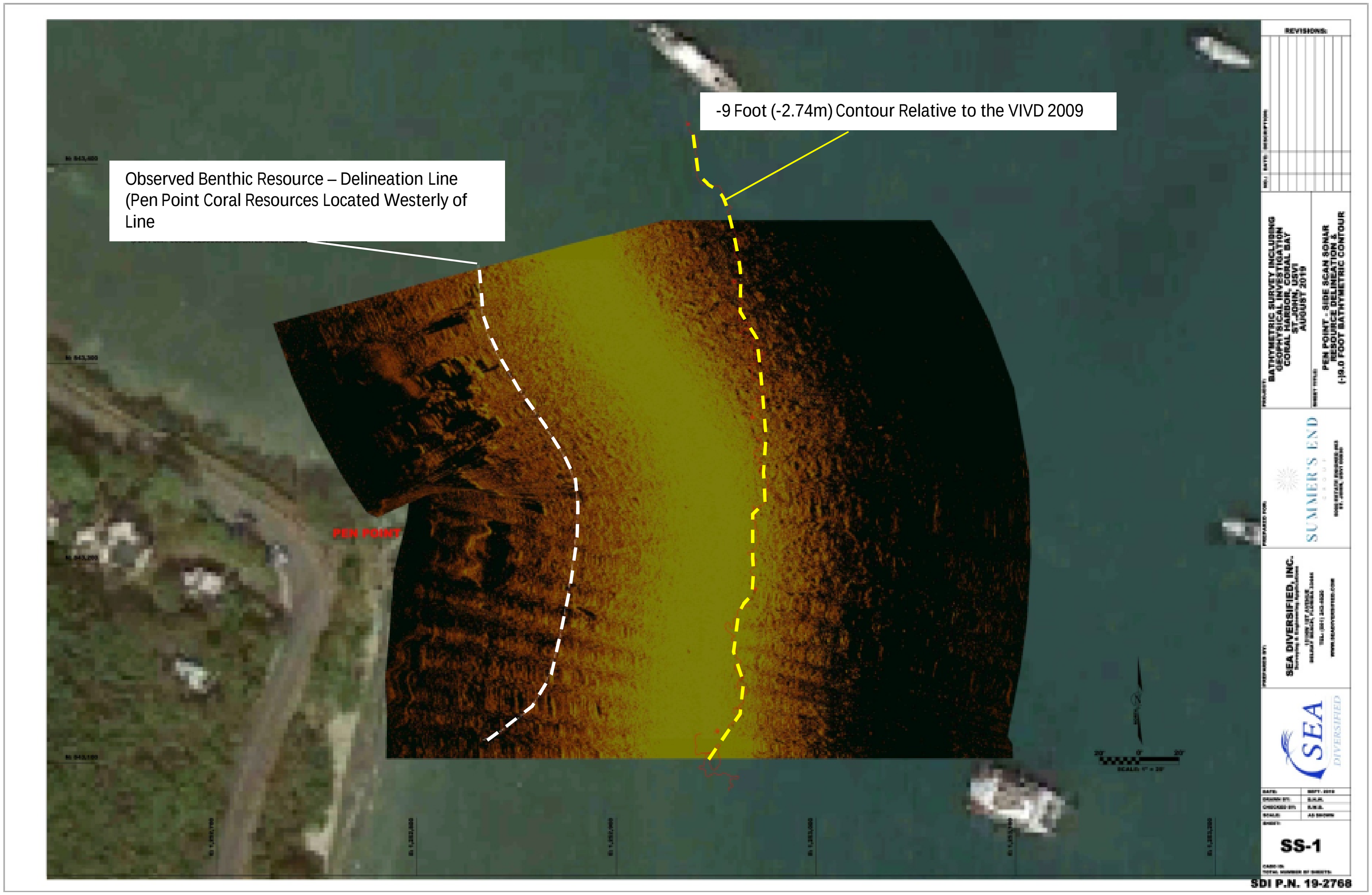


Figure 9: Coral Harbor – Sea Diversified Side Scan Sonar – Pen Point Reef

consistent with model results which show mostly flow going outside of the Harbor. Based on these observations, an increased turbidity at the marina would remain at the marina location or would migrate outside of the Harbor. The seagrass beds that could be affected are within the marina footprint area and possibly towards the south end of Coral Harbor within the 120m action area radius.

04 REFERENCES

Bio-Impact Inc., 2019, Turbidity Measurements.

Buttolph, A. M., C. W. Reed, N. C. Kraus, N. Ono, M. Larson, B. Camenen, H. Hanson, T. Wamsley, and A. K. Zundel. 2006. Two-dimensional depth-averaged circulation model CMS-M2D: Version 3.0, Report 2: Sediment transport and morphology change. Coastal and Hydraulics Laboratory Technical Report ERDC/CHL TR-06-09. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

CLE Engineering, Inc., 2016, Environmental Conditions & Structural Calculations for Twin Dolphin Marina.

Sea Diversified Inc., 2019, Hydrographic Survey Data, ADCP Current Measurement Data, Sieve Analysis Data.

APPENDIX A

CMS MODEL RESULTS

WAVE ONLY SIMULATIONS

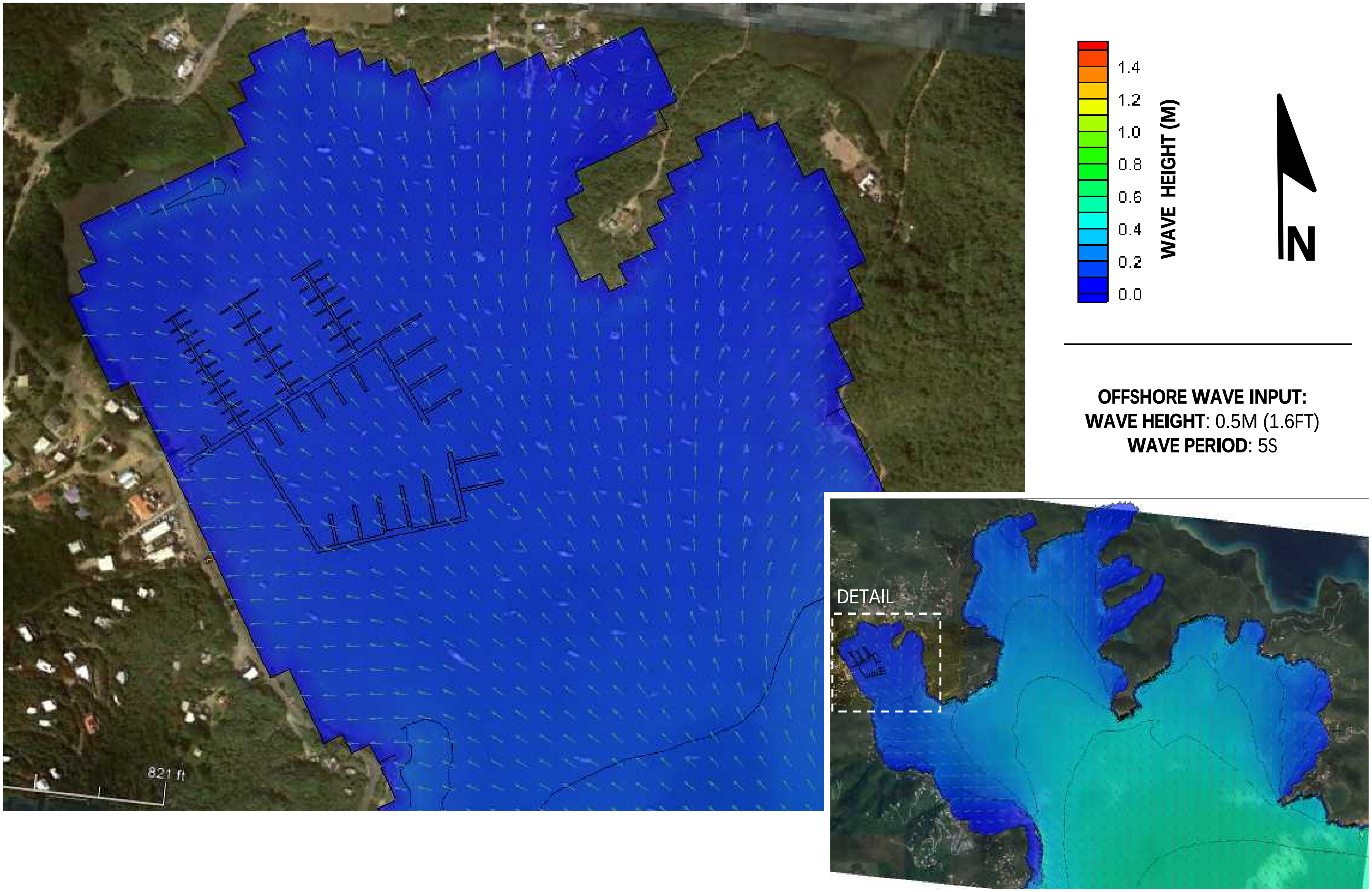


Figure A1: Coral Harbor – CMS-Wave Results – Hs=0.5m

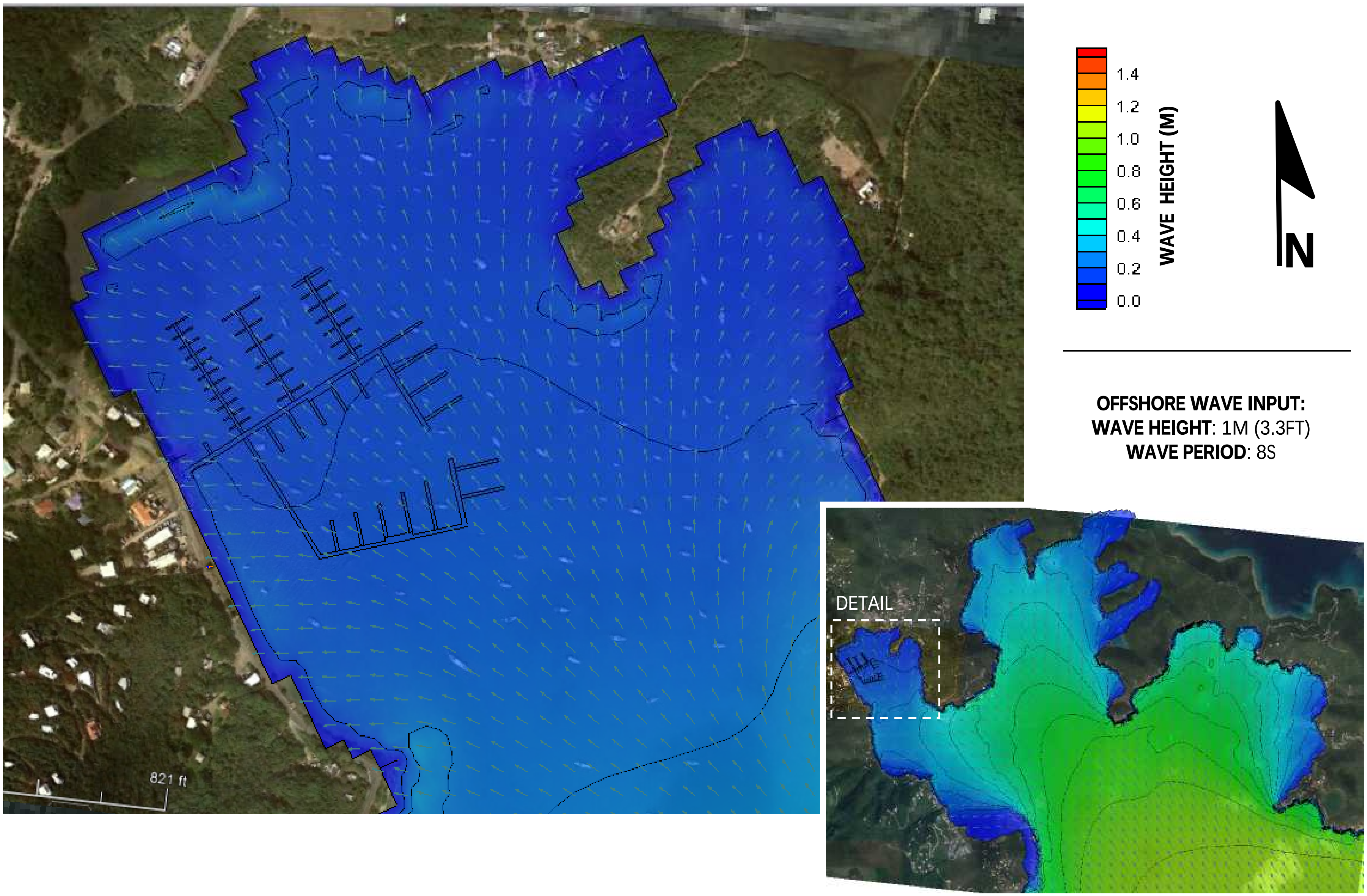


Figure A2: Coral Harbor – CMS-Wave Results – Hs=1m

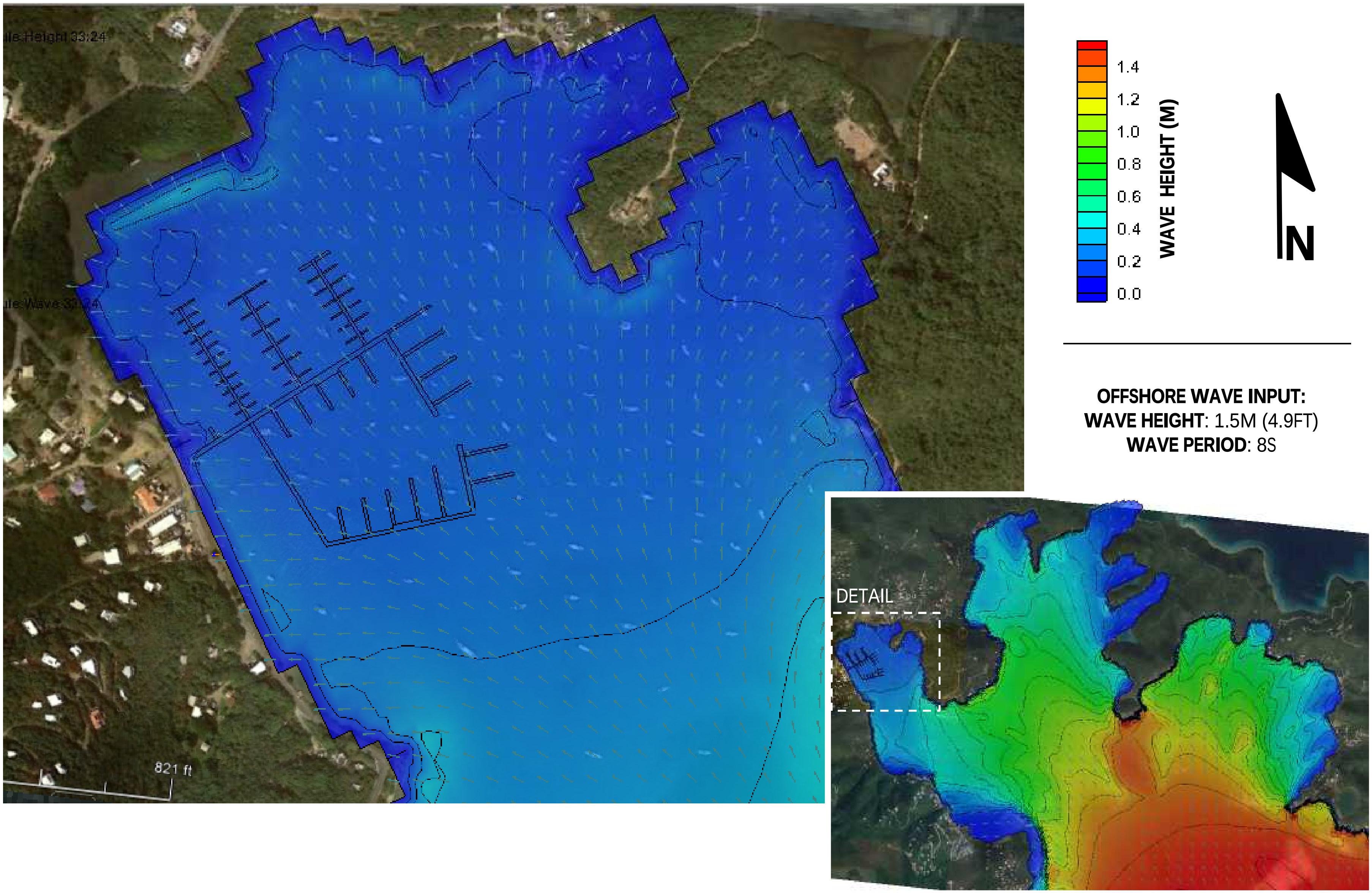


Figure A3: Coral Harbor – CMS-Wave Results – Hs=1.5m

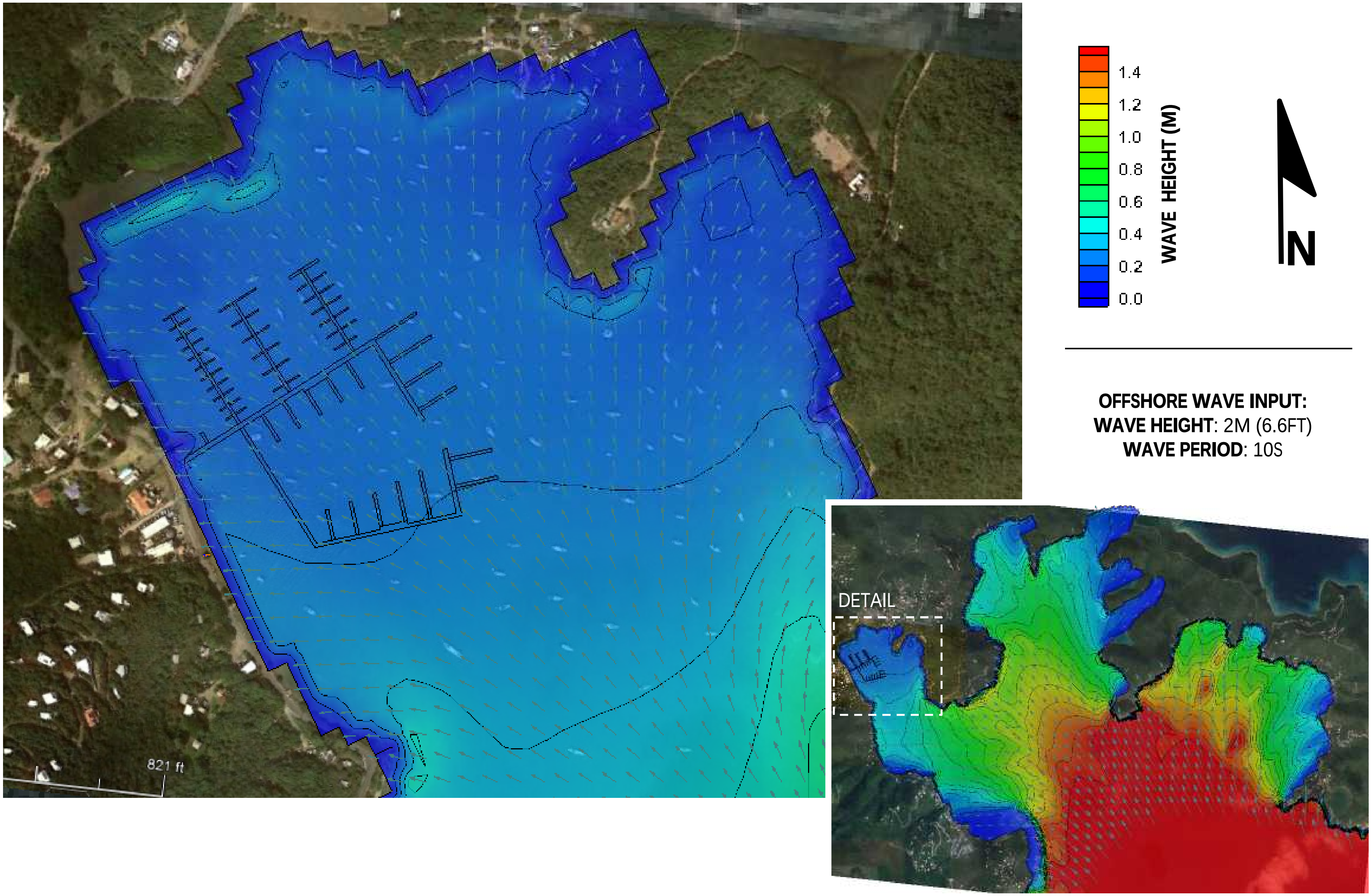


Figure A4: Coral Harbor – CMS-Wave Results – 2m

APPENDIX B

CMS MODEL RESULTS

WAVE & CURRENT SIMULATIONS

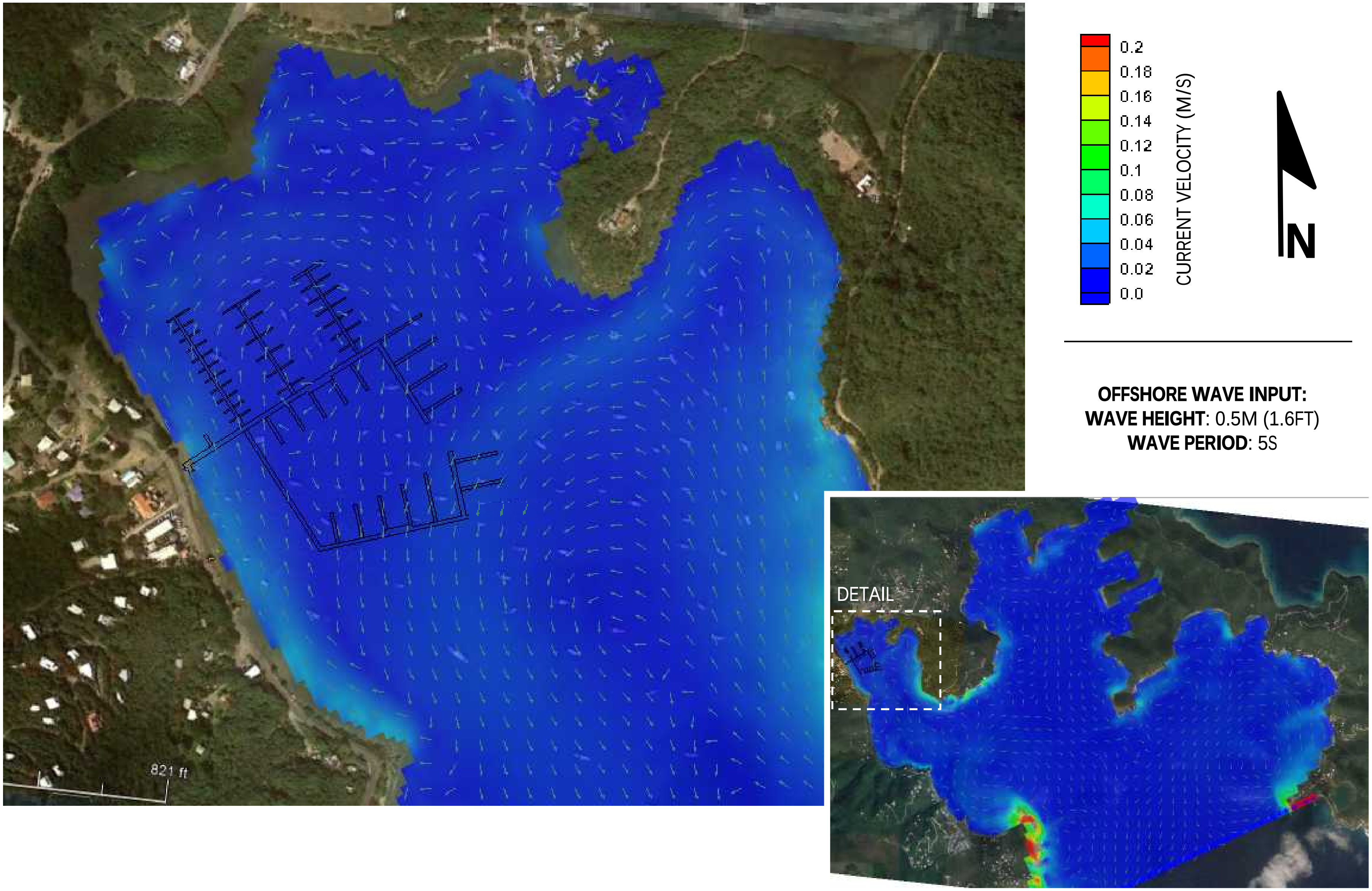
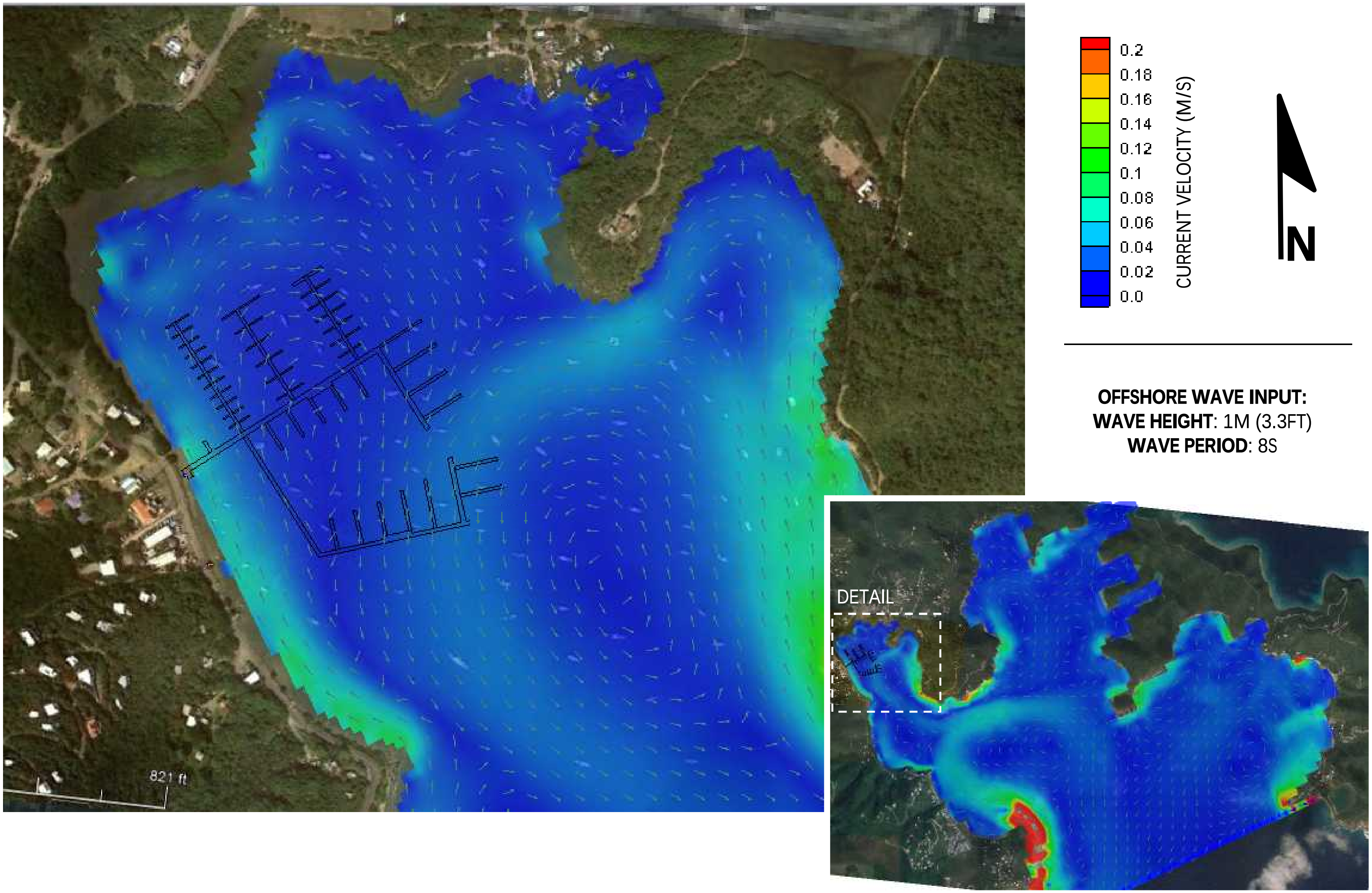
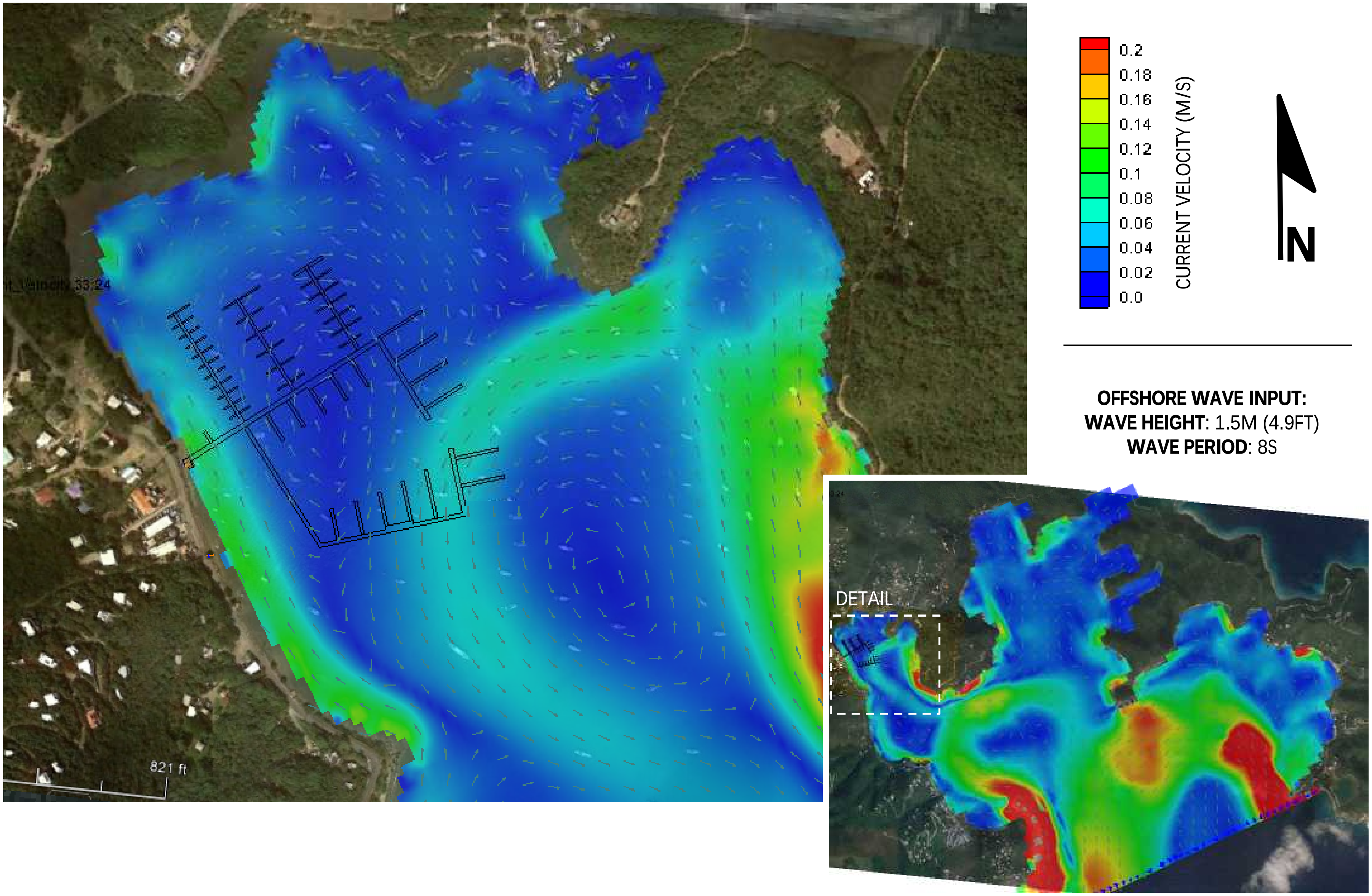


