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Memorandum

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Subject	**Town of Orleans, MA** **Water Quality and Wastewater Planning** **Task Number 8.1.2 – NT Demonstration Projects** **Final Technical Memorandum on a Work Plan for Oyster Bed Propagation**
Project Number	60476644
From	Thomas Parece, P.E., AECOM Project Manager
Date	10/11/16

1. Background

As proposed in the AECOM Technical Memorandum entitled Preliminary Engineering Design and Work Plan for Preferred Site(s), dated May 4, 2016 (Preliminary Engineering Tech Memo), the Orleans oyster bed demonstration project involves growing remote sets and planting them in suitable areas, resulting in oyster bed-like grow-out under the diverse environmental conditions experienced over the course of a typical Pleasant Bay growing season:

- Oyster beds are often created by growing remote set (spat-on-shell) in floating gear for a period of time, then bottom-planting on suitable substrate;
- Oyster beds have higher densities than gear-based systems per unit area, and create diverse ecosystem habitats;
- A demonstration is needed to determine whether oyster beds can be established as a sustainable habitat on a long-term basis in suitable areas within Pleasant Bay; and
- Predation and disease prevention must be considered for this growing option.

Remote set includes a firm substrate, or cultch, such as hard clam shells, with oyster spat attached (spat on shell). Eastern oyster larvae (*Crassostrea virginica*) produced in a hatchery can be "set" on cultch after a larval stage spent feeding in the water column. Spat can also be induced to set on microscopic shell fragments to produce seemingly unattached "singles". When attached to a substrate, this spat, invisible to the naked eye, is often called "spat-on-shell" or "remote set". The waters of Pleasant Bay do not have a naturally-occurring oyster population that could spawn. Therefore, in order to establish an oyster bed in areas where there is no natural set, remote set can be used to introduce oysters into the natural coastal environment.

The technique for establishing an oyster bed in Pleasant Bay will be similar to techniques used throughout Cape Cod, and recently implemented successfully in West Falmouth Harbor, Falmouth, MA and Popponeset Bay (Shoe String Bay Subembayment), Mashpee MA. This technique will begin with installing remote set in trays and floating bags for an initial growing period. In Pleasant Bay, remote set will likely be able to be bottom planted after approximately twelve weeks. The significant benefit of planting remote set after a maturation period is that it allows the oyster spat to grow-out in a protected environment, thus reducing predation and mortality.

Growing out remote set in both trays as well as floating bags with bottom-planting will enable an evaluation of the growth and survival rates of each technique. Moreover, evaluating the potential for bottom-planting oyster remote set in Pleasant Bay will help determine the feasibility of expanding oyster beds in other parts of Pleasant Bay where there is suitable substrate.

2. Introduction

The goal of this project is to determine whether it is feasible to establish oyster beds in Little Pleasant Bay. To accomplish this goal, the plan is to grow oyster remote set starting in late spring 2017 and to bottom plant them after 12 weeks within a 2,500 square foot demonstration site at the end of the first growing season. Remote set will first be installed in floating bags and off-bottom trays (4' x 4'). Once the oysters are at least 1.5 inches (38 mm) on average, and the water temperature reaches 6°C, they will be bottom planted at suitable locations.

The AECOM Technical Memorandum on Final Site Characterization and Evaluation for Shellfish Aquaculture/Shellfish Propagation dated March 13, 2016 (Site Characterization) evaluated seven sites that had been previously identified as part of the Orleans Consensus Plan endorsed by the Orleans Water Quality Advisory Committee and presented at the Orleans Shellfish Forum on June 2, 2015. After a matrix-based review of these sites, Quanset Pond was recommended as the most suitable site for an oyster bed demonstration. The outer shore of a sand spit at Quanset Pond were also identified by the Orleans Shellfish Constable as suitable for bottom planting oyster remote set.

Over the course of the summer months of 2016, the selection of Quanset Pond was revisited at several meetings of the Orleans Shellfish Working Group (SWG). The SWG consists of the Shellfish Constable/Harbormaster, representatives from the Shellfish and Waterways Advisory Committee, Orleans Marine and Freshwater Quality Task Force, Orleans Pond Coalition, Citizens Peer Review Committee, and Orleans Water Alliance. Concerns were raised regarding:

- Predation from both oyster drills and whelks (conch);
- Wave action possibly removing the remote set from the outer shore;
- Accretion concerns and movement of the sand spit;
- Ability to effectively monitor water quality changes; and
- Use conflicts with private landowners and boaters.

