

*Options for Improving the Beach for  
Cadaques Caribe Dominicanus Americanus  
Bayahibe, Dominican Republic*



by Lee E. Harris, Ph.D., P.E.  
Consulting Coastal and Oceanographic Engineer  
Melbourne, Florida USA

October 2007

## Table of Contents

<b>1</b>	<b>Introduction.....</b>	<b>1</b>
<b>2</b>	<b>Location .....</b>	<b>1</b>
<b>3</b>	<b>Existing Conditions .....</b>	<b>6</b>
<b>3.1</b>	<b>Oceanographic Conditions .....</b>	<b>6</b>
3.1.1	Tides and Water Levels.....	6
3.1.2	Winds and Waves.....	6
3.1.3	Ocean Currents .....	6
<b>3.2</b>	<b>Beach Topography and Offshore Bathymetry .....</b>	<b>7</b>
<b>4</b>	<b>Proposed Beach Improvements .....</b>	<b>11</b>
<b>5</b>	<b>Conclusions .....</b>	<b>14</b>

## List of Tables

Table 1.	Existing Offshore Submerged Artificial Reef Breakwaters.....	3
----------	--	---

## List of Figures

Figure 1.	Cadaques Project Location.....	1
Figure 2.	Cadaques Project Location (Google Earth) .....	2
Figure 3.	Dominicus Beach Area (Google Earth).....	3
Figure 4.	View West of Existing Submerged Artificial Reef Breakwaters .....	4
Figure 5.	View East of Existing Submerged Artificial Reef Breakwaters.....	4
Figure 6.	Oasis Canoa Submerged Artificial Reef Breakwater .....	5
Figure 7.	Nine Beach and Offshore Profiles (aerial photo date May 2007) .....	7
Figure 8.	View to NW from center of project (photo date September 10, 2007) .....	8
Figure 9.	View to SE from center of project (photo date September 10, 2007) .....	8
Figure 10.	Offshore Depths from Boat Survey (September 2007) .....	9
Figure 11.	Plan view of the project bathymetry.....	10
Figure 12.	Nine Beach Profile Cross-sections (survey date September 2007) .....	11
Figure 13.	Plan View of Proposed Submerged Artificial Reef Breakwater .....	12
Figure 14.	Profile View of Proposed Submerged Artificial Reef Breakwater.....	13
Figure 15.	Plan View of Proposed Rock Removal Areas .....	14

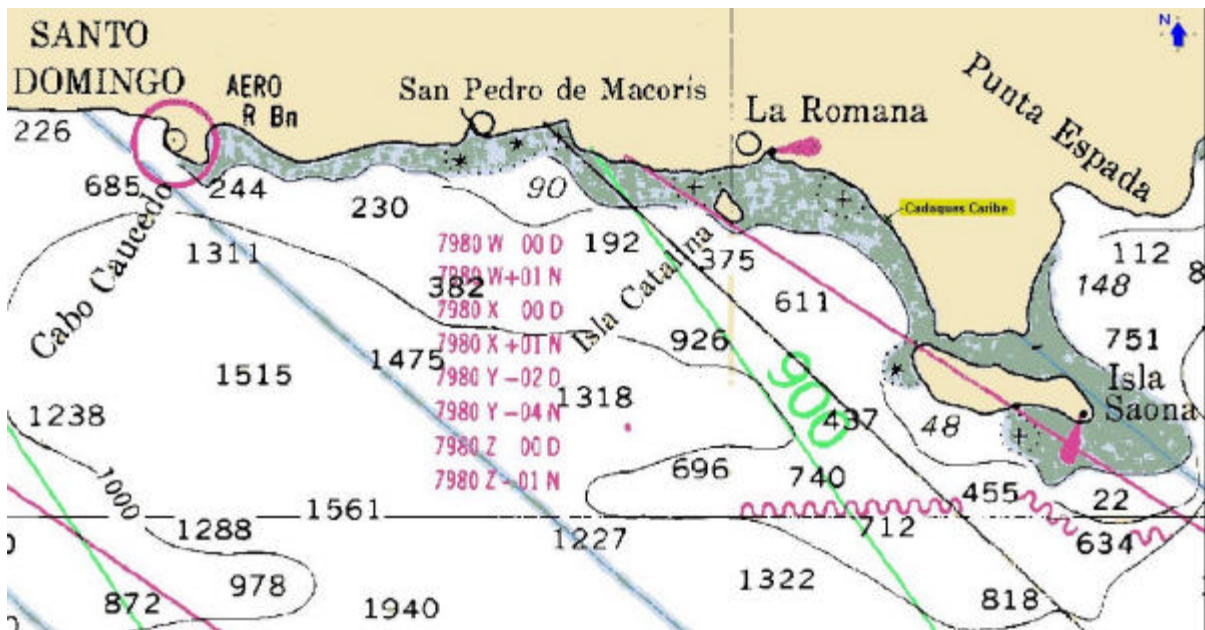
# *Options for Improving the Beach for Cadaques Caribe Dominican Americanus Bayahibe, Dominican Republic*

## **1 Introduction**

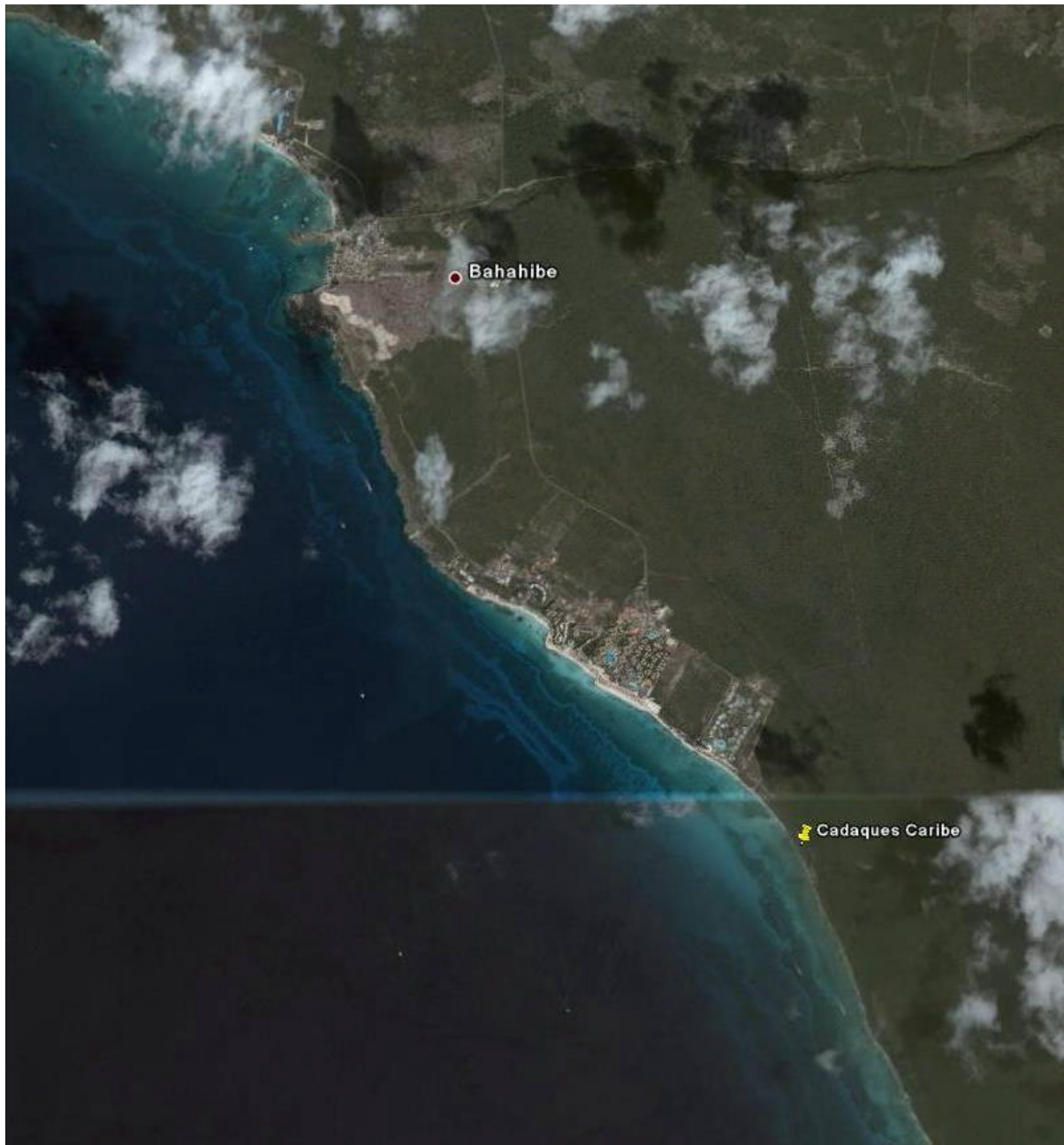
This report presents the options for improving the beach conditions for the Cadaques Caribe development project. Existing conditions are documented, performance of nearby beach improvements are reviewed, and the options for beach improvements for Cadaques Caribe are developed and discussed.

## **2 Location**

The Cadaques Caribe project is being constructed along the southern Caribbean Coast of the Dominican Republic, east of La Romana near the town of Bayahibe. Figure 1 shows the project location indicated on a nautical chart, and Figure 2 shows the location plotted in Google Earth.

