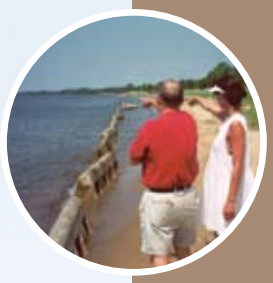
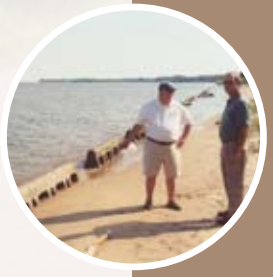
Beach Prisms™

Shoreline Erosion Control And Beach Replenishment Performance Summary

Location:
Terrapin Nature Park, Kent Island,
Queen Anne's County, MD



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Established 1986

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November 29, 2007

Mr. Richard J. Ayella
Chief, Tidal Wetlands Division
Wetlands and Waterways Program
Maryland Department of the Environment
1800 Washington Blvd., Ste. 430
Baltimore, Maryland 21230-1708

Re.: SUMMARY AND FINDINGS OF USING BEACH PRISMS
FOR SHORELINE EROSION CONTROL AND BEACH REPLENISHMENT
AT TERRAPIN NATURE PARK
KENT ISLAND, QUEEN ANNE'S COUNTY, MARYLAND

Dear Mr. Ayella,

I have enclosed a copy of our report *entitled "SUMMARY AND FINDINGS OF USING BEACH PRISMS FOR SHORELINE EROSION CONTROL AND BEACH REPLENISHMENT AT TERRAPIN NATURE PARK, KENT ISLAND, QUEEN ANNE'S COUNTY, MARYLAND".* This report details the results of the 1989 Pre-Existing Conditions Topographic and Bathymetric Survey at Terrapin Nature Park and the follow-up 2004 Topographic and Bathymetric Survey after the Chesapeake Bay had suffered the severe impact of Hurricane Isabel in September 2003 which damaged significant areas with high winds, extremely high tides and storm surges.

The results of our 2004 resurvey of the Beach Prism installation at Terrapin Nature Area found that:

- The Beach Prism installation had exhibited minimum movement from the original placement in 1989 even after suffering numerous Nor'easters and sustaining the full impact of Hurricane Isabel.

- Sand accumulation of the site has been impressive with 117,410 square feet of new beach created. Some 4,978 cubic yards of sand stabilizing a previously highly eroding beach where only water existed prior to the placement of the

Beach Prisms. The mean high watermark has migrated westward over 40 feet and 7,465 tons of sand has accreted landward of the Beach Prisms. The 7,465 tons of sand accumulated on Terrapin Nature Area is equivalent to 310 dump truck loads of sand.

- The shoreline erosion existing in 1989 has been halted. The beach has extended over 40 feet westward and the tidal pond is no longer in danger from severe erosion or breaching its banks to the Chesapeake Bay.

These results of the Beach Prism installation at Terrapin Nature Area proves conclusively that Beach Prisms work effectively against shoreline erosion and can accrete and capture significant amounts of sand to restore beaches. We believe that Beach Prisms are an extremely cost effective, economically viable and environmentally friendly method for shoreline protection. The slot design of the Beach Prism allows the natural flow of water through the Beach Prism which in addition to the parabolic curve of the Beach Prism face dissipates the energy of the waves that crack against the Beach Prisms. Beach Prisms become artificial reefs in the water and provide sanctuary for small fish, crabs and turtles. In summary, Beach Prisms significantly dissipate wave energy thus reducing erosion, provide sanctuary for marine life and help rebuild beaches through sand accretion and accumulation.

Sincerely yours,

Thomas D. Lane, PLS
President
Lane Engineering, LLC

Cc: Mr. Robert V. Tabisz
Chief, Southern Division
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Maryland Department of the Environment

Ms. Tressa Ellis
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PURPOSE:

In 1988 the Terrapin Nature Area, a Queen Anne's County Park, was suffering severe shoreline erosion threating to breach a large tidal pond that covered approximately 25% of the surface area of Terrapin Nature Area. On December 7, 1988 the firm Advanced Erosion Control, Queenstown, Maryland submitted a proposal to Queen Anne's County and the Maryland Department of Natural Resources for a *Demonstration Project* involving the use of Beach Prisms at Terrapin Nature Area. The engineering firm of Rauch, Walls and Lane, Inc. were contracted to prepare project specifications and bid documents for this project along with the establishment of baseline mapping for Terrapin Nature Area. A subsequent topographic and bathymetric survey was completed covering approximately 1000 linear feet of severely eroding shoreline and beach endangering a large tidal pond.