Figure B1: Coral Harbor – CMS-Flow Results – 0.5m



OFFSHORE WAVE INPUT:
WAVE HEIGHT: 1M (3.3FT)
WAVE PERIOD: 8S

Figure B2: Coral Harbor – CMS-Flow Results – 1m



OFFSHORE WAVE INPUT:
WAVE HEIGHT: 1.5M (4.9FT)
WAVE PERIOD: 8S

Figure B3: Coral Harbor – CMS-Flow Results – 1.5m

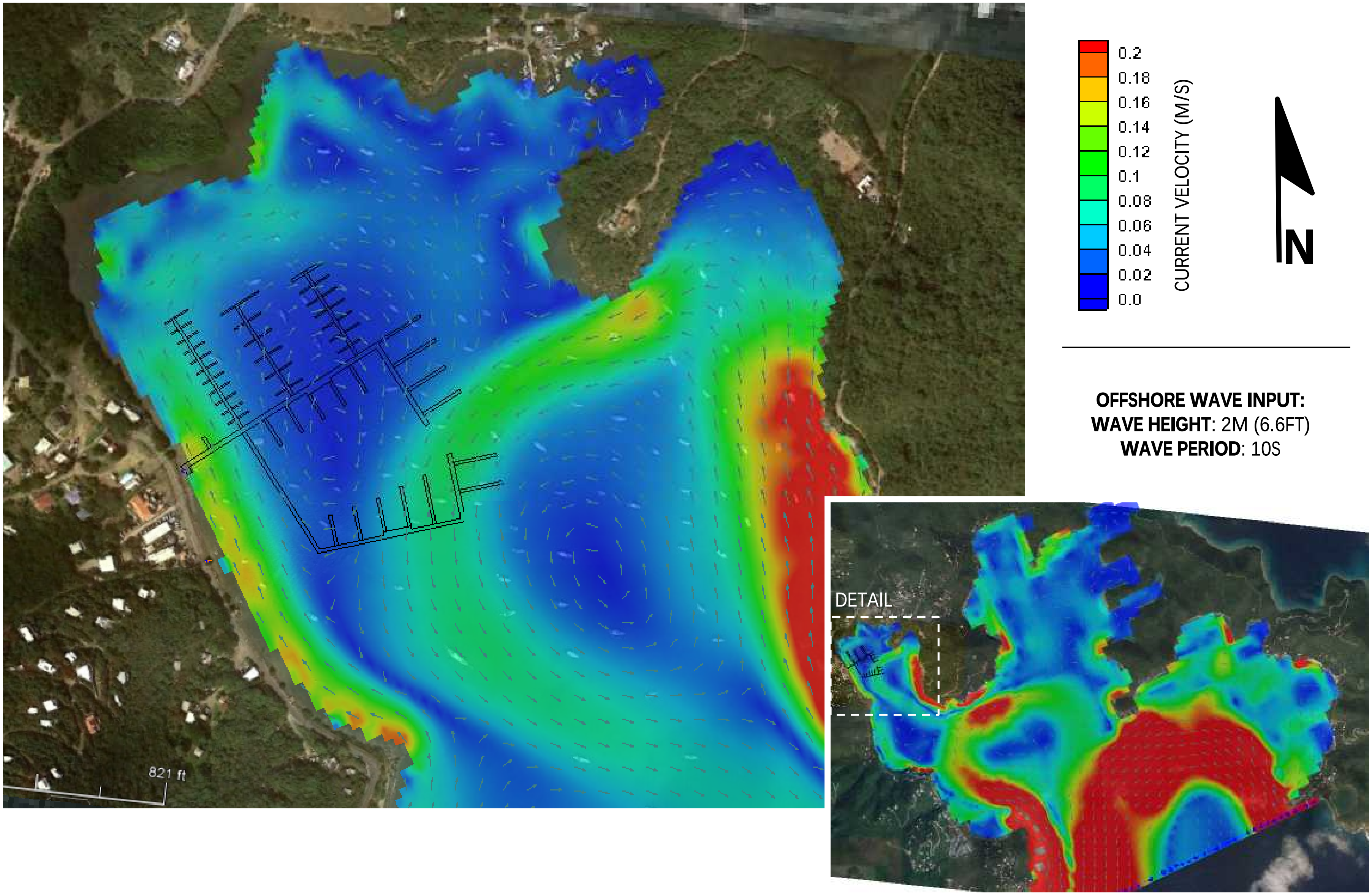


Figure B4: Coral Harbor – CMS-Flow Results – 2m

APPENDIX C

ST JOHN VIRGIN ISLANDS ANNUAL WAVE TIME SERIES

STATION 41052

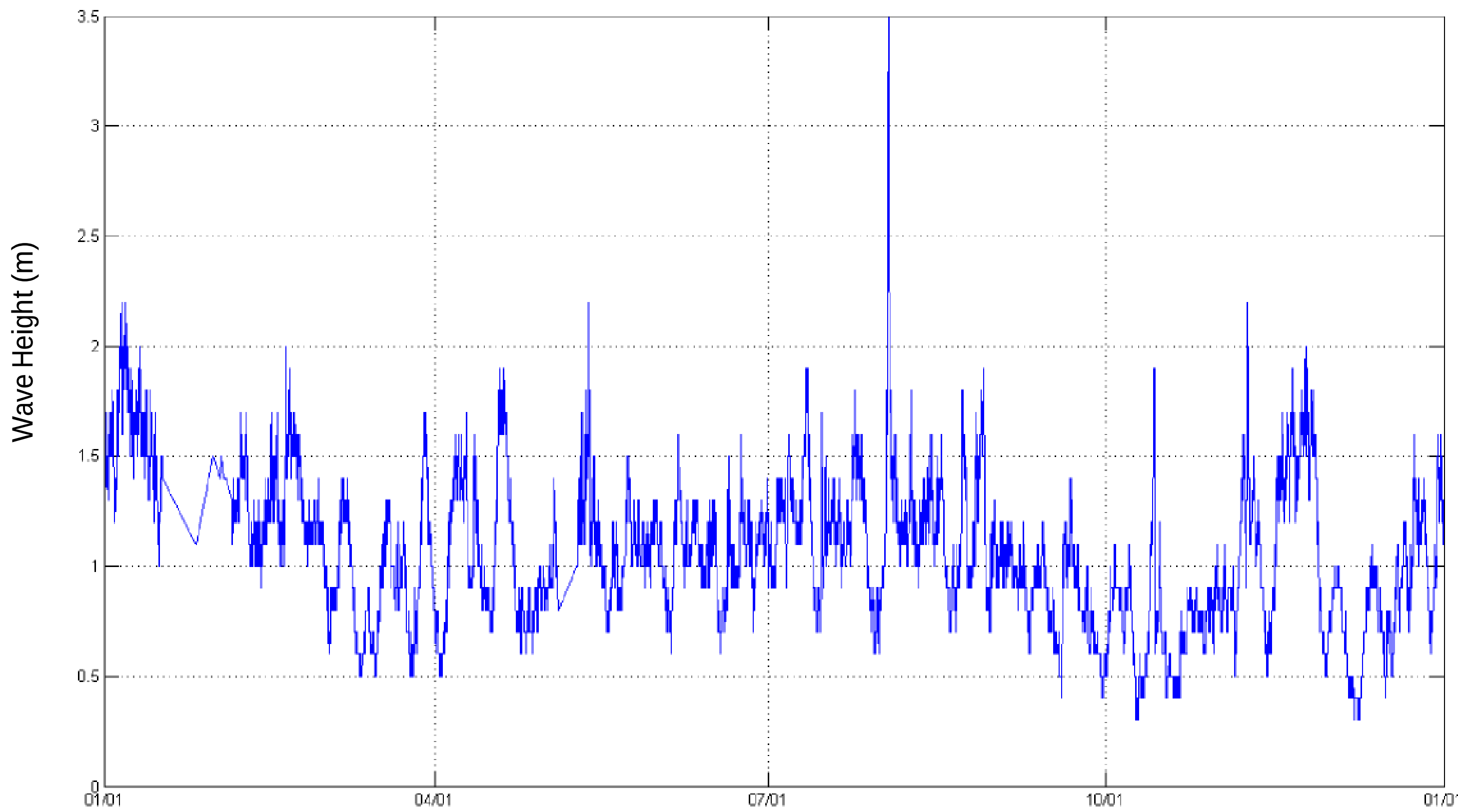


Figure C1: Coral Harbor – Offshore Wave Height 2014 – Station 41052

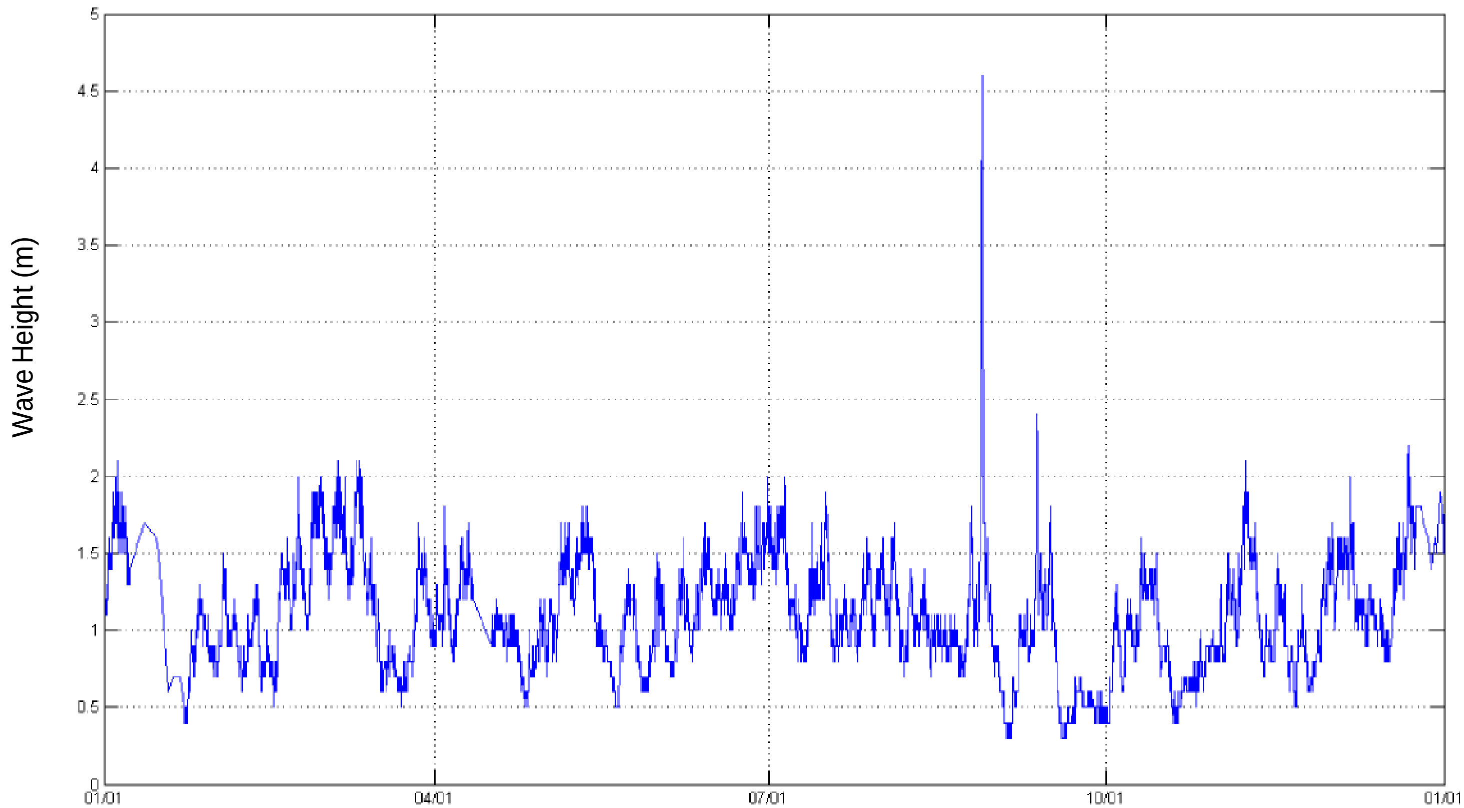


Figure C2: Coral Harbor – Offshore Wave Height 2015 – Station 41052

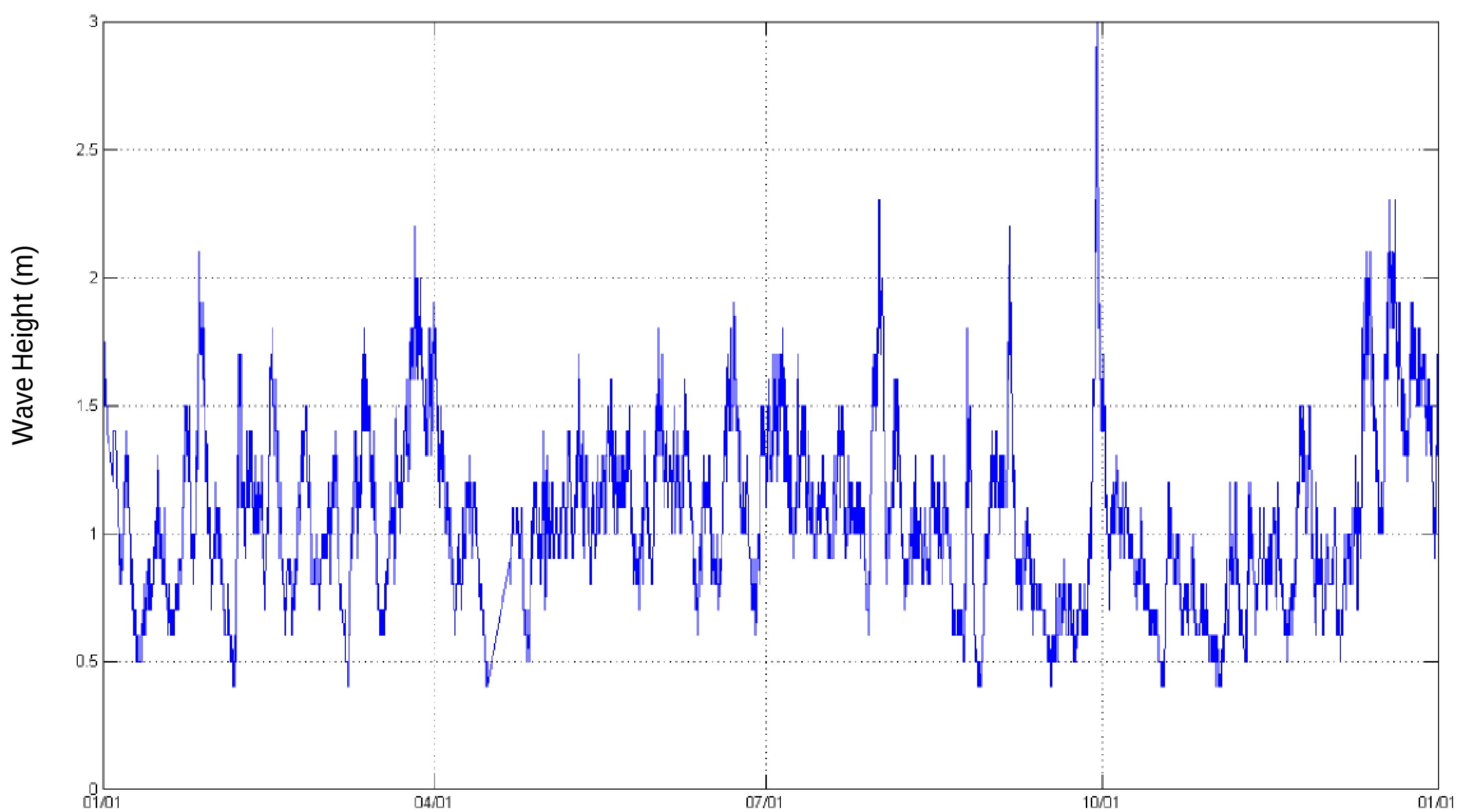


Figure C3: Coral Harbor – Offshore Wave Height 2016 – Station 41052

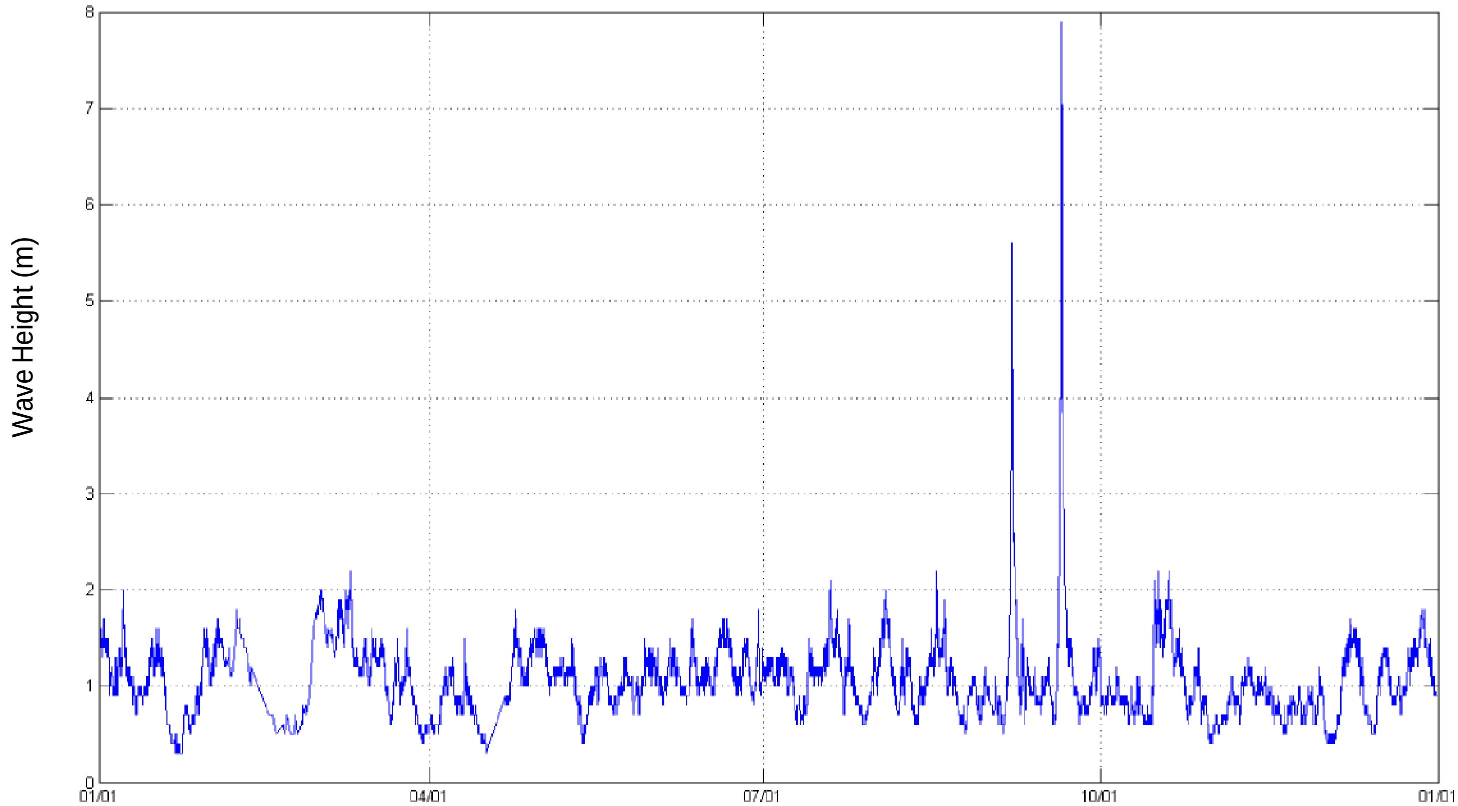


Figure C4: Coral Harbor – Offshore Wave Height 2017 – Station 41052

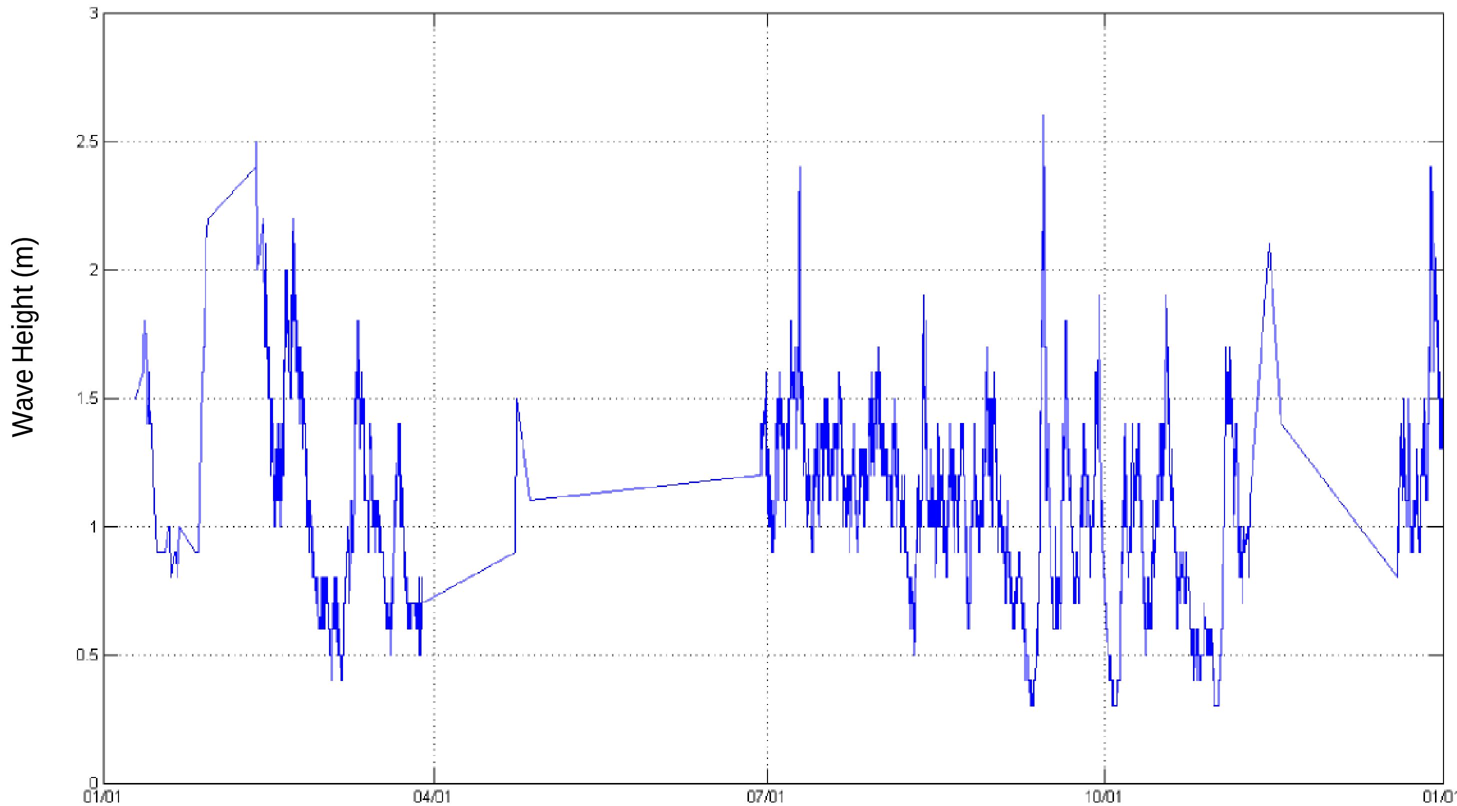


Figure C5: Coral Harbor – Offshore Wave Height 2018 – Station 41052

APPENDIX IV

Avoidance and Mitigation

Summer's End Group LLC

St. John Marina

Avoidance and Minimization

Suggested Modifications

1) Redesigned layout to provide only one main walkway from shore and shifted docks and slips further out into deeper water to avoid potential damage and shading to seagrass and inshore habitat.
2) Changed dock construction from floating concrete (originally proposed) to raised fixed docks. Allows for greater light penetration into the water and reduces shading impacts.
3) Synthetic graded dock decking material over heavy aluminum framed dock sections rather than solid concrete allows for maximum light penetration and a faster dock and utility installation.
4) Adjustments of piling locations for avoidance of impacts to coral.
5) Reduction of pilings from 1,333 to 960, reduction of 28%.
6) Based on the recently completed Geotechnical Study of the dock location area results show that the use of a vibratory hammer will greatly increase the piling installation speed and reduce the days required for driving pilings.
7) Removed from the original design of inclusion of two one-story buildings out on the docks, a reduction of vertical shading potential.
8) Removed from development two non-shoreline upland parcels reducing overall potential construction impacts.
9) Development of a comprehensive Hurricane Preparedness Plan for Coral Harbor, helping to maximize public safety and environmental protection.
10) Customs and Border Protection office on site to help prevent illegal entry, drug trafficking and overall law enforcement presence.

Mitigation and improvements to Coral Bay and Harbor long term water quality and safety for vessels visiting Coral Harbor.

1) Installation and management of up to 75 public moorings, designed for various sized vessels, professionally installed and maintained coupled with a Harbor Management Plan to help enhance environmental protection and public safety. Placement of the moorings will be determined in coordination with USVI DPNR.
2) Marina to provide fixed and portable remote sewerage pump-out, for both docks, and moorings.
3) Installation of regulatory buoys marking shallow water and habitat.
4) Installation of channel markers to provide navigational safety.
5) Provide vessel fueling that complies with EPA regulations.
6) Provide an information center for environmental pamphlets that educate visiting boaters and the public.

7) As part of the St. John Marina mobile app, provide information on the marina and moorings, as well as links to St John's National Park and Coral Reef National Monument rules regarding use of them, and preservation of the local environment.
8) Develop within the app instructions to boaters general information on securing their vessel in hurricane events, where to haul out etc.

APPENDIX V

Applicant's Alternatives Analysis

February 2018

APPENDIX VI

Geophysical Investigation and Bathymetric Survey

St John Marina

Sea Diversified Inc.

Survey Report
Geophysical Investigation and Bathymetric Survey
St. John Marina

Coral Harbor, Coral Bay
St John, USVI

September 2019

Prepared for:

The Summer's End Group, LLC
5000 Estate Enighed #63
St. John, USVI 00830
www.summersendvi.com

Prepared by:

Sea Diversified, Inc.
151 NW 1st Avenue
Delray Beach, Florida 33444
www.SeaDiversified.com

Sea Diversified P.N. 19-2768

TABLE OF CONTENTS

INTRODUCTION

Sea Diversified, Inc. (SDI) was contracted by The Summer's End Group, LLC. (SEG) for analysis of their marina development project planned for Coral Harbor, located in Coral Bay, St. John, USVI. The project includes the construction of a fixed dock marina that can accommodate multiple vessels of varying sizes and type. Project plans and other documents provided to SDI indicate the marina will be constructed using pre-manufactured fixed frame dock systems supported by approximately 960 steel pipe piles filled with reinforced concrete. The project is currently under review by the U.S. Army Corps of Engineers (USACE) in consultation with the National Marine Fisheries Service (NMFS) and other federal agencies having jurisdiction to review and comment on the project.

One concern raised by the agencies is the potential impacts to sea turtles, marine mammals and other marine organisms caused by the extent and duration of noise resulting from the pile driving activities. Initial assumptions by project consultants indicate that impact hammers will likely be required for the pile installation. If this method is employed, assuming silty sand and clay conditions, consultants (Technomarine, February 23, 2018) estimated it could take approximately 300 strikes to install each pile to grade based on forty-five (45) foot piles with twenty-five (25) feet of pile embedment. Assuming 960 piles and six (6) piles driven per day there would be a total of 1800 pile strikes each day for a period of 160 days. These estimates were conditioned on actual sediment conditions with the understanding that rock, if encountered within the pile driving profile, could increase the number of required strikes per pile resulting in a longer duration of pile driving activities.

Noise levels developed from pile driving vary with type of pile, characteristics of sediments, water depth, extent of pile penetration and pile driving methodologies. Noise levels produced from piles driven with mechanical impact hammers will vary substantially from piles installed using vibratory hammers. Potential noise impacts have been discussed by the agencies, however it is apparent there was insufficient geophysical data to determine what means and methods of pile driving will ultimately be most practical for the project. Therefore, in order to determine the most practical pile driving techniques and subsequently validate initial estimates of pile driving duration, as relating to assessment of potential noise impacts, the USACE requested verification of the type of sub-surface materials within the footprint of the marina. A specific objective is to determine the presence or absence of hard material within the range of projected pile penetration that could affect overall pile driving methods and associated noise levels produced from the activity.

PROJECT APPROACH

Through coordination with the USACE, a geophysical study comprised of seismic or reflection profiling survey techniques was determined to be an effective means of evaluating sub-surface material conditions within the footprint of the proposed marina. Although there are inherent limitations in the ability to characterize sub-bottom material type through seismic profiling, the system can be very effective in detecting and mapping interfaces between various sedimentary layers beneath the seafloor including the interface between overburden and bedrock. This technology is commonly used to assess variations in sub-bottom material conditions over large areas and is used extensively to determine the location of apparent hardbottom or bedrock to assist in project planning and design initiatives.

SURVEY SCOPE

The geophysical survey was conducted on July 16, 2019 with the assistance of Sonographics, Inc., using a X-Star Full Spectrum Sonar system with Edgetech model SB 216S towfish. The system utilizes CHIRP technology, which enables the acquisition of seismic refection data over many frequency ranges, achieving great resolution of sub-bottom material stratifications. The survey was conducted using a 50-foot fiberglass vessel, a local vessel of opportunity secured for the project by the client. A Trimble SPS-461 Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) for vessel positioning and heading. For vessel navigation and data collection / storage, the Coastal Oceanographics' (Xylem) "Hypack" system was utilized. Pre-planned survey transects were established for data collection based on a transect spacing of fifty (50) feet extending northeasterly from the west shoreline of the harbor. See **Figure 1.** However, the presence of numerous moored vessels, vacant mooring systems and other expected submerged obstructions required data collection along randomly spaced meandering lines to avoid collisions and other conflicts.

Figure 1: Planned Survey Lines

As part of the survey effort, SDI collected bathymetric data for purposes of translating or converting seismic reflector data to sub-surface profile elevations relative to the project vertical datum. The survey was conducted using a 35-foot fiberglass vessel equipped with SDI's automated hydrographic survey system. This encompassed an Odom Model CV100 echo-sounder operating at 200kHz with integrated TSS model DMS-05 3-axis motion sensor and a Trimble SPS-461 Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) for vessel positioning and heading. Data was collected along the same planned survey transects established for the geophysical survey. The sounder was calibrated via bar checks at the beginning of each survey day. Soundings were corrected for tidal fluctuations using an integrated Real-Time

Kinematic GPS. A tide gauge was also established and monitored in proximity to the project area as a redundant means of recording tides during the course of data collection.

SUMMARY OF SURVEY

Project Datum

Horizontal Data:	Feet, relative to WGS-84 ellipsoid, State Plane NAD-83, Zone PR-5200 PR & VI.
Vertical Datum:	Feet, relative to Virgin Island Vertical Datum (VIVD) based on benchmarks previously established on the island

Control

TBM 102	Northing:	844,129.40	(Feet, NAD 83, Zone PR-5200 PR & VI)
	Easting:	1,252,066.15	
	Elevation:	4.20	(Feet, VIVD)
	Description:	PK Nail set in paint stripe at edge of road	
1373A	Northing:	845,474.87	(Feet, NAD 83, Zone PR-5200 PR & VI)
	Easting:	1,253,190.85	
	Elevation:	1.34	(Feet, VIVD)
	Description:	NOS B/D "1373A" 1983	

Equipment (Geophysical Survey):

Survey Vessel:	50' Sea Ray, Vessel supplied by SEG
Sub-Bottom Profiler:	EdgeTech 3100-P Portable Sub-Bottom Profiling System w/ SB-216 towfish
Positioning:	Trimble SPS 461 Real Time Kinematic (RTK) Global Positioning System (GPS)
Navigation:	Coastal Oceanographics' (Xylem) "Hypack" software

Equipment (Bathymetric Survey):

Survey Vessel:	35' Intrepid, Vessel supplied by SEG
Sounder:	Odom Model CV100 echo-sounder operating at 200kHz
Motion Sensor:	Teledyne TSS Dynamic Motion Sensor (DMS-05)
Positioning:	Trimble SPS 461 Real Time Kinematic (RTK) Global Positioning System (GPS)
Navigation:	Coastal Oceanographics' (Xylem) "Hypack" software

DATA PROCESSING AND CHART PREPARATION

Upon completion of the sub-bottom profile data collection, seismogram records were reviewed and interpreted by Sonographics. Seismic reflectors, indicative of material changes, were mapped and extracted as ASCII X,Y,Z digital data files and imported into contouring software to produce isopachs of each reflector layer. The deepest reflector was assumed by the interpreter to be the location of bedrock and is considered to be of primary importance to the investigation. Isopach plots depicting the apparent location of bedrock within the proposed marina area are provided, herein as **Sheet SB-1**, **Appendix A**.

Upon completion of the bathymetric data collection activities, data was edited and reduced to the project datum and formatted as required for bathymetric modeling and chart preparation. Final data, reduced to an X,Y,Z, ASCII format was imported to a CADD environment and subsequently translated to Digital Terrain Model (DTM) for generating contour charts and profile plots. Bathymetric contour plots are provided, herein as **Sheet B-1**, **Appendix A**.