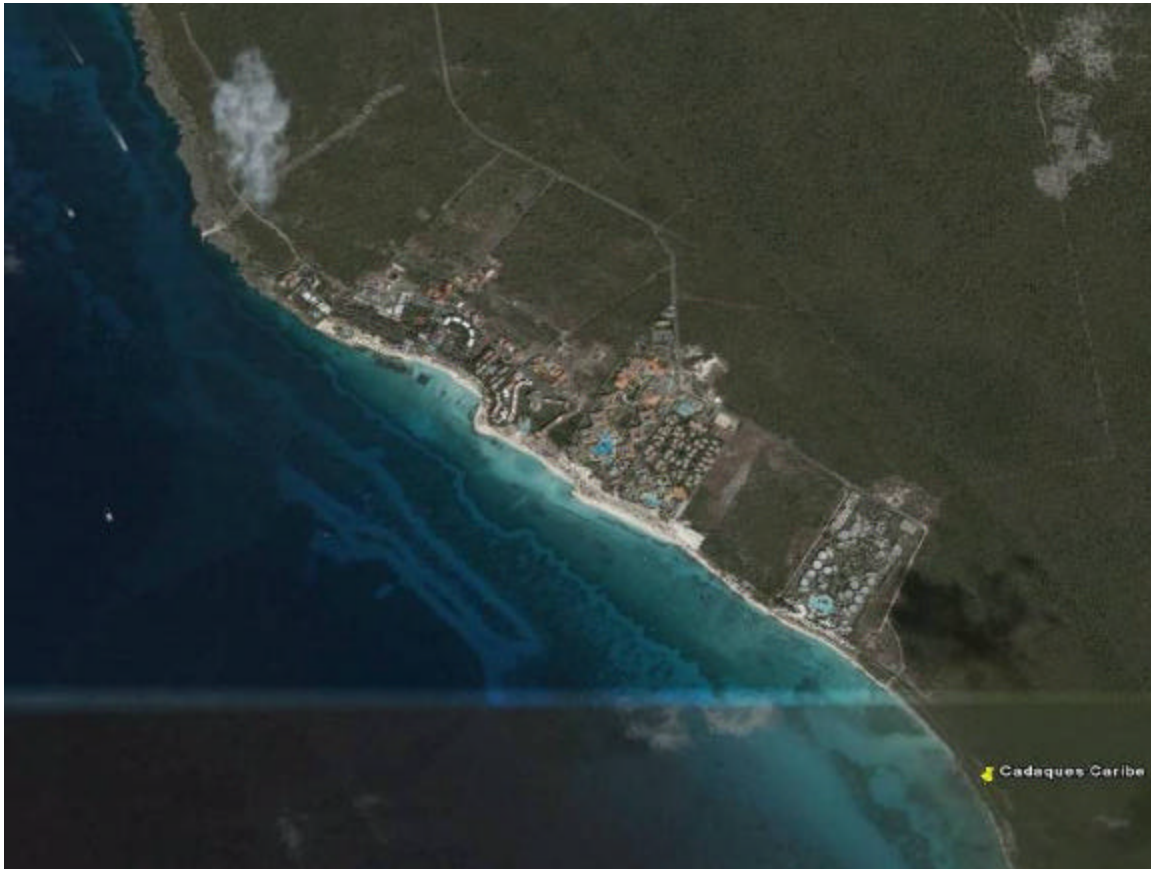


**Figure 1. Cadaques Project Location**



**Figure 2. Cadaques Project Location (Google Earth)**

This stretch of coast is referred to as the Dominican Beach Area, and consists of several oceanfront beach resorts located just northwest of the Cadaques site. These resorts are shown in Figure 2 and with a close-up in Figure 3, and include the Oasis Canoa, Rosa de Bayahibe (under construction), Gran Dominican, Iberostar, and Wyndham Dominican Beach resorts. Immediately to the south of Cadaques is the Park, Parque Nacional del Este.



**Figure 3. Dominican Beach Area (Google Earth)**

This stretch of coast is often referred to as the Dominican Beach Area, and consists of several oceanfront beach resorts. Three of these four resorts currently in operation have improved their beach areas by deploying offshore artificial reef submerged breakwaters (Gran Dominicus, Iberostar, and the Oasis Canoa). The beaches in this area have been awarded the “Blue Flag” designation due to the high quality of the beaches and environment. Details of these existing breakwaters are summarized in Table 1, with aerial photographs showing the projects in Figures 4 to 6.

**Table 1. Existing Offshore Submerged Artificial Reef Breakwaters**

1. Gran Dominicus breakwater constructed in 1998, relocated in 2004, 500 units.
2. Iberostar breakwater constructed in 2001, 150 units.
3. Oasis Canoa breakwater constructed in 2004, 300 units.
4. Rosa de Bayahibe breakwater constructed in 2004, 300 units.



**Figure 4. View West of Existing Submerged Artificial Reef Breakwaters**



**Figure 5. View East of Existing Submerged Artificial Reef Breakwaters**



**Figure 6. Oasis Canoa Submerged Artificial Reef Breakwater**

### **3 Existing Conditions**

The existing conditions for the project area are presented in this section of the report. This includes the meteorological and oceanographic conditions (winds, waves, tides, and currents) and the existing coastal geomorphology (beach topography and offshore bathymetry).

#### **3.1 Oceanographic Conditions**

The Cadaques Caribe development is located on the southern Caribbean Coast of the Dominican Republic. The project is located in the lee of the island of Hispaniola from dominant winds and waves, and is generally calm except during the passage of nearby tropical storms and hurricanes.

##### **3.1.1 Tides and Water Levels**

Tides for the southern Caribbean coast of the Dominican Republic are mixed, varying from diurnal to semi-diurnal. The tide range is small, generally less than 0.3m. Predicted tides for Santo Domingo during the September survey dates are shown in the Appendix. High water levels are possible and do occur due to tropical storms and hurricanes, that are able to produce storm surges that can

##### **3.1.2 Winds and Waves**

The Tradewinds provide a dominant wind pattern for the area, with winds from the east. Calm mornings with afternoon onshore sea breezes are common, except when the weather is influenced by the passage of frontal systems or nearby tropical systems. This area is sheltered from swell waves from the Atlantic Ocean, with the wave climate due to locally generated wind waves. Tropical storms and hurricanes produce the strongest winds and largest waves for this area.

