# SITE INVESTIGATIONS OF THE BEACH EROSION PROBLEM AT MAHO BEACH, ST. MAARTEN

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## 1. Introduction

This report presents the results of a site visit performed on 21-24 February 2003 at Maho Beach on the island of St. Maarten, DWI. The purpose of the visit was to investigate the beach erosion problem and possible alternatives for stabilizing the beach.

Maho Beach is located at the western end of the Princess Juliana Airport on the island of St. Maarten. It is located within the crenulate-shaped bay known as Maho Bay, and consists of a sandy beach with rock outcroppings. There is a polular bar for watching airplanes land located at the southern end of the beach, and the beach extends northward along the west end of the airport runway to the Maho Beach Hotel and Casino located at the northern end of this beach area. The shoreline is curved with an orientation that varies from north-south at the southern end to east-west at the north end, and rock headlands exist at both ends of the Maho Beach area.

The aerial photograph in Figure 1 shows the location of the four adjacent pocket beaches within the embayments known as (from north to south) Mullet Bay, Maho Bay, Beacon Hill cove, and Simson Bay. Sand transport between these pocket beaches would be difficult, due to the rocky headlands separating them.

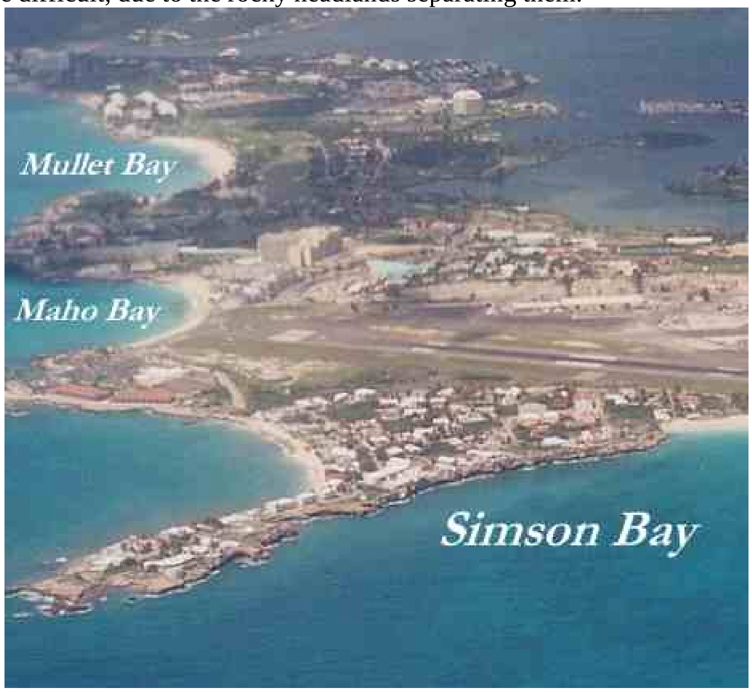


**Figure 1. Oblique aerial photograph of Maho bay area.**

## 2. Existing Beach Conditions

Inspection of Maho Beach during this site visit revealed a beach that can be divided into four reaches as shown in Figure 2 (photo date unknown):

A. beach at the north end (Maho Beach hotel),
B. rock outcrop (south end of hotel),
C. beach at end of the runway, and
D. beach at the south end.

During this site inspection the beach at the north end (Reach A) was the widest and flattest, and had a steep foreshore slope with relatively large waves (estimated at 1m wave height and 8-second wave period) breaking directly on the shore. The beach narrowed going south, with little sand between the exposed rock outcrop and the south end of the hotel seawall in Reach B. There is a rock revetment and wall along reaches C and D, as shown without the sand cover in Figure 3. During this site inspection there were exposed rock revetment at the north end of Reach C, with sand covering the rocks until the south end of Reach D. Wind gusts from airplanes taking off creates a slightly lowered beach berm elevation at Reach C. In Reach D, the berm elevation was quite high, and a vertical escarpment varying from 6 to 8 feet high separated the upper flat beach from the water. Local winds blow this higher elevated sand onto the road, which must be removed to enable vehicles to use the road.


**Figure 2. Four beach zones of Maho Beach (photo date unknown).**

**Figure 3. Wall and rocks along road at end of runway (photo date unknown).**

Measurements of the existing beach width were taken on 22 February 2003 at 50-foot intervals along the beach from north to south. Figure 4 presents an aerial photograph of the Maho Beach area that shows the approximate locations of the beach width measurements, and Table 1 presents the beach width measurements.


