BEACH EROSION AND PRESERVATION

By William T. Vosburgh

In many waterfront areas a decline in the size of beaches has impacted shorelines, roads, buildings and recreational use, forever changing our maps. The issue is compounded by our human expectation that these iconic beaches of our youth should be permanent.

In “Geologic Time” everything along a shoreline is moving and changing. Sandy beaches especially are not static and are in constant motion. There is a source of sand and an accumulation along the shoreline. The sand moves around and out, usually to the depths or by littoral drift down the shoreline. The beach sand came from rock and shell ground up by natural forces. The finer the particles the more easily it is moved. Wind direction, rain run-off, waves, tide, current and sea level rise are all factors in the accumulation of sand on waterfronts. Simply a change in wind direction and intensity -- a storm surge with waves building across a broad fetch of open water, can dramatically change a beachfront in a single day. Man-made boat wakes can accelerate beach destruction over a few summers. Observing the same stretch of beach year-round can show dramatic sand movement through the seasons.

The Chesapeake Bay estuary features a soft geology. Unlike the rocky coastlines found in New England, the Chesapeake has been constantly widening. Most of the shoreline soils are alluvial clay and sand deposited by glaciers thousands of years ago. Maps of the region over the last 300 years show how dramatic the loss of land can be, in some areas hundreds of feet in a century.

The problem today is we would like to maintain what we have in real estate, beaches and islands. Simply replenishing beaches with sand either trucked in or dredged is a Sisyphean effort. There is no perfect engineering solution that is immune to destruction under the wrong circumstances. Up and down the Chesapeake there have been many studies and attempts to curb Mother Nature’s rule and make idyllic beaches permanent. With all the permits needed to perform any alteration of our shorelines, an entire industry directs the process. Studies of the problem area by a licensed marine engineering firm comes first. Plans are then submitted for approval by county, state and federal entities. Bids from certified marine contractors and securing funding for these expensive projects takes time and commitment. The fear factor is the substantial failure rate of projects installed with good intent. Many projects in the Chesapeake region have been reworked in just a few decades as some essential variable in the process of beach erosion was misunderstood.

Hard structures include jetties, bulkheads, groins and breakwaters. Vertical flat surfaces such as wooden jetties and bulkheads are not just out of favor but usually banned. They create wave reflection or bounce so the disruptive energy from the wave will continue to cause damage. Traditional jetty placement was perpendicular to the shore with regular beach nourishment. The sand will accumulate on the up current side and scallop away on the down current side as the barriers attempt to slow littoral drift. These do not stop the direct erosion assault from man-made boat wakes or heavy rains.

The best structures for permanence are rock breakwaters or sills and rip-rap. The uneven jagged surfaces and gaps between rocks aid in the dispersion of wave energy. The rock must be placed on filter cloth or it will sink over time into the soft sediments near shore. The size of the stone is selected based on the conditions at the site, the fetch, average size and direction of waves. Typically, large stones (500-2,000 lbs. each) when loosely piled are quite resistant to displacement by storm waves.

Breakwaters parallel to shore and with gaps have gained popularity as being the most durable. They will cause a natural beach arc to form behind each gap with a critical ratio of 1: 1.65 for depth of arc toward shore relative to a wider opening toward open water. These beach arcs are self-correcting and produce much lower loss of beach sand to littoral drift. However, a storm surge from a major hurricane event can still overtop the breakwater and rearrange the sand behind it dramatically. Rain erosion will always occur so if there is a high bank rising behind a beach expect more damage in such events.

The physics of beach sand movement is a three-dimensional problem so all aspects of the design count toward success. The grade along the bottom should be an 8:1 incline from deep water to mean high water and above. This is for proper wave formation approaching the shoreline throughout the tidal cycle. Sand particle size and shape makes a difference with construction grade sand the best. It has irregular polygonal forms which tend to hold together better than very smooth fine sand found on a natural beach.

Shore plantings as found in living shorelines will help stabilize sand when added. Even if the beach is for swimming, there should be places to stabilize it with plantings. If there is an area with heavy storm run-off, a rain garden style depression with plantings will hold water for absorption into the beach rather than cutting a channel. The old-style sand fence can help to form dunes and ridges behind a beach but are unsightly.

We enjoy our beaches and wish to preserve them forever. We must then be willing to pay the price to keep our shoreline cartography stable. Blending recreational areas with living shorelines is the best possible outcome for a natural look and ecology.