##### **3.1.3 Ocean Currents**

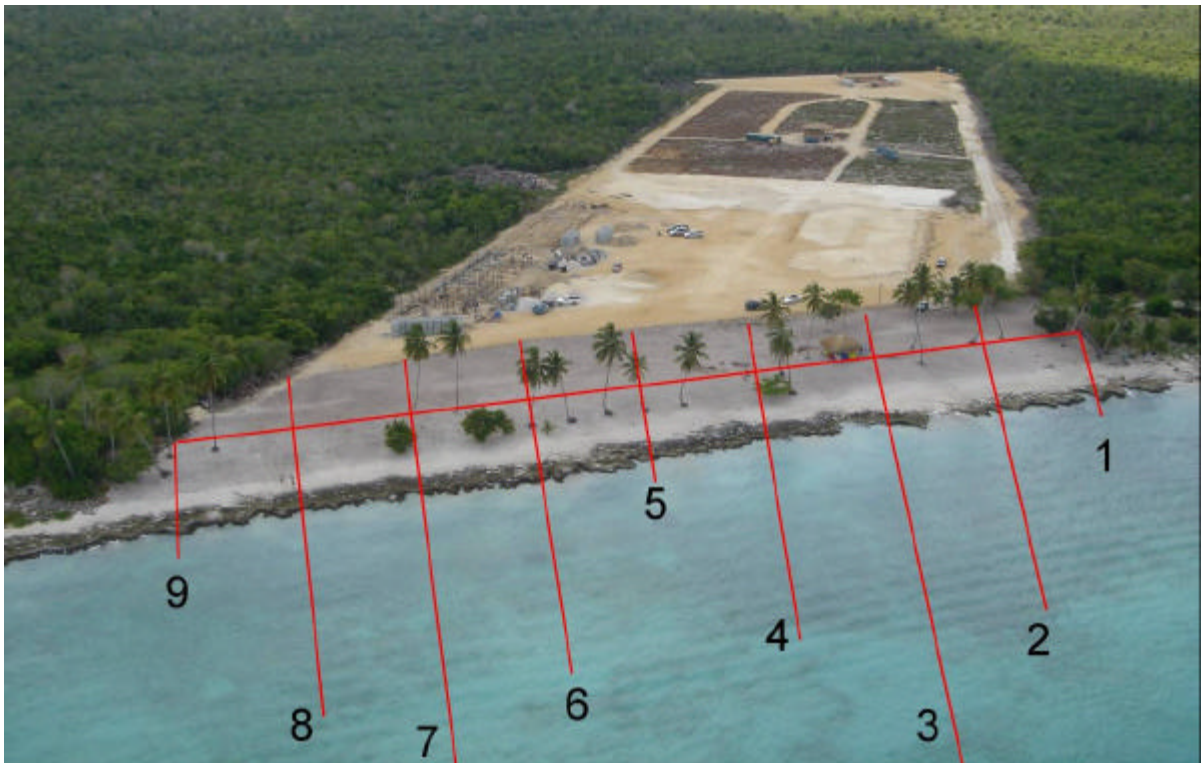
Due to the small tide range, there are no tidal currents in this area. No major ocean currents affect the area, so the currents that do occur are a combination of locally wind-driven and wave generated currents, most severe during tropical storm events. Due to the dominant wind direct from east to west in this area, and combined with the afternoon sea breeze and resulting waves, there is a very small longshore current with dominant east to



west direction. However during tropical storms and hurricanes, the winds and waves can produce stronger than normal longshore currents, and in either direction.

### 3.2 Beach Topography and Offshore Bathymetry

Surveys of the Cadaques Caribe project area were performed in May and September 2007. A baseline was established along the 160m oceanfront, and nine profile lines at 20m intervals along the baseline were surveyed. Figure 7 shows the locations of the baseline and the nine profile lines. As shown in the aerial photograph in Figure 7 and ground photographs in Figures 8 and 9, the shoreline at this site is rocky, with a rock structure ranging from 1 to 3 meters wide, and an elevation of the top of the rock up to 0.5 meters above the sea bottom immediately seaward of the rock.



**Figure 7. Nine Beach and Offshore Profiles (aerial photo date May 2007)**



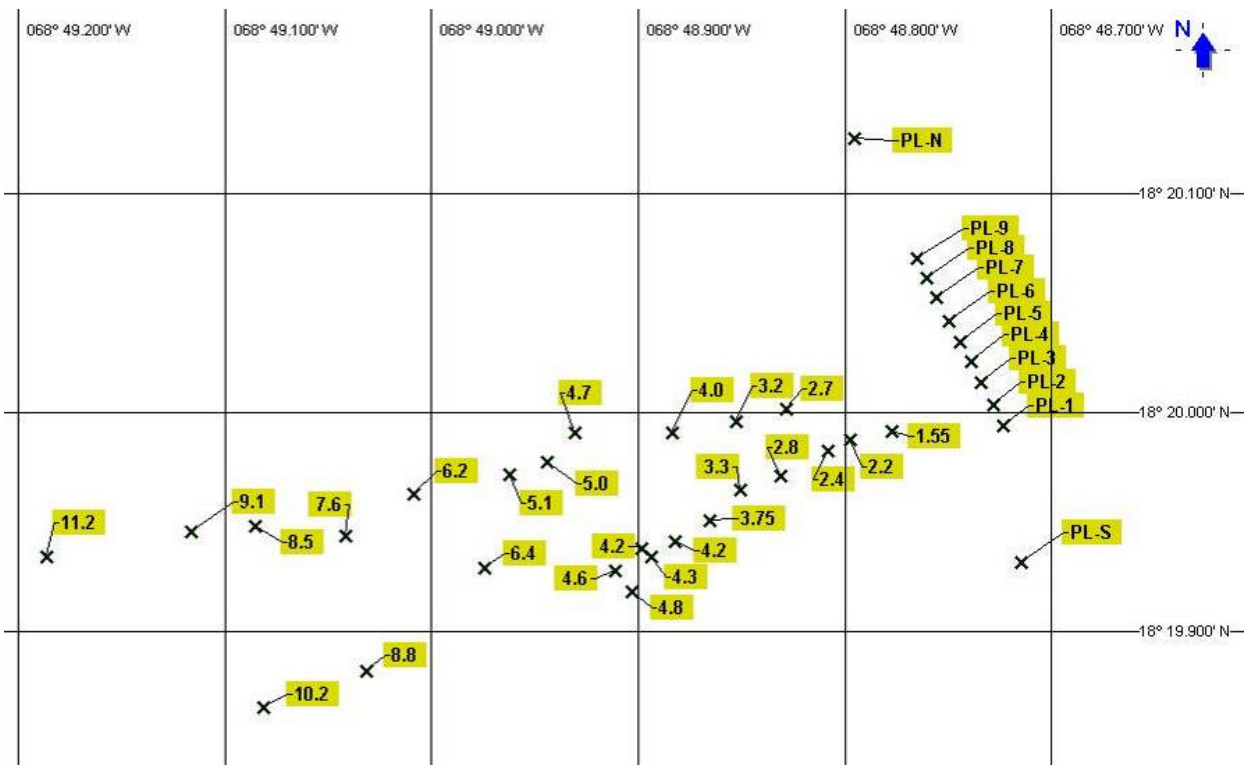
**Figure 8. View to NW from center of project (photo date September 10, 2007)**