The AECOM Shellfish Team was asked to review new sites in Little Pleasant Bay that were not part of the original analysis to find a more advantageous site for an oyster bed demonstration. Identifying a site with the highest likelihood of oyster survival has been raised as a key criterion in site selection. To meet this criterion, the Shellfish Team surveyed for sites within Little Pleasant Bay that may have a smaller predator population, and may facilitate the creation of habitat that reduces predation while maintaining a high probability for success and ease of monitoring the demonstration aspects.

3. Evaluation of Additional Sites

The Shellfish Team conducted two site visits to Little Pleasant Bay and identified four additional potential demonstration sites, including:

- Outer Paw Wah;
- Namequoit Point;
- Namequoit River; and
- Kent's Point.

The other sites that had been evaluated previously for an oyster bed, and were reviewed again as part of this analysis include:

- Pochet; and
- Quanset Pond.

Sites that were reevaluated and re-ranked are shown in Figure 1 and include:

- Kent's Point;
- Namequoit River
- Outer Paw Wah;
- Pochet;
- The River; and
- Quanset (not shown on Figure 1).

A fundamental constraint on creating oyster beds in Pleasant Bay is soft sediment (muck). Oyster remote set will suffocate if planted in areas where it will be covered by sediment. Therefore, locations with hard bottom are required for siting oyster beds. To evaluate sediment types in Namequoit River, a bathymetric survey was completed on September 21, 2016 to characterize bottom sediment types in Namequoit River. Appendix A is a map of the bathymetric survey of Namequoit River which contains a thick layer soft sediment making the bottom conditions unsuitable to oyster beds.

The presence of significant areas of soft sediment (muck) were seen during two prior surveys of the Kent's Point area (one by boat with the Harbormaster and Assistant Harbormaster in October 2016 and the other from land using waders in September 2016). A third site assessment was completed on October 4, 2016. Two areas of hard bottom were discovered, as shown in Figure 2.

Figure 1. Sites Evaluated as potential Oyster Bed demonstration project areas.

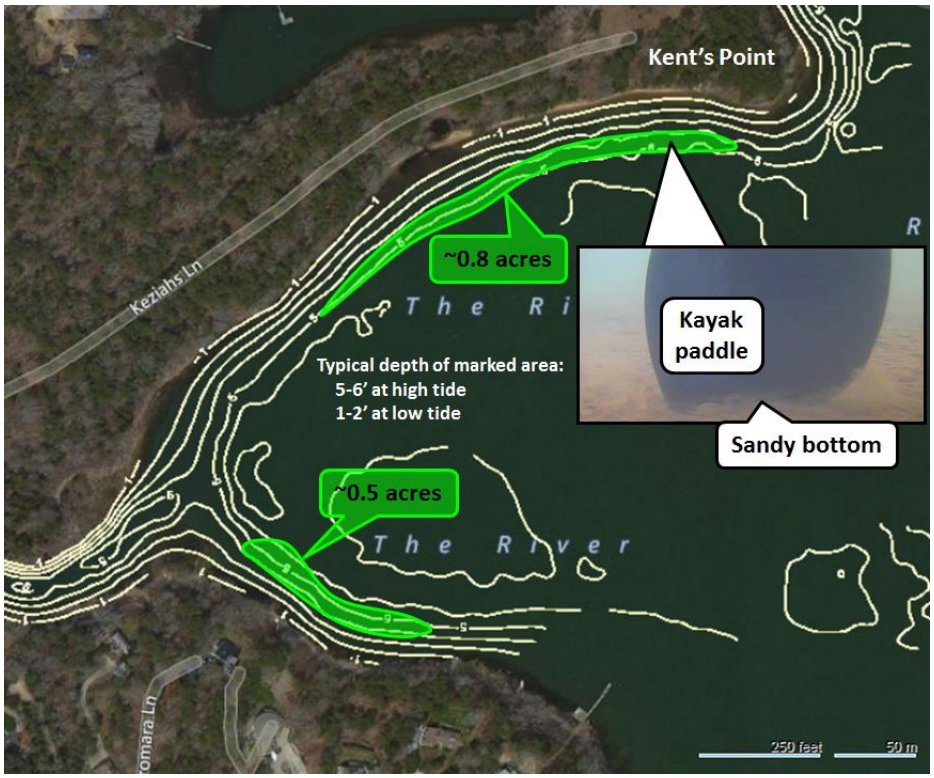

Figure 2. Two areas of hard bottom.

