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LIVING BREAKWATERS: REBUILD BY DESIGN

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Living Breakwaters is a post-Sandy project off the South Shore of Staten Island designed to break waves, reduce (and eventually reverse) erosion of the shoreline, and provide a range of habitat spaces for oysters, fin fish, and other marine species.

Living Breakwaters primarily consists of 2,400 linear feet of near-shore breakwaters—structures built of stone and ecologically-enhanced concrete with a variety of features such as “reef ridges” and “reef streets” that will provide diverse habitat space for marine species.

Beyond the breakwaters, the project has involved nearly a decade of educational and engagement-related programming designed to advance community stewardship, citizen science, and recreation along the water’s edge.

The project was initially developed by a SCAPE-led team for Rebuild By Design—a design competition led by the U.S. Department of Housing and Urban Development (HUD) after Superstorm Sandy. The project’s implementation is led by the NYS Office of Resilient Homes and Communities (RHC).

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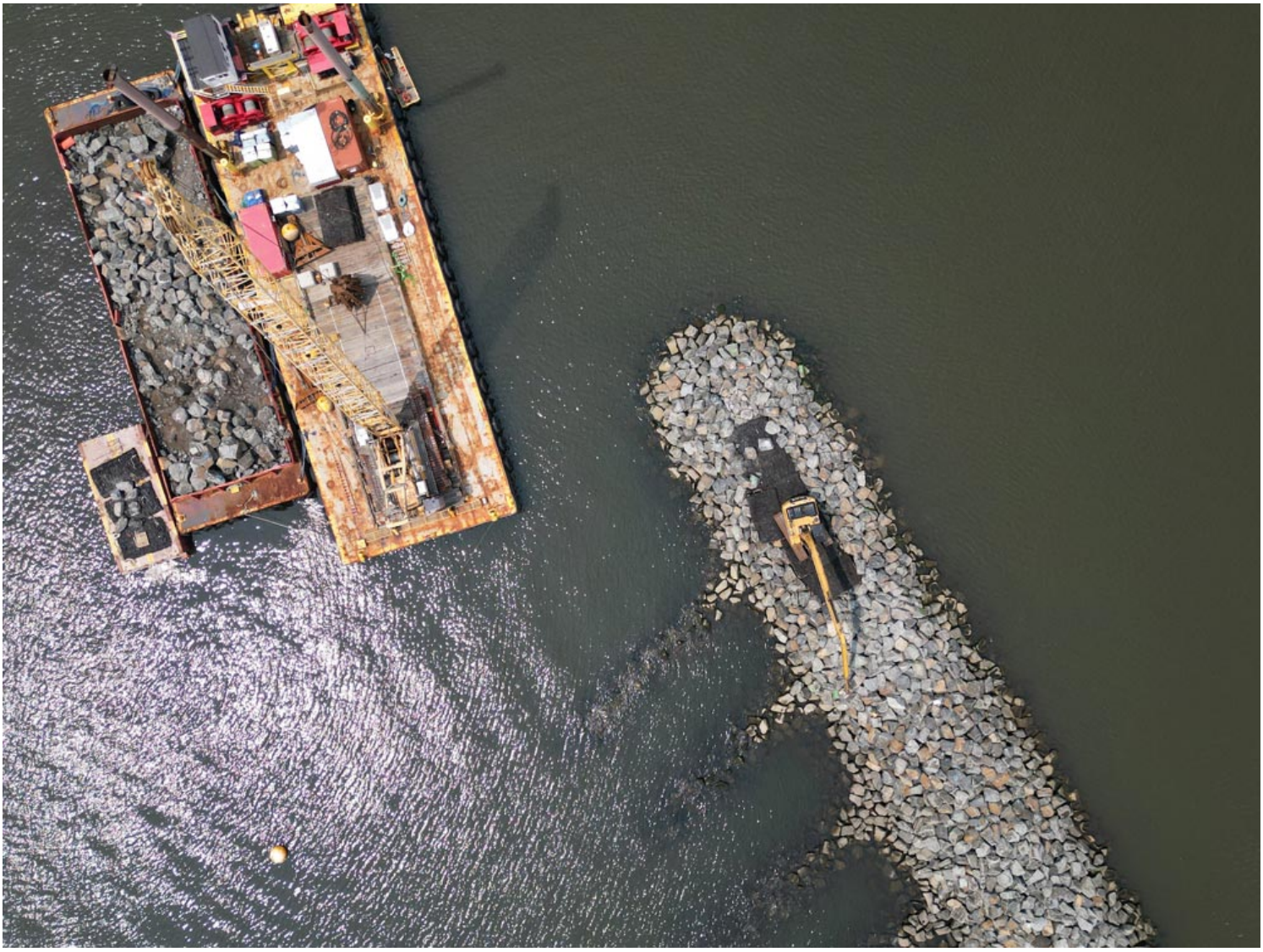

The need

“Breakwaters” are physical structures partially submerged in water. They are designed to break waves, dissipate wave energy, and slow the movement of water in order to reduce shoreline erosion and prevent wave damage onshore.

