Lafayette River Oyster Restoration Tributary Plan: A Blueprint for Restoring Oyster Populations per the Chesapeake Bay Watershed Agreement

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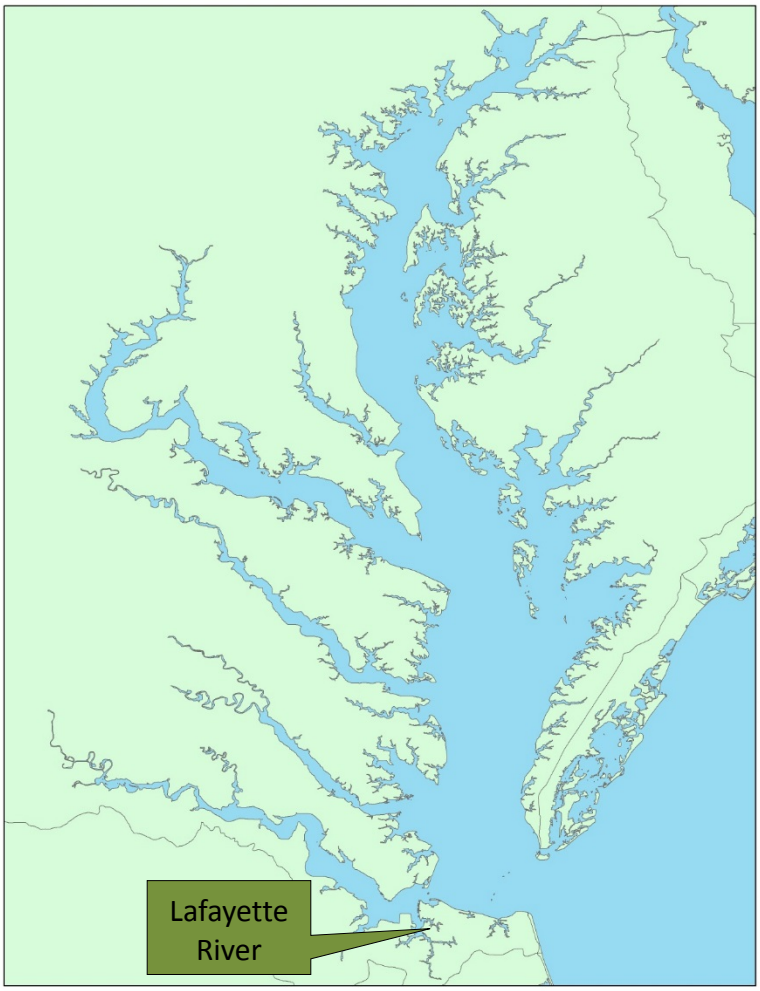
August 2017



Drafted by the Lafayette River Oyster Restoration Workgroup under the
Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team

Lafayette River Oyster Restoration Workgroup includes representatives from:
National Oceanic and Atmospheric Administration (chair), Chesapeake Bay Foundation, Christopher Newport University, City of Norfolk, Elizabeth River Project, U.S. Army Corps of Engineers' Norfolk District, Virginia Commonwealth University, Virginia Institute of Marine Science, and Virginia Marine Resources Commission.

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Executive Summary

The 2014 Chesapeake Bay Watershed Agreement[1], which guides the work of the Chesapeake Bay Program, calls for state and federal partners to "restore native oyster habitat and populations in 10 Bay tributaries by 2025, and ensure their protection." Responsibility for achieving this goal rests with the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (GIT). For Virginia, the Sustainable Fisheries GIT convened tributary-specific workgroups to plan, implement, and track progress toward this goal. The Lafayette River Oyster Restoration Workgroup (hereafter, Workgroup) developed the Lafayette River Oyster Restoration Tributary Plan to: (1) describe how the river's restoration goal was established, and (2) describe plans to achieve it.

Oyster reef construction in the Lafayette River (top); same reef five years later (bottom), showing some of the highest oyster densities in the river.
Photos: ERP/ CBF

Consistent with the Chesapeake Bay Oyster Metrics[2] success criteria, the Workgroup developed a restoration goal of 80 acres for the river. There are 70.5 acres of existing reefs in the river (22.5 acres of existing reef projects, and 48 acres of 'relict reefs' that have self-restored or existed historically). Thus, an additional 9.5 acres of restoration work are needed in the river to meet the Oyster Metrics definition of a restored tributary under the Chesapeake Bay Agreement oyster outcome (Fig 3).