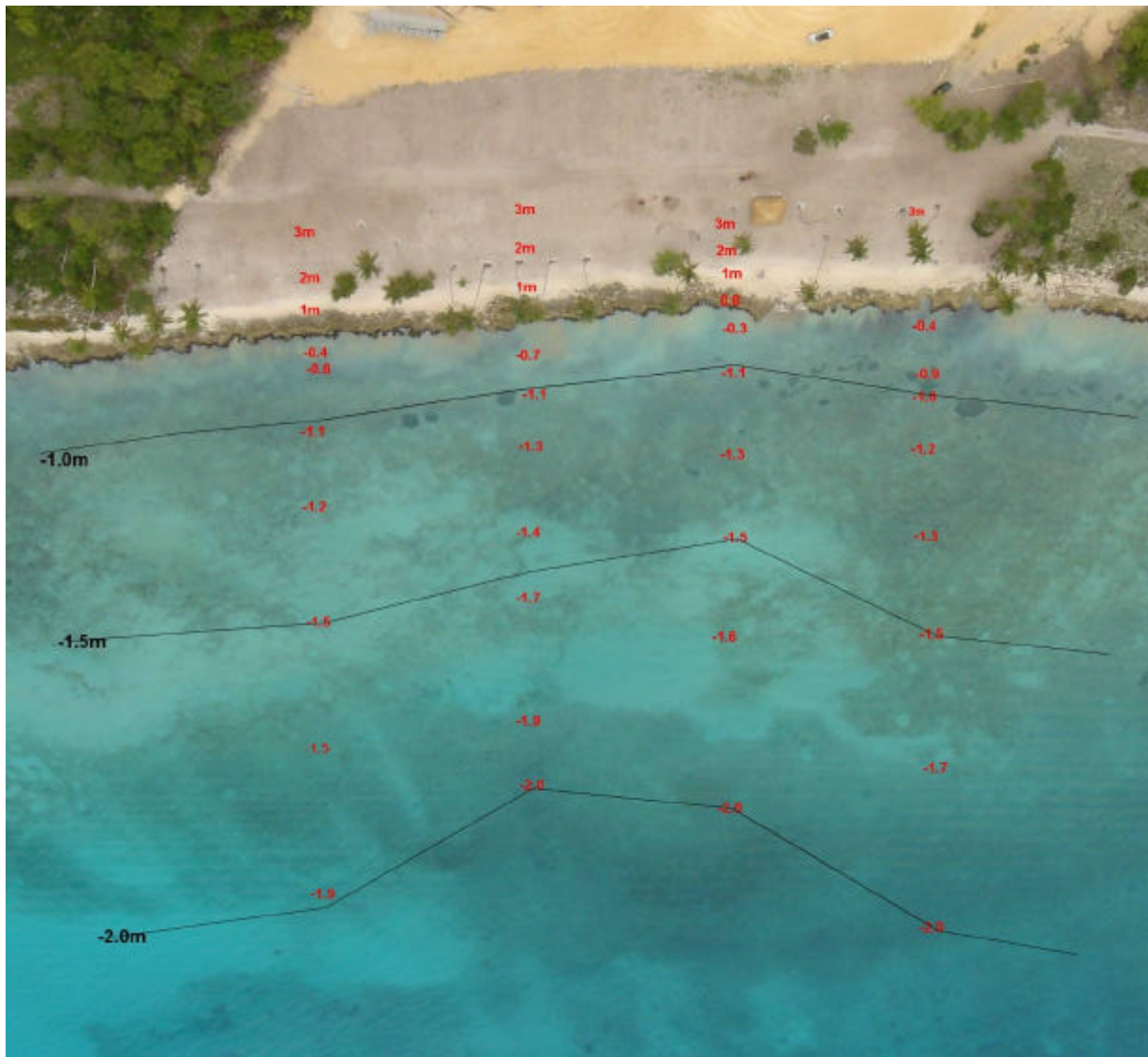
**Figure 9. View to SE from center of project (photo date September 10, 2007)**

All nine profiles were surveyed across the dune and into the water, with all of the even numbered lines surveyed out to maximum wading dept (2m). Boat surveys were performed for Profile Lines 3 and 7 with lines surveyed out to a depth of 11m. Additional profile lines were surveyed further north and south along the coast to document the conditions of the adjacent properties.

The survey data for the offshore depths measured from the boat are shown in Figure 10, and the detailed bathymetry surveyed out to the 2m depth is shown in Figure 11. Beach profiles for the nine profile lines are plotted in individual graphs in the Appendix, and are shown plotted all on the same graph in Figure 12.



**Figure 10. Offshore Depths from Boat Survey (September 2007)**



**Figure 11. Plan view of the project bathymetry**

The survey data show that the existing topography of the beach and dune area consists of a dune crest elevation of 3m, that slopes landward to a 2m elevation, and slopes seaward to the sea. Elevations on top of the rock shelf at the shoreline range from 0.2 to 0.5m. Water depths seaward of the rock vary from 0.0 to -0.5m. The offshore sea bottom consists of sand, with some rocks and seagrasses.

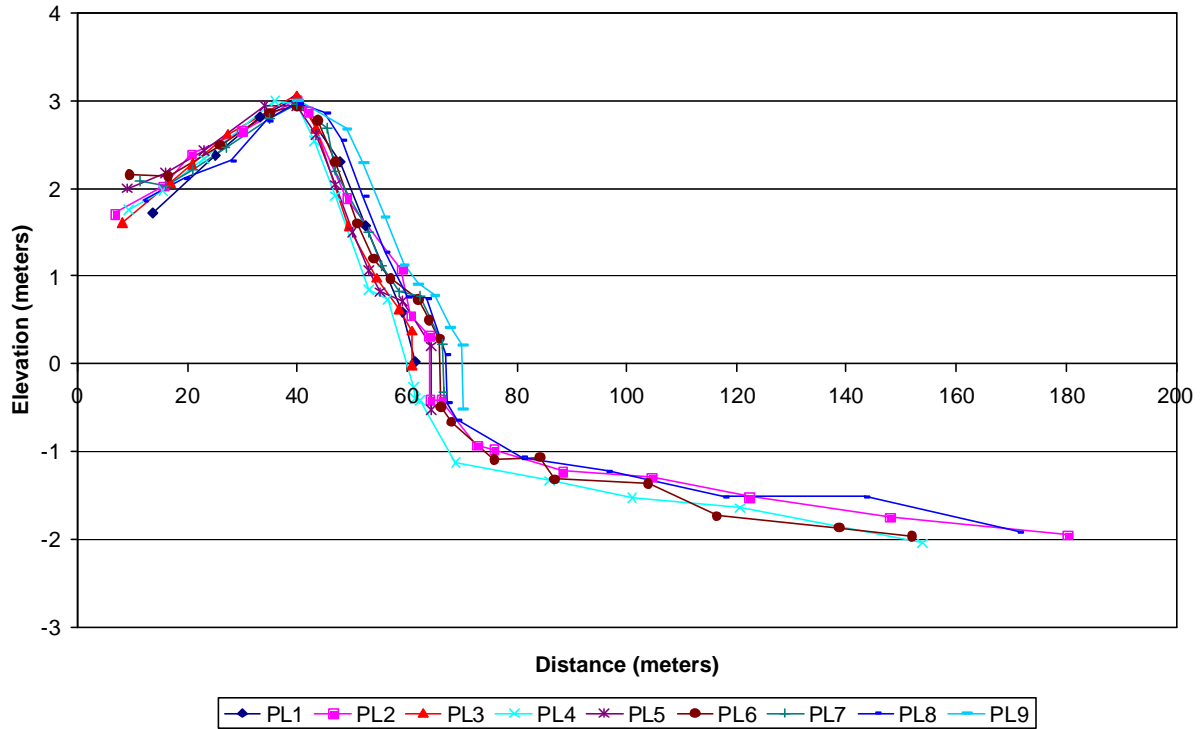
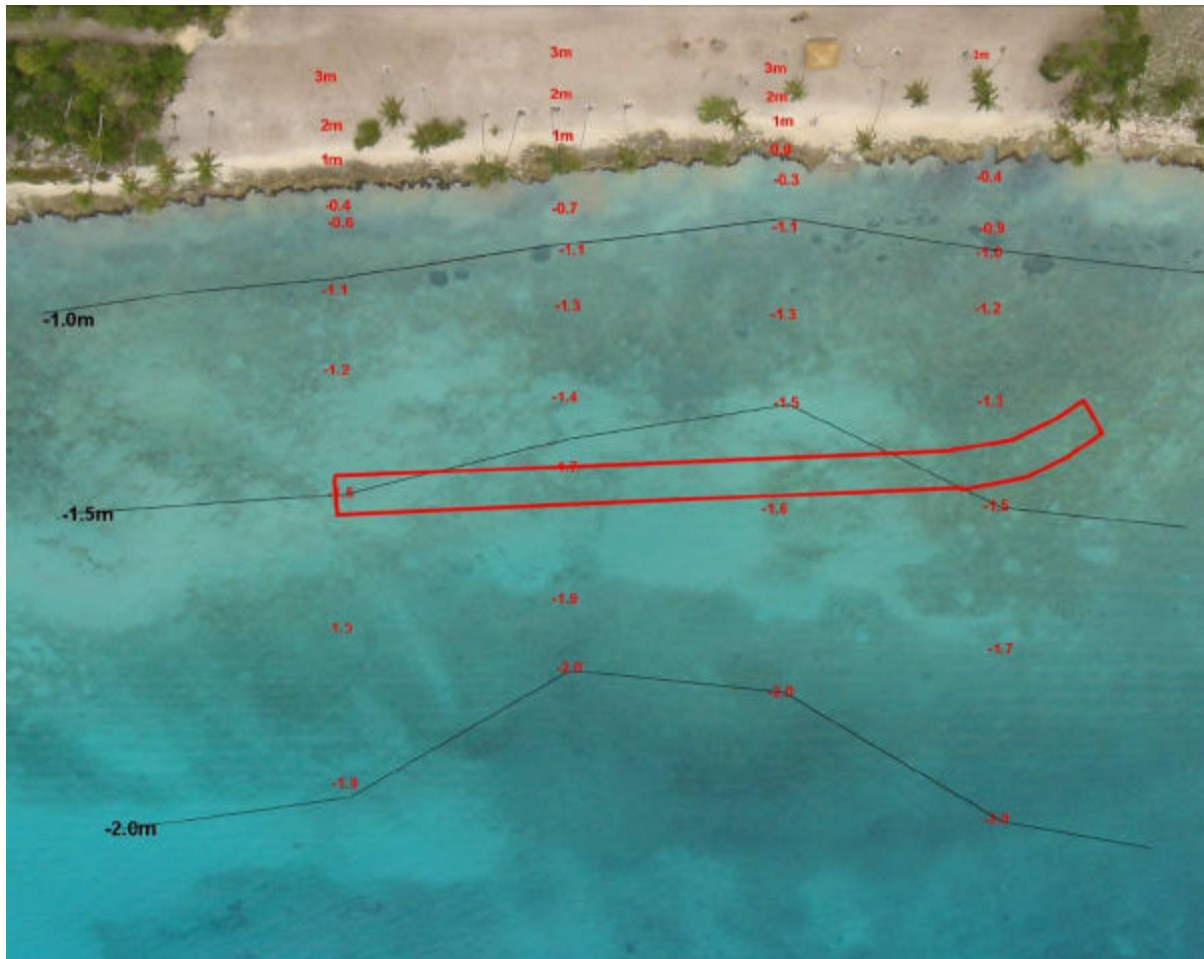