RESULTS

Results of the survey indicate that apparent bedrock varies extensively throughout the limits of the proposed marina footprint. This apparent bedrock layer, however was found to be consistently very deep with the shallowest areas mapped at approximately forty (40) feet (12m+/-) below the seafloor extending to as deep as one hundred fifty (150) feet (46m+/-) in certain areas where reflectors were ultimately lost and no longer discernable. Seismic reflectors indicative of varying sedimentary layers above bedrock were identified throughout the project area but were more random in nature. Representative seismogram clips are presented on **Figures 2 - 5**.

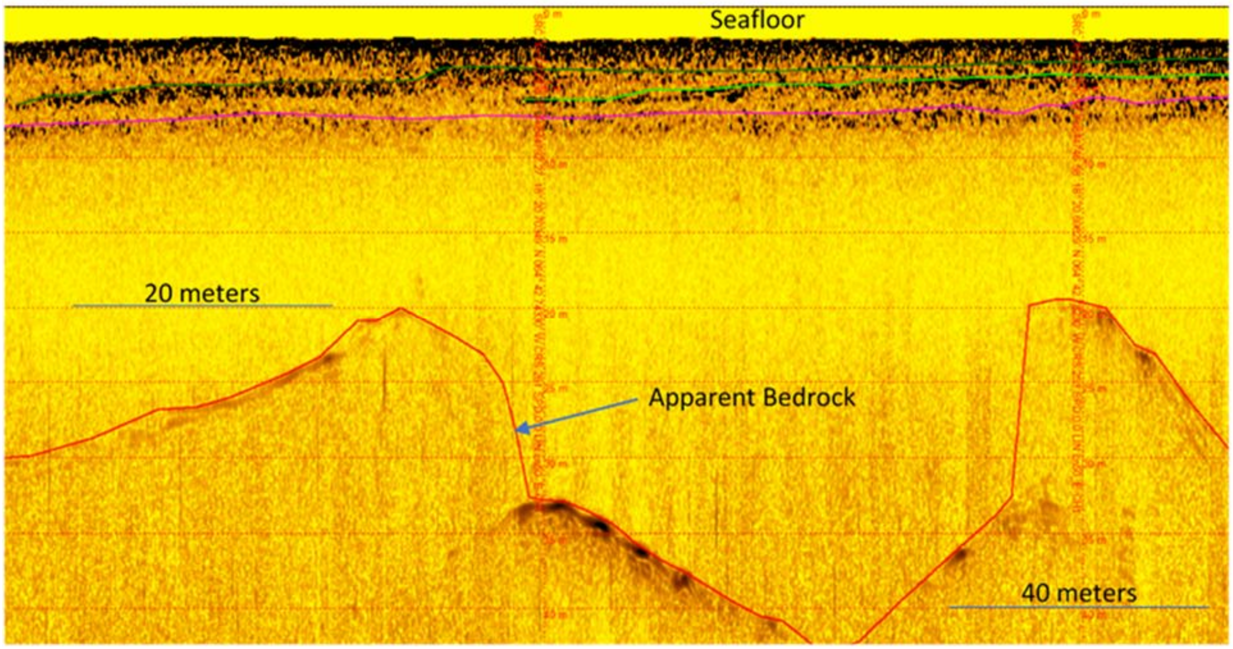


Figure 2: Typical Seismogram Clip

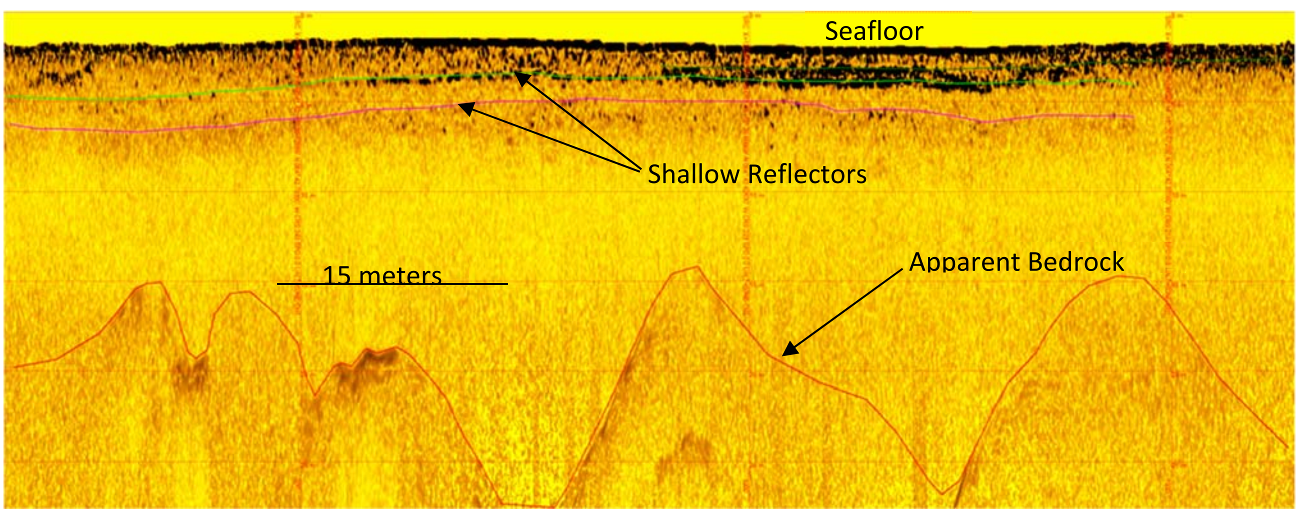


Figure 3: Typical Seismogram Clip

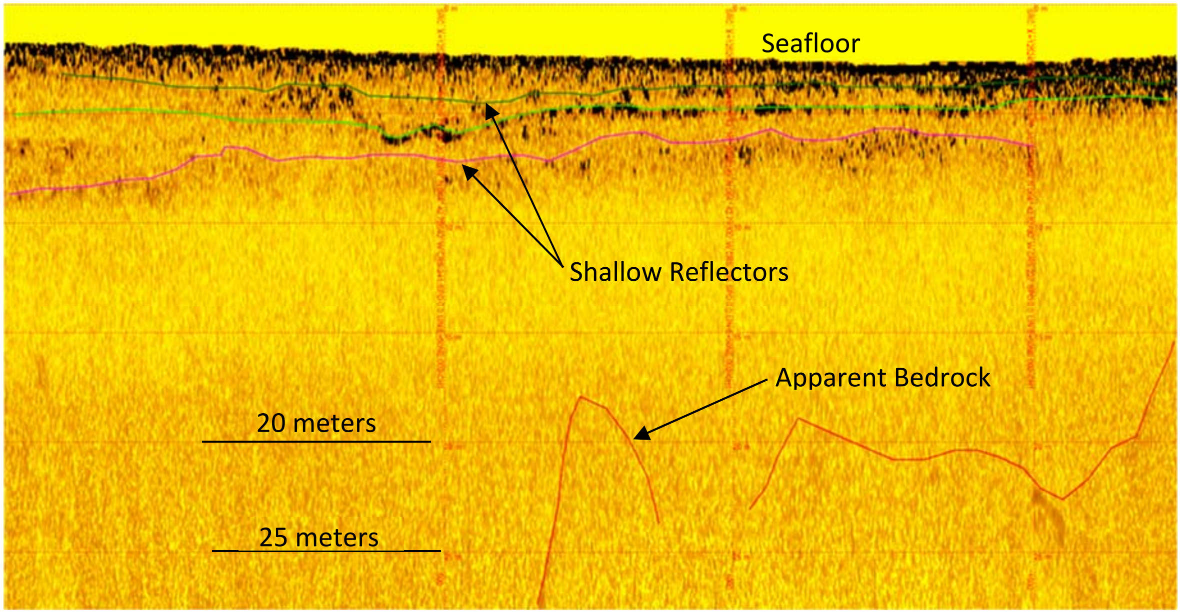


Figure 4: Typical Seismogram Clip

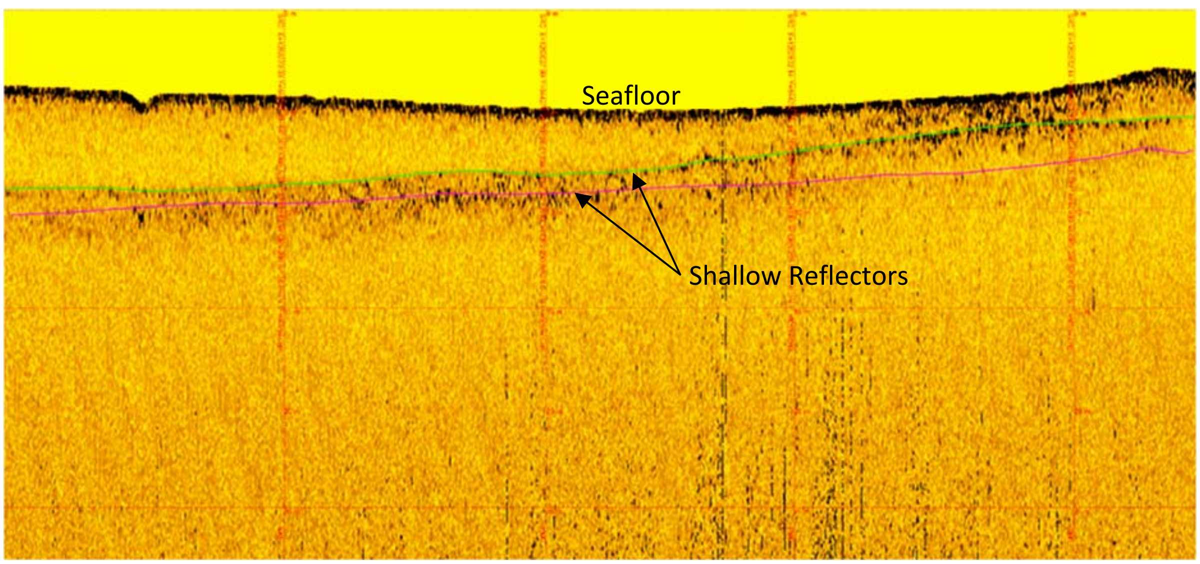


Figure 5: Typical Seismogram Clip

SUMMARY
Based on the results of the geophysical survey, it is apparent that marina piles would not extend to a deep bedrock layer. Therefore, with no evidence of hardbottom material within the projected limits of pile penetration, it is SDI's opinion based on experience with similar projects, that a no-impact, (high frequency / low resonance) vibratory hammer operating at very low noise levels could be used for the installation of steel piles. Project engineers concur and have updated their assumptions on pile driving methods, as well as their predictions on duration of pile driving activities (Technomarine, September 17, 2019 update). They now estimate, based on the new geophysical information, that eight (8) piles could be installed per day instead of their original estimate of six (6) piles per day due to an expected 33% greater efficiency of using vibratory hammers over impact hammers. This would result in 120 days to install 960 piles using a vibratory hammer, 40 days less than their original estimate of 160 days using standard mechanical pile driving techniques. This equates to a 25% reduction in overall time to install the piles from initial estimates.

The fact that a vibratory hammer can likely be used for the pile installation instead of an impact hammer, noise produced from this activity should be substantially minimized. Combined with the reduction in estimated timeframe to install the piles, agency concerns of potential impacts to sea turtles, marine mammals and other marine organisms from the overall pile driving component of the project, should be greatly reduced from what was originally assumed.

APPENDIX A:

SURVEY MAP REDUCTIONS
Cover – Survey Notes
Bathymetric Survey Contours
Geophysical Isopachs

BATHYMETRIC SURVEY
INCLUDING GEOPHYSICAL INVESTIGATION
CORAL HARBOR, CORAL BAY
ST.JOHN, USVI
AUGUST 2019

PREPARED FOR:

SUMMER'S END GROUP

LOCATION MAP

VICINITY MAP

VERTICAL DATUM DIAGRAM

VIVD 09 — MLLW: 0.38 FEET

MEAN SEA LEVEL — MLLW: 0.40 FEET

RELATIONSHIP BETWEEN VIVD 09, MLLW AND MSL.
SOURCE: TIDE STATION 9751381 AT LAMESHUR BAY, ST JOHN, VI.

SURVEY CONTROL

CONTROL	SPCS (FT) DATUM: NAD 83 NORTHING	EASTING	ELEV. (FT) VIVD 09	DESCRIPTION
TBM 102	844,129.40	1,252,066.15	4.20	FND PK NAIL IN ROAD
SDI BASE	844,265.51	1,251.966.95	4.63	SET SPIKE
1373A	845,474.87	1,253,190.85	1.34	NOS B/D "1373A" 1983

AERIAL IMAGE

SHEET INDEX

ORDER	SHEET ID	DESCRIPTION
SHEET 1	C-1	COVER SHEET / SURVEY NOTES
SHEET 2	B-1	BATHYMETRIC CONTOURS
SHEET 3	SB-1	SUB-BOTTOM ISOPACH MAP
SHEET 4	SB-2	SUB-BOTTOM TOPOGRAPHY
SHEETS 5-8	XS-1 THRU XS-4	CROSS SECTIONS

ABBREVIATIONS

FT	FEET
BD	BRASS DISK
MSL	MEAN SEA LEVEL
MLLW	MEAN LOWER LOW WATER
NAD 83	NORTH AMERICAN DATUM OF 1983
VIVD 09	VIRGIN ISLAND VERTICAL DATUM OF 2009
NOS	NATIONAL OCEAN SERVICE
SPCS	STATE PLANE COORDINATE SYSTEM
FND	FOUND

SURVEY NOTES:

1. REFER TO SEA DIVERSIFIED PROJECT NUMBER 19.2768
2. THIS HYDROGRAPHIC SURVEY WAS PERFORMED AT THE REQUEST OF THE SUMMER'S END GROUP, LLC.
3. THIS SURVEY WAS CONDUCTED ON JULY 16 & 19, 2019.
4. THE INFORMATION DEPICTED HEREIN REPRESENTS THE RESULTS OF THE SURVEY ON THE DATE INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THE TIME.
5. HORIZONTAL DATA ARE IN UNITED STATES SURVEY FEET AN RELATIVE TO THE STATE PLANE COORDINATE SYSTEM BASED ON THE TRANSVERSE MERCATOR PROJECTION FOR PUERTO RICO & THE VIRGIN ISLANDS (5200), NORTH AMERICAN DATUM (NAD) OF 1983, 1990 ADJUSTMENT. VERTICAL DATA ARE IN FEET AND RELATIVE TO THE VIRGIN ISLANDS VERTICAL DATUM OF 2009 (VIVD 09).
6. GEOPHYSICAL SEISMIC DATA WAS COLLECTED USING A 50' SURVEY LAUNCH EQUIPPED WITH TRIMBLE DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) FOR POSITIONING. DIFFERENTIAL CORRECTIONS WERE ACQUIRED FROM THE U.S. COAST GUARD NAVIGATION BEACON SYSTEM. HORIZONTAL POSITION ACCURACY WAS VERIFIED USING SURVEY CONTROL POINTS LISTED HEREIN. SEISMIC DATA COLLECTED USING AN EDGETECH 3100P PORTABLE SUB-BOTTOM PROFILER WITH AN EDGETECH TOWFISH MODEL SB 216S OPERATING FREQUENCY BETWEEN 2-16 kHz.
7. BATHYMETRIC DATA WAS COLLECTED USING A 35' SURVEY LAUNCH EQUIPPED WITH TRIMBLE REAL-TIME KINEMATIC (RTK) DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS) FOR POSITIONING AND AN ODOM CV100 SOUNDER USING A 200kHz NARROW BEAM TRANSDUCER. DIFFERENTIAL CORRECTIONS WERE ACQUIRED FROM THE U.S. COAST GUARD NAVIGATION BEACON SYSTEM. HORIZONTAL POSITION ACCURACY WAS VERIFIED USING SURVEY CONTROL POINTS LISTED HEREIN. THE SOUNDER WAS CALIBRATED PRIOR TO THE START OF THE SURVEY FOLLOWING MANUFACTURER RECOMMENDED PROCEDURES
8. AERIAL IMAGERY DATED FEBRUARY 2017, SOURCE GOOGLE EARTH.

DRAFT

REVISIONS:

NO.:	DATE:	DESCRIPTION:

PROJECT: BATHYMETRIC SURVEY INCLUDING GEOPHYSICAL INVESTIGATION CORAL HARBOR, CORAL BAY ST.JOHN, USVI AUGUST 2019

SHEET TITLE: COVER / SURVEY NOTES

PREPARED FOR: SUMMER'S END GROUP
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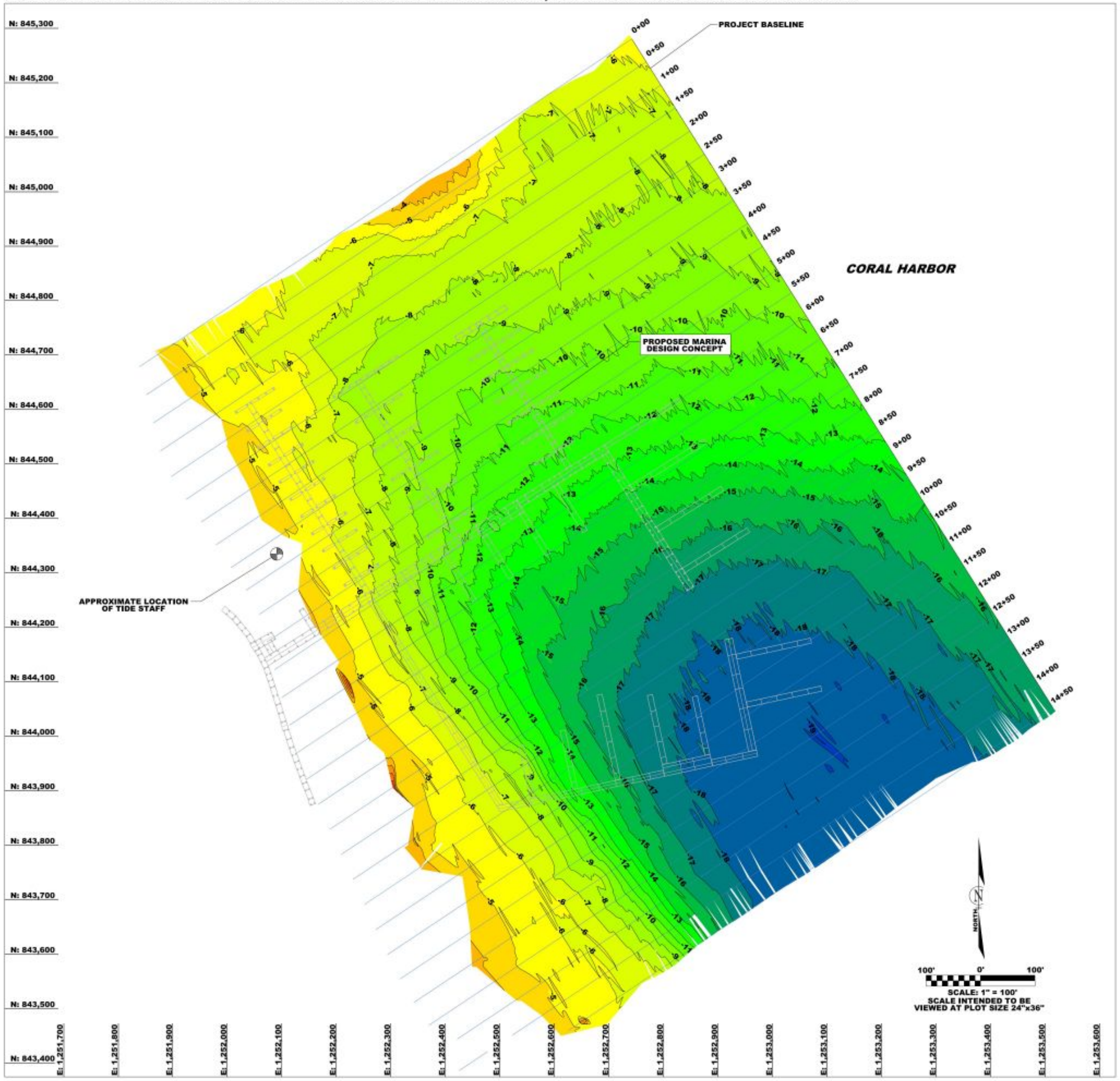
DATE:	AUGUST 2019
DRAWN BY:	B.N.W.
CHECKED BY:	R.W.B.
SCALE:	AS SHOWN
SHEET:	C-1

CADD ID:
TOTAL NUMBER OF SHEETS: 7

SDI P.N. 19-2768

NOTE: CONTOURS ARE DEPICTED AT ONE-FOOT INTERVALS RELATIVE TO VIVD 2009, REFER TO COVER SHEET FOR SURVEY DETAILS.



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DRAFT

REVISIONS:

NO.:	DATE:	DESCRIPTION:

PROJECT: BATHYMETRIC SURVEY INCLUDING GEOPHYSICAL INVESTIGATION CORAL HARBOR, CORAL BAY ST.JOHN, USVI AUGUST 2019

SHEET TITLE: BATHYMETRIC CONTOURS

PREPARED FOR: SUMMER'S END GROUP
5000 ESTATE ENIGHED #63
ST. JOHN, USVI 00830

PREPARED BY: SEA DIVERSIFIED, INC.
Surveying & Engineering Applications
151NW 1ST AVENUE
DELRAY BEACH, FLORIDA 33444
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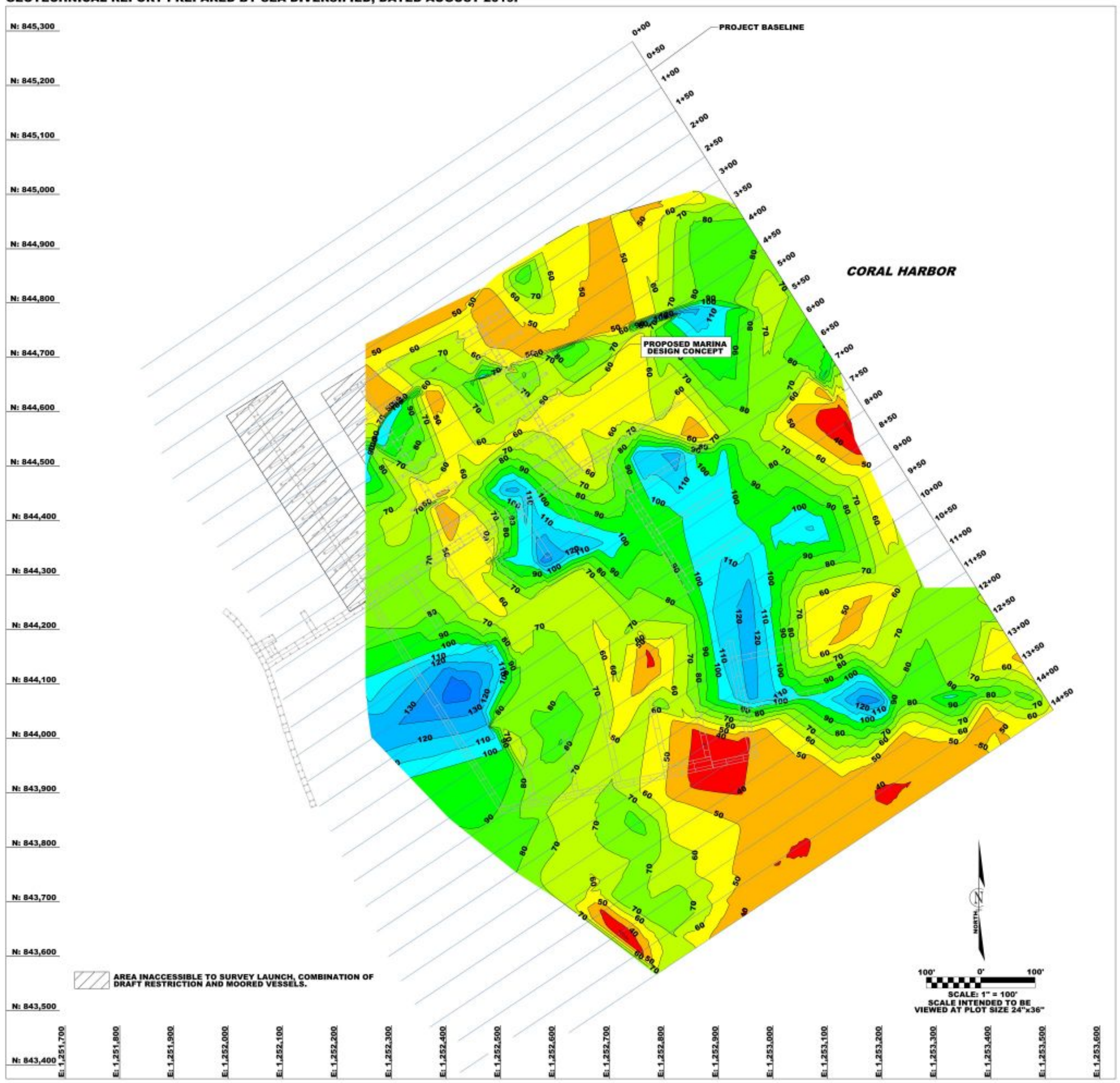
DATE:	AUGUST 2019
DRAWN BY:	B.N.W.
CHECKED BY:	R.W.B.
SCALE:	AS SHOWN
SHEET:	B-1

CADD ID:
TOTAL NUMBER OF SHEETS:

SDI P.N. 19-2768

19-2768 BATHYMETRY.dgn 8/16/2019 5:02:35 PM SEA DIVERSIFIED INC.

NOTE: ISOPACH PLOT DEPICTS THE SEDIMENT THICKNESS BETWEEN SEAFLOOR AND THE DEEPEST SEISMIC REFLECTOR, WHICH IS ASSUMED TO BE BEDROCK. REFER TO GEOTECHNICAL REPORT PREPARED BY SEA DIVERSIFIED, DATED AUGUST 2019.



ISOPACH COLOR BAR

- 30.0' TO 40.0'
- 40.0' TO 50.0'
- 50.0' TO 60.0'
- 60.0' TO 70.0'
- 70.0' TO 80.0'
- 80.0' TO 90.0'
- 90.0' TO 100.0'
- 100.0' TO 110.0'
- 110.0' TO 120.0'
- 120.0' TO 130.0'
- 130.0' TO 140.0'
- 140.0' TO 150.0'

DRAFT

REVISIONS:

NO.:	DATE:	DESCRIPTION:

PROJECT: BATHYMETRIC SURVEY INCLUDING GEOPHYSICAL INVESTIGATION CORAL HARBOR, CORAL BAY ST.JOHN, USVI AUGUST 2019

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SHEET:

SB-1

CADD ID:
TOTAL NUMBER OF SHEETS:

SDI P.N. 19-2768

APPENDIX VII

Sedimentary Development of Coral Bay, St John

Brooks, Devine, Larson and Rood

Caribbean Journal of Science, Vol. 43, No. 2, 2007

Caribbean Journal of Science, Vol. 43, No. 2, 226-243, 2007

Sedimentary Development of Coral Bay, St. John, USVI: A Shift From Natural to Anthropogenic Influences

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ABSTRACT.—Analyses of sediment cores and surface samples collected in Coral Bay, St. John, USVI, reveal four sedimentary facies. The bottom three reflect the natural transgressive evolution of the bay during the Holocene sea-level rise. The surficial facies represents a dramatic increase in terrigenous sediment input since the 1950's. This surficial layer is defined by a decrease in grain size, increase in organic content, increase in terrigenous constituents, and subtle decrease in calcium carbonate content compared to underlying sediments. Based upon ^{210}Pb and ^{14}C dating, accumulation rates have increased by roughly one order-of-magnitude since the 1950's as a result of this increase in terrigenous sediment input. The surficial sediment layer likely represents an anthropogenic signal reflecting the dramatic increase in island development over the past few decades. The surficial "impacted" layer is most pronounced (i.e., exhibits the greatest deviation from underlying sediments) adjacent to the most heavily developed areas, and in protected, low energy regions. It becomes less pronounced in the more open and seaward portions of the bay. This pattern suggests proximity to input and energy level are the dominant controls governing where terrigenous sediments ultimately accumulate. Comparisons with anthropogenically-impacted estuaries along the U.S. Atlantic and Gulf coasts show that, although there are substantial differences in scale and watershed character, all have experienced recent dramatic increases in sediment accumulation. Unlike Coral Bay, however, there is no anthropogenic signal in sediment texture and composition. This may be a reflection of St. John's high-relief terrain, high erodibility of rocks/soils, and intense weathering associated with tropical volcanic island settings.

KEYWORDS.—anthropogenic impacts, sediment accumulation rates, Caribbean island sediments, coastal sediments, sediment input

INTRODUCTION

Background

The rapid degradation of coastal resources throughout the Caribbean as a result of anthropogenic impacts has been well documented in recent years (Rawlins et al., 1998; Nemeth and Nowlis, 2001; Gardner et al., 2003). The increased rate in sedimentation resulting from development has received considerable attention, due in part to the subsequent stress exerted on coral reefs. Suspended sediments act to decrease light penetration, thereby reducing photosynthesis and coral growth (Rogers, 1979). Sediment erosion and delivery into coastal waters are natural processes, but rates are increased by human activities such as deforestation, urbanization and agriculture (Rawlins et al., 1998). The removal of natural vegetation and construction of unpaved roads have been shown to greatly intensify erosion rates in the US Virgin Islands (MacDonald et al., 1997; Ramos-Scharron and MacDonald, 2005), and linkages have been established between upslope sediment production and increased sediment impact in the downstream marine environment (Nemeth et al., 2001).

On St. John, USVI, unpaved road construction has been linked to an increase in sediment delivery to the marine environment causing a threat to the health of sur-

ms. received Jan. 11, 2006; revised September 1, 2006; accepted March 7, 2007

rounding coral reefs (Hubbard et al., 1987; MacDonald et al., 1997; MacDonald et al., 2001). The most pronounced runoff occurs during storm events and erosion increases in areas with heavy truck traffic and frequent regrading (MacDonald et al., 2001).

Setting

St. John is the third largest of the US Virgin Islands covering approximately 50 km^2 (Fig. 1). The terrain is steep and highly dissected with >80% of the island having slopes exceeding 35% (Anderson, 1994). The geology is complex consisting of heavily faulted and folded Cretaceous to Neogene volcanics and igneous intrusives with minor chert and calcareous rocks (Donnelly, 1966; Rankin, 2002). Unlike other areas in the Greater Antilles, the lack of uplifted beaches, wave-cut platforms, or fault scarps suggests that St. John has remained tectonically stable (Rankin, 2002). Over half of the island has been designated the Virgin Islands National Park, and along with the rugged topography, is responsible for St. John being less subject to development than most of the other islands in the eastern Caribbean (MacDonald et al., 1997). Plantation agriculture began in the early 1700's, but was abandoned in the 1800's. By the early 1900's, the permanent human population had declined to approximately 800 (Armstrong, 2003). In 1956 the Virgin Islands National Park was established and over the past few decades development has increased substantially in response to increased tourism and the influx of part-time inhabitants (MacDonald et al., 2001).

Coral Bay is a large, multi-lobed embayment occupying the east side of St. John (Figs. 1 and 2). It has one of the largest watersheds in the Territory encompassing ~12 km^2, with steep slopes averaging 18% (many >35%), highly erodible rocks and soils, and very diverse land use, much of it clustered along the shoreline. The inner portion of the bay, known as "Coral Harbor", covers roughly 2 km^2 with a watershed of about 6 km^2. Water depths drop off dramatically from the shore, exceeding 5 m in the middle of Coral Harbor, and reaching up to 25 m at the bay mouth. Discharge rates and average runoff volume are among the largest in the Territory (Hubbard et al., 1987). Most discharge occurs via large gullies, known as "guts" that dissect the steep slopes. Consequently, the bulk of

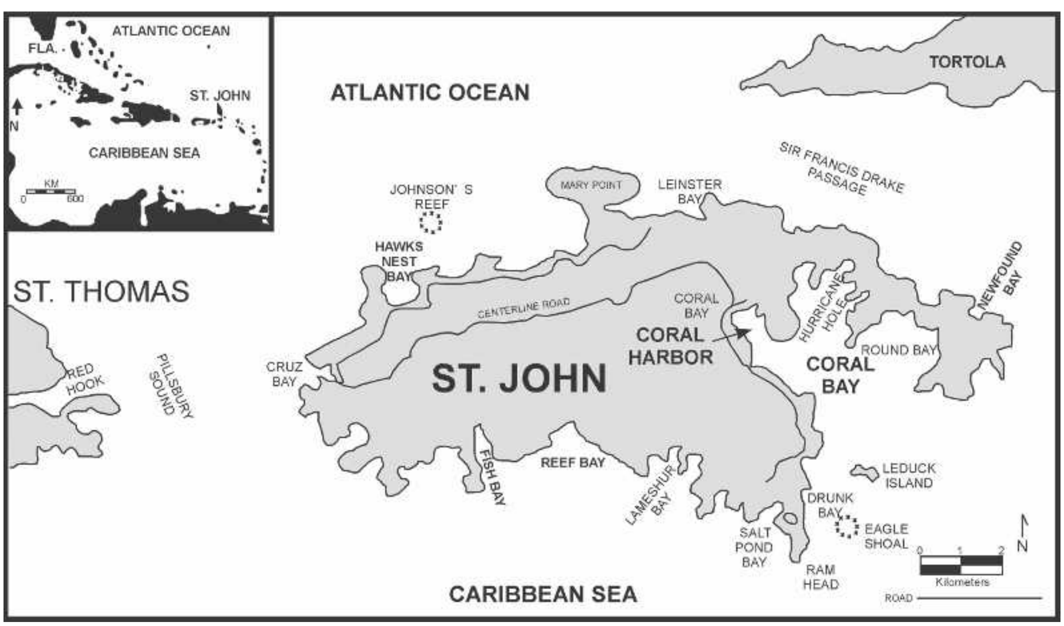

FIG. 1. Location map of St. John, USVI showing Coral Bay.