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With projected sea-level rise and the increasing frequency and intensity of storms, climate risks along the South Shore will only grow more acute.

In October 2012, Superstorm Sandy devastated communities across the New York-New Jersey region, impacting Staten Island's East and South Shore residents particularly hard. In New York City, 44 individuals died—over half on Staten Island. Homes and businesses were damaged, driving extensive economic loss. The Tottenville shoreline experienced some of the most destructive waves in the region.

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The goal

A model for climate-adaptive green infrastructure, Living Breakwaters aims to:

Reduce risk. Supported by years of iterative modeling and robust scientific analysis, the breakwaters are designed to attenuate wave energy, lessen the effects of coastal erosion, and

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generally reduce physical risk for on-shore communities.

Enhance marine ecosystems and habitat. Incorporating a wide range of habitat-supporting features, the breakwaters are designed to foster biodiversity for a range of species.

Promote social resilience. Beyond the breakwaters, the project has involved nearly a decade of educational and engagement-related programming designed to advance community stewardship, citizen science, and recreation along the water's edge.

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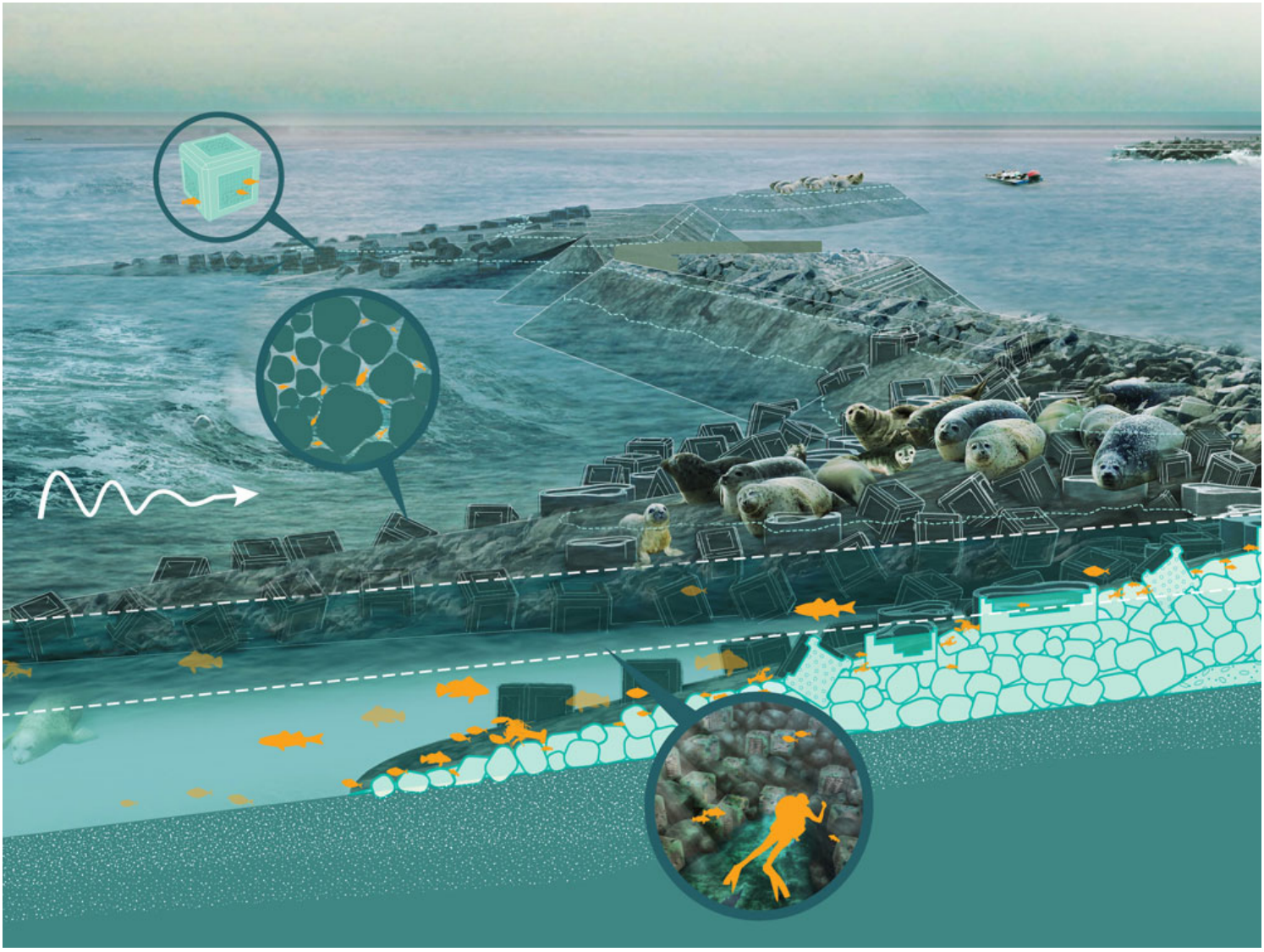

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The design

Living Breakwaters is made up of nine separate breakwater segments. Each breakwater was individually designed based on its location. Different parts of the shoreline have higher levels of risk; in turn, some of the breakwaters have been designed to attenuate more intense waves (and are taller), while others have been designed to modify wave behavior and reduce erosion (and are

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shorter). Additionally, each breakwater has been individually designed to enhance habitat in its unique surroundings, including “reef streets” that change the shape of the breakwaters in order to create space for marine life.

The breakwaters are rubble mound (rock) structures with a stone core, a base layer (bedding stone or marine mattress, depending on the breakwater) to protect against scour, and outer layers consisting of armor stones and ecologically enhanced concrete armor units.

In several locations throughout the breakwaters, ecologically-enhanced concrete units will be deployed to enhance the habitat function of the breakwaters and overall ecological benefit to the surrounding water body. These units are engineered to provide the same protective benefits of stone units, but are manufactured with a unique, marine-grade mixture that promotes biological growth on its surface. Additionally, these units are cast with high surface complexity, which further promotes the growth of marine life and creates a higher diversity of potential habitat spaces.

The layout was refined through the process of design and computer modeling, where scenarios were iteratively developed, modeled to evaluate impacts on shoreline change and storm wave attenuation, and the results analyzed to help inform the design refinement and optimize the design to reduce or reverse erosion (grow beach) and reduce coastal storm risk through wave attenuation.

In addition to the computer modelling, the team built a physical model of the breakwaters at a facility in Canada to do hydrodynamic wave modelling. Each rock and e-concrete element was painted in different colours so that the team was able to see which of the elements could withstand the waves, and which ones could not. The design of the Living Breakwaters was adjusted accordingly.

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The oysters

Historically known as “The Town the Oyster Built,” Tottenville was once protected and sustained by an extensive system of oyster reefs, which both diminished damaging waves and supported a thriving oyster farming industry. Over time, a number of factors — siltation, overharvesting, dredging, and human pathogens — led to the near-total collapse of these reefs. Today, Raritan Bay lacks not

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just the oysters, but also the complex habitat space and biodiversity they nurtured.

Once the Living Breawaters are constructed, the Billion Oyster Project will install live oysters on the breakwaters. Techniques may include placing spat (baby oysters) on some of the ecologically enhanced concrete units, installing oyster shell gabions (non-structural units), placing spat on shell in the reef streets, and in-situ setting pilots.

All of these design features will help the breakwaters provide the kind of “structured” habitat for marine species that was historically provided by features like oyster reefs in this area of Raritan Bay — reefs that are no longer present.

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The communities

Beyond the breakwaters, the project aims to build social resilience in Tottenville, one of the communities most impacted by Superstorm Sandy, through educational programs in local schools; nearly a decade of engagement with the Citizens' Advisory Committee (CAC), a coalition of local stakeholders; and an open-access Living Breakwaters Curriculum co-created with the Billion Oyster

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Project.

As a core part of the Living Breakwaters project, RHC and the SCAPE team developed an approach to social resilience across the South shore communities of Staten Island. This meant engaging and working with partners through the design process, but also ensuring that the breakwaters provide opportunities for education and raise awareness of coastal risk and resilience and harbor ecosystem health once constructed. This has informed traditional engagement as part of the project—open houses, informational sessions, community meetings, focus groups, charrettes and more—as well as less traditional engagement methods such as shore tours, pop-up engagement booths, site-specific installations, exhibitions, virtual reality (VR) experiences and digital outreach.

In 2015, RHC assembled a Citizens' Advisory Committee (CAC) to provide regular input on the Living Breakwaters project as it advanced. The CAC is comprised of local and regional stakeholders representing the diverse communities of Staten Island; all meetings were open to the public. This committee was intended to serve in an advisory role, not replace direct public engagement events and workshops, which also occurred in parallel throughout the duration of the project.

Over several years, RHC and the SCAPE team also collaborated with the Billion Oyster Project (BOP) to develop classes and field trips for Staten Island schools, educating local students about 101 concepts related to coastal resilience, climate change and the Living Breakwaters project. An open-access STEAM curriculum was jointly developed by SCAPE and BOP to be used by teachers in their classes for years to come.

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