**Figure 4. Location of beach width measurements.**

**Table 1. Beach width measurements taken 22 February 2003**

| Point | Distance (feet) | Beach Width (feet) | Point | Distance (feet) | Beach Width (feet) |
|---|---|---|---|---|---|
| 1 | 50 | 32 | 12 | 600 | 59 |
| 2 | 100 | 63 | 13 | 650 | 58 |
| 3 | 150 | 76 | 14 | 700 | 64 |
| 4 | 200 | 88 | 15 | 750 | 64 |
| 5 | 250 | 76 | 16 | 800 | 63 |
| 6 | 300 | 65 | 17 | 850 | 62 |
| 7 | 350 | 53 | 18 | 900 | 52 |
| 8 | 400 | 39 | 19 | 950 | 46 |
| 9 | 450 | 18 | 20 | 1000 | 42 |
| 10 | 500 | 23 | 21 | 1050 | 45 |
| 11 | 550 | 39 | 22 | 1085 | 0 |

Table 1 shows that the beach was approximately 1100 feet long with an average width of 50 feet (maximum width = 88 feet and minimum width = 0). Review of historical aerial photographs reveals that the beach widths and shapes can vary considerably for Maho Beach, as seen in Figures 5 and 6.

**Figure 5. Previous wide beach (on left) and subsequent narrower beach (on right).**

Sea conditions were quite rough during the site survey, but water depth measurements were made by free diving with a depth gage. The water depths are shown in the approximate locations in Figure 6.


**Figure 6. Water depths offshore of the Maho Beach Hotel and Casino.**

## 3. Alternatives for Shoreline Stabilization

Based on the field investigations, alternative methods for restoring the beach and stabilizing the shoreline were developed. For the Maho Beach area, beach restoration and stabilization alternatives include beach renourishment with sand fill, shore perpendicular groins to stabilize this beach sand fill, a shore parallel sill to perch the beach sand fill, and an offshore submerged or emergent breakwater. These alternatives are discussed in the following sections.

### A. Beach Renourishment with Sand Fill

According to local knowledge, beach nourishment with sand fill has been performed in the past for the Maho Beach area. Trucking in sand from an upland source or hydraulically pumping sand from offshore to renourish the beach are methods that can be considered for this site. Beach renourishment with sand fill is the most direct way to restore the beach.

### B. Shore Perpendicular Groins

Shore perpendicular groins can be used to hold sand on the beach, preventing it from being washed along the shoreline. By themselves, groins can trap sand on one side, while causing erosion of the beach on the other side. This can be minimized by using short groins, and adding sand to the beach to fill the groins immediately after they are installed. The use of groins as structures to stabilize sand fill placed on the beach by Alternative A would increase the longevity of the beach fill. Groins can impede pedestrian travel along the beach, and with little natural longshore sand transport they are not expected to be effective in increasing the width of the beach unless sand is also added to the beach. The use of a groin as a terminal structure north of the existing sand beach may assist with beach stabilization if sand is being lost from Maho beach by being transported around the rock headland to the Mullet Bay area.

### C. Perched Beach

Another method to assist with holding sand on the beach is to install a shore parallel structure just seaward of the shoreline, and fill the area between this structure and the seawall with fill. The ends of the sill structure must curve back to the seawall at the north and south ends. This shore parallel structure functions as a sill to hold the sand on the beach, but can be an obstacle to beach users and swimmers.

### D. Submerged Breakwater

A submerged breakwater reduces the wave action that reaches the beach, thereby assisting to stabilize the shoreline. The use of artificial reef units for a submerged breakwater also provides underwater habitat, enhancing the environment. Unlike traditional breakwaters that project above the water surface and stop all wave action, submerged breakwaters allow the smaller waves to pass over the structure so that sand transport along the coast is maintained during normal conditions. During large wave events, the larger waves are forced to break on the submerged breakwater, thereby reducing the wave energy reaching the beach from large waves, and reducing the associated beach erosion. The disadvantage of submerged breakwaters is that they become less effective as their depth of submergence increases, so that they are less effective at reducing wave action during elevated water levels due to storm surge.

## 4. Recommendations

From the site investigations and research performed, the following recommendations are presented:

1. The beach sand that blows from Maho Beach onto the road should be returned to the beach and should not be removed from the area, otherwise this practice would contribute to the beach erosion.

2. The most sure and effective method for increasing the beach widths at Maho Beach is by adding sand to the beach. This can be done using beach compatible sand from an upland or offshore source. Costs and feasibility of beach nourishment is dependent upon the source and quality of available sand materials.

3. An offshore breakwater can be used to reduce the wave action reaching the beach, thereby reducing the wave energy and erosion of the shoreline. The difficulties with this alternative for the Maho Beach area are the deeper water depths and sand bottom offshore of the beach area. The deeper water depths require a greater structure height to be effective. The sand bottom presents a potential problem with scour and settlement of breakwater units. For this alternative to be considered further additional measurements of water depths and probes of the bottom to determine the depth down to rock need to be performed.

4. Beach width measurements and beach profile surveys are recommended to allow for monitoring of the Maho Beach area (and other beach areas around the island). Six reference points along the Maho Beach area can be chosen (such as seawall corners or other landmarks) from which measurements can be made at monthly intervals and following major storm and erosion events. This will provide data that will be helpful in improving the understanding of the coastal processes and developing solutions to beach erosion problems.