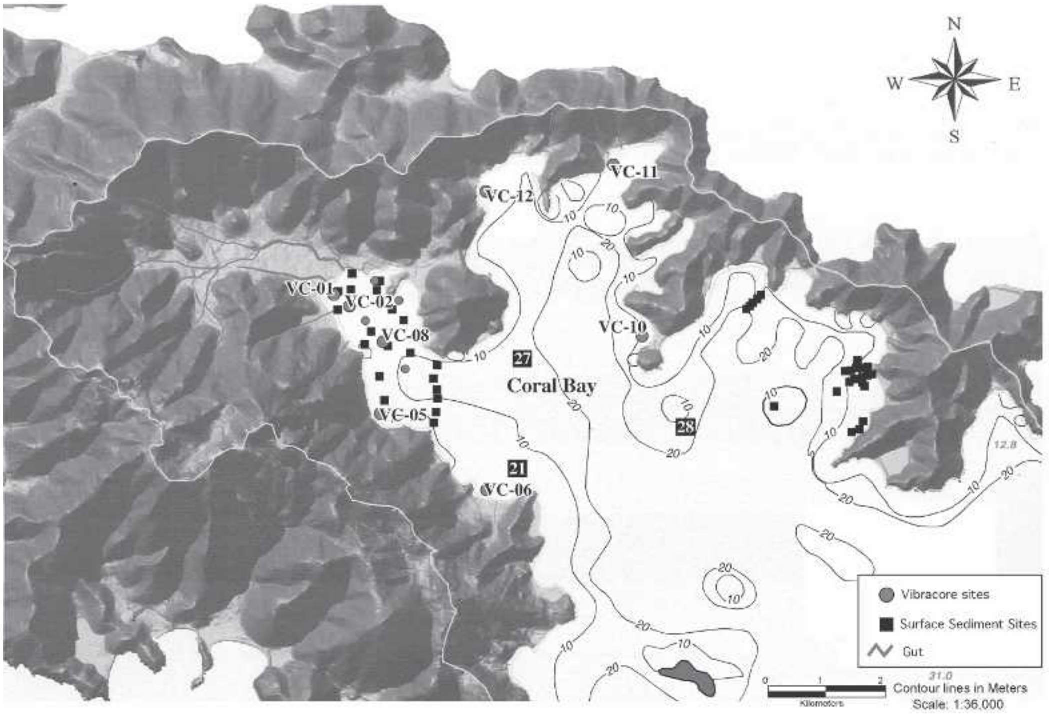

FIG. 2. Map of Coral Bay showing vibracore and surface sediment sampling sites (basemap from Devine et al., 2003).

island-derived sediments enter the bay as point sources where guts empty into the bay.

Coral Harbor is fringed by mangroves and salt ponds, and is home to a cruising and live-aboard population of 75-150 boats at any particular point in time. Adjacent to Coral Harbor, Hurricane Hole forms part of the relatively new Virgin Islands Coral Reef National Monument Protected Area, along with numerous other smaller bays to the east. This area contains a very diverse near-shore ecosystem, deeper open-marine environments and offshore cays and rocks. Sea-grass beds, fringing mangroves, wetlands, coral reefs, and other coral communities are common. The elkhorn coral, *Acropora palmata*, once common in these waters as an important reef builder, was decimated over the past 20 years by storms and diseases of unknown origin, but has been showing signs of limited recovery over the past few years (Devine et al., 2003).

Coral Bay has experienced a recent and rapid growth in population, increasing by almost 80% from 1990 to 2000 (U.S. Census Bureau, 2000). This rapid growth rate was accompanied by a dramatic increase in infrastructure including paved and unpaved roads, residential and commercial construction, and other permitted and non-permitted uses (Devine et al., 2003). Runoff associated with these activities has transported sediments directly into Coral Bay, thereby providing a unique opportunity to track the sedimentary signature of a recent (past few decades) transition from a natural to an anthropogenically impacted coastal system in a high relief, tropical setting.

Approach

The majority of Caribbean sedimentation studies have used sediment traps to determine sediment source, sediment quality, rates of input, and distribution of sediment input to the marine environment (Nowlis et al., 1997; Nemeth and Nowlis, 2001; Torres et al., 2001; Nugues and Roberts, 2003). While sediment traps provide useful information for determining linkages between source and the marine environment, as well as establishing the threshold and extent of run-off in response to a particular event, they are inefficient for determining where sediments are ultimately deposited, sediment accumulation rates, and temporal changes in sedimentation over geologic or historic time frames.

Sediment vibracores and surface samples were collected in this study to record the Holocene geologic development of Coral Bay, and determine if there has been an increase in terrigenous sediment deposition as a result of increases in anthropogenic activities associated with island development over the past few decades. Specific objectives include the following:

1. Identify sedimentary facies (i.e., distinct sedimentary units), environments of deposition, sources of inputs, and rates of accumulation.
2. Determine the natural depositional history of Coral Bay since being flooded by the Holocene sea-level rise.
3. Identify sedimentary facies resulting from anthropogenic activities, by comparing the surficial sediments deposited during the time of most recent anthropogenic activities, with underlying units deposited prior to these activities.
4. Define the distribution pattern of natural and anthropogenically altered sediments, and the processes and controls governing their distribution. Specifically, are sediments preferentially deposited near their sources of input? Are they transported into deeper parts of the bay and deposited in a low energy regime, or are they transported completely out of the bay and into the deep marine environment?

Results of this study will help to better understand the marine impacts of island development as well as provide data that will aid in the management of marine resources.

METHODS

Vibracores and surface sediment samples were collected in Coral Bay during the summer and fall of 2002. Sampling locations were chosen by proximity to input sites, while maintaining adequate coverage throughout the study area (Fig. 2). Sites were concentrated within Coral Harbor, the area of most likely impact due to recent increases in development. Locations were determined using a handheld GPS.

Vibracores were collected at 12 sites (Fig. 2) in 3″ (diameter) by 10′ (long) aluminum barrels attached to a standard cement vibrator, which was driven by a 5 hp gasoline powered engine (Lanesky et al., 1979). Each vibracore was split longitudinally, described, photographed, and subsampled for further analyses. Subsample locations were based upon visual descriptions, and at least one sample for every lithology was collected. Where no lithologic breaks were detected samples were collected at regular intervals down core. At least four samples per core were collected.

Surface sediment samples were collected at 47 sites (Fig. 2) by diver or Ponar grab sampler. Sample site locations were determined based upon coverage and bottom type. Approximately the upper 2 cm of the surface sediment layer were collected.

All sediment samples were analyzed in the laboratory for grain size, calcium carbonate content, organic content, and constituent composition. Grain size was determined by initially wet sieving the sample through a 63 μm screen. The sand-size (>63 μm) fraction was then analyzed by settling tube (Gibbs, 1974), and the fine-size (<63 μm) fraction by pipette (Folk, 1965). Carbonate content was determined by the acid leaching method (Milliman, 1974). Organic content was determined by loss on ignition (LOI) after at least 2.5 hours at 550°C (Dean, 1974). Selected samples were visually observed under reflected light by the line method (Carver, 1971) in order to determine the composition of the sand-size fraction. Most samples selected were near the core tops in order to characterize recent deposition. Mineralogical content was determined on selected samples by x-ray diffraction (XRD) at the University of Georgia, Athens.

The geochronologic framework was determined using ^{14}C and ^{210}Pb dating methods. Due to the paucity of datable material, only one core (VC-02) was dated, but results are augmented with data from outside the study area. Accelerator Mass Spectrometry (AMS) ^{14}C dating was derived from organic-rich sediments at a depth of 90 cm in core VC-02 in an interval presumed to represent the pre-anthropogenic development of the system. Analyses were conducted by Beta Analytic, Inc., in Coral Gables, FL. Age calibrations were calculated according to Stuiver and Plicht (1998), Stuiver et al. (1998) and Talma and Vogel (1993).

Samples for ^{210}Pb analyses were collected at 2-cm intervals over the upper 1 m of core VC-02. This procedure has the potential of determining age and timing of events over the past 100 years and is ideal for characterizing short-term ecosystem changes. Analyses were conducted at the USGS Short-Lived Isotope Lab, St. Petersburg, FL.

Accumulation rates were calculated for the natural development of the system over the past several thousand years based on ^{14}C dates. Rates over the past 100 years, the period of most recent anthropogenic activities, were calculated using ^{210}Pb profiles. Both linear accumulation rates (expressed as cm/yr) and mass accumulation rates (expressed as $g/cm^2/yr$) were calculated to correct for discrepancies due to differential compaction, allowing a direct comparison of modern accumulation rates with natural, long term accumulation rates.

RESULTS

Sediment grain size, calcium carbonate content and organic content are all highly variable likely reflecting a variety of sources, input mechanisms and energy regimes.

Sedimentary constituents are composed of a combination of biogenically precipitated carbonate fragments and non-carbonate grains (Table 1). The carbonate fraction consists of typical shallow-water tropical organisms. The non-carbonate fraction consists of quartz, feldspar, and terrigenous rock fragments from the nearby island, with subordinate amounts of organic material.

Sedimentary facies

Based upon texture and composition four distinct sedimentary facies are identified reflecting a variety of depositional environments (Table 2). The **blue-green clay (bgc) facies** is the lowermost sedimentary facies sampled in cores. It is dominantly blue-green in color with mottles of dark gray and brown. It consists of >40% mud-size (<63 μm) material, <10% calcium carbonate and variable organic content (LOI). The high degree of sediment cohesion suggests significant clay mineral content. Results of XRD analysis indicates the presence of the clay mineral palygorskite, commonly thought to represent deposition under elevated pH and salinity (Jones and Galan, 1988). Roots, burrows, and sporadic concentrations of cobble-sized lithoclasts of terrigenous origin are also present. The "bgc" facies was found in the lower section (0.89-2.2 m down core) of core VC-01 only (Fig. 3).

Overlying the blue-green clay facies is the **organic mud (om) facies**. The transition between the two facies is indistinct and burrowed. The organic mud facies contains >60% mud (<63μm) with 8-20% organic content (LOI) (Table 2). Carbonate content is highly variable and roots, burrows, and fibrous organic material are common. The organic mud facies was identified in cores VC-01 and VC-02 (Figs. 3 and 4). The upper part of the "om" facies in VC-02, residing ~6± m below present sea level, yielded a radiocarbon date of 5,040 calendar years before present.

Overlying the organic mud facies is the **muddy shelly sand/gravel (mssg) facies** (Figs. 3 and 4). The contact between the two facies is generally well defined and distinct, but may be burrowed and less distinct. The "mssg" facies is characterized by >40% sand/gravel sized grains, with most samples containing >60% (Table 2). The carbonate content is >40% with most samples containing >80%, and the organic content (LOI) is consistently <<5%. Sediment constituents consist of echinoderm

TABLE 1. Sediment constituents of selected Vibracore samples. Gray shading indicates samples in the impacted layer.

Core	cm downcore	Terrigenous	Benthic foram	Echinoderm	Mullusc	Coraline algae	*Halimeda* sp.	Unidentified CO_3 fragments	Other*
VC-01	0.05	D	—	C	—	—	C	—	—
	0.15	A	C	—	C	—	C	—	—
	0.44	C	—	—	—	—	C	—	—
VC-02	0.02	C	C	C	C	—	C	A	—
	0.10	C	—	—	—	—	—	D	—
	0.24	A	A	—	A	—	—	—	—
VC-03	0.18	A	C	R	C	—	C	—	—
	0.31	A	A	—	A	—	—	—	—
	0.68	Tr-R	—	—	C	—	C	A	—
VC-04	0.12	D	R	R	R	—	—	—	—
	0.30	D	C	C-R	C	—	—	—	—
	0.45	R	R	—	R-C	—	—	D	—
	0.60	C	C	—	—	—	—	D	Tr
VC-05	0.02	A-D	C	—	C	—	C	—	—
	0.10	R	—	R	C-R	R	C	D	Tr
VC-06	0.05	R	A	—	A	—	—	A	—
	0.14	C	A	A	A	—	—	—	—
VC-07	0.02	D	C	R	C	—	—	—	—
	0.10	C	C	R-C	C	—	R-C	—	—
	0.22	A	C	R	C	—	—	—	—
	1.00	Tr	C	—	C	Tr	—	—	Tr
VC-08	0.02	—	A	C	—	—	C	A	C
	0.10	C	C	R-C	C	—	—	A	—
	0.18	A	C	R	C	—	—	—	—
	1.00	Tr-R	C	C	C	—	—	—	—
VC-09	0.04	R	R	—	R-C	—	A	—	—
	0.15	R	C	C	C	—	A	—	—
	0.25	—	R-C	R-C	R-C	R	R-C	C-A	—
VC-10	0.07	C	C	R	C	R	—	C	R
	0.22	C	C	R	—	—	—	C-A	R
	0.83	Tr	C	—	C	—	C	C-A	—
VC-11	0.04	R	C-A	R-C	C	—	—	—	R
	0.18	R	A		A	—	—	C-A	—
	0.40	Tr	C	—	C	—	—	C	—
	0.95	—	—	C	C	A	—	—	C
VC-12	0.04	—	—	—	R	—	R	D	C
	0.18	A	C	R	C	—	C	—	—
	1.10	Tr-R	—	C	A	—	C	—	—

D = Dominant (>50%), A = Abundant (25-50%). C = Common (10-25%), R = Rare (1-10%). Tr = Trace (<1%).
*Includes; sponge, ostracod, annelid, bryozoa, organic material.

fragments, *Halimeda* grains, molluscan fragments, benthic foraminifera tests, and unidentifiable carbonate fragments (Table 1). Terrigenous material generally occurs in trace to rare quantities. Carbonate debris consists of fresh to worn whole shells or shell fragments, and rare blackened carbonate particles. The "mssg" facies is commonly fining upward and consistently light tan in color. It makes up the bulk of the sediment recovered in cores.

The surficial facies in the study area is the **sandy mud/muddy sand (smms) facies**. It is generally a thin (8-50 cm thick), fining-upward sequence with an indistinct, gradational or burrowed basal contact. It typically consists of 25-60% mud-size (<63μm) particles, <80% carbonate grains,

TABLE 2. Sediment facies and distinguishing characteristics.

Facies	Core	% Sand & % gravel	% Mud	% CO3	% TOC (LOI)	Sedimentary constituents	Depositional environment
Sandy mud-muddy sand	VC-01-12	Variable	25-60%, some <20%	<80%	>5% most	Terrigenous-R-D most A-D, increasing toward top?, some high below contact	Impacted marine
Muddy shelly sand/gravel	VC-01-12	>40%, most >60%	Variable	>40%, most >80%	<<5%	Mollusc, Halimeda, B. Foram, Echinoderm, unidentified CO3-C-A, Terrigenous-Tr-R	Open marine
Organic mud	VC-01, VC-02	Variable	>60%	Variable	8-20+%	No data	Marginal Marine Paralic
Blue green clay	VC-01	Variable	>40%	<10%	Variable	No data	Marine/non-marine Pre-transgressive

and >5% organic content (LOI) (Table 2). Sediment constituents generally consist of abundant to dominant terrigenous clastic material that commonly increases toward the surface. Results of XRD analysis record terrigenous material consisting dominantly of quartz and feldspar. The "smms" facies is defined by a finer grain size, increase in organic content, increase in terrigenous constituents, and subtle decrease in carbonate content with respect to the underlying "mssg facies". ^{210}Pb data show that the entire surficial unit from core VC-02 was deposited since the 1950's at a linear accumulation rate of 0.25 cm/yr and a mass accumulation rate of 0.146 g/cm^2/yr (Fig. 4).

Characteristics and distribution of surface sediments

Surface sediments in Coral Bay show a general pattern of finer sediments near the bay head and coarser sediments near the bay mouth (Fig. 5). Finest sediments are concentrated in Coral Harbor with most in the 2ø - 6ø mean grain size range (medium sand to medium silt). The finest sediments in Coral Harbor are medium silt size, and are confined to the innermost portion.

Surface sediments in Coral Bay outside Coral Harbor have mean grain sizes in the 0 ø-2 ø (medium to coarse sand) range. Exceptions include the tops of cores VC-12, VC-06, VC-10 and VC-11 and site 21 (Fig. 2) with mean grain sizes between 2 ø and 4 ø (fine sand to very fine sand). All were collected from protected, low-energy areas. Site 27 had a mean grain size of 4 ø-5 ø (coarse silt), and was collected from an open, exposed portion of the bay (Fig. 2).

Calcium carbonate content in surface sediments is typically >80% indicating a strong marine influence (Fig. 6). Exceptions are concentrated in the innermost portions of Coral Harbor, where values are consistently <60%. Calcium carbonate sediments consist primarily of biogenic grains thereby representing a marine source. Noncarbonate sediments may reflect a variety of sources, but are primarily quartz, feldspar and terrigenous rock fragments. Another minor component of non-carbonate

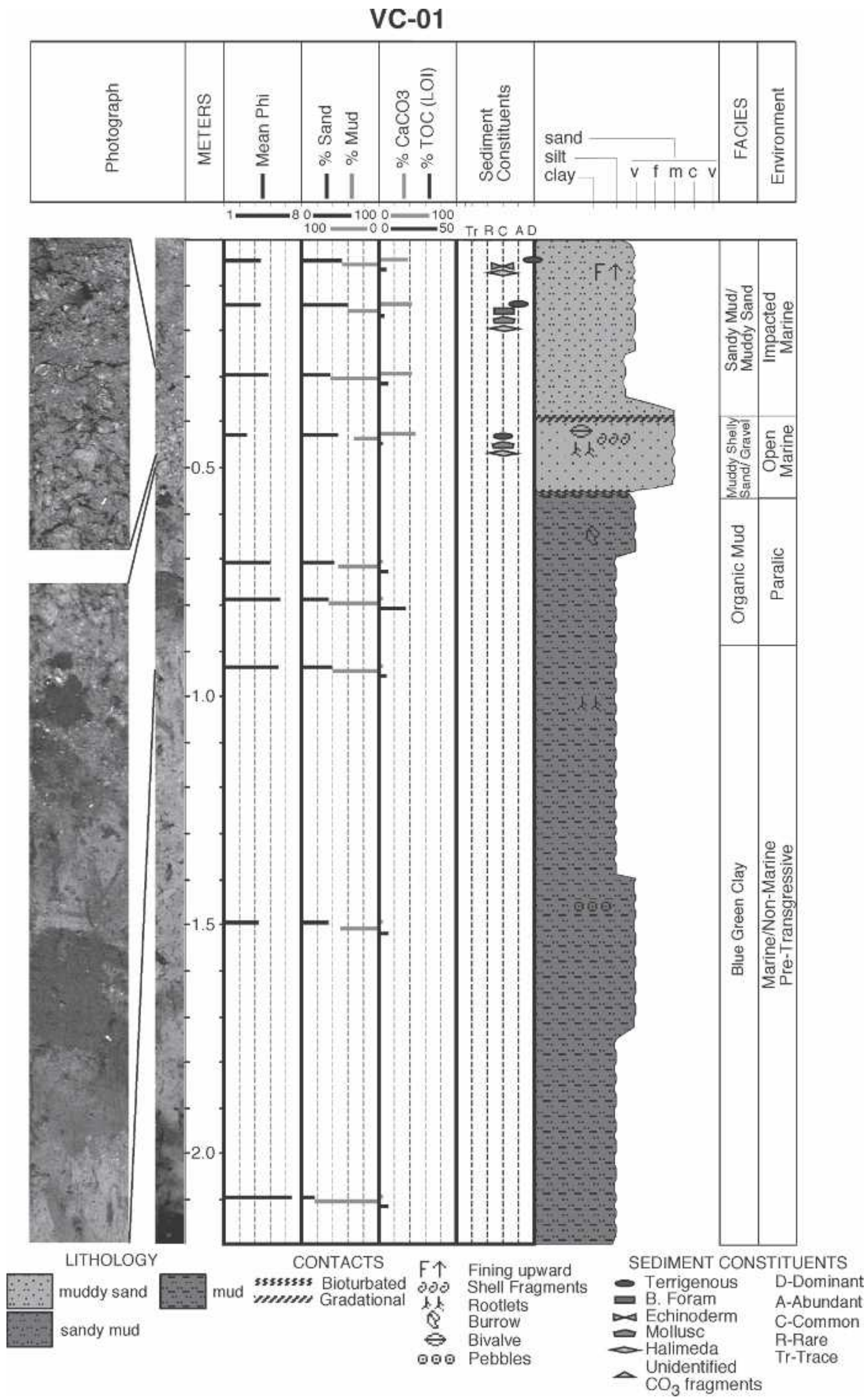

FIG. 3. Photographs and description of vibracore VC-01. See Figure 2 for core site location.

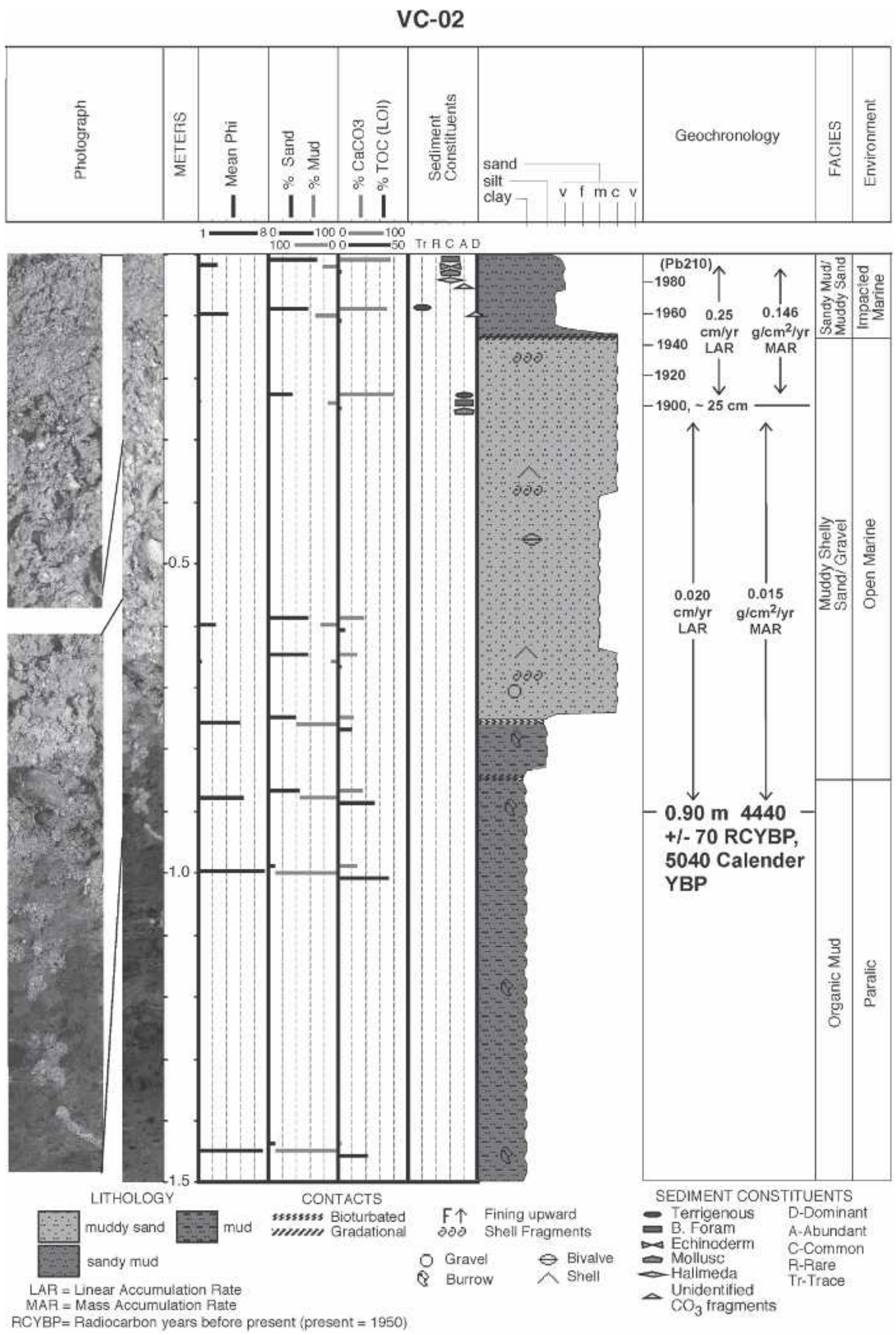

FIG. 4. Photographs and description of vibracore VC-02 including geochronology and accumulation rates. See Figure 2 for core site location.

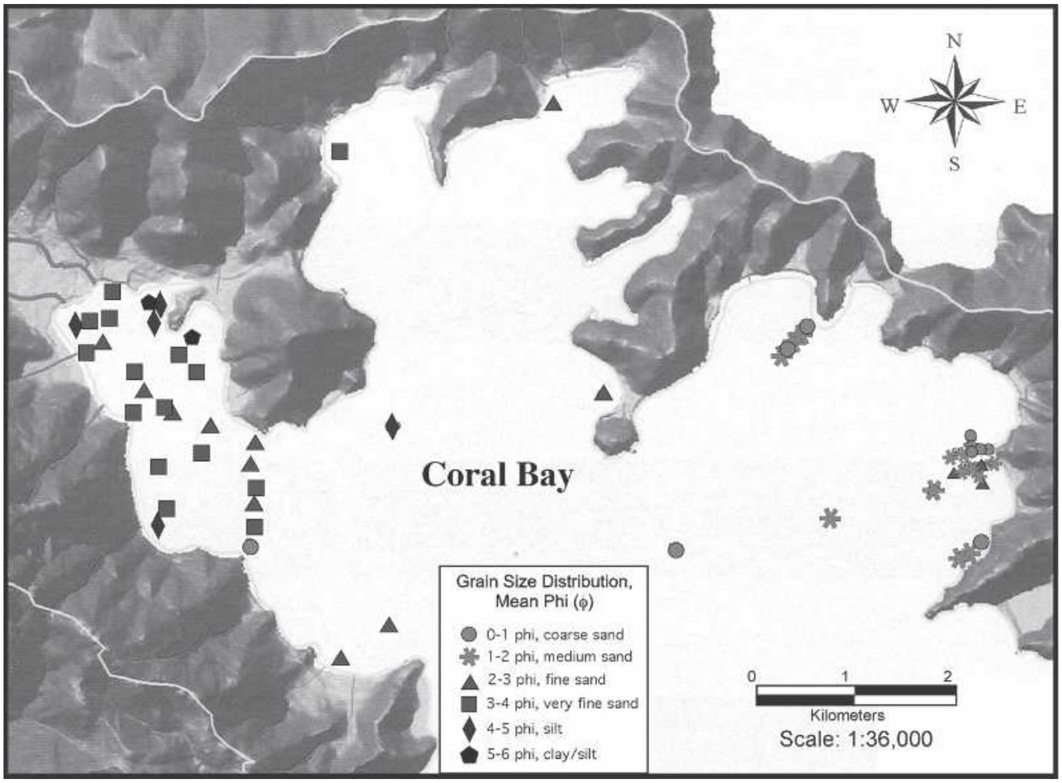

FIG. 5. Map of Coral Bay showing the distribution of surface sediment mean grain size in phi (ϕ) units. Note that finest sediments are concentrated near heaviest island development in Coral Harbor.

sediments is organic matter, but it generally represents a small percentage of the total sediment. The greatest variability in calcium carbonate content is within Coral Harbor where values range from approximately 30% to 80%. Calcium carbonate content increases in a seaward direction. Sediment samples in Coral Bay outside of Coral Harbor are almost entirely calcium carbonate (>95%) except some sites in the southeastern portion of the bay in a protected area where values range from 50% to 80% calcium carbonate. In general, the distribution of calcium carbonate is consistent with grain size in that most terrigenous (non-carbonate) deposition is concentrated in the northern, most protected part of Coral Harbor, and most marine (carbonate) sediments are deposited in more exposed portions of Coral Harbor and the open bay (Fig. 6).

The organic content (LOI) of surface sediment samples in Coral Bay is generally low with most below 2% (Fig. 7). Highest values were found in Coral Harbor with most >2%. The highest value (>9%) was found at the top of core VC-08 in the center of the harbor. The next highest values, reaching 4-5%, were found in the northwest corner of Coral Harbor. This distribution pattern reflects substantial organic input coupled with poor circulation in Coral Harbor, especially in the innermost and deepest (>5 m), central portions. The source of organic matter is difficult to assess, but could be the vegetation surrounding the harbor, or potentially waste from the large numbers of boats typically anchored in the harbor. The latter may be true for the high value (>9%) at the top of core VC-08, which had a distinct sewage smell upon opening the core. The top of core VC-05, located near the mouth of a major gut west of the entrance to Coral Harbor (Fig. 2), also had a sewage odor and an organic content of 3-4%.

Outside of Coral Harbor, the organic

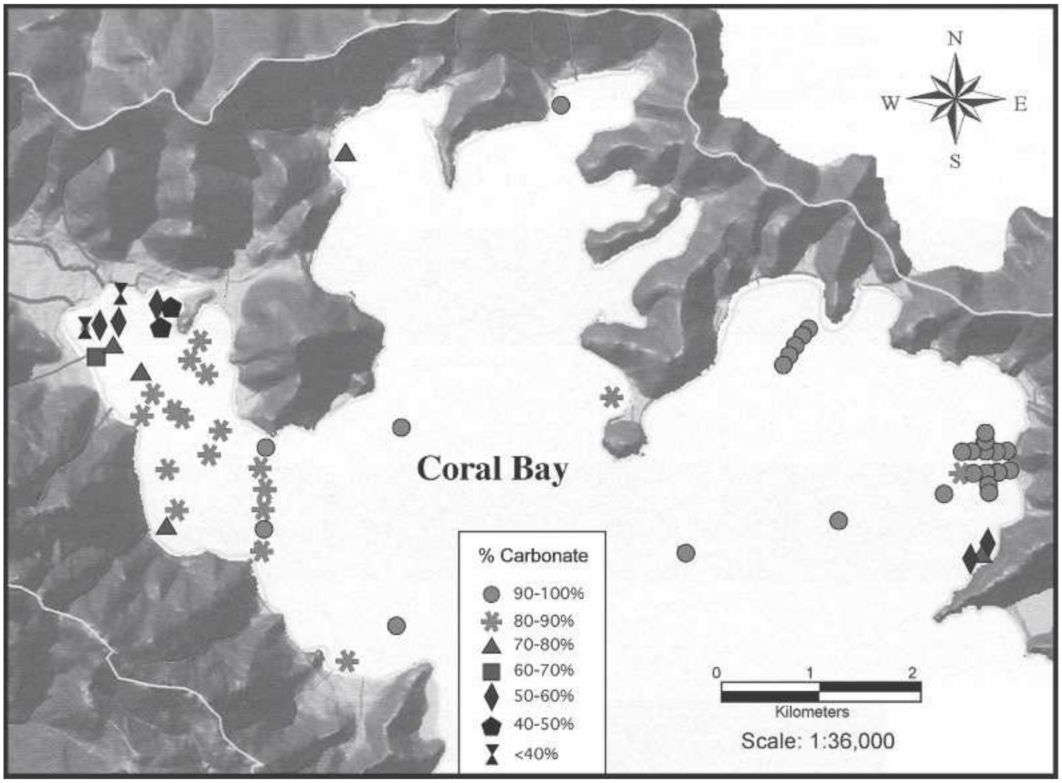

FIG. 6. Map of Coral Bay showing the distribution of calcium carbonate in surface sediments. The non-carbonate fraction consists dominantly of terrigenous sediments from island runoff. Note that terrigenous sediments are concentrated near heaviest island development in Coral Harbor.

content is consistently below 1%, except for the top of core VC-12 with >5%, and site 28 with 1-2%. Core VC-12 was collected from Hurricane Hole, a protected portion of the bay that has experienced recent development, and site 28 was located in the open bay (Fig. 2). The reason for elevated organic levels at these sites is unknown.