After these site evaluations were completed, sites were rated using the following criteria, which are described in detail in the Site Characterization Technical Memorandum. Two additional criteria (presence of eelgrass and presence of salt marsh) and one overriding criteria (soft, mucky sediment) have been added in this new evaluation.

- Site Suitability
    - Available Growing Area/Adequacy of Acreage;
    - Water Quality Indicators;
    - Disease/Predation;
    - Ease of Access;
    - Aesthetic Impacts;
    - Representativeness of the Site (Transferability);
    - Use Conflicts;
    - Presence of Eelgrass; and
    - Presence of Salt Marsh.
- Permitting
    - Abutter Compatibility;
    - Wild Harvest Conflicts;
    - Grow-Out to Harvest Size Allowed; and
    - Ability to Obtain Permits.
- Project Evaluation
    - Expected Survival; and
    - Overall Likelihood of Monitoring Plan to Yield Quantified Results.
- Other/Overriding Considerations
    - Soft Sediment (Muck).

To rate each criterion in the Site Selection Matrix, the Shellfish Team assembled available data, and conducted additional site visits. A similar rating system as that used for the Site Characterization Technical Memorandum was applied to each criterion to quantify how well each site met a specific criterion. The point-based system is as follows:

- Good = 1 point: A good rating (1) was assigned if the criterion could be met fully.
- Neutral = 0 points: A neutral rating (0) was assigned if the criterion could be met in part, but there were some potential issues and/or difficulties
- Poor = -1 point: A poor rating (-1) was assigned if the criterion could not be met.

For the Site Suitability criteria, if a site was fully suitable based on the criterion being rated it was assigned a numerical value of 1, if the site was mostly suitable based on the criterion being rated it was assigned a rating of 0, and if the site was unsuitable it was assigned a rating of -1. Two criteria were added to the Site Suitability Criteria (presence of eelgrass and presence of salt marsh) in order to capture the unique features of the sites at Paw Wah and Namequoit Point. At both of these sites we identified fringing salt marsh and eelgrass with epiphytes and algal growth (due to excess nutrient/nitrogen loads). These conditions make it possible to create an oyster bed habitat in close proximity to the degraded eelgrass beds, that may serve to enhance and restore eelgrass habitat, by imporivng water and sediment quality. Integrated habitat restoration may both improve eelgrass health and create an ecosystem that mitigates against oyster predation, increase biological diversity and minimize shoreline erosion.

For the Permitting criteria, if a site was likely to be permitted based on the criterion being rated it was assigned a numerical value of 1; if the site was likely to be permitted, but there were potential issues based on the criterion being rated, it was assigned a rating of 0; and if the site was unable to be permitted within a particular criterion, it was assigned a rating of -1. Of note is that all of Pleasant Bay except Paw Wah Pond is open to shellfishing. Therefore, oysters planted in Pleasant Bay are allowed to grow out to harvest size without the DMF requiring the grow-out area to be closed. Any area selected for the demonstration project will need to be closed to the harvest of oysters in order to maintain and monitor populations for the research aspects of this demonstration. These closures can be “species specific”, thereby allowing wild harvesters to continue to collect other species while the oyster bed develops.

For the Project Evaluation criteria, if a site was likely to produce a successful demonstration based on the criterion being rated it was assigned a numerical value of 1, if the site was probably able to produce a successful demonstration based on the criterion being rated it was assigned a rating of 0, and if a demonstration was unlikely to succeed at a site, based on a particular criterion, it was assigned a rating of -1. The criterion of expected survival was weighted higher that other criteria to reflect the importance of a demonstration having a high likelihood of success.

To apply this tool to each potential shellfish demonstration site, the Shellfish Technical Team met and first reviewed and discussed all of the available information for each site, then evaluated each demonstration site and rated the criteria for each site based on this available information.

Once the criteria for each site were rated, the Team reviewed the numerical values assigned to each criterion across sites to ensure consistency. The Team also discussed whether any criterion was more important than another and determined that each criterion should mostly be weighted equally. However, other overriding considerations and the expected survival were given a higher weight.

The final step in site evaluations is to assign an overall ranking to each site based on evaluation findings and criteria ratings. Quantitative rankings were tabulated in the Site Selection Matrix, and the results are as follows:

- Kent's Point: Ranked highest by SWG due to several advantages* (see below)
- Outer Paw Wah: 10 points
- The River: 6 points
- Pochet: 5 points
- Quanset: 2 point

* Kent's Point was not initially ranked by the Shellfish Team due to the significant amount of soft sediment seen in the first two site visits. At the October 3, 2016 meeting of the SWG, the Shellfish Team was asked to review Kent's Point again for suitable bottom because this location has several advantages, including:

- Situated in the section of Pleasant Bay that is more impaired/nitrogen-enriched;
- Good access;
- Visibility for public education;
- A recent designation by the Town as a "no wake" zone; and
- A town-owned parcel with specific provisions in the deed for shellfish cultivation.