Figure 12. Nine Beach Profile Cross-sections (survey date September 2007)

#### 4 Proposed Beach Improvements

This section of the report presents proposed improvements to the beach area for the Cadaques Caribe project. In order to establish a sandy beach at the shore, an offshore submerge artificial breakwater is proposed, similar to those that have been constructed at Gran Dominicus, Iberostar and Oasis Canoa beach resorts. Preliminary design layouts are shown in Figure 13 (Plan View) and Figure 14 (Profile View).

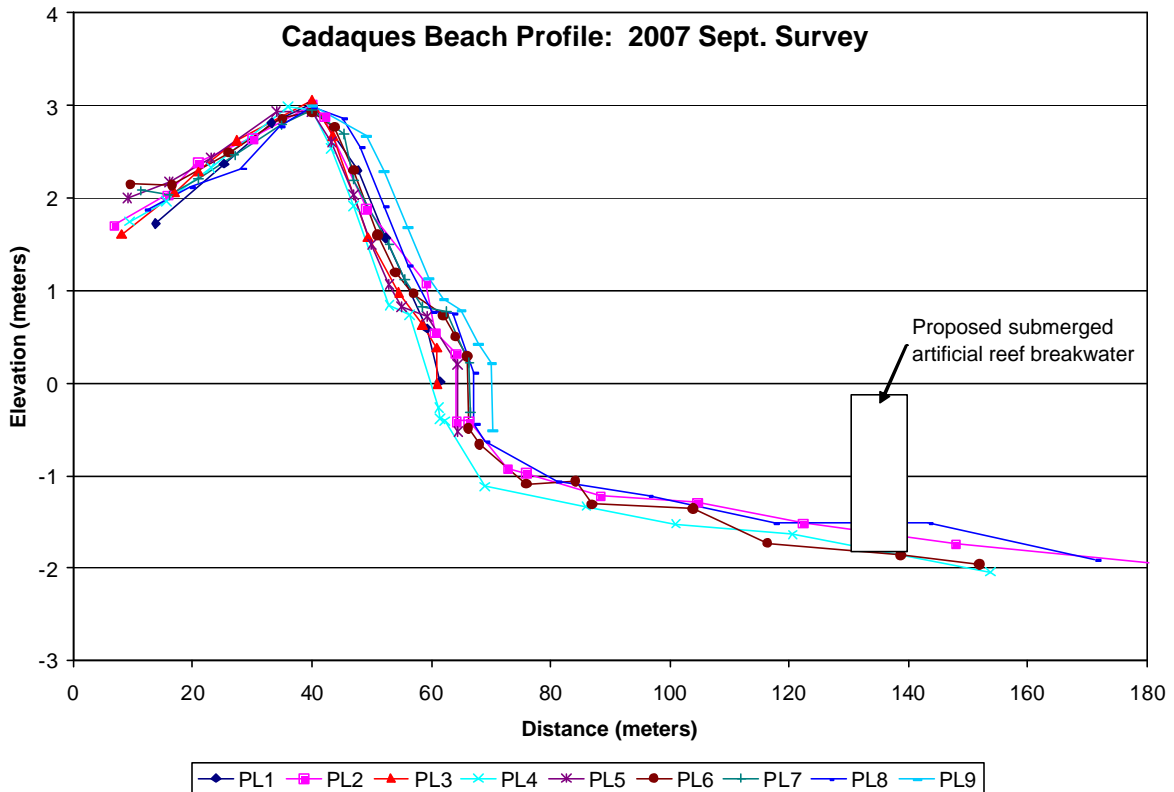
The total length of the breakwater is 140m long, and would be constructed of four rows of Reef Ball artificial reef units (similar to the Oasis Canoa, Iberostar, and Gran Dominicus breakwaters). The breakwater is located approximately 65m offshore in water depths of -1.5 to -1.8m, with a curved section at the south end, into water depths of -1.3m. Various size Reef Ball units will be used to construct the breakwater, varying in heights from 0.8 to 1.4m so that the crest of the breakwater will be at an elevation of -0.5m.