DISCUSSION

Facies architecture and depositional history

Based upon the 3-D arrangement of sedimentary facies, a 4-stage conceptual model of Coral Bay was developed (Fig. 8). Focusing on Coral Harbor, it illustrates the natural transgressive development of the bay, followed by a recent increase in terrigenous input likely reflecting anthropogenic influences. The basal sedimentary unit, "bgc" facies, is interpreted to represent a combination of marine and non-marine deposits, including soil horizons and weathering residua. The mixture of different sediment types suggests that deposits were reworked and amalgamated, likely while exposed prior to being inundated by the Holocene sea-level rise (Stage 1).

Stratigraphically overlying the "bgc" facies, the "om" facies is interpreted as paralic (i.e., marginal marine) in origin, likely deposited in a coastal mangrove swamp or similar type of environment (Stage 2). The radiocarbon date of 5,040 calendar years near the top of this unit ~6± m below present sea level, suggests that rising sea level was just beginning to inundate the area during this time period. This is consistent with Caribbean sea-level curves (Toscano and Macintyre, 2003; Hubbard et al., 2005), and provides a time constraint for the deposition of overlying marine sediments.

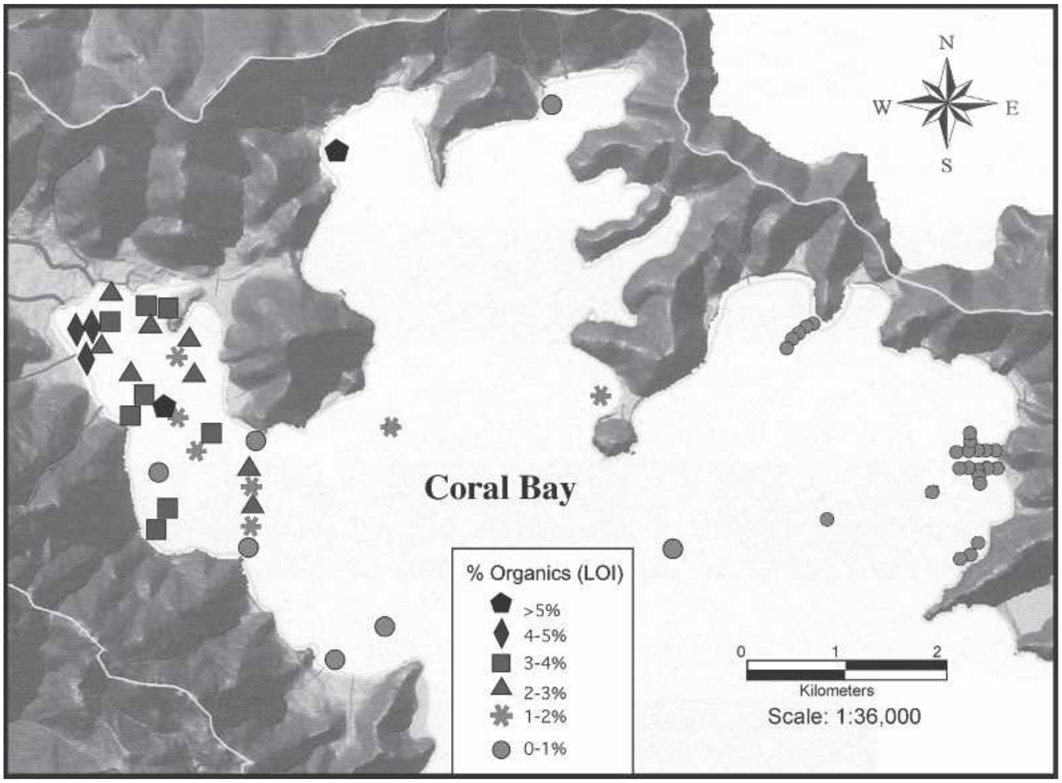

FIG. 7. Map of Coral Bay showing the distribution of organic matter (LOI) in surface sediments. Note that highest values are concentrated near heaviest island development in Coral Harbor.

Following inundation by rising sea level, marine conditions were established and tropical marine carbonate sediments were produced and deposited along with terrigenous material from the adjacent island (Stage 3). This is represented by the "mssg" facies, which reflects the natural development of Coral Bay prior to extensive human activities.

The surficial "smms" facies has been designated as impacted marine, and is interpreted to represent increased sediment runoff from the nearby island likely in response to human activities (Stage 4). Most cores show evidence of increased terrigenous input. This terrigenous signal, defined by a deviation in sediment texture and composition from underlying sediments deposited previous to anthropogenic occupation, is strongest in Coral Harbor and, with few exceptions (e.g., VC-12), decreases in the open portions of Coral Bay.

Based upon ^{14}C and ^{210}Pb data, sediment accumulation rates have also recently increased, reflecting the intensification of island runoff. The radiocarbon date (5,040 calendar years) collected from the uppermost part of the paralic unit in VC-02, yields an average linear accumulation rate of approximately 20 cm/1,000 years (0.02 cm/year) since being flooded by Holocene sea-level rise. This is a reasonable rate for a natural coastal system and assumes that there have been no breaks in deposition during this period. ^{210}Pb data from the same core yield a linear accumulation rate of 0.25 cm/yr for the entire "smms facies" (surficial 14 cm), an increase by approximately one order-of-magnitude. Mass accumulation rates, calculated to correct for differential compaction, similarly showed an increase from 0.015 g/cm^2/yr to 0.146 g/cm^2/yr over the same interval. Although this increase is slightly less than that calculated using linear accumulation rates, the increase is still approximately one order-of-

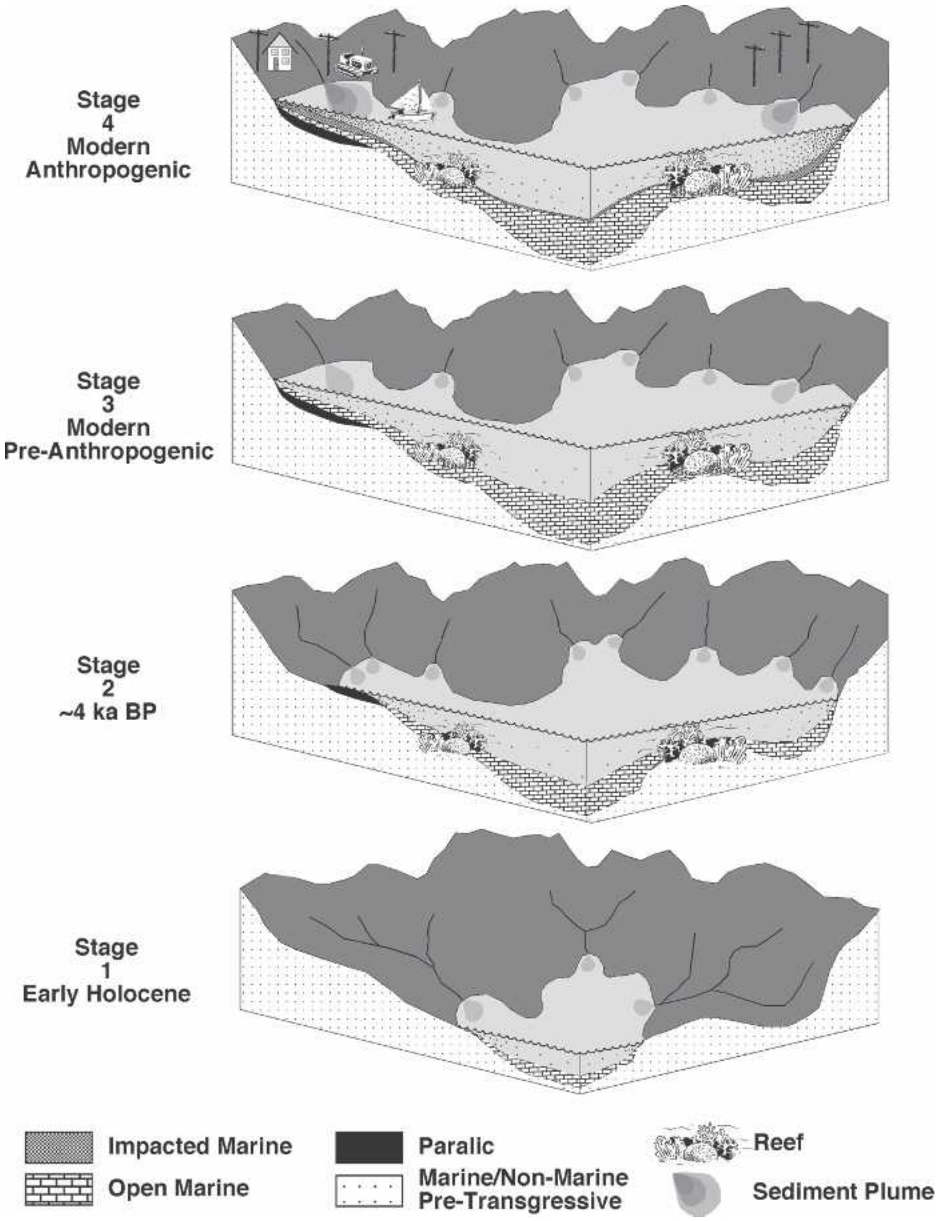

FIG. 8. Conceptual 4-Stage model depicting the sedimentary development of Coral Bay during the Holocene sea-level rise. Note the increase in sediment input associated with anthropogenic activities.

magnitude, which means the entire surficial (impacted marine) facies was deposited within approximately the past 50-60 years, or since about the 1950's.

The lack of datable material precluded the calculation of additional accumulation rates in Coral Bay, but data from nearby Fish Bay and Newfound Bay salt ponds (Fig. 1) can be used for comparison. Fish Bay salt pond is located at the base of a watershed exhibiting moderate development. Linear accumulation rates have shown a modest 2.5x increase from an average of 0.08 cm/yr over the past few thousand years, to 0.20 cm/yr over the past 100 years (Mclean et al., 2004; Schwing et al., 2005). Mass accumulation rates have increased from an average of 0.03 $g/cm^2/yr$ to 0.10 $g/cm^2/yr$, or a factor of 3.3x, over the same time period. This modest increase in sediment accumulation rate is consistent with the moderate rate of anthropogenic development the area has experienced in the recent past, and similar to current sediment yield rates (Anderson and MacDonald, 1998; Ramos-Scharron and MacDonald, In Press).

Newfound Bay salt pond, on the other hand, is at the base of an undeveloped watershed and average linear accumulation rates have shown only a slight increase (a factor of 1.4) from 0.05 cm/yr over the past 2,000 years, to 0.07 cm/yr over the past 100 years (Mclean et al., 2004). These rates are similar to those calculated for the pre-anthropogenic section of VC-02. Mass accumulation rates show even less of an increase (a factor of 1.2) from 0.015 $g/cm^2/yr$ to 0.018 $g/cm^2/yr$ for the same time period (Mclean et al., 2004). The lack of a significant increase in accumulation rate is consistent with the lack of recent anthropogenic activities in the Newfound Bay drainage basin.

It is reasonable to conclude that the dramatic increase in sediment accumulation rates in Coral Bay over the past 50-60 years is a result of the increase in anthropogenic activities during this time period. Since the 1950's St. John has experienced rapid development of vacation homes and tourist related activities (MacDonald et al., 1997), and the unpaved road network has expanded correspondingly. It is estimated that sediment delivery to the coastal environment in the early 1990's was 3-4 times greater than the long-term historic rate, and the expanded unpaved road network was identified as the primary sediment source (Anderson and MacDonald, 1988; Ramos-Scharron and MacDonald, In Press). It follows therefore that the surficial terrigenous signal detected in cores is a result of an increase in sediment delivery to the coastal system in response to heightened anthropogenic activities since the middle of the last century. An implication of this interpretation is that either the early plantation agriculture and associated activities beginning in the early 1700's had no detectable impact on the sedimentary record in Coral Bay, or the signal of these activities cannot be resolved with available technology.

Controls and processes influencing sediment distribution

The magnitude of the surficial terrigenous signal (i.e., deviation from the underlying natural signal) varies considerably and generally decreases outside of Coral Harbor and into the more open and unprotected parts of Coral Bay (Fig. 8—Stage 4). Deposition of terrigenous sediment is more pronounced near shore in the innermost portion of Coral Harbor, as well as in the central, deep (>5 m) portion. This suggests that the spatial distribution of terrigenous sediment in Coral Harbor is controlled by proximity to input source in combination with energy level. Coarser grained terrigenous sediments accumulate near shore, adjacent to their input sources, where finer grained terrigenous sediments accumulate near shore in sheltered, low energy areas where they cannot be easily remobilized and exported. Similarly, the central portion of the harbor is also the deepest (>5 m), and energy levels are lower, thereby facilitating the deposition and accumulation of fine-grained sediments.

Outside of Coral Harbor in the open portion of Coral Bay, surface sediments are dominantly medium-coarse, sand-sized biogenic carbonates, and the terrigenous signal is minimal. This is probably due to the higher energy levels, causing most of the fine-grained terrigenous sediment input into the open portion of the bay to be quickly exported out of the bay and into deeper water, or possibly transported back into Coral Harbor. In more sheltered portions of Coral Bay such as Hurricane Hole (Fig. 1), the surficial terrigenous signal is more substantial with primarily very fine sand size sediments and less (70-80%) calcium carbonate (Figs. 5 and 6). This pattern suggests that recent development may have increased terrigenous run-off in some areas, and that small, isolated depositional centers exist that collect and accumulate terrigenous sediments. Carbonate sediments continue to dominate however.

In summary, the surface sediment distribution pattern suggests that proximity to input source and energy level are the dominant controls for terrigenous sediment deposition and accumulation. The bulk of terrigenous deposition is in Coral Harbor. Coarser-grained terrigenous sediments are deposited near shore adjacent to their input source. Some fine-grained terrigenous sediments are deposited in low energy regions within the harbor. Most terrigenous sediments making it outside Coral Harbor are fine-grained and likely bypass the bay completely. Similarly, most fine-grained terrigenous sediment that is input directly into the open bay is likely exported quickly, except for some entering into low energy, poorly flushed areas where they accumulate in isolated depositional basins.

Comparisons with other impacted coastal systems

Previous studies on Hawksnest Bay along the northwest St. John shore, and Fish and Reef Bays along the southwest St. John shore (Fig. 1), yielded similar results in that sediment distribution was found to be controlled by proximity to input source and energy levels (Hubbard et al., 1987). Age dating and associated accumulation rates were not determined so the magnitude of increased sediment input remains unknown, but it was concluded that terrigenous input varied greatly among the three bays and depositional patterns were interpreted to reflect an increase in fine-grained sediment input associated with anthropogenic activities. They also established that fine-grained sediments were deposited in the deeper and quieter seaward most portions of the bays (Hubbard et al., 1987).

Surface sediment distribution patterns and core data from Coral Bay are consistent with the findings of Hubbard et al. (1987), except that in the open Bay outside of Coral Harbor there appears to be little accumulation of terrigenous sediment, even in deeper areas. This may be because the Bay is exposed and energy levels are too high for the deposition of fine-grained sediments as discussed above, although Hawksnest, Reef and Fish Bays are much more open and exposed than Coral Bay. The similarity in historical patterns of sediment accumulation suggests that Coral Bay experienced a similar evolution to Fish, Reef and Hawksnest Bays, and that increases in terrigenous content in surface sediments are likely due to anthropogenic activities.

The sedimentary records of Mandel salt pond and Reef Bay mangrove swamp on the south coast of St. John were investigated to determine if sedimentation rates had changed in response to human activities in the watersheds (Nichols and Brush, 1988). Mandel Pond, described as relatively free from human activity, revealed mass accumulation rates ranging from 0.03-0.042 $g/cm^2/yr$ for the past 3,300 years with no appreciable change over the past 560 years. These rates are consistent with pre-anthropogenic rates calculated for Coral Bay, as well as historic and modern rates calculated for the nearby, and relatively unimpacted Newfound Harbor salt pond. Reef Bay mangrove swamp, described as having a history of substantial human activity, revealed mass accumulation rates ranging from 0.014-0.173 $g/cm^2/yr$ for the past 3,300 years, with one of three cores showing a fivefold increase in younger material over older material (Nichols and Brush, 1988). Although a recent increase in accumulation rate is evident in some cores, results are inconsistent and the increase is not as dramatic as that found for Coral Bay. This is likely due to the differences in dating methods as Mandel salt pond and Reef Bay mangrove swamp sediments were dated by ^{14}C augmented with pollen records, which resulted in averaging data over the past 500+ years. Coral Bay sediments, as well as Newfound Harbor and Fish Bay salt ponds, were dated using a combination of ^{14}C and ^{210}Pb methods, which allow the determination of accumulation rates over the last 100 years, the period of most intense human activities.

Other anthropogenically impacted coastal systems that can be used for comparison include Tampa Bay and Charlotte Harbor, two Florida gulf coast estuaries, and Chesapeake Bay, along the mid-Atlantic U.S. coast, although all are much larger in scale than Coral Bay. Tampa Bay and Charlotte Harbor are strikingly similar to one another in both depositional pattern and accumulation rates. Both were inundated by the Holocene sea-level rise starting ~6 ka and overlying estuarine sediments have accumulated at average rates of ~0.03-0.06 cm/yr since that time (Brooks et al., 2004). The surficial 30± cm show no appreciable differences in texture and/or composition from underlying sediments, but ^{210}Pb and ^{137}Cs data indicate linear accumulation rates have increased to ~0.28-0.44 cm/yr, or almost one order-of-magnitude, likely due to anthropogenic activities over the past 100 years. This suggests that anthropogenic activities have not substantially altered the natural sediment distribution patterns, but the rate of sediments entering the estuary has increased dramatically (Brooks et al., 2004).

Chesapeake Bay, the largest estuary in the US, exhibits a similar scenario. It was inundated by rising sea level ca. 6-8 ka (Cronin et al., 2000) and contains a thick Holocene sedimentary section made up primarily of restricted to open estuarine muds, muddy sands and sandy muds (Baucom et al., 2000). Like Tampa Bay and Charlotte Harbor, there are no obvious deviations in sediment texture and composition that can be attributed to anthropogenic activities, but mass accumulation rates have increased by a factor of four since the period of initial land clearance in the early 19^{th} century (Colman et al., 2000).

These findings are consistent with results presented here, except that Coral Bay sediments contain a distinct anthropogenic signal represented by deviations in surficial sediment texture and composition. Consequently, unlike Tampa Bay, Charlotte Harbor and Chesapeake Bay, anthropogenic activities have not only resulted in a dramatic increase in sediment accumulation rates in Coral Bay, but have altered sediment distribution patterns as well. The reasons for this are presently unclear, and it is likely that watershed character and scale plays a role. It may also be related to the high relief, intense tropical weathering processes and highly erodable rocks and soils typical of tropical, volcanic-island settings. Selective clearing/development in this type of environment would likely create a dramatic increase in sediment input rates, as well as provide new and different pathways for sediment delivery to the coastal system. Coupled with the distinctly different marine sediments (i.e., tropical marine carbonates) naturally deposited in the system, the anthropogenic signal would be much easier to detect than in the temperate-subtropical estuaries discussed above.

CONCLUSIONS

Based upon texture and composition four sedimentary facies are identified. The facies architecture reflects a typical transgressive sequence deposited during the Holocene sea-level rise, capped by a surficial unit that represents an increase in terrigenous input. The surficial unit is defined by a decrease in grain size, increase in organic content, increase in terrigenous constituents, and subtle decrease in calcium carbonate content from underlying units. This deviation is interpreted as representing an anthropogenic signal, likely caused by the recent increase in island development. Radiocarbon and ^{210}Pb data indicate that accumulation rates have increased by approximately one order-of-magnitude over the past 50-60 years, presumably in response to an increase in anthropogenic activities during this time period.

The magnitude of deviation of the anthropogenic signal over the underlying natural signal is greatest adjacent to the most heavily developed areas and protected, low-energy embayments such as Coral Harbor, and decreases in the more open and seaward portions of the Bay. This pattern suggests that proximity to input source and energy level are the dominant controls governing where terrigenous sediments ultimately accumulate.

In comparison with other anthropogenically-impacted coastal systems, Coral Bay is similar in that accumulation rates have increased by up to one order-of-magnitude in response to anthropogenic activities. Unlike these other systems, Coral Bay contains a distinct anthropogenic signal represented by deviations in surficial sediment texture and composition. Consequently, anthropogenic activities have not only resulted in a dramatic increase in sediment accumulation rates, but have altered sediment distribution patterns as well. This may be related to the high relief, intense weathering processes and highly erodible rocks and soils typical of tropical, volcanic-island settings. Tropical, high relief, volcanic islands, therefore, provide an ideal setting for studying natural vs anthropogenically-altered sediment distribution patterns in coastal systems.

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LITERATURE CITED

Anderson, D. M. 1994. Analysis and modeling of erosion hazards and sediment delivery on St. John, US Virgin Islands. *US National Park Service Water Resources Division*. NPS/NRWRD/NRTR-94/34.

Anderson, D. M. and L. H. MacDonald. 1998. Modelling road surface sediment production using a vector geographic information system. *Earth Surface Processes and Landforms*. 23:95-107.

Armstrong, D. V. 2003. *Creole transformation from slavery to freedom*. Gainesville: University Press of Florida.

Brooks, G. R., R. A. Larson, N. T. Edgar, R. H. Pierce, D. Wetzel, C. W. Holmes and M. Henry. 2004. Holocene Depositional History in Two Florida Gulf Coast Estuaries: Tampa Bay and Charlotte Harbor. *Geological Society of America Abstracts with Programs*, 36:301.

Baucom, P. C., J.F. Bratton, S. M. Colman, J. Fridell and A. Rochon. 2000. Sedimentology and core descriptions, Marion-Dufresne cores MD99-2204 through -2209, Chesapeake Bay. In *Initial report on IMAGES V cruise of the Marion-Dufresne to the Cheaspeake Bay June 20-22, 1999*, ed. T. M. Cronin, 49-71. US Geological Survey.

Carver, R. E. 1971. *Processes in sedimentary petrology*. New York: Wiley-Interscience.

Colman, S. M., J. F. Bratton and P. C. Baucom. 2000. Radiocarbon dating of Marion-Dufresne cores MD99-2204 -2207 and -2209, Chesapeake Bay. In *Initial report on IMAGES V cruise of the Marion-Dufresne to the Cheaspeake Bay June 20-22, 1999*, ed. T. M. Cronin, 72-77. US Geological Survey.

Cronin, T. M., T. Willard, A. Karlsen, S. Ishman, S. Verardo, J. McGeehin, R. Kerhin, C. Holmes, S. Colman and A. Zimmerman. 2000. Climatic variability in the eastern United States over the past millennium from Chesapeake Bay sediments. *Geology*. 28:3-6.

Dean, W. E. 1974. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignition: comparison with other methods. *Journal of Sedimentary Petrology*. 44: 242-248.

Devine, B., G. R. Brooks and R. Nemeth. 2003. Coral Bay sediment deposition and reef assessment study. *V.I. Department of Planning and Natural Resources*.

Donnelly, T. W. 1966. Geology of St. Thomas and St. John, U.S. Virgin Islands. In *Caribbean Geological Investigations*, ed. H. H. Hess, 85-176. Geological Society of America, Memoirs.

Folk, R. L., ed. 1965. *Petrology of sedimentary rocks*. Austin: Hemphills.

Gardner, T. A., I. M. Cote, J. A. Gill, A. Grant and A. R. Watkinson. 2003. Long-term region-wide declines in Caribbean corals. *Science*. 301:958-960.

Gibbs, R. J. 1974. A settling tube for sand-size analysis. *Journal of Sedimentary Petrology*. 44:583-588.

Hubbard, D. K., J. D. Stump and B. Carter. 1987. Sedimentation and reef development in Hawksnest, Fish and Reef Bays, St John, US Virgin Islands. *Virgin Islands Resource Management Cooperative*. Biosphere Reserve Research rept. 21.

Hubbard, D. K., H. Zankl, I. Van Heerden and I. P. Gill. 2005. Holocene reef development along the southeastern St, Croix shelf, Buck Island, U.S. Virgin Islands. *Journal of Sedimentary Research*. 75:97-113.

Jones, B., E. Galan. 1988. Sepiolite and palygorskite. In *Hydrous phyllosilicates*, ed. S. W. Bailey, 631-674. Mineralogical Society of America.

Lanesky, D. E., B. W. Logan, B. W. Brown and A. C. Hine. 1979. A new approach to portable vibracoring underwater and on land. *Journal of Sedimentary Petrology*. 49:54-57.

MacDonald, L. H., D. M. Anderson and W. E. Dietrich. 1997. Paradise Threatened: Land Use and Erosion on St. John, US Virgin Islands. *Environmental Management*. 21:851-863.

MacDonald, L. H., R. W. Sampson and D. M. Anderson. 2001. Runoff and road erosion at the plot and road segment scales, St. John, U.S. Virgin Islands. *Earth Surface Processes and Landforms*. 26:251-272.

Mclean, M.R., G. R. Brooks, B. Devine, R. A. Larson, P. T. Schwing and K. M. McMullen. 2004. Coastal Sedimentary Evolution of St. Thomas and St. John, US Virgin Islands: A Function of Drainage Basin Diversity. *Geological Society of America Abstracts with Programs*, 36:288.

Milliman, J. D. 1974. *Marine carbonates*. New York: Springer-Verlag.

Nemeth, R. S. and J. S. Nowlis. 2001. Monitoring the effects of land development on the near-shore reef environment of St. Thomas, USVI. *Bulletin of Marine Science*. 69:759-775.

Nemeth, R. S., L. H. MacDonald and C. E. Ramos-Scharron 2001. Delivery, Deposition and effects of Land-Based Sediments on Corals in St. John, U.S. Virgin Islands. *University of the Virgin Islands*.

Nichols, M. M. and G. S. Brush. 1988. Virgin Islands Resource Management Cooperative. *Virgin Islands National Park*. No. 23.

Nowlis, S. J., C. M. Roberts, A. H. Smith and E. Siirila. 1997. Human-enhanced impacts of a tropical storm on nearshore coral reefs. *Ambio*. 26:515-521.

Nugues, M. M. and C. M. Roberts. 2003. Partial mortality in massive reef corals as an indicator of sediment stress on coral reefs. *Marine Pollution Bulletin*. 46:314-323.

Ramos-Scharron, C. E. and L. H. MacDonald. 2005. Measurement and prediction of sediment production from unpaved roads, St. John, U.S. Virgin Islands. *Earth Surface Processes and Landforms*. 30: 1283-1304.

Ramos-Scharron, C. E. and L. H. MacDonald. In Press. Runoff and suspended sediment yields from an unpaved road segment, St. John, U.S. Virgin Islands. *Hydrological Processes*.

Rankin, D. W. 2002. Geology of St. John, U.S. Virgin Islands. *U.S. Department of the Interior*. 1631.

Rawlins, B. G., A. J. Ferguson, P. J. Chilton, R. S. Arthurton and J. G. Rees. 1998. Review of Agricultural Pollution in the Caribbean with Particular Emphasis on Small Island Developing States. *Marine Pollution Bulletin*. 36:658-668.

Rogers, C. M. 1979. The effects of shading on coral-reef structure and function. *Journal of Experimental Marine Biology and Ecology*. 41:269-288.

Schwing, P. T., G. R. Brooks, B. Devine, R. A. Larson, and L. E. Wallace. 2005. Interaction of regional climatology and anthropogenic impacts on sedimentation on St. John, USVI, *9th Annual Virgin Island Non-Point Source Pollution Conference*, St. John, USVI

Stuiver, M. and H. van der Plicht. 1998. Calibration Database - Editorial Comment. *Radiocarbon*. 40:xii-xiii.

Stuiver, M., et al. 1998. INTCAL98 radiocarbon age calibration. *Radiocarbon*. 40:1041-1083.

Talma, A. S. and J. C. Vogel. 1993. A simplified approach to calibrating ^{14}C dates. *Radiocarbon*. 35:317-322.

Torres, R., M. Chiappone and F. Geraldes. 2001. Sedimentation as an important environmental influence on Dominican Republic reefs. *Bulletin of Marine Science*. 69:805-818.

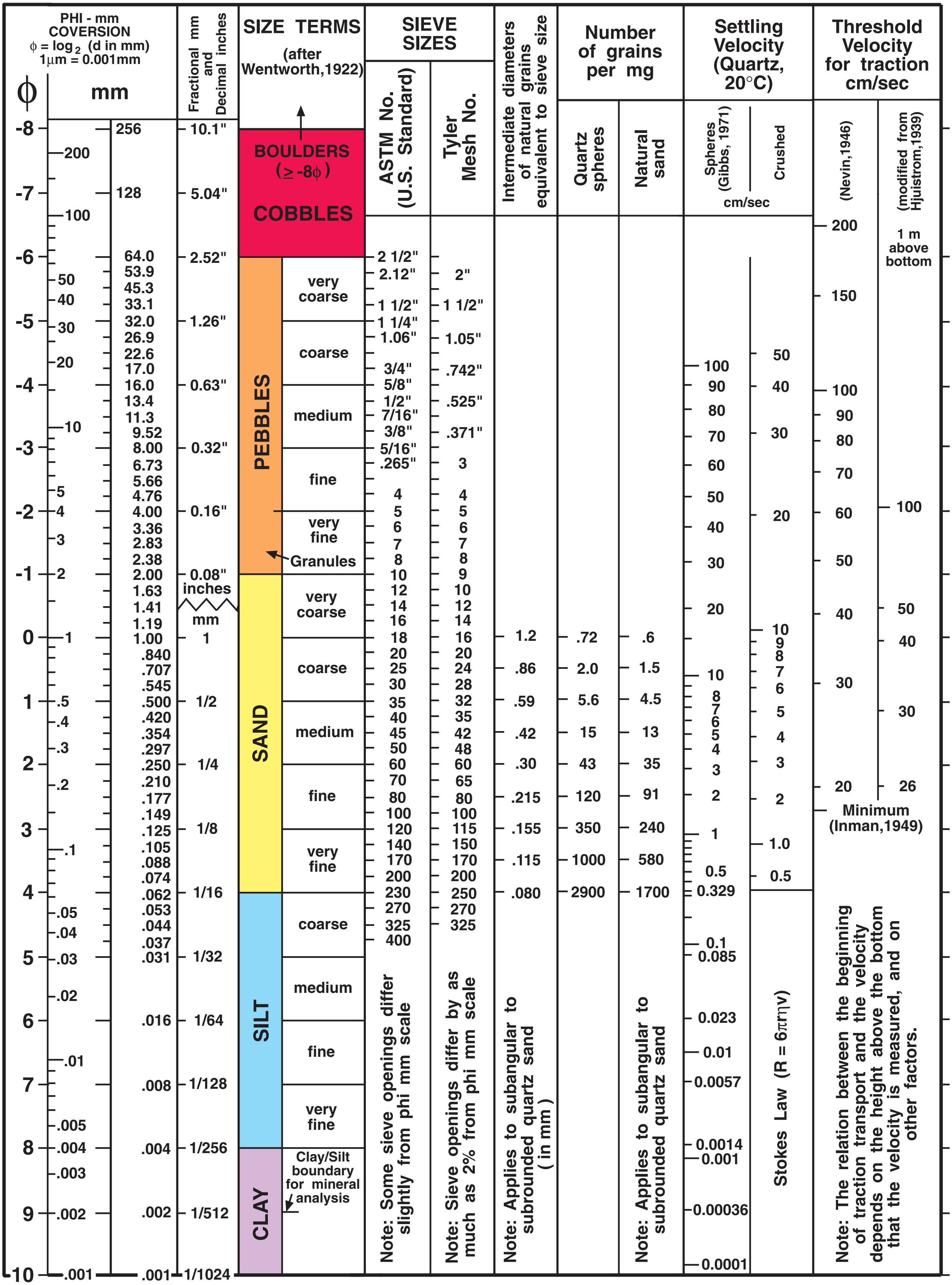
Toscano, M. and I. G. Macintyre. 2003. Corrected western Atlantic sea-level curve for the last 11,000 years based on calibrated ^{14}C dates from *Acropora palmata* framework and intertidal mangrove peat. *Coral Reefs*. 22:257-270.

U. S. Census Bureau. 2000. Census 2000—US Virgin Islands. www.census.gov/population/www/censusdata/sch_vislands.html

APPENDIX VIII

USGS Wentworth Scale

Particle Size and Settling Velocities


PHI - mm COVERSION
ϕ = log2 (d in mm)
1µm = 0.001mm
ϕ
mm
Fractional mm and Decimal inches
SIZE TERMS
(after Wentworth,1922)
SIEVE SIZES
ASTM No. (U.S. Standard)
Tyler Mesh No.
Intermediate diameters of natural grains equivalent to sieve size
Number of grains per mg
Quartz spheres
Natural sand
Settling Velocity (Quartz, 20°C)
Spheres (Gibbs, 1971)
Crushed
cm/sec
Threshold Velocity for traction cm/sec
(Nevin,1946)
(modified from Hjuistrom,1939)
1 m above bottom
-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
200 100 50 40 30 20 10 5 4 3 2 1 .5 .4 .3 .2 .1 .05 .04 .03 .02 .01 .005 .004 .003 .002 .001
256 128 64.0 53.9 45.3 33.1 32.0 26.9 22.6 17.0 16.0 13.4 11.3 9.52 8.00 6.73 5.66 4.76 4.00 3.36 2.83 2.38 2.00 1.63 1.41 1.19 1.00 .840 .707 .545 .500 .420 .354 .297 .250 .210 .177 .149 .125 .105 .088 .074 .062 .053 .044 .037 .031 .016 .008 .004 .002 .001
10.1" 5.04" 2.52" 1.26" 0.63" 0.32" 0.16" 0.08"
inches
mm
1 1/2 1/4 1/8 1/16 1/32 1/64 1/128 1/256 1/512 1/1024
BOULDERS (≥ -8ϕ)
COBBLES
PEBBLES
very coarse
coarse
medium
fine
very fine
Granules
SAND
very coarse
coarse
medium
fine
very fine
SILT
coarse
medium
fine
very fine
CLAY
Clay/Silt boundary for mineral analysis
2 1/2" 2.12" 1 1/2" 1 1/4" 1.06" 3/4" 5/8" 1/2" 7/16" 3/8" 5/16" .265" 4 5 6 7 8 10 12 14 16 18 20 25 30 35 40 45 50 60 70 80 100 120 140 170 200 230 270 325 400
2" 1 1/2" 1.05" .742" .525" .371" 3 4 5 6 7 8 9 10 12 14 16 20 24 28 32 35 42 48 60 65 80 100 115 150 170 200 250 270 325
Note: Some sieve openings differ slightly from phi mm scale
Note: Sieve openings differ by as much as 2% from phi mm scale
1.2 .86 .59 .42 .30 .215 .155 .115 .080
Note: Applies to subangular to subrounded quartz sand (in mm)
.72 2.0 5.6 15 43 120 350 1000 2900
.6 1.5 4.5 13 35 91 240 580 1700
Note: Applies to subangular to subrounded quartz sand
100 90 80 70 60 50 40 30 20 10 8 7 6 5 4 3 2 1 0.5 0.329 0.1 0.085 0.023 0.01 0.0057 0.0014 0.001 0.00036 0.0001
50 40 30 20 10 9 8 7 6 5 4 3 2 1.0 0.5
Stokes Law (R = 6πrηv)
200 150 100 90 80 70 60 50 40 30 20
Minimum (Inman,1949)
100 50 40 30 26
Note: The relation between the beginning of traction transport and the velocity of traction depends on the height above the bottom that the velocity is measured, and on other factors.

APPENDIX IX

Enhanced Current Gradient and Multi-Component Sediment Settling Model

Current Gradient + Multi-Component Sediment Transport Model

Transport Distance (TD) Equation

$$TD = \int_{D=0}^{D=MaxDepth} CV(D) / FV \, dD$$

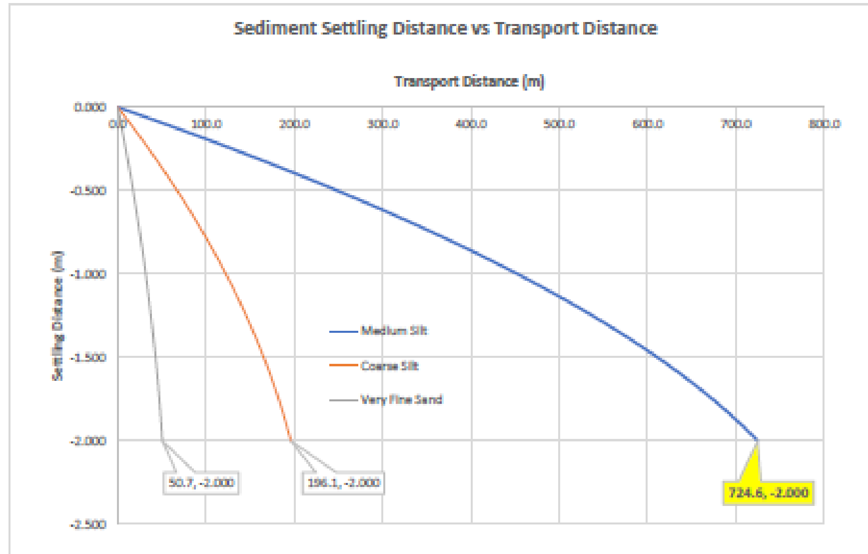
Current Velocity Linear Gradient Equation

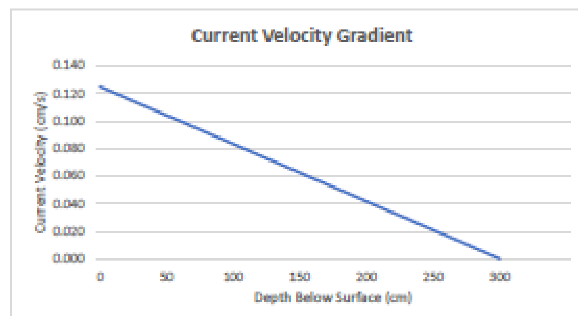
$$CV(D) = (-SC / ZCD) * D + SC$$

$$TD = (-SC / (2 * ZCD * FV)) * D^2 + (SC / FV) * D$$

Model Parameters	
0.125	Surface Current
300	Zero Current Depth
0.063	Average Current
0.023	Fall Velocity Medium Silt
0.085	Fall Velocity Coarse Silt
0.329	Fall Velocity Very Fine Sand
200	Vertical Fall
all values in cm and cm/s	
5	Depth Increment

Water Depth	Water Depth	Current Velocity	Transport Distance		
WD (cm)	WD (m)	CV (cm/sec)	Medium Silt	Coarse Silt	Very Fine Sand
0	0.000	0.125	0.0	0.0	0.0
5	-0.050	0.123	26.9	7.3	1.9
10	-0.100	0.121	53.4	14.5	3.7
15	-0.150	0.119	79.5	21.5	5.6
20	-0.200	0.117	105.1	28.4	7.3
25	-0.250	0.115	130.2	35.2	9.1
30	-0.300	0.113	154.9	41.9	10.8
35	-0.350	0.110	179.1	48.5	12.5
40	-0.400	0.108	202.9	54.9	14.2
45	-0.450	0.106	226.2	61.2	15.8
50	-0.500	0.104	249.1	67.4	17.4
55	-0.550	0.102	271.5	73.5	19.0
60	-0.600	0.100	293.5	79.4	20.5
65	-0.650	0.098	315.0	85.2	22.0
70	-0.700	0.096	336.1	90.9	23.5
75	-0.750	0.094	356.7	96.5	24.9
80	-0.800	0.092	376.8	102.0	26.3
85	-0.850	0.090	396.5	107.3	27.7
90	-0.900	0.088	415.8	112.5	29.1
95	-0.950	0.085	434.6	117.6	30.4
100	-1.000	0.083	452.9	122.5	31.7
105	-1.050	0.081	470.8	127.4	32.9
110	-1.100	0.079	488.2	132.1	34.1
115	-1.150	0.077	505.2	136.7	35.3
120	-1.200	0.075	521.7	141.2	36.5
125	-1.250	0.073	537.8	145.5	37.6
130	-1.300	0.071	553.4	149.8	38.7
135	-1.350	0.069	568.6	153.9	39.8
140	-1.400	0.067	583.3	157.8	40.8
145	-1.450	0.065	597.6	161.7	41.8
150	-1.500	0.063	611.4	165.4	42.7
155	-1.550	0.060	624.8	169.1	43.7
160	-1.600	0.058	637.7	172.5	44.6
165	-1.650	0.056	650.1	175.9	45.5
170	-1.700	0.054	662.1	179.2	46.3
175	-1.750	0.052	673.7	182.3	47.1
180	-1.800	0.050	684.8	185.3	47.9
185	-1.850	0.048	695.4	188.2	48.6
190	-1.900	0.046	705.6	190.9	49.3
195	-1.950	0.044	715.4	193.6	50.0
200	-2.000	0.042	724.6	196.1	50.7
205	-2.050	0.040	733.5	198.5	51.3
210	-2.100	0.038	741.8	200.7	51.9
215	-2.150	0.035	749.8	202.9	52.4
220	-2.200	0.033	757.2	204.9	52.9
225	-2.250	0.031	764.3	206.8	53.4
230	-2.300	0.029	770.8	208.6	53.9





APPENDIX X

SEA GRASS IMPACTS FROM MARINA CONSTRUCTION AND OPERATION

I. SEA GRASS IMPACTS FROM MARINA CONSTRUCTION AND OPERATION

The applicant has calculated impacts to sea grasses from all sources (construction, dock shading, boat shading, ongoing operations) as 3.75 acres in total. We believe this estimate significantly understates the impacts to sea grass and mischaracterizes the overall impact to the benthic habitat. The erroneous estimate is then repeated by the applicant in numerous responses, in rebuttal to six federal agencies (NMFS-PRD, NMFS-HCD, FWS, NPS, EPA, USCG) and in multiple appendices and in multiple commentaries within the rebuttal letter (Alternatives Analysis, Benthic Mitigation Plan, Responses to CBCC, Impacts to Seagrass, Threatened or Endangered Species).

The basis for the 3.75 acre estimate is stated in the excerpt below from the applicant's August 2017 submission:

> "The project will be directly impacting approximately 1350ft2 due to the placement of 960 piles ranging from 14”-18” in diameters (66- 14”square concrete, 457 14”- round steel encased concrete, 437-18” – round steel encased concrete). A total of 39,258.18sf of docks are over areas with SAV, the majority of which has densities between 20 and 100%. Based on a 46% survival due to shading since the Applicant is using grated decking, 21,199.42sf (0.487ac) of seagrass may be lost. At the maximum capacity and at the maximum size boat in each slip there will be 5.65 acres of shading due to vessels. It can be assumed that 50% of the seagrass under vessels will be lost due to vessels being in placed more than 2 weeks at a time. There will be some survival due to angle of the sun and vessel types and some available light. There will be impacts due to spudding impact during construction which will probably account for between a 900-1020 sf of impact (6sf per spudding event and between 150 and 170 relocations. The operation of the marina will have an impact due to prop wash scour and you can assume another 10% loss. In total approximately 3.75 acres of seagrass will probably be lost as a result of the project."

To summarize the paragraph above, the table below shows the area impacts (as claimed by the applicant) from each of the main sources of impact:

Cause of Impact	**Area of Impact to Sea Grasses**
Piling Footprint	0.031 acre
Dock Shading	0.487 acre
Vessel Shading (at 50% impact)	2.825 acre
Barge Spudding	0.023 acre
Subtotal	3.366 acre
Marina Operations – Prop Wash and Scour @10% of above	0.337 acre
Total Impact (per applicant)	**3.703 acre (approx 3.75 acre)**

There are multiple problems in this analysis. First, the estimate of shading impacts from the fixed dock structures and boats within the marina neglects the cumulative impacts of these two sources of shading impacting the same regions of sea grass and ignores the fact that although any single vessel may, on average, be in place for short periods of time the overall occupancy of the marina will reach close to 90% during peak months of the boating season, according to the applicant's market analysis. Second, the estimate neglects the shadows created by 966 pilings, 5 feet high, and averaging 16" in diameter. Third, the estimate neglects the effects of shadow elongation in the latitude of Coral Bay. Finally, the estimate for the effects of prop wash and scour (10%) has no basis in science, has no supporting discussion and is flawed for a number of reasons discussed later.

Cumulative Effect of Dock and Boat Shadows

The cumulative shading effect is due to the fact that the grated decking, which by itself will reduce sea grass cover by at least 54% (Landry, 2008), is overlapped by the shadows created by boats within the marina. Due to the fact that the sun is virtually never directly overhead the shadows of the dock and the boats move in an east west direction during the course of the day and the large boat shadows cover areas which would otherwise be in partial dock shadow. The result of these cumulative shading impacts is to render the entire area of dock and boat shading unsuitable for sea grass growth.

It should be noted that the Landry study applied primarily to single family, small dock structures. The extrapolation to a large commercial marina with 12' wide walkways running in a predominantly east-west direction and 100'+ mega yachts is problematical.

We believe that a more accurate estimate of sea grass impact is obtained by adding the boat shadows at peak month occupancy to the fixed marina structure shadows and then increasing by average shadow elongation.

Effect of Shadow Elongation

At the latitude of Coral Bay (18 degrees North) the average elongation of shadows is approximately 22% during the mid day period (10am- 2pm) of the winter months (Dec – Feb). This means that a yacht with a footprint of 1000 square feet will cast a shadow elongated by an average of 22%, for a total shadow area of 1220 square feet. The elongation factor varies by time of day and time of year. In this estimate we are using the average shadow elongation from 10am through 3pm on January 1.

Piling Shadows

The current design calls for 960 pilings at an average height of 5' above the water at an average water depth of approximately 10'. The pilings are, on average 16" in diameter. The total length of the piling above and below water will cast a shadow on the sea bed. The calculation for this shading is shown below:

Factor	Value
Number of Pilings	960
Average Piling Height (sea bed to deck)	15 feet
Average Piling Diameter	16 inches
Single Piling Shadow Area	18.75 sq ft (height * diameter)
Total Piling Shadow Area	18000 sq ft (0.413 acres)

Total Shadow Impact from Fixed Structures and Vessels

As a consequence of (a) the overlapping of boat shadows and marina structure shadows, and (b) the elongation of shadows, it is erroneous to use the estimates of 54% for sea grass loss due to docks and 50% for sea grass loss due to boats. It is well known that sea grasses will die after two weeks in shade. It is our opinion that the total area of the boat shading during peak utilization months (90% occupancy of 5.65 acres) should be added to the total dock area (0.90 acres) and piling shadows and then increased by 22% to account for shadow elongation in order to arrive at a reasonable estimate for the cumulative effects of dock and boat shading at the latitude of Coral Bay.

The resulting shade impacts and loss of sea grass from the fixed marina and boats therein is summarized in the table below:

Shading Component	**Acres Shaded**
Fixed Docks	0.90 acres
Piling Shadows	0.413 acres
Boats Shadows at 90% occupancy peak month	5.085 acres
Sub Total	6.398 acres
Shadow Elongation Factor	22%
Total Sea Grass Shading	**7.801 acres**

Construction Impact

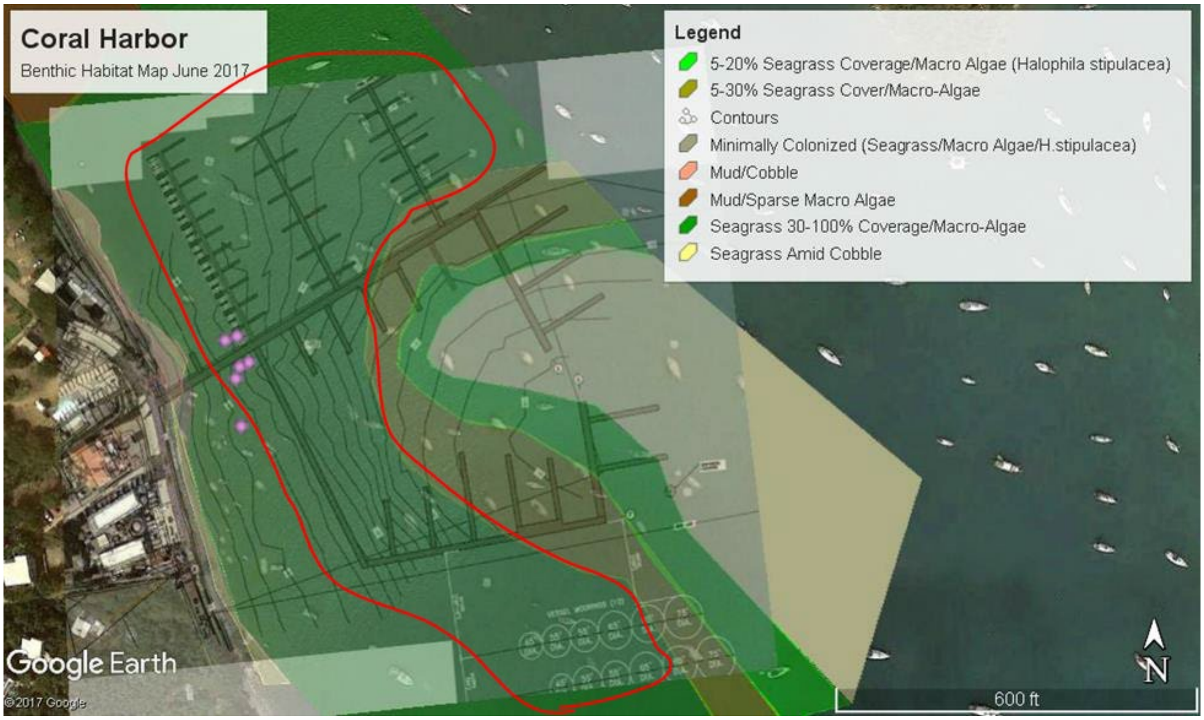
The direct impacts to sea grasses from construction, as estimated by the applicant, are minor. They consist of the piling footprint (1350 square feet) and the barge spudding (900 -1200 square feet). This amounts to a total impact of 0.05 acre and we are omitting this component from our analysis.

Marina Operational Impacts

The applicant has made an unsupported claim that "the operation of the marina will have an impact due to prop wash scour and you can assume another 10% loss." There is no reference cited for this 10% estimate, and there is no data cited to support it. It is also unclear from the text what the 10% is intended to apply to, although the numerical result indicates they are applying the 10% factor to the shading impact total. This does not make logical sense: the impacts of prop wash scour will extend throughout the navigational ways and berths of the entire marina, not solely where shadows fall.

Furthermore, the die-off of sea grasses due to shading will release large quantities of fine terrigenous sediments which are trapped within the root structure of healthy sea grasses. When these grasses die off due to shading, the effect of prop wash, currents, wind and wave action will be to resuspend these sediments in the water column, and then to redeposit them on adjacent areas of the seabed, thereby causing further die-offs of sea grasses.

The distribution of healthy sea grass meadows within the marina footprint is shown in the overlay image below (excerpted from the applicant's submission with added highlight):



The dark green area closest to the shoreline is the 30-100% seagrass coverage region, and it is on this region that the majority of the marina and navigation ways are located. The red line encloses the region of dense sea grass within the navigable portions of the overall marina. The majority of this region is at depths considerably less than 10 feet. The region enclosed in red is approximately 13 acres.

Rather than make the same error as the applicant, we prefer to use a range estimate for the cumulative impact of prop wash and scouring on the sea grasses already impacted by shading. We estimate that between 25% and 50% of these grasses will die off over time due to marina operations.

As evidence for the impact of prop wash, the photograph below is a 120 ft yacht which attempted to come into Coral Bay Harbor in the vicinity of the proposed marina. This photograph was taken on Feb 22, 2017 under normal wind and water conditions. It is obvious that the yacht captain misjudged bottom depth resulting in severe prop wash and damage to the sea bed. We anticipate this will happen frequently with the size and number of vessels navigating the proposed marina and surrounding waters.

Total Impact to Sea Grasses Due to Construction and Operation

The table below summarizes all of the foregoing considerations.

Impact Factor	**Acres Impacted**
Shading from Fixed Structures	1.313 acres
Shading from Boats	5.085 acres
Shadow Elongation	22%
Total Shading Impact	**7.801 acres**
Total Dense Sea Grass Cover in Navigational Area	13 acres
Range Estimate for Cumulative Impact of Prop Wash	25-50% (4.25 – 6.5 acres)
Total Sea Grass Impact (all factors)	**12.1 – 14.3 acres**

We believe that a reasonable estimate of loss of sea grass meadows due to the construction and operation of the marina is in the range summarized above – approximately 12 – 14 acres. This is to be contrasted with the applicant's estimate of total impact to sea grasses of 3.75 acres. Based on the analysis of all impacts above, it is our opinion that the applicant has understated the loss of sea grass by at least 10 acres.

This is a critical error in the applicant's analysis and it impacts their rebuttal in all of the areas mentioned in the first paragraph, including responses to federal agencies and the alternatives analysis.

II. SIGNIFICANT ERRORS IN APPLICANT'S SEA GRASS IMPACT STATEMENT

In estimating environmental impacts the applicant, and the Corps, are obligated to use the best scientific data available. We have reviewed the applicant's estimate of total sea grass loss (3.75 acres) and the scientific authorities cited in their report and our review raises significant concerns about the science behind the applicant's estimates.

The sole authority referenced by the applicant in the computation of sea grass loss due to shading and marina operations is cited as (Landry, 2008). This is a reference to a study on the impacts on sea grasses from grated versus solid decking in Florida for small residential docks. The author of the study, Brooke Landry, is currently an employee of the Maryland Department of Natural Resources.

I contacted Ms. Landry and asked her to review the applicant's estimate of sea grass loss (3.75 acres) and to review our independent estimate of sea grass loss (12.1 – 14.3 acres) and to provide an opinion as to which estimate is a more accurate projection of sea grass loss from the construction and operation of the marina. Brooke Landry is currently the Chair of the Chesapeake Bay Program's SAV Workgroup and Biologist at Maryland Department of Natural Resources. She is the author of the study cited by the Summers End Group ("The Effects of Docks on Seagrasses" - 2008) and is an authority on sea grass and SAV impacts and recovery.

I provided Ms. Landry with three documents: the February 5, 2015 letter from NMFS-HCD to USACE, the August 15, 2017 response to the NMFS letter from SEG ("Appendix C2"), and our independent estimate and computational methodology for sea grass loss (Section VII of this response). I asked Ms. Landry if she could compare the applicant's estimate and methodology with our work and provide any relevant feedback.

On April 26, 2018, I received this message from Ms. Landry:

> "Thanks for forwarding the NMFS letter as well as Appendix C2, the rebuttal. I can't imagine how this consultant determined a 46% survival rate based on the data presented in our dock study. The docks, grated or not, all had a significant negative impact on underlying seagrasses.
>
> In any case, **I've read through your counter-estimates and I find them much more appropriate than what the consultant came up with. It's an incredibly thorough and thoughtful approach to estimating shading impact and I would recommend any scientist in the field consider using similar methods. You're correct, seagrasses don't survive shading for too long at all. If you park a yacht over a patch of seagrass in shallow water and don't take it out for several weeks, the seagrasses underneath will die.** Even if they're not completely eliminated by the time you do take the boat out, one or two days of sun isn't enough to reset their clocks." (**emphasis added**)
>
> Brooke Landry, email communication, 26 April 2018

This is from the scientist who is cited by SEG as their authority on shading impacts to sea grasses. The conclusion from this is that, based on the best scientific analysis available, and validated by the authority cited by the Summers End Group, the probable loss of sea grass from construction and operation of the proposed marina is most likely between 12.1 and 14.3 acres, not the 3.75 acres claimed by the applicant. Their estimate is too low by a factor of 350% based on the best science available.

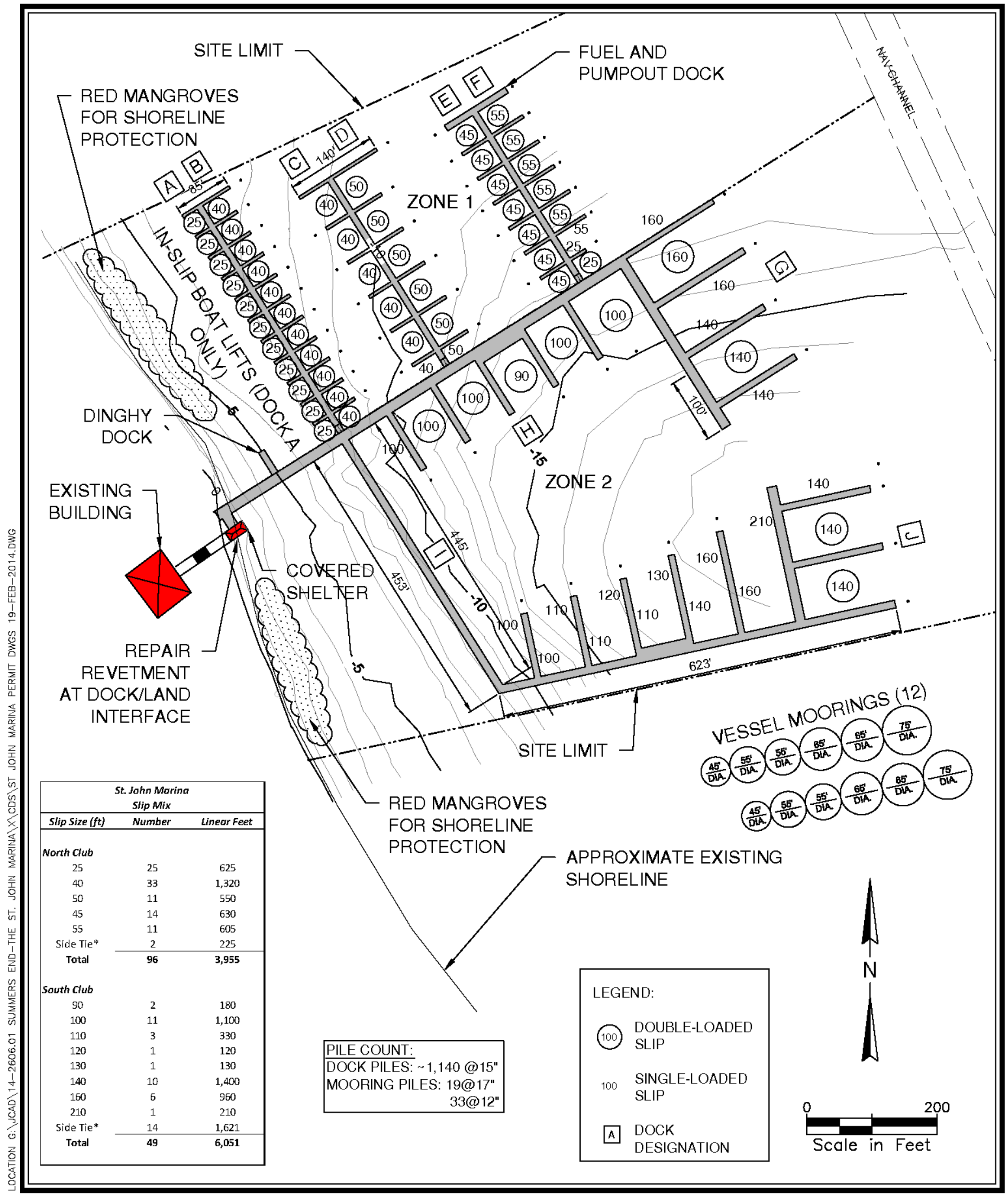
APPENDIX XI

SUMMERS END MARINA DOCK DESIGN COMPARISON

2014 - 2017

Summers End Marina Docks - 2014 Permit Submission

FOR PERMITTING ONLY - NOT FOR CONSTRUCTION



St. John Marina Slip Mix

Slip Size (ft)	*Number*	*Linear Feet*
North Club		
25	25	625
40	33	1,320
50	11	550
45	14	630
55	11	605
Side Tie*	2	225
Total	**96**	**3,955**
South Club		
90	2	180
100	11	1,100
110	3	330
120	1	120
130	1	130
140	10	1,400
160	6	960
210	1	210
Side Tie*	14	1,621
Total	**49**	**6,051**

ATM℠ APPLIED TECHNOLOGY & MANAGEMENT
PO Box 20336
Charleston, SC 29413-0336
843.414.1040
Certificate of Authorization #00359

PROPOSED IMPROVEMENTS
(SLIP MIX)

St. John Marina
St. John, USVI

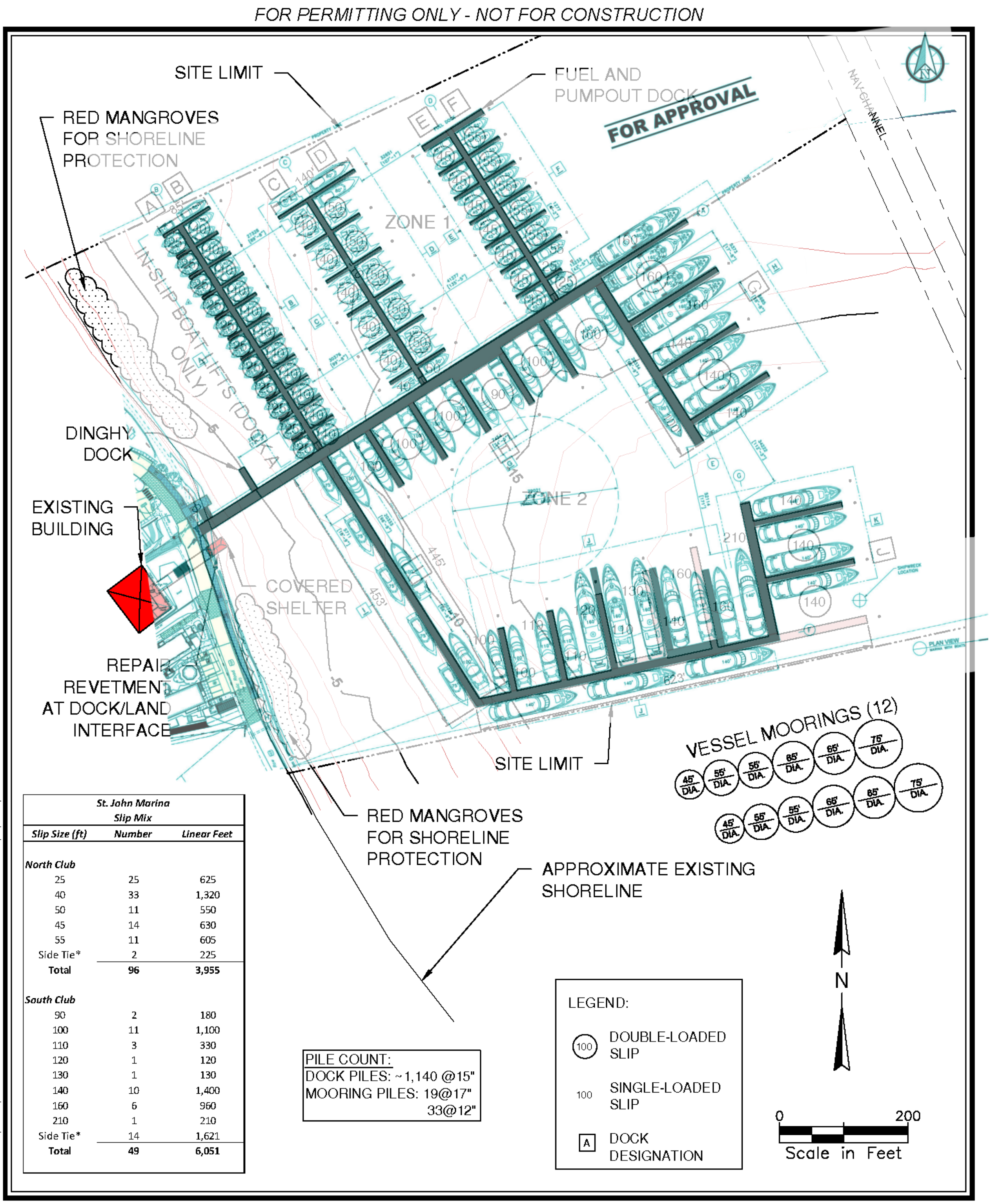
WATERBODY: CORAL HBR
JOB NUMBER: 14-2606
ISSUE DATE: 26-MAR-2014
SHEET NUMBER: 03

APPLICANT INFORMATION

THE SUMMER'S END GROUP, LLC
5000 ESTATE ENIGHED SUITE 63
ST. JOHN, USVI 00830

Summers End Marina Docks – August 2017 Permit Submission (Most Recent)

Summers End Marina Docks – 2014/2017 Overlay Comparison



St. John Marina
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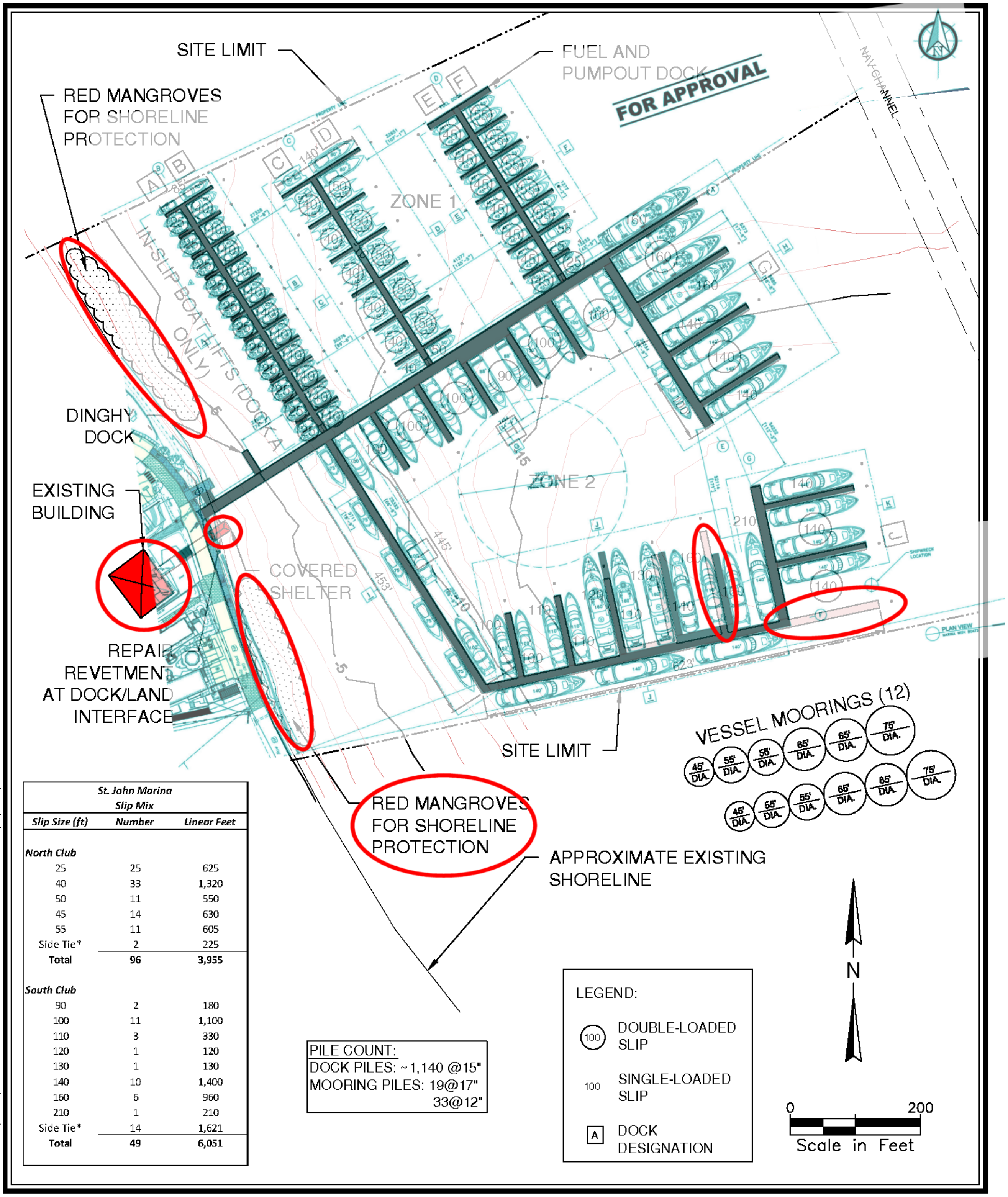
FOR PERMITTING ONLY - NOT FOR CONSTRUCTION



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140	10	1,400
160	6	960
210	1	210
Side Tie*	14	1,621
Total	**49**	**6,051**

PILE COUNT:
DOCK PILES: ~1,140 @15"
MOORING PILES: 19@17"
33@12"

LOCATION G:\JCAD\14-2606.01 SUMMERS END-THE ST. JOHN MARINA\X\CDS\ST JOHN MARINA PERMIT DWGS 19-FEB-2014.DWG

APPENDIX XII

INDEPENDENT ALTERNATIVES ANALYSIS

ALTERNATIVES ANALYSIS

This note analyses the project purpose and need addressed by the proposed Summers End Group marina, and identifies a number of on-site and off-site alternatives which are then evaluated to identify the least environmentally damaging practicable alternative that achieves the project purpose. Such an analysis is required according to the federal regulations for implementation of the Clean Water Act. Specifically, 40 C.F.R. § 230.10(a) states:

> “No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.”