The cost estimate for completing the remaining 9.5 acres is $800,000. In summer 2017, Chesapeake Bay Foundation and the Elizabeth River Project will construct a 4.5-acre reef with $300,000 in funding from the National Oceanic and Atmospheric Administration (NOAA) and the National Fish and Wildlife Foundation (NFWF). Partners are seeking the estimated $500,000 required to complete the remaining five acres. Additional funding will be required for reef monitoring per the Chesapeake Bay Oyster Metrics recommendations.

Summary Table: Lafayette River Oyster Restoration Goal, Existing Restored Area, and Cost Estimate

Restoration goal for the Lafayette River	80 acres
Existing reefs in Lafayette River (22.5 acres of existing restoration projects, and 48 acres of self-restored relict reefs)	70.5 acres
Remaining area to be restored	9.5 acres
Cost estimate	$800,000

Section I: Policy Drivers, Chesapeake Bay Oyster Metrics, and Lafayette Oyster Restoration Workgroup Organizational Framework

1.1 Policy Drivers

The 2014 Chesapeake Bay Watershed Agreement, which guides the work of the Chesapeake Bay Program, calls for state and federal partners to "restore native oyster habitat and populations in 10 Bay tributaries by 2025, and ensure their protection." Responsibility for achieving this goal rests with the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team (GIT). For Virginia, the Sustainable Fisheries GIT convened tributary-specific workgroups to plan, implement, and track progress toward this goal.

The "10 tributaries by 2025" goal was also associated with a prior policy initiative, the 2009 Executive Order 13508 on Chesapeake Bay Protection and Restoration[3]. The Sustainable Fisheries GIT was similarly responsible for achieving this goal, and progress began under this initiative.

1.2 Chesapeake Bay Oyster Metrics

The Sustainable Fisheries GIT convened the Oyster Metrics Workgroup to develop a science-based, common definition of a successfully restored tributary for the purpose of tracking progress toward the "10 tributaries by 2025" goal. The Oyster Metrics Workgroup was composed of representatives from the state and federal agencies involved in Chesapeake Bay oyster restoration, as well as oyster scientists from academic institutions. The Workgroup produced "Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries," a report detailing the recommended success metrics (hereafter referred to as the Oyster Metrics report).
The following criteria were among those set forth in the Oyster Metrics report:
1) A successfully restored reef should have:

- A 'minimum threshold' of 15 oysters and 15 grams dry weight/square meter (m^2) covering at least 30 percent of the target restoration area at six years post restoration;
- Ideally, a higher, 'target' of 50 oysters and 50 grams dry weight/square meter (m^2) covering at least 30 percent of the target restoration area at six years post restoration;
- Two or more oyster year classes present; and
- Stable or increasing spatial extent, reef height, and shell budget.

2) A successfully restored tributary is one where:

- 50 to 100 percent of the currently restorable bottom has oyster reefs that meet the reef-level metrics above. Restorable bottom is defined as area that, at a minimum, has appropriate bottom quality and water quality for oyster survival; and
- Eight to 16 percent of its historic oyster bottom has oyster reefs that meet the reef-level metrics above.

These Oyster Metrics success criteria are being applied to tributary-scale oyster restoration work planned and implemented under the 2014 Chesapeake Bay Watershed Agreement.

1.3 Selection of the Lafayette River as Target Tributary under the Chesapeake Bay Watershed Agreement Oyster Outcome

Several factors led to the designation of the Lafayette River as a target tributary for large-scale oyster restoration under the Chesapeake Bay Watershed Agreement.

