



Innovative Reef Engineering for Small Island States

The Grenville reef engineering and restoration project is one component of a larger initiative called "At the Water's Edge". The AWE initiative is a multi-year integrated effort with aims that range from increasing the social and economic capacity of local communities to adapt to climate change, to restoring and protecting the ecosystems that reduce the scale of climate change impacts. ([AWE Brochure](#)).

The specific aims of the reef engineering and enhancement project of the AWE initiative are:

1. To use an eco-engineering approach to reduce the coastal erosion and storm related salt water flooding affecting the Grenville and Telescope area in the northern section of Grenville Bay, Grenada.
2. To restore the wave-breaking function of the degraded reefs in northern Grenville Bay and to facilitate the reestablishment of coral growth and ecological functions in the Bay.
3. To demonstrate the feasibility of a new eco-engineered submerged breakwater design that can be installed utilizing local community labor, at lower cost and with higher ecosystem benefits than traditional grey infrastructure such as seawalls, rip rap, and groins.



A completed 2-tier pilot breakwater structure (this one with blocks) with rescued corals placed along their sides. The baskets were interconnected (side to side, top and bottom) using stainless steel "clips" as shown in this photo. These structures have been carefully designed to lock together into one large structure that is engineered to withstand the powerful waves on the reef flat.



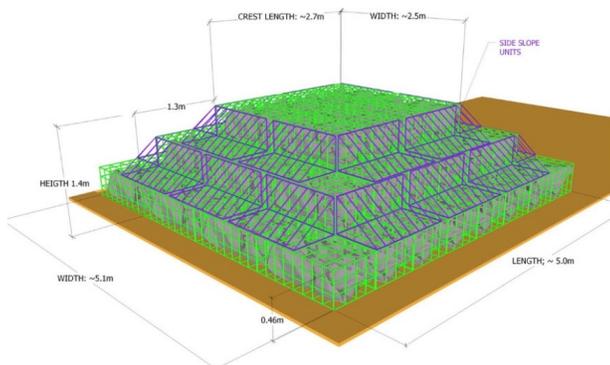
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The Process

To help identify solutions that address increased wave energy, erosion and flooding, The Conservancy and the Environmental Hydrological Institute (IH Cantabria) developed a sophisticated hydrodynamic model of the Grenville area designed to accurately simulate wave and current patterns influencing the bay. The models incorporated detailed data on 60 years of wave dynamics for the area, the history of storm events, and fine scale bathymetry. The models were then used to explore different engineering solutions to reduce wave energy and currents within Grenville Bay, including the best placement for a series of submerged breakwaters along 300 meters behind the reef crest. Pilot structures were installed in January 2015 to test feasibility and design.

Design and installation



Perspective engineering design of 5meter breakwater structure filled with armor rocks—Smith Warner International

The Nature Conservancy worked closely with Smith Warner Engineering to design a submerged breakwater suitable for placement in a high-energy reef environment. Some of the specifications for this breakwater design included that it should :

- reduce 80-90% of the wave energy passing over it
- could be built with small boats and local community labor
- have a longevity of at least 30 years
- promote natural biological growth and accretion of coral and crustose coralline algae
- be constructed with common local materials at a cost less than that of a traditional breakwater.

The resulting design incorporated a new type of thick steel gabion basket made out of 5/8” rebar, that could be filled with a variety of materials and stacked and locked together in a pyramid allowing for different widths and heights. To test the integrity and feasibility of this new breakwater design, a pilot project was proposed before designing and constructing the full breakwater. A series of four pilot structures were installed, and will be monitored for the next year. The data collected will inform the final build-out of the full breakwater.



Official Rock Placing with the German Ambassador to the Caribbean (Dr. Goergens) and Parliamentary Representative Hon Emmalin Pierre. The pilot phase is funded by The German Federal Foreign Office



A cross section of launch attendees during an interpretative walk-through of the project site

With support from The German Federal Foreign Office and in partnership with Grenada Fund for Conservation, Grenada Red Cross Society and community members, the pilot project for building a submerged breakwater on the Grenville reefs was formally launched in early January 2015. A total of 30 meters of submerged breakwater structures were constructed on the northern portion of the Grenville reef flat.