BEACH PRISMS AND PROJECT BACKGROUND:

Beach Prisms are available in several sizes and the two most common sizes are the 4 foot high by 4 foot wide by 10 feet long, weighing 9,100 pounds commonly used on the Chesapeake Bay and a 6 foot high by 6 foot wide by 10 ½ feet long Beach Prism is used for ocean shoreline protection. Beach Prisms are precast concrete modular permeable breakwater structures normally placed offshore parallel to the shoreline with two foot spacing in about two feet of water. When waves strike the Beach Prisms the wave energy is dissipated and broken into spray by the parabolic surface and open "slot" design of the Beach Prism significantly reducing the wave energy as it reaches the shore. Any material, i.e. sand, held in suspension settles out and is accreted around the Beach Prism and can build up beaches and change the beach profile.

Beach Prisms are considered an environmentally friendly or "soft application" compared to armor stone or rip-rap which are hard applications. The slot design of the Beach Prisms allows the natural flow of water through the Beach Prism, which, in addition to, the parabolic curve of the Beach Prism face dissipates the energy of waves that crash against the Beach Prisms. Once placed in the water, Beach Prisms become instant artificial reefs and provide sanctuary for small fish, crabs and turtles. The fish population increases significantly in areas where Beach Prisms are in the water. In summary, Beach Prisms significantly dissipate wave energy thus reducing erosion, provide sanctuary for marine life, and may help to rebuild beaches through sand accretion and accumulation.

A lengthy review process was carried out by the Maryland Department of Natural Resources dating from the initial correspondence letter of May 15, 1989 from Mr. L.M. Larese-Casanova, Director, Shore Erosion Control Program to Advanced Erosion Control, Inc. (Attachment I) until the final approval from the Maryland Department of Public Works dated November 22, 1989 (Attachment II) and the final permit approval by the U.S. Army Corps of Engineers dated December 20, 1989 (Attachment III). Mr. Jordan R. Loran, Engineer, Shore Erosion Program raised numerous questions about Beach Prisms under a variety of conditions listed in a letter to Mr. David Wilson, Maryland Eastern Shore Resource Conservation and Development Area dated October 2, 1989 (Attachment IV). The third section of his letter mentioned the following concerns that needed to be addressed and please note that the term ***Beach Prisms*** has been substituted for Beams in the letter:

- "Has a foundation analysis been done to determine bottom conditions along the proposed alignment of the *Beach Prisms*? Under what conditions would preparatory work have to be done before the *Beach Prisms* could be set in place?

- Against what level of storm will the four-foot *Beach Prisms* provide protection against?

- Are the four-foot *Beach Prisms* adequate at this site to attenuate sufficient wave energy and thereby protect the shoreline? What is the porosity of the units and as deployed, what will be the percentage of wave energy, what will be the percentage of wave energy transmission through and over the *Beach Prisms*?

- What is the anticipated critical wave height expected to impact the *Beach Prisms*?

- What is the anticipated wave height in the lee of the *Beach Prisms*?

- How much sand is expected to accrete landward of the *Beach Prisms*? first year?, second year?

- Will there be a problem with the undermining of the ends of the individual *Beach Prisms* due to 'jetting' between the structures? Should the ends of the individual *Beach Prisms* be contact with each rather than gaped? Will the *Beach Prisms* eventually align themselves perpendicularly to the project axis?

- Sufficient topo should be developed on top of the bank to clearly define the entire project area.

- Stake out data should be clearly shown and described on the drawings. Bearings and distances should be called out by front sightings from the control points to the points of emplacement of the *Beach Prisms*.

- It is absolutely imperative that the baseline traverse be carefully and completely laidout in the field and described on the drawings so that monitoring data can be easily and accurately compared to the before conditions at the site.

- Should marker piles be installed along the project site channelward of the structures? Since the *Beach Prisms* will be nearly submerged during high tides they could become a hazard to small boats in the immediate vicinity.

- Why do the plans call out 823 feet of protection when the entire length of the structures including gaps is 817 feet?

- Our comments concerning the Specifications have been forwarded to Jim Wright, engineer for Rauch, Walls, and Lane and a copy is attached for your use. All of our comments should be addressed, including inspection of the *Beach Prisms* at the plant, inspection of materials during manufacturing, certification for curing time concrete mix, steel, etc.