Method of Analysis

The analysis consists of three parts. First, the existing "Alternatives To Proposed Action" provided by the applicant in their Environmental Assessment Report is reviewed with commentary provided on errors, omissions, and inconsistent information. This serves to illustrate deficiencies in the baseline data supplied by the applicant.

Second, a set of practicable alternatives, including a robust discussion of the No-Action Alternative, is provided. This includes maps, sketches, and sufficient detail to evaluate the merits of each alternative.

Finally, all alternatives, including the applicant's Preferred Alternative, are evaluated according to the set of standard criteria provided by the applicant, so that the least environmentally damaging practicable alternative can be identified, as required by the federal regulations.

The first part, a review of the applicant's alternatives discussion, follows. The applicant's text is copied verbatim from their EAR, and the analysis and comments are offset by double lines and italicized, highlighted text.

PART ONE – REVIEW OF APPLICANT'S ALTERNATIVES DISCUSSION

In this section we will review the statements made by the applicant in their Environmental Assessment Report, Section 9.0, entitled "Alternatives to Proposed Action". The applicant's text is in black, *the commentary is highlighted in yellow and italicized.*

9.0 ALTERNATIVES TO PROPOSED ACTION

This is the review of the statements and conclusions presented in the "ALTERNATIVES TO PROPOSED ACTION" section of the "Environmental Assessment Report for the St John Marina" prepared by the applicant, the Summer's End Group, LLC. Comments are interspersed in the text of the applicant's alternatives analysis. All comments are in italics and offset with double lines from the applicant's text.

The following discusses the site selection process for the St. John Marina as well as minimization and avoidance activities implemented during the design process as well as for proposed marina operations. Every effort was made to eliminate impacts as much as possible through the minimization and avoidance process. Where impacts were not completely able to be eliminated, mitigation plans as described in Section 8.0 were developed to offset the potential impact.

No-Action Alternative

The No-Action Alternative of the proposed marina would avoid any potential negative impacts to the environment, which have been carefully considered and addressed. However, the No-Action Alternative negates the opportunity for the project impact to the St. John economy to a tune of over $32M and employment and wage impacts of a projected 90 jobs and $3M in employee earnings in just the first year of operation.

The economic impact of the No-Action Alternative needs to be weighed against the potential adverse economic impact to the existing tourism economy resulting from the proposed project. An analysis of potential cumulative economic impacts – both positive as well as negative – is found in Appendix 6 and this analysis shows that the net economic impact of the marina project is an economic loss of $102 million over five years. Hence, the No-Action Alternative provides a superior economic effect to the applicant's preferred alternative.

Additionally, CBCC questions the validity of the applicant's claimed St John economic benefit of $32M, 90 jobs, and $3M in employee earnings in the first year of operation. No financial data or business plan has been made available for review to justify these numbers. In the time since the first Public Notice was issued the tourism market in Cuba has opened to the United States and *the competitive impact of this significant event has not been factored into any of the economic claims of the applicant.*

A No-Action Alternative leaves vacant buildings and land to sit fallow. Additionally, the No- Action alternative results in maintaining the status quo with respect to illegal and improperly designed mooring in Coral Bay and the dumping of untreated human waste into the harbor with respect to pumpout unavailability. The continued damages to seagrasses and water quality would continue unabated for the foreseeable future under this No-Action scenario.

Quite to the contrary, it is the presence of the proposed development that has caused buildings and land to remain fallow. The property owners, all of whom are principals or backers of the marina, have not allowed their properties to be improved or allowed sufficiently long term leases to encourage investment. The No-Action Alternative would provide the impetus for improvement of these buildings and land.

Additionally, there is no evidence or data provided in this EAR to support the claims made above regarding existing mooring and boating practices. The EAR does not demonstrate significant damage to sea grass or water quality from existing boats. Furthermore, the current application DOES NOT remediate any of the claimed problems from existing mooring practices, inasmuch as it removes the mooring field component.

Preferred Alternative

The St. John Marina will be located on the northwestern side of Coral Harbor where some support businesses already exist. This site offers St. John's best location to service the needs of recreational boaters now and in the future while it serves the community through employment, tax revenue and education.

This statement is entirely incorrect. The Coral Harbor site is the arguably the worst location on St John to "service the needs of recreational boaters." It does not have adequate infrastructure (potable water, reliable electric supply, roadways, sewage treatment). It has no convenient access for incoming boat owners who need to fly to St Thomas, ferry to St John, then taxi to Coral Bay – an overall 2 hour trip. It is a 20-30 minute drive to the nearest medical support facility. All needed marine maintenance services are in either Cruz Bay or St Thomas or BVI.

Most importantly, the proposed project has considered all potential environmental impacts and has taken avoidance, minimization and mitigation steps to minimize overall impacts. In addition, The St. John Marina proposes to sponsor adult and child education, as an active participant in Phase II of the Coral Bay Watershed Management Plan and membership in at least 3 environmental monitoring programs including Blue Flag. Exposure issues have been addressed with a dock design and construction method to withstand impacts from seasonal swells to those of category 3 hurricanes.

With the removal of the mooring field, this application deleted the main claimed environmental mitigation. The remaining mitigation, consisting of transplanting 0.05 acre of sea grass into an area where it is unlikely to thrive, and planting red mangroves on a shoreline where they do not currently grow due to wind and wave action, amounts to essentially nil mitigation.

The proposed location of The St. John Marina represents best use principles as this location provides for adequate parking and opportunity for controlled growth in a non-congested area of Coral Bay.

Considerations

Literally, the largest factor to consider in locating a marina site on St. John are The Virgin Islands National Park, The Virgin Islands Coral Reef National Monument and the proliferation of coral surrounding her shores. An estimated 70% of the land area of St. John is protected by the National Park. When shore protection is added to that of the National Monument and live coral, it is safe to say that over 90% of St. John's shoreline is legally unavailable for use by a marina.

No data has been supplied to quantify this assertion that "over 90% of St John's shoreline is legally unavailable for use by a marina."

Of those areas not protected by the National Park and Monument, another estimated 90% of what remains is zoned for residential use. Of the small percentage remaining that is zoned for commercial activity, most of it is already in use, incompatible for marina use or unavailable, or all three.

According to "USACE Alternative Analysis Guidance" current zoning does not exclude property from consideration under an alternatives analysis. "Just because an alternative is not zoned for a certain type of development does not eliminate it from consideration. Zoning is a planning tool, not an absolute, and is subject to adjustments through variances, as well as through policy changes."

In fact, several of the parcels being utilized in the current application were not originally zoned for marina or business use, and have been rezoned for this use in the past. So the applicant is proposing development on parcels that were not originally planned or zoned for marina use.

Land availability – The St. John Marina requires both dry and submerged land for the project. Thus, there must be both adequate land to provide support goods and services for the marina, and an amount of submerged land that will adequately support an economic model that is sustainable considering the current and projected future market.

The "BASIC PURPOSE" stated in the USACE Project Notice is "offshore marina" which does not, per se, require dry land or the extensive upland development proposed in this project. The choice by the applicants to include several acres of retail amenities, crew quarters, restaurant and service buildings is not required by the explicit purpose defined in the public notice, and therefore the requirement for "dry land" is not inherent in the purpose.

Exposure - A suitable site must not have dominant exposure issues regarding excessively high seas and winds. A suitable site will be able to successfully manage any moderate exposure issues.

If the site and structures cannot withstand anticipated exposure over a 20 year period then it should not be considered suitable. All of the investment models assume a 20 year life. The submerged land lease is for 20 years. However historical records prove that a major storm with damaging wind and wave action will occur far more frequently than once every 20 years. The applicant's claim that a site is suitable if can manage "moderate exposure issues" is not a realistic criterion, and the requirement should be "capable of managing a major hurricane".

Zoning – A major consideration of a site's suitability is its current zoning and compatibility within the area. For a site to be suitable, it must be zoned for marina compatible use and within a commercial area.

This is explicitly contrary to USACE alternatives guidelines quoted earlier. Zoning is a planning tool, which can be, and frequently is changed in the USVI. In fact, the parcels selected by the developer were not zoned for marina use 25 years ago, but were rezoned for that use.

Buildability – While a site may provide adequate acreage, it must do so in a way that income can support the cost basis inherent in using that particular site. If a site has limitations such as accessibility or incompatible topography then it is not considered a viable site.

According to USACE guidelines, the alternatives analysis must EXCLUDE profit analysis: "Cost: overall cost of the project and whether it is unreasonably expensive or exorbitant. Excludes the consideration of financial return or profit, land price, investment, and other types of individual financial considerations"

Environmental Compatibility – What are the environmental resources on site and can they be successfully avoided, and if impact is necessary are there ways to minimize the impact.

Aquatic Suitability – For a particular location to be aquatically suitable, it must be easily accessible and have adequate depth to support a commercial marina operation. A submerged land lease must be able to be obtained that will allow for docks to be designed in such a manner as to meet market needs and be economically sustainable.

Best Use – Best use practices ask if the proposed project maximizes the potential available. Best use often increases the value of not only the proposed site, but increases the value of other property within its area of influence. Best use is also tied to economic viability in that when best use is achieved, it helps to insure long-term success of a project.

"Best Use" must also consider the impact on the existing economic conditions, and whether the project will impact (positively or negatively) the existing economic environment. See letter from Coral Bay business owners who believe the project would be detrimental to local business. Furthermore, the CBCC Economic Impact Analysis demonstrates that this project would have a

devastating effect on the eco-tourism market of Coral Bay, so the proposed use diminishes the value of all other businesses in the immediate vicinity.

Economic Viability – To be a positive contribution to the St. John economy, a marina has to be sustainable for a long period of time. A realistic approach involves cost considerations weighed against potential economic success. Does this site offer everything needed for the St. John marina to be financially successful for the long term?

Economic Viability must consider the total economic impact of the proposed action. If the action has adverse impacts on the existing economic environment this must be balanced against any positive economic impacts stemming from the action.

Location – This criterion involves assimilating other considerations to ask the question: Does this location make sense?

When asking if the location makes sense, the criterion must also address other features in proximity to the proposed location, and whether they will be impacted positively or negatively by the proposed development. See letter from Virgin Islands National Park Superintendent stating that the proposed location does not make sense due to the proximity to lands and waters of the National Park and Coral Reef National Monument.

Parking – Another major consideration of any location is the ability to meet the additional need for parking by the marina. Does the location under consideration support adequate parking?

Community – Will this site serve the needs of the community through the production of jobs, increase quality of life, support youth and education, foster growth of local businesses and foster community involvement?

Please read the hundreds of letters from residents of Coral Bay who state that this project will result in severe adverse impacts to quality of life. Please read the letter from over 20 local business owners in Coral Bay who state that this project would adversely impact their businesses. There is no objective evidence this project would increase quality of life or foster *growth of local business; all evidence is to the contrary.*

Market Appeal – This is probably the most important consideration to the recreational boater, charter or yacht owner. Each of these prefers a marina set in post card setting where only steps from their boat they can find necessities, respite and repast.

The claim that the target market "prefers a marina set in a post card setting" is not supported by evidence, market survey, or data. In fact, there are many letters from people in the yachting industry who dispute this claim. George Sass Jr., Group Editorial Director,
Active Interest Marine Group (publisher of Passage Maker Magazine) states the he "personally agrees with the reasoning why a marina does not make sense in and around Coral Bay."

Alternative Site Analysis

The sites below represent the areas of St. John that have been researched by the developers of the St. John marina in an effort to perform proper due diligence with respect to understanding the overall landscape of potential marina sites and their ability to meet project compatibility requirements.

Both current and previous MLS records have been used in the evaluation of the sites listed below. Long time St. John Realtors and successful St. John business owners were also consulted in the research and evaluation of the potential sites listed below.

Cruz Bay – In recent years as many as six redevelopment plans have been proposed for "downtown" Cruz Bay, several of which had a marina component. The current vehicular and boat traffic congestion, lack of parking, limited available land and frail infrastructure all torpedoed any hope of redevelopment. All of the issues that downtown redevelopment faced were amplified by those developers looking to put a marina in Cruz Bay who have since abandoned their hope of doing so due to the plethora of insurmountable issues with that location, both on land and water.

The claim that there are a "plethora of insurmountable issues" with Cruz Bay is utterly untrue. The primary impediment to a Cruz Bay marina has been the unwillingness of the VI Port Authority to consider such a use. The Chairman of the Port Authority throughout this period is an acknowledged investor and spokesperson for the Summers End marina.

Turner Bay/Enighed Pond – While this site offers a few positive aspects, this location lacks the most important consideration of any commercial venture, market appeal. Existing boat traffic congestion, especially by large commercial barges is just one of many factors that are a detriment to this area's appeal to the local and transient recreational boating community.

Please see the attached detailed plans for a proposed marina announced in 2015 in Enighed Pond. These plans clearly cast doubt on the claim that the location lacks market appeal.

South Side STJ – From Great Cruz to Calabash Boom (Lagoon Point) there are many beautiful views. However, they are zoned residential and have significant unmanageable exposure to wind and sea.

Great Cruz Bay faces southwest, and the northern shore of this bay has undeveloped parcels of substantial acreage. Zoning is not relevant to an alternatives analysis. All of the existing marina plans have either benefitted from prior rezoning, or are proposing rezoning for their current plans.

North Shore – From the NPS dock to Haulover Bay the entire shoreline is protected by the National Park and National Monument.

East End – St. John's East End shore is nearly completely encircled by live, active coral and is does not provide for a safe location during adverse weather conditions. While there is a 5-acre waterfront parcel currently available, it is zoned for residential use in a deeded residential community and not suitable for a marina development.

Existing zoning does not preclude a location from alternatives consideration.

Zootenvaal – Estate Zootenvaal is 5-10 minutes ENE of Coral Bay. Currently offered is a 5- acre combination waterfront and hillside site consisting of five cottages that have in the past been operated as short term rental property. However, this site and the adjacent available 20 acres are zoned for residential use and are not suitable for marina development.

Existing zoning does not preclude a location from alternatives consideration. Other factors may *render this site unsuitable, but not zoning, per se.*

Calabash Boom – During season, Johnson's Bay can average upwards of 30 vessels both anchored and on moorings, and is located approximately 3-5 minutes south of Coral Bay. There are no commercially available properties large enough for the facilities to support a marina.

There are 3-5 acres of undeveloped waterfront property in this location, and several more flatland acres in shore. Other factors may render this site unsuitable, but not property availability, per se.

Coral Harbor – Over the past three decades Coral Harbor has been targeted by marina developers as the location best suited to almost meet all of the criteria necessary to support a successful marina for St. John. Its well-known location to boaters, easy accessibility and protected harbor just begin the list of positive attributes of locating a marina there. There are some unavoidable environmental impacts associated with a marina in Coral Bay, but as discussed in this report, they have been minimized and will be mitigated for as necessary.

Over more than three decades people have considered marinas in Coral Bay and concluded it was unsuitable for a wide range of reasons. Had it been a suitable location, it is likely that a marina would have been built during this period. The lack of wind and wave protection from the southeast is a major detriment. Not only during tropical storms, but at any time the wind shifts to the south the harbor becomes unsuitable for boats tied to a marina broadside to the waves. Anyone who has seen the aftermath of a major storm knows how unsuited this exposed location is for a marina.

Table 9.0-1represents a comprehensive look at possible marina sites for St. John. The conclusions are based on scientific evidence, market analysis by experts, sound business principles, the opinions of professional marina developers and managers with decades of experience in the Caribbean.

The table is general and non-specific – it fails to look at specific locations and most importantly fails to consider actual marinas planned elsewhere on St John. The claims that the table is based on "scientific evidence, market analysis by experts, sound business principles, the *opinions of professional marina developers" is not supported by actual data. Where is this analysis, evidence, and opinion? It isn't in this Environmental Assessment Report, in the Army Corps application, or in any document available for review. The conclusions in the table – simple Yes/No – are not accompanied by any analysis or data.*

Subsequent to the selection of Coral Bay as the most feasible site in St. John for The St. John Marina project, the developer initiated efforts to evaluate each component of the project that may have an environmental impact, assess alternatives and determine how these potential impacts may be avoided completely and if not able to be totally avoided, assess how they can be minimized. Table 9.0-2 is a summary of these efforts. Details pertaining to these impacts and minimization efforts are contained in Sections 6 and 8 of this report.

Table 9.0-2 does not reflect the current Army Corps application or Public Notice. In fact, the "Minimization and Avoidance Effort" most frequently cited in the table (cited seven places) does not even exist in the current plans. The "mooring field" is mentioned in 7 places and is not a component of the current application.

Table 9.0-1. Matrix of Potential St. John Marina Sites and their Suitability

Evaluation Criteria	Location							
	Cruz Bay	Turner Bay	South Side	North Shore	East End	Zooten-vaal	Calabash Boom	Coral Harbor
Land Available	N	N	N	N	Y	Y	N	Y
Exposure	Y	Y	N	Y	N	N	Y	Y
Zoning	Y	N	N	N	N	N	N	Y
Buildability	N	N	N	Y	N	Y	N	Y
Environmental Compatibility	Y	Y	N	N	N	N	Y	Y
Aquatic Suitability	N	N	N	N	N	N	Y	Y
Best Use	N	N	N	N	N	N	N	Y
Economic Viability	N	N	N	N	N	N	N	Y
Location	N	N	N	N	N	N	N	Y
Parking	N	Y	N	Y	Y	Y	N	Y
Community	N	Y	N	N	N	N	N	Y
Market Appeal	N	N	N	N	N	N	N	Y

The table above does not provide any analysis or rationale for the rankings that are shown. The alternative locations are "generic" and do not refer to specific alternative sites, simply to regions of St John. Without any specific references or analysis there is no way to verify the accuracy of the tabular data, or of any conclusions stemming from it.

Table 9.0-2. Summary of Design & Construction Alternatives/Minimization Efforts

Impact Evaluated	Alternative/Minimization & Avoidance Effort
Design and Construction Related	
Seagrass & Coral - Elimination from piling footprint	Reduce pile size and count through innovative structural design
	Realign marina to avoid corals
	Reduce number of slips in Zone 1
	Utilize mooring piles to eliminate up to 7,900 ft^2 of finger pier
Benthic damage from barges and work boats	Require construction plan that minimizes spud use
	Prohibit piling templates attached to the bottom
	Utilize pre-cast dock components for faster construction and less work activities over water
	Move marina waterward to a minimum of depth of -5’
Noise/acoustic impacts	Require contractor to utilize vibratory hammer where feasible
Displaced vessels from marina footprint	Work with mooring ball permit holder and DPNR to relocate to properly constructed new mooring balls
Marina lighting	Model design after Florida standard for sea turtle safe lighting while maintaining nighttime safety and security
Reduced public access to shoreline	Construct public dinghy dock
Seagrass – Shading from dock structure	Grated decking, fixed docks instead of floating and raise docks as high as possible
	Reduce slip number in Zone 1 to the north
	Commit to create regulated Coral Bay mooring field under public-private partnership with DPNR
	Utilize mooring piles to eliminate ~7,900 ft^2 of finger piers
	Move marina waterward to a minimum of -5’ of depth
	Alter marina design to eliminate all but one access walkway from the shoreline
	Eliminate wave attenuator from marina design
	Move proposed building structures on docks to upland areas
	Utilize fixed docks instead of floating and maintain as much air space as possible underneath docks
Seagrass – Shading from boat hulls	Install boat lifts on slips closest to the shoreline
	Market marina in Zone 2 area to larger transient boaters, leading to fewer boats and lower long-term occupancy of slips
	Commit to create regulated Coral Bay mooring field under public-private partnership with DPNR
Seagrass – Prop scour by work boats	Move marina waterward to a minimum of -5’ of depth
Shoreline habitat degradation	Remove bulkhead from design and stabilize with rip rap where needed
	Plant fringing mangroves along shoreline

	Install upland stormwater controls to reduce sedimentation

Table 9.0-2. Summary of Design & Construction Alternatives/Minimization Efforts

Impact Evaluated	Alternative/Minimization & Avoidance Effort
Operational Related	
Elimination of existing mooring within marina footprint	Work with mooring permit holder and DPNR to relocate to properly constructed new mooring balls
	Create regulated mooring field with 75 moorings through Public-Private partnership with DPNR
Unlawful wastewater and solid waste discharges from existing vessels in Coral Bay	Commit to create regulated Coral Bay mooring field under public-private partnership with DPNR
	Allow public use of marina pumpout system
	Provide refuse containers available to the public
	Achieve Blue Flag status for marina to assure environmental protection
	Initiate education program for residents and marina users regarding environmental protection
Seagrass – Prop scour by recreational vessels	Install warning buoys in shallow areas of the marina adjacent to the shoreline
Sea Turtles – Boat impacts	Initiate education program for residents and marina users regarding sea turtle safety
	Restrict vessel speed to no wake within marina controlled areas
Navigation safety	Locate proposed mooring field outside of channel area
	Install proper markers in Coral Bay navigation channel
Fuel spillage	Site specific SPCC plus leak detection and double-wall piping within additional conduit
	Allow public access to fueling facility to assure fueling is done in a controlled environment

The table references a "mooring field" at least seven times. The "mooring field" is the most frequently cited minimization/avoidance measure in this table, however it is no longer a part of the current application.

PART TWO – REVIEW OF PROJECT PURPOSE AND NEED

Project Purpose and Need Statements

The applicant's stated "Project Purpose" is contained in their Department of the Army permit application and is as follows:

> "The primary purpose is to create a premier marina development to serve local needs and to attract private and charter yachts from around the world."

The Corps has provided the following statement of Basic Purpose and Overall Purpose in the Project Notice:

> "**BASIC PROJECT PURPOSE**: offshore marina"

> "**OVERALL PROJECT PURPOSE**: Construct a private commercial offshore marina with ancillary and commercial facilities in adjacent uplands in St. John, USVI. "

Commentary on Purpose and Need Statements

Several important observations on the Purpose and Need statements provided by the applicant and by the Corps are in order:

1. The need identified by the applicant has two components: "to serve local needs" and "to attract private and charter yachts from around the world." Neither of these needs are specifically related to Coral Bay.

2. The Corps has correctly identified the scope of the need as covering all of St John, USVI.

3. The Corps has identified two overall purposes: "construct a private commercial offshore marina" and construct "ancillary and commercial facilities".

4. Although the marina, per se, is clearly a water dependent use, the "commercial facilities" (which include retail shops, accommodations, club quarters and offices), may not be water dependent.

Federal regulations regarding project need make it clear that the Corps has discretion to independently review the need for a project based on overall public interest (33 CFR, Part 320.4(q), Economics):

> "When private enterprise makes application for a permit, it will generally be assumed that appropriate economic evaluations have been completed, the proposal is economically viable, and is needed in the market place. However, the district engineer in appropriate cases, may make an independent review of the need for the project from the perspective of the overall public interest."

In the case of the current application, the Corps has received extensive comments from individuals as well as experts stating that there is no objective evidence that the project will be economically viable, nor that there is a proven need. The following considerations weigh heavily on the question of need, from a public interest perspective:

1. There are 210 moorings within the National Park system, including 10 moorings for yachts of up to 100' in length. These provide safe anchorage for transient vessels and do not create any significant impact to the sea bed.

2. The existing economy of Coral Bay is heavily based upon eco-tourism. People visit Coral Bay for its undeveloped nature, the quiet, and the proximity to the National Park. An independent analysis has shown that is this project were undertaken in Coral Bay the adverse impact to the tourism economy would far outweigh any positive economic impacts stemming from the marina.

3. The distance between Coral Bay and the airport at St Thomas, measured in travel time, is close to two hours. Most boat owners want to be able to fly to their boat and not have to endure long travel times between airport and marina. This makes the location in Coral Bay highly undesirable from a travel logistics perspective, and undermines any perceived need in this location.

4. The marinas on St Thomas and throughout the British Virgin Islands provide more than sufficient capacity for the volume of yachts utilizing these waters.

5. With the mooring field removed from this application, the construction of this marina, covering a site of 28 acres plus navigational channels, will displace as many as a third of the boaters currently legally utilizing the Coral Bay Harbor designated mooring area.

For these and other reasons, we believe it is incumbent upon the Corps to conduct an "independent review of the need for the project from the perspective of the overall public interest" as permitted under the federal regulations.

PART THREE – IDENTIFICATION OF ALTERNATIVES

Army Corps guidelines for alternatives analysis require, at a minimum, evaluation of four types of alternatives:

- Applicant's Preferred Alternative
- No-Action Alternative
- Offsite Alternative Locations
- Onsite Alternatives

We will look at each of these in turn with several examples where appropriate.

Applicant's Preferred Alternative

The applicant's proposal for addressing the Project Purpose and Need is "to construct a 145-slip fixed-dock marina with slips of varying length up to 210 feet long and 12 permanent mooring buoys." The site encompasses approximately 28 acres of Coral Bay harbor. The fixed marina is built on a structure of 1,333 steel pilings. In addition to the marina, the project involves development or redevelopment of approximately 3.25 acres of buildings and parking areas.

The preferred alternative involves extensive impacts to special aquatic sites, namely vegetated shallows, as described below:

> § 230.43 Vegetated shallows.
> (a) Vegetated shallows are permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass in estuarine or marine systems as well as a number of freshwater species in rivers and lakes.

The Corps has provided an estimate of 8 acres of impacted sea bed, including vegetated shallows. Others have estimated upwards of 30 acres of impact based upon the cumulative impact of released sediments, sea grass die-off, propeller wash, and reduced circulation. It is clear that the "Applicant's Preferred Alternative" will result in significant impacts to protected resources.

The Applicant's Preferred alternative is located in a region of Coral Bay harbor subject to extreme wind and wave action during major storm events. The photographs below are a small sample of the numerous ships that have come ashore in the precise locale of the Summers End Group project following hurricanes and tropical storms:


The adverse economic impacts of a major marina construction project in Coral Bay have been discussed elsewhere. This is clearly not a "Best Use" of the properties, and the economic viability is highly doubtful on a standalone basis, and clearly unviable on a net basis with Coral Bay eco-tourism.

The foregoing discussion dealt exclusively with the marina, per se, and not with the associated upland project. The upland development in the applicant's Preferred Alternative will create approximately 30,000 square feet of new impervious surfaces to provide off-street parking for 96 vehicles and another 24 parking spaces on permeable surfaces. All of this parking is located less than 200' from the shoreline of Coral Bay harbor. The stormwater runoff from this parking will contain significant amounts of petrochemicals that will impact water quality of Coral Bay harbor.

Because of lack of municipal infrastructure for potable water in this location, the applicant will need to rely on large quantities of trucked in water. There is insufficient capacity in the cisterns and roof collection areas to supply the total fresh water needs of the marina.

The location of Coral Bay, at the remote end of an electrical grid whose generators are located in St Thomas, results in a highly unstable electrical supply. Outages are frequent and often extend over multiple hours. Following significant storm events outages can last for several days. A large commercial marina that depends on reliable power for a wide range of critical functions (the applicant estimates a need for 1.5 megawatts of power), should not be located in an area with such an unreliable public power supply.

Regarding the "Market Appeal" of the applicant's Preferred Alternative, the remote location in Coral Bay – a two hour travel time from the nearest airport under ideal circumstances – makes it undesirable for charter customers and yacht owners who generally want to fly into a location close to their vessel. Any location on St John which is closer to Cruz Bay will be preferable from an access perspective.