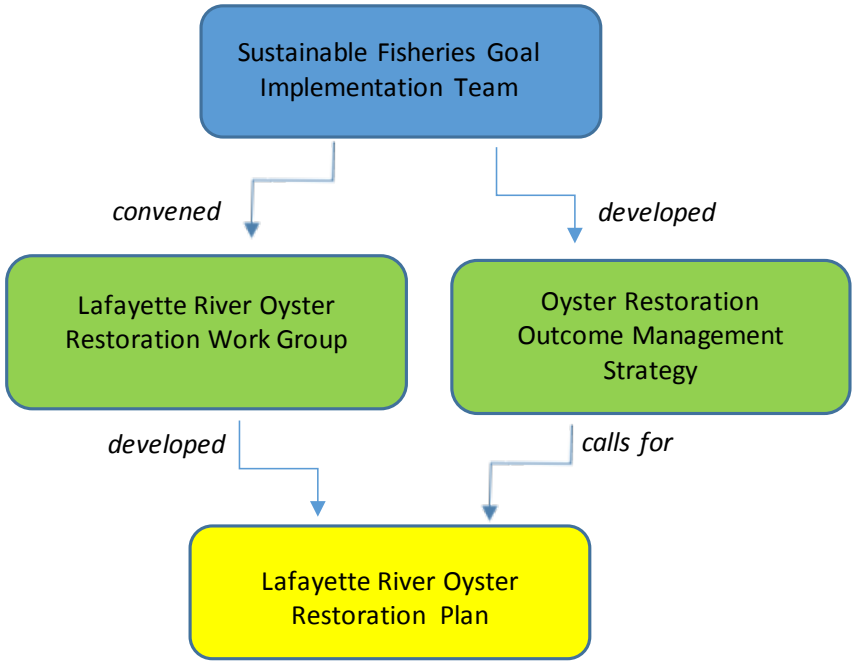
- In 2012, the U.S. Army Corps of Engineers (USACE) drafted the Native Oyster Restoration Master Plan[4], which evaluated 63 tributaries of the Chesapeake Bay watershed. The document prioritized rivers based on historical, physical, and biological attributes to determine those tributaries with the potential to support large-scale oyster restoration. In this document, the Lafayette River is listed as a subsegment of the Elizabeth River, which was designated as a Tier One tributary, indicating that it is suitable for oyster restoration.
- The river has been closed to wild commercial oyster harvest since the 1930s due to poor water quality. Therefore, restoration efforts here will not compete with that sector of the fishery. All oysters in the Lafayette River are protected from harvest.
- The river has historically exhibited very strong oyster recruitment (natural spat set)[5,6].
- Oyster reef construction work has been under way in the river since the early 1990s. These projects were implemented by the Virginian Marine Resources Commission (VMRC), Elizabeth River Project (ERP), Chesapeake Bay Foundation (CBF), U.S. Army Corps of Engineers' Norfolk District (USACE), and Norfolk Rotary Club. Existing projects have multiple generations of healthy oysters.
- Interest from local watershed groups was strong.
- NOAA, USACE, and VMRC held conversations at length examining which tributaries in Virginia would be suitable and tenable for large-scale oyster restoration. The Lafayette River consistently was among the top candidates.

By consensus among NOAA, USACE, VMRC, and local partners, and with agreement from the Sustainable Fisheries GIT, the Lafayette River was designated as a target tributary for large-scale oyster restoration in Virginia under the 2014 Chesapeake Bay Watershed Agreement.

1.4 Organizational Framework

Responsibility for achieving the Chesapeake Bay Watershed Agreement oyster outcome to "restore native oyster habitat and populations in 10 Bay tributaries by 2025, and ensure their protection" rests with the Sustainable Fisheries GIT. To plan and coordinate large-scale oyster restoration, the Sustainable Fisheries GIT convened one workgroup in Maryland and three workgroups in Virginia (one each for the Lafayette, Lynnhaven, and Piankatank rivers).

Figure 1: Organizational Framework for Large-Scale Oyster Restoration in Lafayette River under the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team



Like all Goal Implementation Teams under the Chesapeake Bay Program, the Sustainable Fisheries GIT has crafted "management strategies" that describe the steps necessary to achieve each goal in the Chesapeake Bay Agreement. The strategies provide broad, overarching direction and are further supported by two-year work plans summarizing the specific commitments, short-term actions, and resources required for success. The Oyster Restoration Outcome Management Strategy[7] calls for each workgroup in Virginia to develop a tributary-specific plan to restore oysters in the river, consistent with the Oyster Metrics success criteria. "The Lafayette River Oyster Restoration Tributary Plan: A Blueprint for Restoring Oyster Populations per the Chesapeake Bay Agreement", developed by the Lafayette River Oyster Restoration Workgroup, is to serve as the plan for the Lafayette River.

The Lafayette River Workgrouprecognizes that its members may also have organization-specific oyster restoration plans and goals (e.g., USACE's Native Oyster Restoration Master Plan). This document is not meant to replace those; rather, it is meant to supplement and further refine elements in those plans.

The Lafayette Workgroup, convened in early 2014, is comprised of representatives from NOAA (chair), CBF, Christopher Newport University (CNU), City of Norfolk, ERP, USACE, Virginia Commonwealth University (VCU), Virginia Institute of Marine Science (VIMS), and VMRC.