A third bathymetric survey was completed of the entire Kent's Point area on Tuesday, October 4, 2016 at near high tide. Two areas around Kent's Point with suitable bottom for an oyster bed were identified as shown on Figure 2. There is one sandy area that is about 50' off the shore of Kent's Point at low tide. This area is about 30' wide and 1100' long – basically the length of the beach - for a total acreage of about .8 acres. The sediment closer to shore is muck and the sediment farther out is muck. But, this 30' strip is hard sand. This strip was prodded with a kayak paddle and pictures were taken with an underwater camera. There is also about .5 acres of hard bottom to the south of this strip. At low tide, these areas are 1' – 2' deep. Using an underwater camera setup, no eelgrass was detected. At the east end of Kent's Point and around the corner, a few orange starfish which are potential predators were present.

It was decided at the October 3, 2016 SWG meeting that if an area of at least an acre at Kent's Point with suitable bottom and enough depth at low tide to keep the oyster bed under water was identified, this site would be the preferred location for an oyster bed demonstration. It should be understood that the process of site selection is adaptive and subject to change as additional information about each of the sites is obtained. The SWG will continue to meet and will further adapt site selections based on all new information discovered by or presented to the group.

Although two areas at Kent's Point have hard bottom, a key issue at Kent's Point is possible siltation by the fine grained sediment that surrounds this suitable bottom, and water depths during winter storms. This will be further evaluated as part of the first year of the demonstration, which has always been presented as a viability study, using only 500 bags of remote set.

As evidenced by the ranking results, there are also several benefits of the Outer Paw Wah location. The presence of fringing salt marsh and impaired eelgrass creates a unique opportunity to evaluate the effect of oyster beds on eelgrass health and to integrate oysters into this habitat. Oysters filter algae and small particles or organic matter and thus increase water clarity, which improves the aquatic environment for eelgrass. As oyster beds grow vertically and mature into reefs, these natural structures buffer against wave action and reduce shoreline erosion, benefitting fringing salt marshes. Because natural salt marsh/eelgrass environments often support a thriving shellfish population, it is likely that the presence of shellfish provide important inputs to these complex ecosystems. Integrating shellfish into the outer Paw Wah location would allow the potentially beneficial impacts of adding shellfish to an existing salt marsh/eelgrass system to be evaluated. In addition, proximity to the new Harbormaster's Office allows for simplified patrol and oversight, as well as efficient implementation logistics. Finally, because this area is outside the mooring field, bottom planting oysters around eelgrass beds will not conflict with the boating and other uses of this area. The River area ranked lower than Outer Paw Wah primarily due to the lack of salt marsh and access being more difficult. Pochet ranked lower due to lack of eelgrass, access issues, difficulty of patrol, and private ownership of the planting area creating potential abutter conflicts. However, all three locations are expected to yield successful results.

Of note is the fact that the Quanset site has now fallen to last place within the ranking of sites this time around. However, it is important to remember that the goal of the initial site evaluations was to identify a single shellfish demonstration location. At the time of the initial site assessments, the goal was to find one location within the Town where a demonstration project of any type could be implemented. The AECOM Team was assessing sites for use as aquaculture projects as well as coastal habitat restoration. Through an iterative planning process with the SWG and the town, four demonstration projects emerged, including:

- Propagation of oysters in Kescayo Gansett (Lonnie's) Pond;
- Increased production of quahogs in Town Cove through additional seed planting;
- Enhancing oyster aquaculture in Pleasant Bay and Town Cove by working with existing growers to increase production and/or through the Town offering additional lease areas; and
- Formation of an oyster bed initially recommended for the outer Quanset Pond Area (Quanset).

Of the seven sites that were initially evaluated for a demonstration, Quanset was chosen for an oyster bed demonstration because it ranked highest of the initial sites evaluated. As part of the next phase in the planning phase and during discussions with the SWG, issues of predation, wave action, and accretion at this location were raised. For this reason, during this next phase of planning the AECOM Shellfish Technical Team revisited possible demonstration locations for an oyster bed in Pleasant Bay and identified three additional locations as described in Section 3. Quanset ranks lower than these sites for several reasons, including the absence of eelgrass, which precludes the opportunity to monitor the impacts of integrated shellfish restoration with impaired eelgrass and fringing salt marsh habitats. Another reason Quanset ranks lower relative to the new sites is that access and use conflicts are comparatively higher in this area.

