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To: Jane Slater, Dan Greenbaum

From: E. Robert Thieler and Walter A. Barnhardt

Re: Squibnocket Beach project

We have reviewed the supplied documents regarding the proposed beach and parking area project. These include the following reports and proposals:

- Greg Berman, Woods Hole Sea Grant / Cape Cod Cooperative Extension, report to Town of Chilmark Conservation Commission, 26 February 2014
- Jim O'Connell, Coastal Advisory Services, report to Town of Chilmark Board of Selectmen, 6 March 2014
- Ropes and Gray, Squibnocket Elevated Roadway, 11 March 2014
- Friends of Squibnocket, Presentation to Squibnocket Committee, 16 September 2014

Below we respond to your questions communicated by email on 17 and 27 October 2014 and make reference to these documents.

Questions received 17 October 2014

A1. What will be the extent of the inland movement of the shoreline due to the revetment removal?

If the revetment is removed, there will be a readjustment of the shoreline to a configuration and position that is in dynamic equilibrium (a beach shape and position that changes due to the amount of sediment available, the amount of wave energy, and direction and magnitude of sea-level change) with the adjacent coast. This will likely include a landward movement of the shoreline. Berman (2014) suggests landward movement of several meters (his Figure 10, red and yellow lines) that we believe is reasonable.

A2. How long will it take to move back to where it would have been had the revetment not been built?

It is likely that the shoreline readjustment will happen relatively quickly (weeks to months), but the rapidity and magnitude of the readjustment will depend on the time of year the revetment is removed. More rapid readjustment can be expected during the fall, winter, and spring due to the greater likelihood of storm events.

A3. There is no beach in front of the revetment now at high tide and very little at other times. What changes can be expected in this beach with the revetment removal?

Although the shoreline will readjust landward, the overall quality of the beach can be expected improve. This includes an increase in intertidal beach width, and possible growth of a supratidal (above the level of high tide) beach/berm that is characteristic of natural beaches in this area. The latter will depend on the amount and timing of natural sediment supply, and/or whether sand nourishment is placed.

A4. What will be the character of the area behind the beach, where the parking is now located?

As described above, the shoreline can be expected to move landward, and the width of the intertidal beach to increase. In the supratidal zone landward of the readjusted shoreline (i.e., the remainder of the parking lot), it is likely that sediment will accumulate through berm accretion and/or storm overwash. This will increase the vertical elevation of the area. The sediment that supplies this beach appears to be principally derived from erosion of the adjacent updrift glacial deposits, which provide a mixture of sand, gravel, and cobble. The new beach can be expected to be comprised of this material, similar to adjacent beaches to the southwest and northeast.

B1. Will the presence of a dune affect the inland movement of the shoreline due to the revetment removal?

Whether a contructed dune affects the inland movement of the shoreline will be determined principally by where it is constructed relative to the readjusted shoreline and the sand volume of the dune. For example, if a dune is constructed seaward of where it would occur naturally relative to a beach in dynamic equilibrium, then it can be expected to erode. During that time, the rate of landward shoreline movement may be reduced relative to a condition with no dune, particularly for a low-volume (small) dune. This behavior will be strongly influenced by the occurrence of storms during that period. In other words, a dune may temporarily slow down the rate of shoreline readjustment if it is built farther seaward than natural conditions would create.

B2. Will the presence of a dune affect the rate of erosion?

As described above, the effect of a dune on the rate of erosion depends on when and where the dune is constructed. In a position seaward of what natural conditions would create (e.g., dune construction takes place before shoreline readjustment is largely complete), the dune may temporarily slow down the rate of shoreline adjustment, but can

be expected to erode rapidly. The eroded dune sediment will contribute to the local sediment supply, and will likely be transported to the northeast over time.

B3. Will the presence of a dune affect the reestablishment of the beach that would otherwise occur after the revetment removal?

A dune constructed at a time following shoreline readjustment and in a location and dimensions similar to what natural conditions would produce can serve as a potential sediment source for the fronting beach during storm events. Presence of a natural or artificially-created dune would also reduce the potential for overwash during storms that might impact a relocated roadway and/or Squibnocket Pond.

B4. Are you aware of dunes that have been built under conditions similar to those at Squibnocket? If so, have they been successful in achieving their goals?

Appendix D in the Friends of Squibnocket (2014) report summarizes several local (Massachusetts) examples of similar projects and their performance that are relevant here.

C. In looking at probable future conditions (+25 and +50 years), what are reasonable assumptions as to sea level rises? The Committee assumes that the erosion rates used by the various proposal proponents were prepared by you and should be used.