- Each specification should be developed into an individual page for individual Division.

- Where will excavated material be placed?

- Has the County agreed to providing the *Beach Prisms* as called out in the Specifications?

- For Item 3 page 1 of Specifications substitute our wording for changes in conditions to site after engineer's survey.

Before the Department can accept the Design Drawings and Specifications for the *Beach Prisms* Project at Terrapin Park, and authorize installation under the terms of the Project Agreement for the matching grant, the following items need to be provided:

1. A corrected Design Drawing with vertical control established by using a reliable vertical datum.
2. An explanation for the location and configuration the *Beach Prisms* devices as they would be represented on the revised preliminary design drawings.
3. A corrected Specifications package, addressing all points noted above.
4. Resolution of all concerns and questions mentioned above."

Advance Erosion Control, Inc. responded to Mr. Loran's letter of October 2, 1989 on October 17, 1989 (Attachment V) and answered a significant number of the questions raised by Mr. Loran.

"Pursuant to certain questions posed in your letter to David Wilson dated October 2, 1989 concerning the Terrapin Park *Beach Prisms* Project, we respond as follows:

PARAGRAPH 3:

QUESTION:

Has a foundation analysis been done to determine bottom conditions along the proposed alignment of the *Beach Prisms*? Under what conditions would preparatory work have to be done before the *Beach Pri*sms could be set in place?

ANSWER:

A foundation analysis was performed by the writer during several on-site/in-water surveys. The entire length of the proposed alignment of the *Beach Prisms* was checked and bottom conditions were found to be sandy and firm, except for the northern-most end from the aluminum bulkhead, southward approximately forty lineal feet, where peat bottom conditions were found.

Since the foundation pressure exerted by the four foot *Beach Prisms* is 1.25 P.S.I., the *Beach Prisms* cannot be placed in this area and as shown on the design plan, terminate before the peat layer with several sections oriented landward to act as flanking sections. These flanking sections serve to prevent north/northwest generated wave energy from scouring out any sediment, which may be accreted in back of the proposed alignment axis.

Under normal conditions, such as firm bottom conditions and soil conditions, other than peat, foundation preparation work is not required prior to setting the *Beach Prisms*. Possible exception to this would be conditions where sand or sediment bars have been created by

current and/or wave action, as debris or other obstructions in way of the desired alignment axis would result in the *Beach Prisms* being out of vertical alignment upon placement. In cases such as this, debris and obstructions should be removed and where underwater bars exist, these should be leveled.

Where peat soil conditions exist, placement of the *Beach Prisms* is not recommended, unless careful consideration is given to providing a proper foundation, such as vertically-driven piling.

QUESTION:

Against what level of storm will the four foot *Beach Prisms* provide protection against?

ANSWER:

The four foot high *Beach Prisms* (9,100 pounds/module) were designed to provide protection against ten year type storms, wherein four to five foot high waves may be experienced along with a storm surge set-up of two to three feet. Due to the weight of the individual modules, displacement of the *Beach Prisms* from the set-in place axis by waves, debris, or ice should not be experienced.

The Wiseman/Love Point Project installed in April, 1988 on Kent Island has experienced such storm conditions during the spring and fall months of 1989. Sediment accreted, beach planform, and salient have experienced little change as a result of these storm conditions, resulting in no degradation of the fastland behind the structures.

QUESTION:

Are four foot *Beach Prisms* adequate at this site to attenuate sufficient wave energy and thereby protect the shoreline? What is the porosity of the units and as deployed, what will be the percentage of wave energy transmission through and over the *Beach Prisms*.

ANSWER:

Four foot *Beach Prisms* are considered adequate for the Terrapin Park site based upon performance to date of the Wiseman installation approximately 1½ miles north-ward, which has the same wind ray exposure ie., four mile over water fetch from the west, 18 plus miles from the north/north-west, and 12 plus miles from the southwest.

The porosity of the units is 29% of the vertical surface area of the structure as viewed from the side elevation.

The percentage of wave energy transmission through and over the structure has not been recorded as of this date, except for video and historical photographs, which were taken over the past seventeen months at the Wiseman site.

The Terrapin Park installation would provide an excellent opportunity for Maryland Department of Natural Resources and/or the U.S. Army Corps of Engineers to record such data using a wave gauge device.