No-Action Alternative

The applicant has provided virtually no objective analysis of No-Action Alternatives. The sole statements that the applicant has made to dismiss the No-Action Alternative are that it:

1. "negates the opportunity for the project impact to the St. John economy to a tune of over $32M and employment and wage impacts of a projected 90 jobs and $3M in employee earnings in just the first year of operation"

2. "leaves vacant buildings and land to sit fallow"

3. "results in maintaining the status quo with respect to illegal and improperly designed mooring in Coral Bay and the dumping of untreated human waste into the harbor with respect to pumpout unavailability"

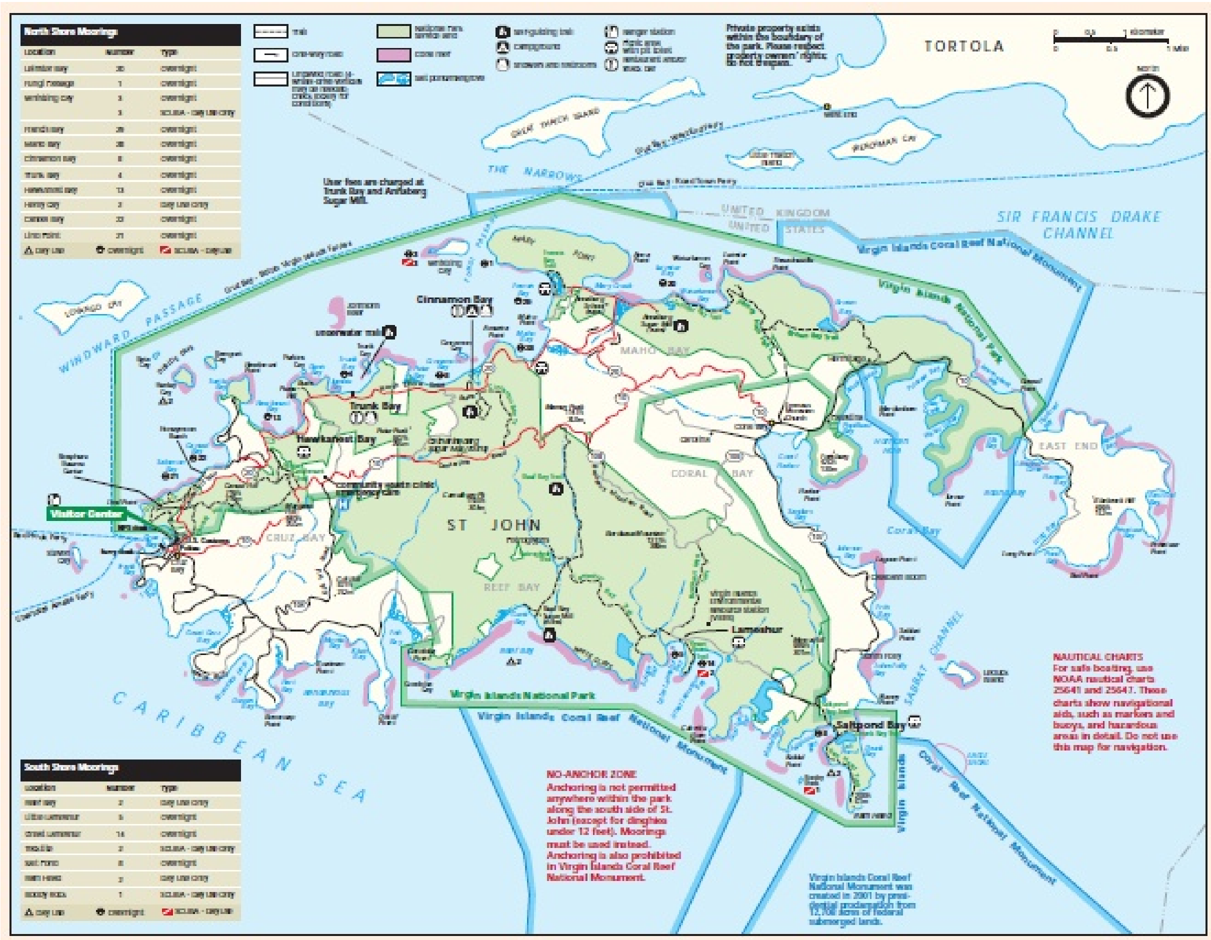
We have provided considerable evidence to refute claim (1) above, and, in fact, we believe that the No-Action Alternative provides for superior economic benefit to Coral Bay and St John than the applicant's preferred alternative.

We have demonstrated that it is the 50 year leases that have been granted to the marina developers, and the purchase options on dormant properties that have kept these properties off the market, and which have led to "fallow buildings". Under a No-Action alternative all of these properties would return to the market and be utilized to benefit the local economy.

Finally, since the current application no longer includes a public mooring field, the applicant's "preferred alternative" is no better and no worse than the No-Action alternative with respect to existing moored boats – it is identical with the sole benefit that a pumpout will be provided. Moreover it is our belief based upon scientific data and water quality samples that existing boating practices are not leading to significant water quality issues in Coral Bay harbor.

The No-Action Alternative does not result in an impediment for yachts to visit St John. The reality is that motor yachts and mega yachts do visit St John, in good numbers, during the prime Caribbean yachting season. These yachts typically either pick up one of the roughly 210 National Park mooring balls (for yachts of up to 100 feet), or anchor offshore in designated areas. The charter guests on the mega yachts rarely come ashore in their tenders and dinghies, since they have purchased “all inclusive” vacations focusing on the amenities and catered food of the yacht, enjoyed in the pristine surroundings of the national park and a new bay – a new view – each day. If they do wish to visit the National Park beaches, or go shopping and explore land, there are designated dinghy channels on many beaches for this purpose, near parking areas where they can hire taxis.

The mooring system of the Virgin Islands National Park is shown below and can be found here - http://www.nps.gov/viis/planyourvisit/upload/MooringGuide.pdf :



One of the No-Action Alternatives that must be addressed is an alternative that would avoid all wetlands and special aquatic site (i.e. marine meadows, sea grass) impacts. This alternative involves installation of specially designated mooring balls for transient yachts in Coral Bay, and a small day use dock situated in an area without submerged vegetation where dinghies and tenders could come ashore. There are multiple locations around Coral Harbor and Johnson Bay that might be suitable for a day dock, including the possibility of such a dock on the applicant's site.

Given the vastly smaller footprint, the less intensive usage pattern, and less invasive construction methods, it is possible that a day use dock, in the right location, could be constructed without significant impacts to protected species or habitats.

The resulting configuration of mooring balls and a day use dock facility on the applicants shoreline would be a "No-Action Alternative" in the sense that it would not require construction of the offshore marina and yet would meet the stated Project Purpose and Need of the applicant ("attract private and charter yachts from around the world").

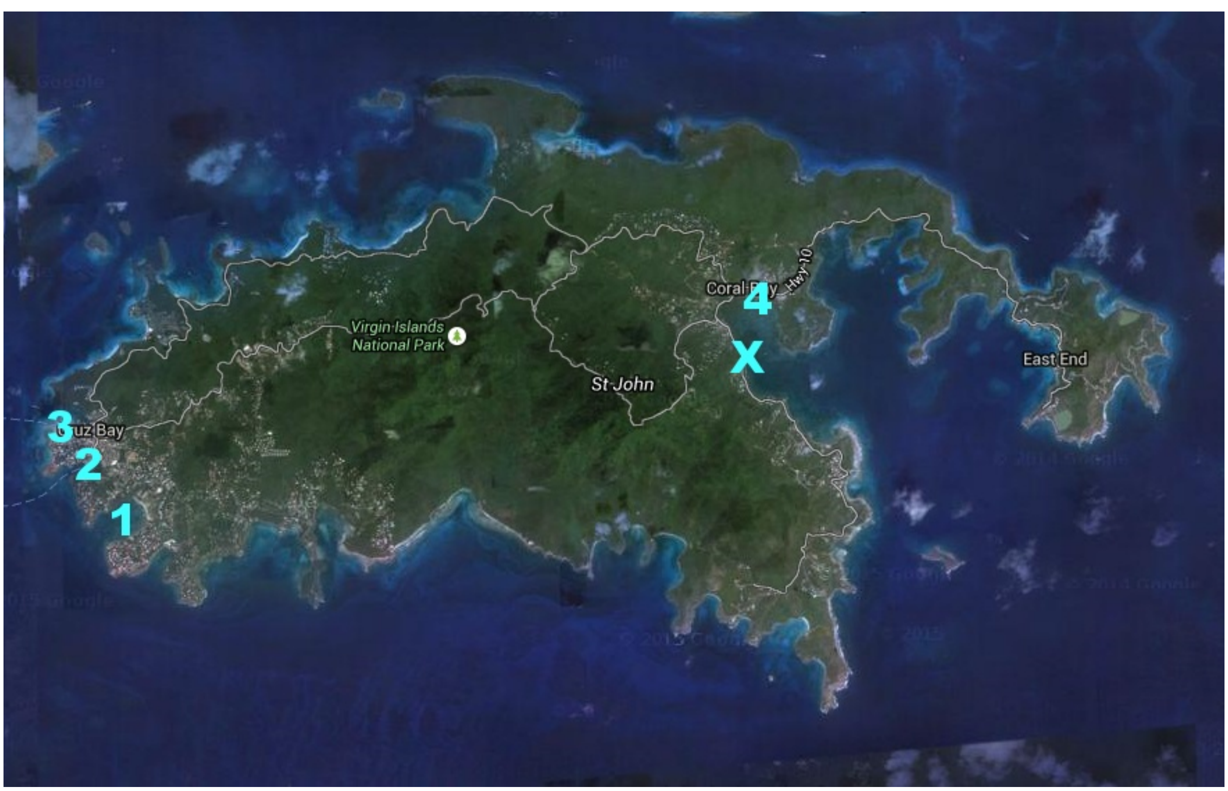
Alternative Offsite Locations

The discussion of alternative offsite locations identifies several sites on St John where a marina could be constructed, meeting the stated Project Purpose and Needs, but with less adverse impact to the waters of the United States (WOTUS), and with less impact to special aquatic sites (wetlands, mangroves, submerged vegetated plains).

The map below highlights three specific locations which are discussed in the following sections. These locations are identified in the map below as (1) Great Cruz Bay, (2) Enighed Pond, and (3) Cruz Bay Creek.

In addition to the three alternative offsite locations identified above, a fourth location within Coral Bay harbor is also discussed, identified on the map below with the number 4.

An overview map of all of St John depicting the locations of alternative sites 1-4 and the applicant's preferred site (X) is shown below:



Alternative Off-Site Location 1: Great Cruz Bay

The aerial map below identifies a general location in Great Cruz Bay which appears to have many characteristics required for an offshore marina. The upland parcels are vacant. The seabed appears from the aerial photograph to be sandy bottom (although no benthic survey data was available to corroborate this). Facilities are readily available due to the close proximity of the Westin Resort, including fuel, potable water, electricity, and waste treatment.

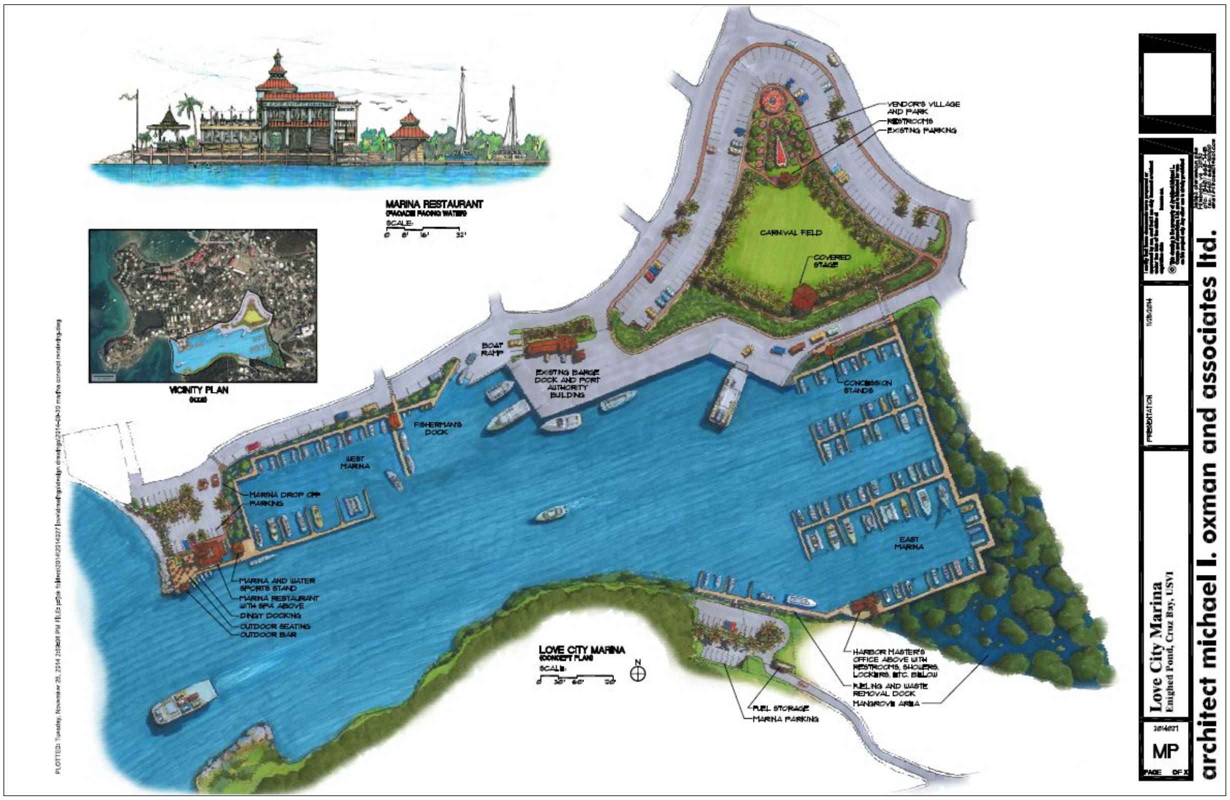
There are a number of unknowns with this location. First, it is unknown whether the landowners would be willing to sell or lease their property at an economically viable price. Second, current benthic survey data for this location was unavailable (although it appears to be sandy bottom). Third, the wind and wave conditions for this southwest facing bay are unknown, although it has been reported that boats accumulate on this portion of the shoreline after severe weather.

Proximity to the amenities of Cruz Bay and the facilities of the Westin Resort add to the appeal of this location. It is also possible that the Westin could join its shoreline into a marina proposal in this alternative location.

Alternative Off-Site Location 2: Enighed Pond

The viability of an alternative location in Enighed Pond is reinforced by the fact that there is currently an active proposal to develop a marina in precisely that location. The proponent and the project have received wide publicity in local media, and so this is a real proposal and not simply a theoretical one.

An overview of the proposed marina in Enighed Pond is shown below. This was provided by the marina proponent and illustrates how the marina will fit into the existing commercial maritime uses of Enighed Pond as a car barge depot for transits to and from St Thomas.

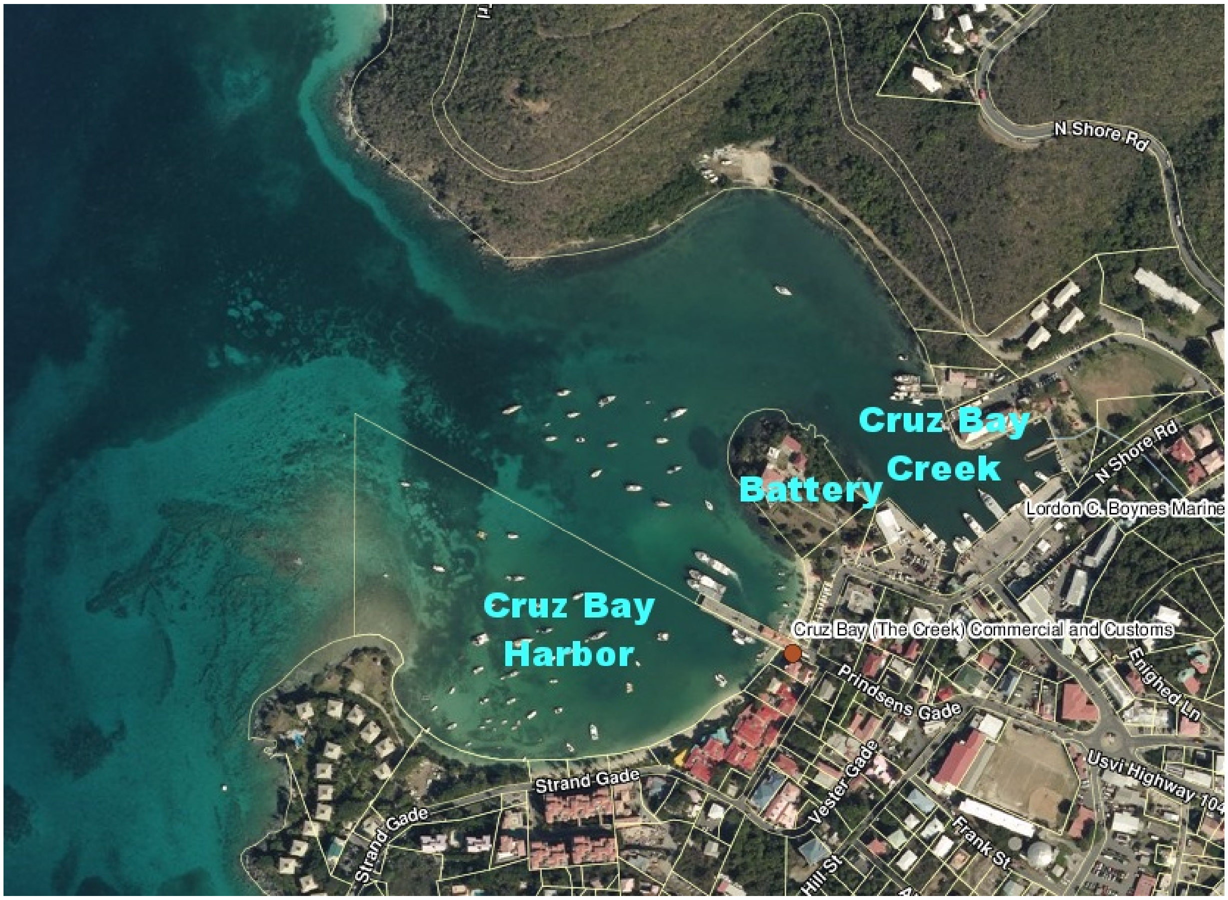


The entire site of Enighed Pond is highly disturbed – it was originally an enclosed salt pond but was opened to the sea and extensively dredged to provide facilities for commercial car barge service. The original plans included a marina, although this was never built. A portion of the currently proposed marina is shown as built in an existing mangrove wetland, however this was not a naturally occurring mangrove – it was constructed as part of the overall Enighed Pond terminal project approval as a component of compensatory mitigation.

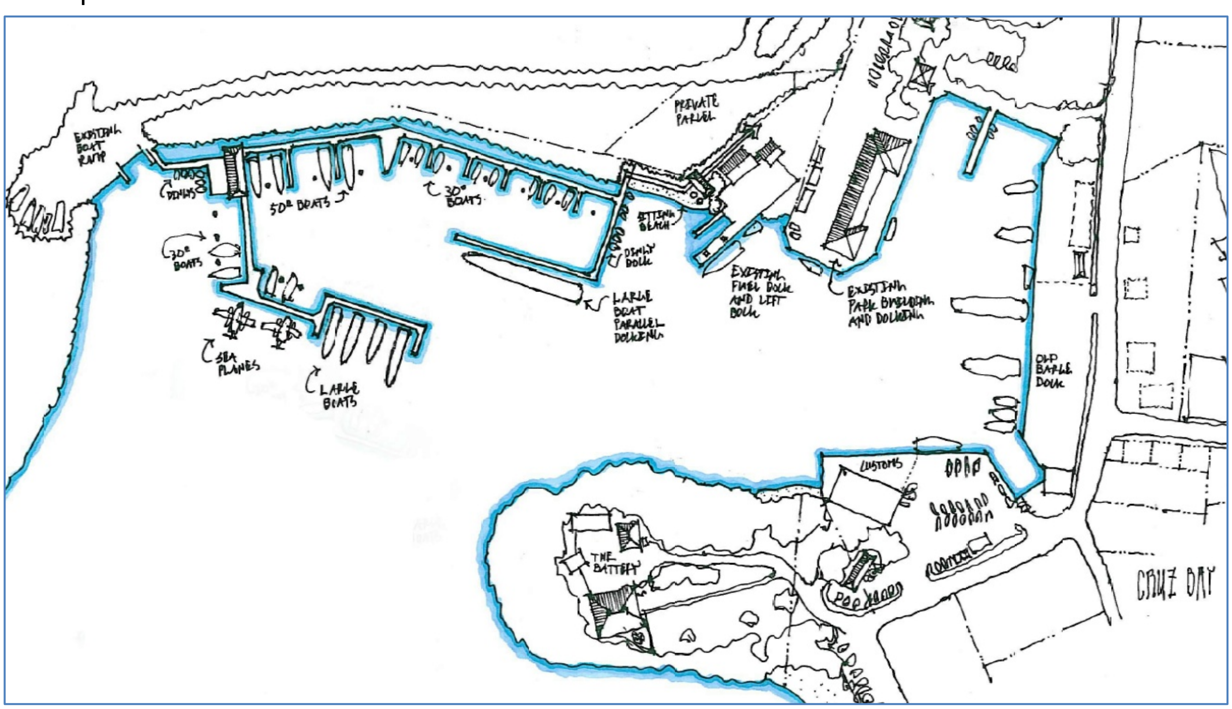
There are a number of highly attractive aspects to this alternative. First, all necessary infrastructure – potable water, sewage treatment, electric power – is readily available in close proximity to the site. Second, ample parking exists in the parking area surrounding the "Carnival Field". Third, the marina is within walking distance from the commercial amenities of Cruz Bay – restaurants, shops, entertainment. And finally, the existing Customs facility of Cruz Bay is within walking distance.

Alternative Off-Site Location 3: Cruz Bay Creek

The body of water just north of the main Cruz Bay harbor, and separated from it by a promontory known as the Battery, is locally called "Cruz Bay Creek." This location has been utilized for maritime services for many years, however its use has not been optimized. The photograph below illustrates the relationship between Cruz Bay Creek and Cruz Bay harbor proper:



If the existing uses of Cruz Bay Creek were reorganized, a commercial marina accommodating a wide range of vessel types could be implemented, in a number of configurations. Slips for boats from 30' up to 150' could be provided, as illustrated in the conceptual sketch below:



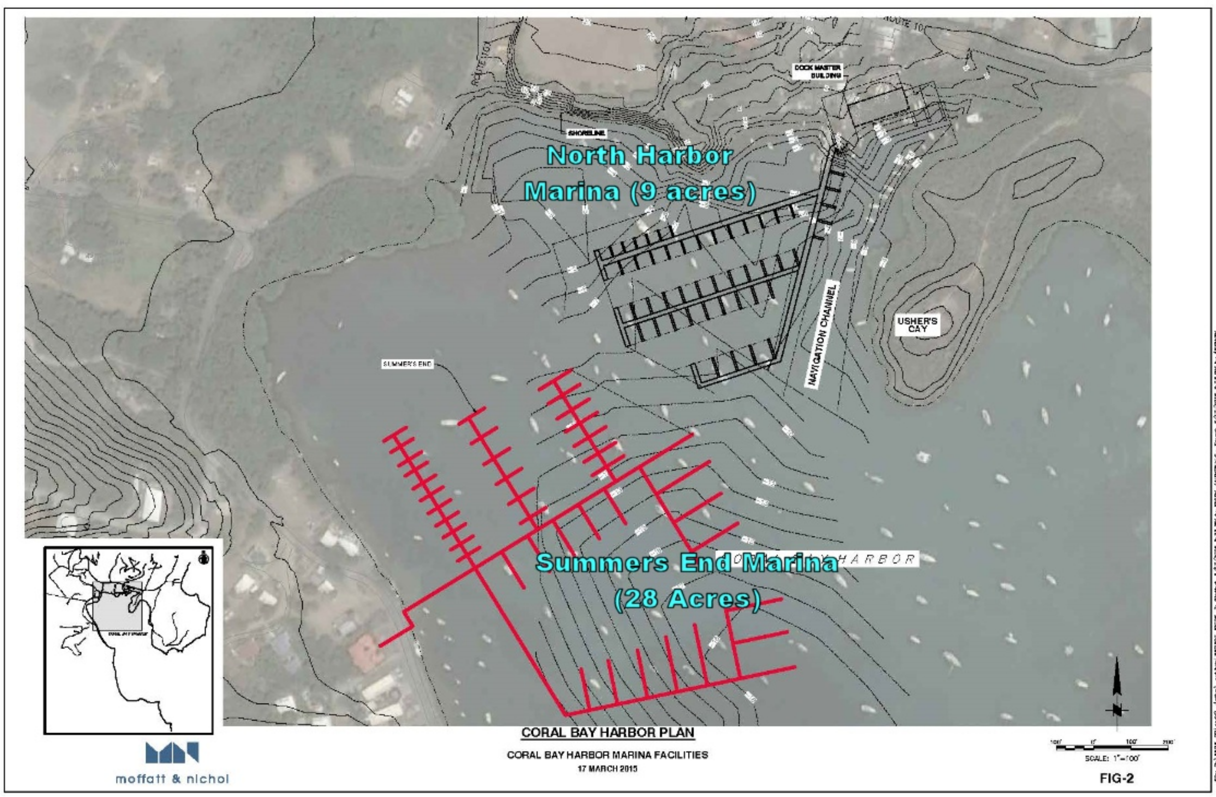
In terms of environmental impacts, and particularly impacts to special aquatic sites, this alternative has the least impacts of any alternative. The entire area of Cruz Bay Creek has been heavily utilized for marine traffic for many years, and the construction of a commercial marina in this location would not cause any further material impacts.

All requisite commercial amenities – fuel, power, water, sewage treatment – are readily available, as is ample parking and transportation. This site is in closest proximity to the National Park facilities, which would make it highly attractive to transient visitors.

Alternative Off-Site Location 4: North Coral Bay Harbor

A second marina is in the planning stages for Coral Bay Harbor. This project, built on property owned by the Moravian Church Conference, is being proposed by a development group known as Sirius Development.

They are proposing a roughly 100 slip offshore marina at the extreme northern end of Coral Bay harbor. Their March 2015 marina plan, juxtaposed with the applicant's plan, is shown below:



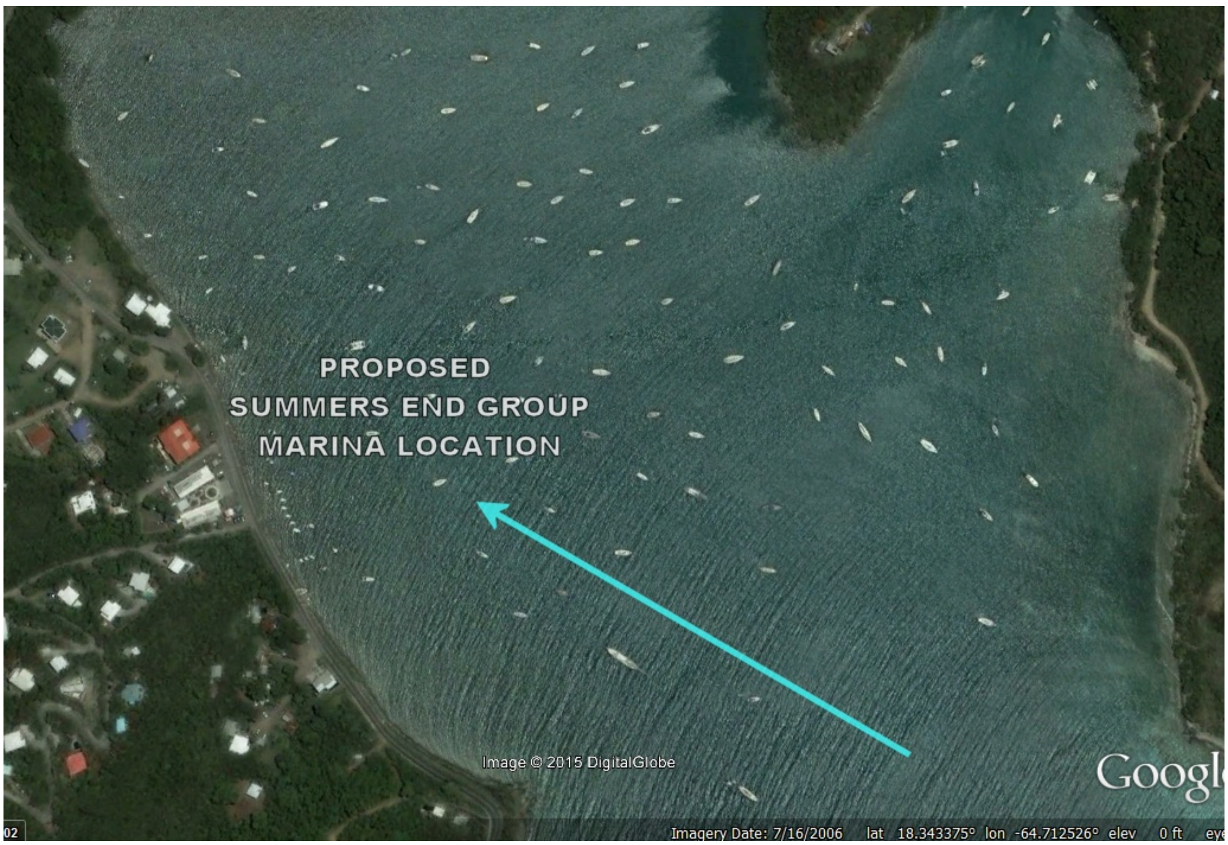
This alternative site poses some of the same challenges as the Summers End Group site – such as sea grass, endangered species, and mangroves – however it avoids certain significant problems of the Summers End plan. First, it is far more sheltered from storm force wind and wave action than the current proposal. And very significantly, it is one third the size of the current plan (approximately 9 acre site, as opposed to 28 acre site).

Clearly, the proponent of the North Coral Bay harbor site believes it is economically viable to construct a marina and associated upland amenities at this location, similar to those proposed by the applicant. The resulting configuration would address the same purpose and need identified by the applicant.

ONSITE ALTERNATIVES

The discussion of Onsite Alternatives will be extremely limited because the location chosen by the Summers End Group for their St John marina project, is wholly unsuited for an offshore marina. Reductions in size or scale will not ameliorate the problems of wind and wave conditions and benthic habitat.

The aerial photograph below helps illustrate the problem with this location. This photograph, from Google Earth, clearly shows the incoming waves from the open fetch to the southwest. The direction of the wave action is directly broadside to the marina location selected by Summer's End.



This photograph is from a random date – not during a storm event. It illustrates a very common condition on that shore with constant wave action impinging the shoreline. Although the swells are not typically large on an otherwise calm day, they do create constant motion for the vessels tied to any marina structure, and extremely uncomfortable conditions for people aboard vessels. Boats at anchor will naturally orient themselves perpendicular to the wind and wave motion, lessening the impact of the seas.

Proof of the effect of this wave action is the condition of the shoreline at this site – it is denuded of the mangroves found elsewhere along the shoreline of Coral Bay harbor, and has frequently eroded to the point of requiring revetment to stabilize the shoreline and roadway.

This location is simply unsuitable for even a reduced-scale marina, hence no Onsite Alternatives are discussed.

TABLE OF EVALUATION CRITERIA FOR ALTERNATIVE SITES

The table below contrasts the alternative sites discussed in the preceding section, utilizing the criteria identified by the applicant. Color coding of GREEN (desirable), YELLOW (unknown or partially desirable), and RED (undesirable) is used to highlight differences in the alternatives.

Evaluation Criteria	Alternative Site					
	Cruz Bay Creek	Enighed Pond	Great Cruz Bay	Zootenvaal	Coral Harbor North	Coral Harbor West (Applicant)
Land Available	YES	YES	Possible	YES	YES	YES
Exposure	Protected	Protected	Partially Exposed	Partially Exposed	Good	Fully Exposed
Zoning	N/A	N/A	N/A	N/A	YES	YES
Buildability	Unknown	YES	Unknown	YES	YES	YES
Environmental Compatibility	YES	YES	Unknown	NO	NO	NO
Aquatic Suitability	YES	YES	Unknown	NO	NO	NO
Best Use	YES	YES	YES	NO	NO	NO
Economic Viability	YES	YES	Unknown	Unknown	Unknown	NO
Location	YES	YES	YES	NO	YES	NO
Parking	YES	YES	YES	NO	YES	YES
Community	YES	YES	NO	NO	NO	NO
Market Appeal	YES	YES	YES	Unknown	Unknown	NO

CONCLUSIONS – LEAST ENVIRONMENTALLY DAMAGING PRACTICABLE ALTERNATIVE

Based on the discussion and analysis in the preceding pages, it should be apparent that there are several alternatives which must be explored as being (a) less environmentally damaging than the preferred alternative, and (b) practicable, and (c) meeting the project purpose and need.

The first is the No-Action Alternative involving either existing or newly installed offshore moorings, coupled with a low-impact shoreline access dock (either at the applicant's location or elsewhere in Coral Bay). This would meet the applicant's stated project purpose of "attracting private and charter yachts from around the world" and meeting "local needs" for access by water to Coral Bay.

The second option is either the Cruz Bay Creek location or the Enighed Pond location, both of which score far higher in the Table of Evaluation Criteria than the applicant's preferred alternative. With significant protection from wind and waves, minimal impact to natural habitat, excellent location, and all available infrastructure, one or both of these alternatives must be viewed as the Least Environmentally Damaging Practicable Alternative to the proposed action.

David Silverman, Board Member, Coral Bay Community Council
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14 August 2015