**Figure 13. Plan View of Proposed Submerged Artificial Reef Breakwater**

The bottom in the area consists of sand lying on a rock substrate, so that anchoring of the reef units into the bottom with fiberglass rebar will be done to prevent sliding (as was done at the Oasis Canoa, Iberostar, and Gran Dominicus breakwaters). Details on the Reef Ball units, including sizes, dimensions, weights, and performance of Reef Ball breakwaters at other locations are provided as an Appendix on Reef Ball breakwaters.

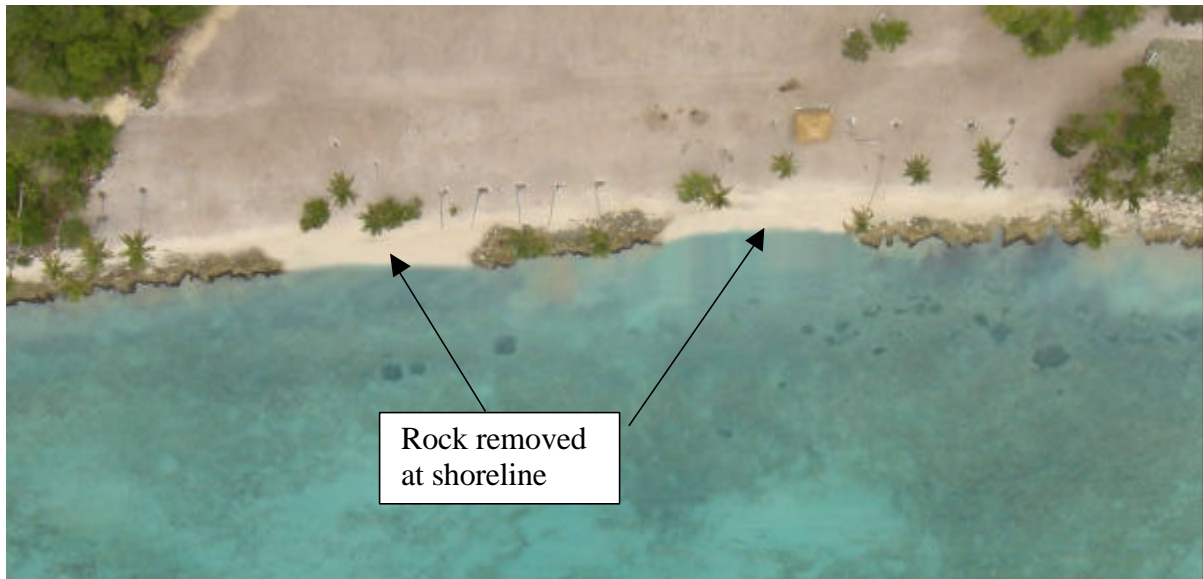
The southern location of the breakwater is to allow for small boat access (kayaks, sailboats, sailboards, etc.) to and from the sea north of the breakwater. If desired, one or two openings in the breakwater can be provided to allow for swimming access through the breakwater.



**Figure 14. Profile View of Proposed Submerged Artificial Reef Breakwater**

Due to the dominant rock shelf in this area, it is proposed to reduce the rock height in two areas, as shown in Figure 15. This will provide areas in which access into and out of the water by swimmers will be facilitated, even prior to any build up of sand landward of the breakwater. The remaining rock will act as headlands, and the beach areas where the rocks are removed may become concave pocket beaches. The locations of these areas can be adjusted to fit the design of the upland development, so that they can be located near shower facilities for beach users and walkways to the upland development areas.

Information on the sea bottom, including underwater photographs and biological information are in the Appendix. Additional design details of the proposed breakwater are also presented in the Appendix. For the 140m long breakwater constructed of four rows of units will be approximately 8m wide. Four units width over a 140m length requires approximately 70 units times 4 rows = 210 units.



**Figure 15. Plan View of Proposed Rock Removal Areas**

## 5 Conclusions

The proposed beach improvements for the Cadaques Caribe development include an offshore submerged breakwater, which is expected to enhance the beach as similar structures have at nearby resorts in the Dominicus Beach area (Oasis Canoa, Iberostar, and Gran Dominicus), which led to those beaches earning the Blue Flag award for their quality. Details of the performance of other Reef Ball breakwaters at those sites and on Grand Cayman are presented in the Appendix.

For immediate beach use, one or two areas of the shoreline can be modified so that the existing rock layer is lowered, so that easy access for swimmers to the ocean is provided. The location can be adjusted to fit the upland development plans. A dock at the southern end of the project may be considered, which would provide access to both the Cadaques Caribe project and the Parque Nacional del Este. The southern end of the proposed breakwater can be adjusted to provide wave attenuation to the dock, as well as to allow boats easy access to the dock.