References:
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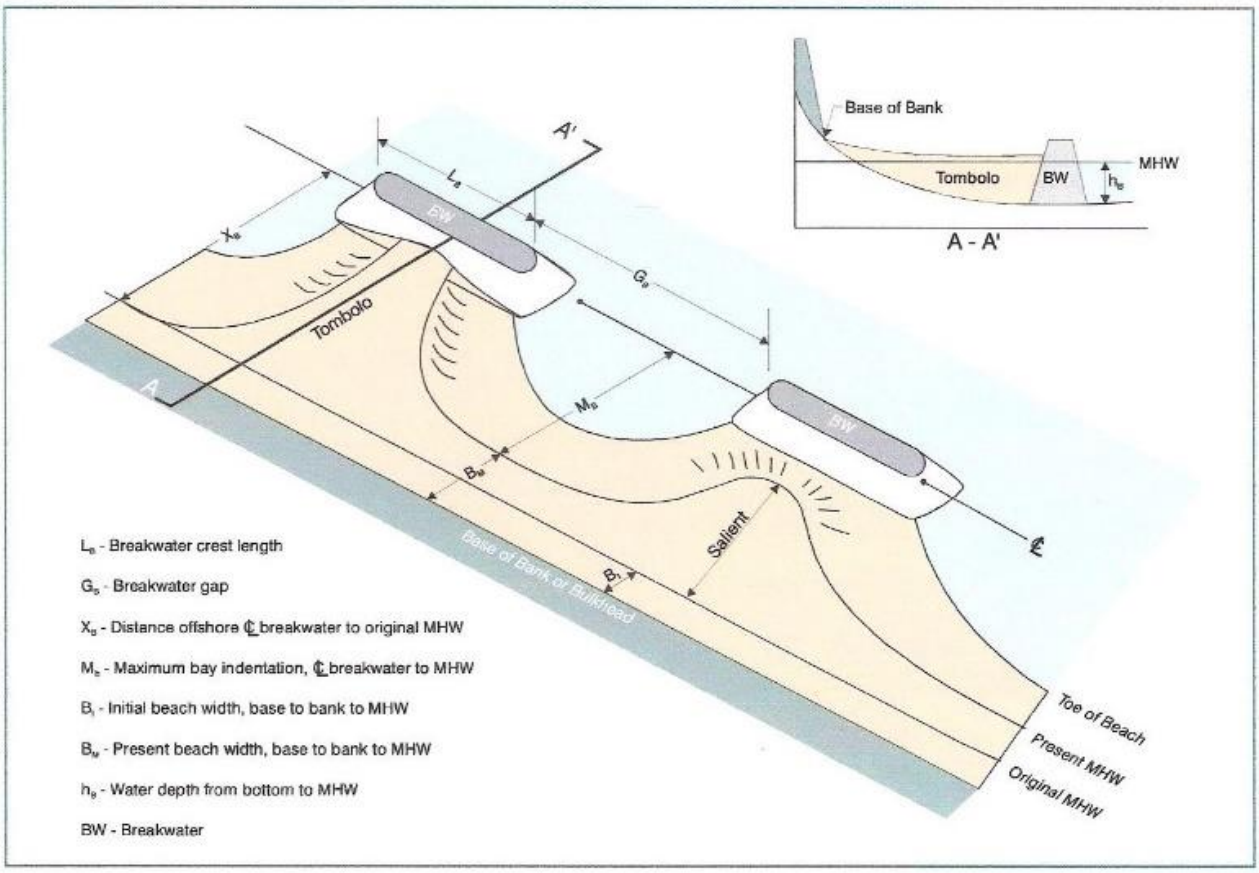
3, Bray Hill LLC, (marine design engineering), Colin MacLachlin, personal communication, 2019


Base of Bank
MHW
Tombolo
BW
h_s
A - A'
A'
L_s
X_s
G_s
Tombolo
A
M_s
B_w
BW
Salient
B_i
Bank of Bank or Bulkhead
℄
Toe of Beach
Present MHW
Original MHW
L_s - Breakwater crest length
G_s - Breakwater gap
X_s - Distance offshore ℄ breakwater to original MHW
M_s - Maximum bay indentation, ℄ breakwater to MHW
B_i - Initial beach width, base to bank to MHW
B_w - Present beach width, base to bank to MHW
h_s - Water depth from bottom to MHW
BW - Breakwater