Materials for the pilot breakwaters were assembled in advance from the Grenville area and included a team of local welders fabricating over 270 steel baskets, cement cinder blocks, and large stones from the adjacent Telescope Quarry. Construction of the pilot breakwater was largely undertaken by a team of 10 fishers from the Grenville area overseen by a Grenadian commercial dive company, Underwater Solutions Ltd. To minimize the ecological impact to the existing reef, any live coral within the building footprint of the submerged breakwaters were transplanted to the adjacent reef in advance of construction. In some cases, coral fragments were also attached to the completed pilot structures.

Grenville Pilot Reef Breakwater



Telescope Beach - Grenada. The mobilization site for the Reef Engineering and Restoration Project where all materials and equipment were kept during construction. The site was landscaped on completion



Assembly of the barge utilized to transport materials out to the reef. The barge was designed and built by Underwater Solutions with 50 gallon molasses barrels serving as pontoons



Loading the barge with rocks from the beach, done manually by a team of 10 spearfish divers from the Grenville community.



Custom made barge loaded with baskets and rocks for constructing breakwater.



Divers carrying and packing the baskets with large armor rocks from the Telescope quarry



Building the reef breakwater, one stone at a time. Packing the second layer of baskets at low tide with waves now breaking directly on the breakwater.

Despite fairly rough January seas, construction of the pilot breakwater structures was completed as specified by the engineering designs on time with no major injuries or mishaps. While the feasibility of constructing the breakwater has now been established, a number of outstanding questions regarding the breakwater design and potential impacts remain to be answered over the coming months before a final assessment on its suitability for Grenville can be made.

Starting in January 2015 the pilot structures will be closely monitored to determine if they are functioning to reduce current and wave energy and are stable in variable wave conditions. The rate of growth of reef species on the structures will also be assessed.

The Conservancy will work with the Government of Grenada to secure funding for the full build out of the breakwater, which will include up to 20 structures spread over a 300 meter length of the northern reef in Grenville Bay. The full array of structures will provide protection for the Telescope and Grenville Town area. The Conservancy will support the development of an independent Environmental Impact Assessment for the full array of breakwater structures. Once constructed, the breakwater will become an integral part of the Government of Grenada's coastal protection infrastructure.

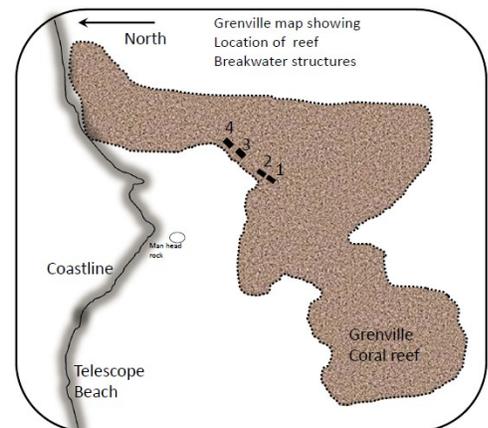
The wider AWE Initiative also includes efforts focused on building social resilience. To this end, The Conservancy, Grenada Red Cross, and Grenada Fund for Conservation will continue engagement with government and community groups to:

- Develop a community resilience plan for climate adaptation and disaster risk reduction
- Propagate and plant mangroves and coastal vegetation in strategic locations
- Initiate a community based water quality monitoring and beach profiling program
- Conduct outreach activities

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Reef Engineering by the Numbers

- ◆ Total length of pilot submerged breakwater built: 30 meters (100ft)
- ◆ Number of community diver man hours for pilot: 1,500
- ◆ Quantity of 5/8" rebar steel utilized: 44,000ft
- ◆ Number of welds for gabion basket manufacture: 41,000
- ◆ Quarry stone mined and placed in baskets: 70 tons
- ◆ Concrete blocks - 8" placed in structures: 2,400
- ◆ Average live cover of coral currently on Grenville reef flat (northern reef) : 1%
- ◆ Coral transplanted to structures: 240



Map of Grenville Bay - Grenada showing the location of the 4 main pilot reef structures project. Telescope beach which lost over 400m of shoreline over the past 2 decades is at the lower left edge of the map

Global Perspective

Upon completion, the breakwater will be one of the first examples in the world demonstrating how communities and Governments of Small Island States can work with nature to protect coastal communities from the impacts of climate change.