This further refinement of site analysis at Kent's Point, Outer PawWah, Pochet and Quanset indicates that if the oyster bed demonstration is successful in one location, there are other areas within Pleasant Bay where the oyster bed growing paradigm can be replicated once the demonstration phase (including monitoring) has been completed. The concept of an oyster bed may also be feasible in areas such as Namequoit River and The River that have soft sediment if the bottom is modified with cultch or other materials. The permittability of adding cultch in the Pleasant Bay ACEC is currently being determined by the Shellfish Team.

4. Minimum Size Requirements for Oyster Bed Demonstration

The current demonstration size is 500 bags of oyster remote set to be started in floating bags and trays and then bottom-planted after the first growing season. A single bag of remote set will cover approximately five square feet at a density appropriate to developing an oyster bed with appropriate three-dimensional structure. Five hundred bags therefore cover an area of 2,500 square feet. The number of oysters that will grow from one bag of remote set and survive into the next growing season is approximately 300 oysters per bag, based on data from the West Falmouth Oyster Bed Demonstration. However, the number of oysters is not the critical determinant in establishing an oyster bed. The AECOM Shellfish Technical Team recommends that 2,500 square feet is the minimum area needed to establish an oyster bed at one location, with the population increasing in density over time as the bed is established.

The cost to increase this demonstration from 500 bags for one location to 1,000 bags, which will allow for two locations to be tested, would be $20,000 to cover the cost of additional bags of remote set, and gear. However, having oysters in more than one location will also increase overall costs for monitoring, etc. This essentially increases the number of demonstration projects that the Town will be funding to five instead of the four currently being planned. The AECOM Team is happy to support the Town in all demonstration efforts, but advises to select one site in the first year in order to demonstrate success before expanding this type of aquaculture/coastal habitat restoration.

5. Work Plan and Timeline

A. Phase I – Project Planning with Shellfish Working Group: September – October, 2016.

The purpose of Phase I is to discuss project planning with the SWG and abutters if possible. Key decisions to be made before October 31, 2016 include:

- Final selection of demonstration site

B. Phase II – Installation Design: October 31, 2016 – June 30, 2017

The project period for Phase II of the Pleasant Bay Oyster Bed demonstration is November 1, 2016 through June 30, 2017. Within this timeframe, the timing and activities to accomplish the various steps of the second phase of this demonstration should proceed as follows:

October 31, 2016 through November 30, 2016	• Prepare a TM with draft engineering design for a 2017 installation, including quantities of remote set, gear types and location, and monitoring plan
October 31, 2016 through December 30, 2017	• Develop a Scope of Work for baseline water quality monitoring within proposed growing area
December 2016	• Review draft engineering design for 2017 installation with SWG and abutters and stakeholders

January 2017	• Prepare final engineering design for 2017 installation and review with SWG • File Request for Determination of Applicability (RDA) with the Conservation Commission • Amend Town Municipal Propagation Permit with the Division of Marine Fisheries
February 2017	• Finalize all permits • Order remote set oysters • Finalize contract for water quality monitoring services
March/April 2017	• Order gear • Order all floating bag components • Build bags
May 2017	• Begin baseline water quality monitoring
June 2017	• Pick-up remote set • Deliver to demonstration location • Install remote set in floating gear

6. Additional Resources

The AECOM Team used personal expertise as well as outside resources to rank the criteria and to determine weighting of factors. The following resources describe key research findings relating to co-locating oysters with eelgrass and fringing salt marsh.

Booth, Dale M., and Kenneth L. Heck Jr. "Effects of the American oyster Crassostrea virginica on growth rates of the seagrass Halodule wrightii." *Marine Ecology Progress Series* 389 (2009): 117-126.

Frankic, A., Greber, L & Fransworth, M. “Teaching and learning with nature using a biomomicry-based approach to restore three keystone habitats: salt marsh, and eelgrass, and shellfish beds. *The Biomimicry Institute Webinar Document* (2011): 5-13.

Newell, Roger IE, and Evamaria W. Koch. "Modeling seagrass density and distribution in response to changes in turbidity stemming from bivalve filtration and seagrass sediment stabilization." *Estuaries* 27.5 (2004): 793-806.

Pinnell, Cassie Maria. *Invertebrate response to eelgrass and oyster restoration in San Francisco Estuary*. Diss. San Francisco State University, 2016.