Sea-level rise is one of the most certain outcomes of climate change, because the fundamental processes and principal contributions to sea-level rise are well understood (Parris et al., 2012). There is substantial uncertainty, however, in the magnitude and timing of future sea-level rise due to uncertainty in future emissions pathways and the behavior of large ice sheets (e.g., in Greenland and West Antarctica). Thus, projections of future sea-level encompass a broad range. A representative recent report for the U.S. National Climate Assessment (NCA; Parris et al., 2012) suggests a range of 8 inches to 6.6 feet by 2100. More recent work suggests a similar range, with a 50% likelihood that sea-level will rise 2.6 feet by 2100 (Jevrejeva et al., 2014). There are a variety of methods for projecting future sea-level rise, which are summarized in Parris et al. (2012).

Sea-level will also vary regionally, due to factors such as land subsidence and changes in ocean currents. Over the next 85 years, these factors can add several inches to the sea-level position along the Massachusetts coast.

Projections of future sea-level for 2040 and 2065 that follow the NCA methodology, and include regional land subsidence (estimated as the difference between the rate of relative sea-level rise at the Woods Hole tide gauge and the global long-term rate of sea-level rise) can be computed using an online tool by the U.S. Army Corps of Engineers (http://corpsclimate.us/ccaceslcurves.cfm). The range of sea-level rise for the NCA low, intermediate-low, intermediate-high, and high scenarios is shown below. All values are in feet.

Scenario	2040	2065
Low	0.42	0.64
Intermediate-low	0.63	1.11
Intermediate-high	1.08	2.16
High	1.6	3.36

For all but the low scenario, the magnitude of sea-level rise for the next 25-50 years is greater than the past century. The scientific understanding of the rate and timing of coastal change in response to these higher values of sea-level rise is generally poor (CCSP, 2009). This is particularly true for sedimentary coasts like Squibnocket. Thus, simple extrapolation of past shoreline rates of change as done in the Friends of Squibnocket (2014) report, which uses data from a USGS study, may poorly represent future conditions (CCSP, 2009). Past rates of shoreline change do serve an important purpose, however, in quantifying historical shoreline behavior and can be used to understand both natural and human-induced changes to the coast.

D. If you have sufficient information, can you comment on the probability of a rise in water level in Squibnocket Pond as a result of the sea level rise?

To the extent that Squibnocket Pond is connected to the larger Atlantic ocean system via Menemsha Pond, it will likely experience a water level rise similar to that on the oceanfront.

E. Any other advise or information that you may believe would assist the Committee in achieving its goal of recommending to the Town an acceptable alternative for maintaining access to the homes on Squibnocket Point and enhancing the beach and its use.

The trend in coastal resilience and hazard mitigation planning is to choose an option that allows flexibility to adapt to changing conditions over time, looks at the coastal system holistically, and is informed by an assessment of risk tolerance for economic, environmental, and social benefits, and safety. This kind of approach has been adopted by coastal communities both large (e.g., New York City, PlaNYC program; http://www.nyc.gov/html/planyc/html/home/home.shtml) and small (e.g., Falmouth, MA; http://www.falmouthmass.us/depart.php?depkey=coastal; Punta Gorda, FL; http://www.ci.punta-gorda.fl.us/userdata/growthmgmt/PuntaGordaAdapatationPlan8-14-09.pdf).

We would be happy to discuss these questions and the proposals further at your convenience.

Additional questions received 27 October 2014

Is the dune essential to protect a road that is over 400 feet back from the current shoreline?

This area is low-lying and characterized by historical overwash that can reach to Squibnocket Pond (e.g., as seen in 1995 USGS imagery available in Google Earth). As such, a road built at current grade may be vulnerable to overwash in a storm of sufficient magnitude. Modeling studies may provide insight into the storm return interval that would cause overwash and/or flooding of the land area between the beach and Squibnocket Pond.

How reliable will a road be in the location shown on the map if it is on a berm with culverts to allow water to flow under it and there was no man made dune?

As mentioned above, this is a low-lying area subject to storm overwash. A more complete study of storm surge and water levels would be required to estimate the vulnerability of the road.

References Cited

CCSP, 2009, Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [James G. Titus (Coordinating Lead Author), K. Eric Anderson, Donald R. Cahoon, Dean B. Gesch, Stephen K. Gill, Benjamin T. Gutierrez, E. Robert Thieler, and S. Jeffress Williams (Lead Authors)]. U.S. Environmental Protection Agency, Washington D.C., USA, 320 pp., http://downloads.globalchange.gov/sap/sap4-1/sap4-1-final-report-all.pdf.

Jevrejeva, S., A. Grinsted, and J. C. Moore, 2014, Upper limit for sea level projections by 2100, Environmental Research Letters, 9(10), 104008, http://dx.doi.org/10.1088/1748-9326/9/10/104008.

Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss, 2012, Global Sea Level Rise Scenarios for the United States National Climate Assessment. NOAA Tech Memo OAR CPO-1. 37 pp., National Oceanic and Atmospheric Administration, Silver Spring, MD, http://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf.