Applied Coastal Research and Engineering, Inc.
766 Falmouth Road
Suite A-1
Mashpee, MA 02649

MEMORANDUM

Date: **March 23, 2018**

To: **Emily Molden and Cormac Collier, Nantucket Land Council**

From: **Trey Ruthven, Matt Doelp, and John Ramsey**

Subject: **Review of SBPF's Annual Review of Sconset Geotextile Tube Project Report**

We have reviewed the SBPF's Annual Review of Sconset Geotextile Tube Project report developed by Epsilon Associates, dated January 12, 2018 (the Epsilon Report), along with the supplemental reports included in the appendices. The documents provide a wide range of data, analysis, and interpretation of the monitoring information collected on behalf of SBPF. Based on their interpretation of the data, the Epsilon Report then draws conclusions regarding the severity of erosion being experienced, the need for mitigation, and recommendations for collection of data into the future. There are several implications of the statements made by the Epsilon Report regarding beach monitoring and potential mitigation volume needs. The most critical shortcomings contained within the Epsilon Report are italicized below. Also included are alternatives to combat some of the consequences of the suggestions made within the Epsilon Report.

- *Beach Monitoring: The Epsilon Report disregards the long-term SBPF survey data as a sound indication of increased erosion rate following project construction. Although a reduction in some bathymetry surveys lines is a reasonable request, the Commission should consider requiring some pre- and post-significant storm surveys over the next couple of years to better understand erosion rates and overall project performance during storms. Storm events create the highest erosion rates, when adverse impacts of the geotube installation likely would be most apparent.*
- *Mitigation Volume: The Epsilon Report suggests a reduction in the mitigation volume required annually because of an apparent reduction in erosion from prior estimates. The claim that there is additional mitigation volume leftover each year is not credible because (1) there were few significant storm events between project completion and the review submittal, (2) the theoretical volume that would have been supplied to the littoral system following geotube exposure was not included and, (3) the design of the mitigation is flawed and significantly limits the volume of mitigation material available during storm events. The continuous availability of mitigation volume to the littoral system in times of frequent elevated water levels and storm events (e.g., March 2018) is crucial to reducing impact of the project on the surrounding beaches.*

Beach Monitoring

- In our response to the December 2016 Annual Monitoring report, we highlighted the value of long term data to evaluate the performance of the geotube project. Epsilon acknowledged in the 2017 report the dependence of time scale on erosion rates. Beach monitoring on the order of a couple years is influenced by shorter events (e.g., a passing sand wave, storm event, etc.), and is not a robust indicator of erosion rates. Monitoring on decadal time scales is crucial to understanding "natural" erosion rates. The Epsilon Report claims that the "variability of shoreline does not lend itself to fitting a long-term trend line with a high degree of statistical accuracy." However, despite the short-term variability, there is a linear trend of shoreline retreat that is consistent between profiles. A comparison between this derived long-term rate and the post-construction erosion rate is a reasonable evaluation given the available data. Therefore, it is critical that the long-term monitoring of these transects continues.
- The reduction in monitored bathymetry profile lines (as long as the historical pre-project lines with years of monitoring data and project specific monitoring lines remain) and frequency of surveys to once per year would not threaten the validity of the beach monitoring. However, there are some ways to strengthen the beach monitoring in the absence of some of these other surveys.
    1. The addition of pre- and post-storm surveys over the next 3-5 years would be beneficial to understand the impact of the structure at critical times associated with significant storm events.
    2. A visual survey following major and minor storm events including images of any exposed regions (as well as duration of exposure) or scour and the project ends would help ensure adequate material is available for the littoral system. Additional photogrammetry surveys should be incorporated to capture the storm impacts associated with the structure post-storms. UAV photogrammetry surveys provide an efficient and rapid method of monitoring the bluff and upper beach.
    3. Expanded monitoring of the aerial beach profile to include mean high water (MHW) as a second measure for beach volume and shoreline change would be beneficial. The continued usage of mean low water (MLW) as an estimate for erosion rate of the entire cross shore can be problematic as MLW and erosion do not necessarily correlate well. Combined use of both the MHW and MLW should be considered to ensure appropriate evaluation of erosion rates.

Mitigation Volume

- The Epsilon Report suggests a reduction in the annual mitigation volume because of the apparent reduction in erosion rate according to their analysis. Although there was residual mitigation volume leftover from prior years, the reduction in mitigation volumes provided to the project site is not justified for several reasons:
    1. Following project construction, there were few significant storms that registering water levels high enough to cause significant erosion, only one storm met the Conservation Commission's definition of a significant storm. The storms experienced were separated by enough time to allow for beach recovery. In 2018, there have been several significant nor'easters in rapid succession, two of which maintained elevated water levels for over a week. Although SBPF states that the

mitigation sediment is rapidly replaced in front of the geotubes following times of exposure, the time while the geotube is exposed (during and after storm events) results in significant reductions to sediment load available to the littoral system. SBPF stated in the 2016 Annual Monitoring presentation to the Conservation Commission that on average it takes 5-7 days for a storm to pass, mobilize equipment, and push sediment in front of the exposed geotubes. That means that after the tubes become exposed early within a storm that no mitigation is available for the littoral system to offset the impacts associated with the geotubes. Since the time period associated with storms is the most critical period when the Sconset Bluffs naturally erode, the lack of sediment availability during storms is a major concern.

2. The shoreline change rates, most of which were generated from changes in MLW position, are not indicative of conditions following storm events as the monitoring typically occurs several months after the storm season. Over this several month period, the beach has time to rebuild in the project area. Over this same time period, adjacent beaches are not supplied the volume of sand that would naturally be available if the geotubes were not present.
3. The geotube project was constructed along the highest eroding section of Sconset Bluff. Therefore, it is not surprising that erosion rates measured north and south of the project would be lower than the rates experienced within the project area. Therefore, those rates should not be considered the basis for lowering mitigation requirements, it would result in increased impacts on adjoining shorelines.
4. The Epsilon Report contends that the mitigation volume is 1.5-1.8 times the average bank contribution. The volume of material contributed has been discussed at length over previous SBPF filings and SBPF's own studies and analysis has shown the bank does indeed contribute at least a 22 cy/lf/yr (and potentially even greater volumes). Massachusetts Department of Environmental Protection (DEP) specified the mitigation volume of 22 cy/lf/yr in the Superseding Order of Conditions dated December 19, 2014. That volume was specified because it provided an equivalent volume of material to the natural bank erosion along the project length of Sconset Bluff. The mitigation volume calculation used to support the Superseding Order is consistent with mitigation requirements for similar projects permitted by DEP within Massachusetts.
5. During storm events, a majority of the mitigation volume is inaccessible for transport once the sediment in front of the geotubes has eroded (Figure I). The additional mitigation volume sitting above the geotubes beyond the reach of the active surf zone is inaccessible to the littoral system (Figure II). SBPF recognizes that a portion of the mitigation volume sits above the project and does not include it in their residual volume survey. However, they do not decrease the residual volume by an estimated eroded volume that should have been available to the littoral system if the geotubes were not covering the bank sediments. This volume is important, as the majority of erosion occurs during storms.

- During storm events, exposed geotubes act as hard structures that exacerbate wave energy reflection. The reflection of wave energy induces turbulence and accelerates the erosion of beach in front of the tubes. The exposed tubes also accentuate the movement of water parallel to the tubes, resulting in currents that can scour the project ends (Figure III). It is critical that the face of the structure is continuously supplied with material to mimic the natural function of the coastal bank. The currently designed mitigation delivery system is unable to achieve this during the critical storm and post-storm time periods; therefore, it is recommended that a portion or the entire mitigation volume be placed on the beach

north and south of the geotubes. By placing the material on the beach, the material will be available during storm events to help mitigate the adverse impacts the geotube structure is causing to adjacent shorelines.

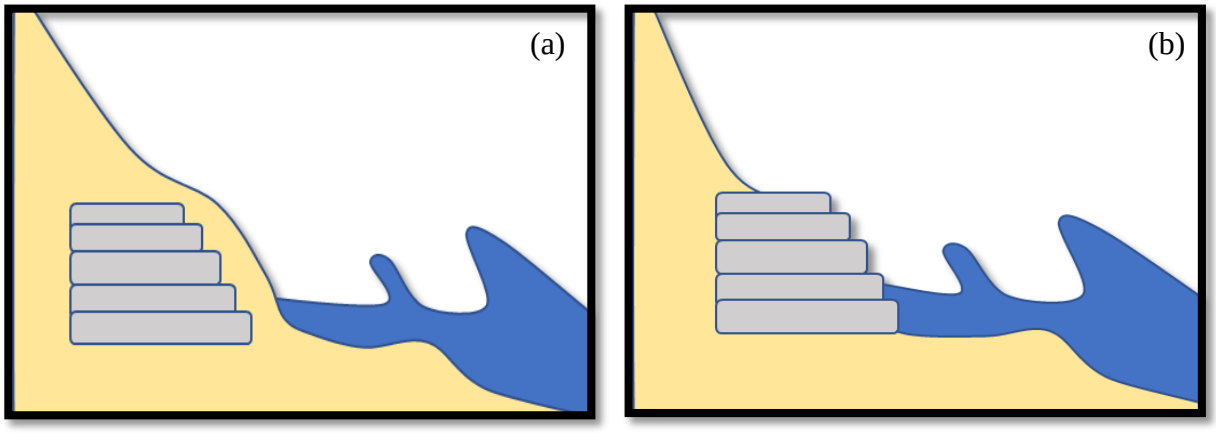

Figure I Schematic profile view of the geotubes (a) before the exposure of the geotubes. In this case, sediment is still available for the natural erosion. Once the geotubes are exposed (b), the littoral system receives a reduced sediment load.

Conclusions

- The review of the data and analysis presented in the Annual Review highlights the need for accurate and defensible analysis to demonstrate the true effects the Geotube Project has upon the Sconset Beach littoral system. The data and analysis highlight the complexity of the littoral system; however, SBPF's data shows erosion has increased since the Geotube Project was constructed. This indicates that the existing mitigation volume (22 cy/ft/yr) may not be enough to offset the impacts of the Geotube Project. Therefore, to reduce the mitigation volume as the Epsilon Report has suggested, would increase the erosional forces along adjacent shorelines, jeopardizing infrastructure, homes, and public lands outside the limits of SPBF's Geotube Project. Possible alternatives to combat some potential consequences of the project include:

    1. Supplying the ends of the projects site with some of the planned mitigation volume to allow for rapid transport north and south of the project site during a storm event in which the tubes are exposed.
    2. Adjustments to the surveying schedule to provide better understanding of erosion rates during significant storm events.
    3. Ensure surveys additionally include MHW information to have an alternative proxy for shoreline change rates.
    4. Require visual inspection and photography of any exposed or scoured regions following minor or major storms to document time periods when mitigation sediments are unavailable. In addition, this documentation would facilitate a better understanding of potential adverse impacts associated with this coastal engineering structure..

Figure II Image of the exposed geotubes (facing the north) after a March 13th, 2018 Nor'easter. The front of the geotubes are fully exposed.

Figure III Image of the north end of the project after a March 13th, 2018 Nor'easter. The front of the geotube are fully exposed with significant erosion at the terminal end. With sand remaining untouched on top of the geotube, the natural longshore transport of sand is interrupted resulting in a starved updrift and down drift beach adjacent to the project. These "end effects" create accelerated erosion of the coastal bank adjacent to the project.