QUESTION:

What is critical wave height expected to impact the *Beach Prisms*.

ANSWER:

Based upon observation during storm conditions at the Wiseman site, waves approximately four feet in height have impacted the *Beach Prisms*.

QUESTION:

What is the anticipated wave height in the lee of the *Beach Prisms*?

ANSWER:

Again, based upon observation during storm conditions at the Wiseman site where wave heights of three to four feet were observed channelward of the *Beach Prisms*, waves in the lee of the *Beach Prisms* appeared to be one foot high or less.

QUESTION:

How much sand is expected to accrete land-ward of the *Beach Prisms* in the first year and the second year?

ANSWER:

The amount of sand/sediment expected to accrete landward of the *Beach Pri*sms is a function of wind and wave energy and direction combined with the amount of sand/ sediment available for transport shoreward.

Only time and the whims of nature can provide the answer as to how much sand is expected to accrete landward of the *Beach Prisms*. However, once the *Beach Prisms* have been installed, further erosion of the fastland and beach area should be brought to a halt.

QUESTION:

Will there be a problem with undermining of the ends of the individual *Beach Prisms* due to jetting between the structures? Should the ends of the individual *Beach Prisms* be in contact with each other rather than gapped? Will the *Beach Prisms* eventually align themselves perpendicular to the project axis?

ANSWER:

To date, we have not experienced undermining of the ends of individual *Beach Prisms* due to jetting of water between structures, which have been installed with two, three, four, and five foot gaps on the Chesapeake Bay and which have been in service upwards of seventeen months. This absence of undermining caused by higher velocity water or jetting is most likely due to several factors and the design of the *Beach Prisms* module.

First, due to the permeability of the structure, the mass of water available to pass through the gapped openings is decreased considerably, since it passes through the structures losing its energy through the process of refraction and turbulence and is, therefore, not reflected around the ends.

Second, the flat ends of the module castings present surface normally perpendicular to high

velocity wave energy, whereupon, it is highly unlikely that the *Beach Prisms* will align themselves perpendicular to the project unless they are impacted by hurricane-force storm conditions.

Third, unlike ocean beaches, soil conditions underwater on the Chesapeake Bay are more firm and experience less fluidization during any given twenty-four hour tidal period.

We feel it is a combination of the above factors, as well as the limited fetch length over water and water depth, which has resulted in the development of a stable beach planform and beach salient parallel to the shoreline for all of the *Beach Prisms* projects installed on the Chesapeake Bay to date.

METHODOLGY:

1989 Pre-Existing Conditions Topographic and Bathymetric Survey

The Rauch, Walls, and Lane, Inc. survey established the location and elevation of observed mean high water as well as important physical features of the site including the topography of the study area, an adjacent farm road, the location of concrete rubble placed to protect the shoreline bank and an aluminum bulkhead. A total of 250 topographic and bathymetric survey points (Attachment VI) were established using Topcon total station. Vertical and horizontal control was established from first order monument Department of Natural Resources – Capital Programs monument (information dated September 13, 1989) referenced to mean low water available on site. The resulting topographic and bathymetric grid would be used to monitor the effects of the placement of 57 *Beach Prisms* along the shore of Terrapin Nature Area.

The 57 *Beach Prisms* were placed by a tracked crane working at low tide in approximately two feet of water 40 feet off-shore of Terrapin Nature Area in a north-south direction parallel to the existing shoreline and tied back into existing concrete rubble at the southern end of the installation (map 1). The *Beach Prisms* were set in three distinct groups based on spacing between the *Beach Prisms*. The southern grouping covered 265 feet and contained 18 *Beach Prisms* with five foot spacing between *Beach Prisms*. The middle grouping covered 266 feet and contained 19 *Beach Prisms* with four foot spacing between *Beach Prisms*. The northern group of *Beach Prisms* contained 20 *Beach Prisms* with three foot spacing between *Beach Prisms* covering 257 feet with the last two *Beach Prisms* angled at 45 degrees and tied back into the existing beach to provide a closed system and ensure that any accumulated sand remained inside the *Beach Prism* enclosure and not wash away.

Terrapin Nature Area was used as a "test site" for determining optimum spacing between *Beach Prisms* to most effectively control shoreline erosion and where conditions permitted encourage the retention of accumulated sand behind the *Beach Prisms*. Different marine contractors placing *Beach Prisms* throughout the Chesapeake Bay had used "ad hoc" or varied spacing and the purpose of three different grouping at Terrapin Nature Area was to determine the most effective spacing in reducing shoreline erosion as well as rebuilding lost beach.

2004 Topographic and Bathymetric Survey

In 2004 after the Chesapeake Bay had suffered the severe impact of Hurricane Isabel in September 2003 which damaged significant areas with high winds, extremely high tides, and storm surges, Mr. Rodney Smith, President and CEO of Smith-Midland, contracted Lane Engineering, the successor to Rauch, Walls, and Lane, Inc. to conduct a follow-up topographic and bathymetric survey to determine in quantative terms the results of the placement of the *Beach Prisms* at Terrapin nature Area. Mr. Smith's firm, Smith-Midland, a large precast concrete firm, had cast *Beach Prisms* for Advanced Erosion Control, Inc. and had acquired the rights to *Beach Prisms*. Lane Engineering re-established a topographic and bathymetric grid over the site of the *Beach Prism* installation at Terrapin Nature Area on Kent Island, Queen Anne's County, Maryland. A total of 200 topographic and bathymetric survey points (Attachment VII) were established using a Topcon total station. Vertical control and horizontal datum was the same datum and control used for the pre-existing conditions survey completed in 1989.

The comparison of the 1989 topographic and bathymetric survey pre-existing conditions and the 2004

topographic and bathymetric survey are illustrated in map 2 along with survey control points, the *Beach Prism* alignment, mean high water line, roads, and area of accretion. (Attachment VIII)

RESULTS:

The results of the 2004 resurvey of the *Beach Prism* installation of Terrapin Nature Area by Lane Engineering found that:

- The *Beach Prism* installation had exhibited minimum movement from the original placement in 1989 even after suffering numerous north easters and sustaining the full impact of Hurricane Isabel.

- Sand accumulation of the site had been impressive with 117,410 square feet of new beach built up. Some 4,978 cubic yards of sand stabilizing a previously high eroded beach where previously only water had existed prior to the placement of the *Beach Prisms*. The mean high water mark had migrated westward over 40 feet and 7,465 tons of sand had accreted landward of the *Beach Prisms*. The 7,465 tons of sand accumulated on Terrapin Nature Area is equivalent to 310 dump truck loads of sand.

- The shoreline erosion occurring in 1989 has been stopped, the beach grew over 40 feet westward back into the Chesapeake Bay and the tidal pond is no longer in danger from severe erosion.

CONCLUSION:

The results of the *Beach Prism* installation of Terrapin Nature Area after more than 18 years in place proves conclusively that *Beach Prism* work effectively against shoreline erosion and can accrete and capture significant amounts of sand to restore beaches. The questions raised in the letter from Mr. Jordan R. Loran, Engineer, Shore Erosion Program to Mr. David Wilson, Maryland Eastern Shore Resource Conservation and Development Area dated 10/2/1989 (Attachment IV), has been addressed positively and doubts raised were erased as the *Beach Prism* installation at Terrapin Beach has withstood a major hurricane (Isabel), significantly improved the beach while suffering high hurricane force winds, extra ordinary high tides, ice, and the most severe weather on the Chesapeake Bay over the last two decades. *Beach Prisms* work and have exceeded expectations that were indicated in the response from Advanced Erosion Control, Inc to Mr. Jordan R. Loran, Maryland Department of Natural Resources (Attachment V). In addition, another study entitled "A Review of *Beach Prisms*: Their Application for Wetland Creation Under Moderated to High Energy Conditions" (Attachment IX) authored by Dr. Steven Ailstock, Professor of Biology and head of the Environmental Center at Anne Arundel Community College has found *Beach Prisms* dissipated wave energy significantly on a test site on the Magothy River, Arnold, Maryland as well as rebuilt beaches. In conclusion, the Lane Engineering, Inc. topographic and bathymetric surveys taken over a fifteen year period (1989-2004) at Terrapin Nature Area on Kent Island, Queen Anne's County, Maryland, provide sound quantifiable survey data that shows that *Beach Prisms* dissipate the waves energy, reduce shoreline erosion, and accrete significant amounts of sand to further protect waterfront properties.

As a post script to this project, the NPCA published an article entitled "Lines in the Sand", which describes how pre-cast concrete prisms halt erosion and restore vanishing shorelines (Attachment X). The article featured Beach Prisms™ manufactured by Smith-Midland®.