Section II: Current Status of Lafayette River Oyster Reefs

The Lafayette River is a high-recruitment area for juvenile oysters. It has been closed to commercial oyster harvesting since the 1930s, due to concerns about contaminants from sewage and heavy metals. The watershed remains highly urbanized, but in 2016 the Virginia Department of Environmental Quality released a report showing that the Lafayette River meets state water-quality standards for recreation because bacteria concentrations had significantly dropped[8]. The river remains closed to commercial oyster harvest, including new leases.

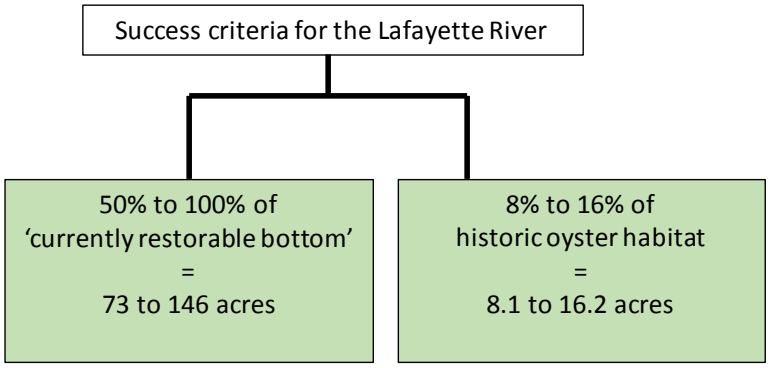
An early task for the Lafayette Workgroup and partners was to determine the status of existing oyster reefs in the River. To achieve this:

• Scientists from Christopher Newport University and VIMS surveyed oyster populations on existing Lafayette River oyster reefs (deemed 'relict reefs')[9,10]. This was done in early 2014 with funding from NOAA and USACE. Assisted by NOAA GIS analysis, they determined that 48 acres of these relict reefs had sufficient oyster populations to be considered restored per the Oyster Metrics success criteria. These reefs presumably existed historically or have 'self-restored' since the river was closed to oyster harvest in the 1970s.

• The Workgroup compiled data on existing restoration projects in the river, and has determined that 22.5 acres have already been restored by USACE, ERP, and CBF. This includes 1.5 acres of reefs to be built by the City of Norfolk in 2017 with funding from NFWF's Hurricane Sandy Coastal Resiliency Program. This information is housed in the Lafayette River oyster restoration GIS geodatabase, http://www.habitat.noaa.gov/chesapeakebay/gis/Oyster_Restoration_Geodatabases/lafayette/, which is maintained by NOAA using information provided by members of the Lafayette Workgroup. Thus, there are 70.5 acres of existing reefs in the Lafayette River, either high-density relict reefs (48 acres) or oyster restoration projects (22.5 acres). (See Map A).

Section III: Oyster Restoration Goal Setting

Figure 2: Oyster Metrics two-prong tributary-level success criteria, as applied to the Lafayette River



The Oyster Metrics success criteria describe a two-pronged test to determine if a river is successfully restored (Fig. 2). First, oyster reefs should cover 50 to 100 percent of a river's 'currently restorable bottom.' To determine this, the Workgroup first had to define 'currently restorable bottom' in the River. By consensus among the Workgroup, the following were used to define 'currently restorable bottom':

- River extent: all waters upstream of a line from Tanner Point south to Lambert's Point were considered to be within the Lafayette River. This was based on the natural geography of the river, and Workgroup consensus. This river segment is 2145 acres. (Fig 4).
- Depth interval: waters between 3.3 feet and 16.5 feet were considered restorable for the purposes of defining 'currently restorable bottom.' The shallow-water limit was set because: a) sonar surveys are unavailable shallower than 3 feet, and b) the Workgroup expressed concerns about both public acceptance of large-scale intertidal reefs and the potential for poaching/attractive nuisance issues. The deep-water depth limit was set due to concerns about hypoxia. The Workgroup notes that there are existing thriving oyster restoration projects in the intertidal zone (shallower than 3.3 feet), and these are counted toward the already-restored acreage. Future small-scale intertidal projects may be constructed, but these will be considered above and beyond the restoration called for in this document.
- Benthic habitat (river bottom) type: NOAA sonar surveys were used to determine which benthic habitat types existed in the river. The following types were considered restorable: anthropogenic shell rubble; biogenic shell rubble, and shell rubble with sand or mud; constructed 3D shell reefs; muddy sand with hard subsurface sediments; other reefs (reef balls and unknown material); unclassified bottom with hard subsurface sediments. Benthic habitat classification information is available in the Lafayette River oyster restoration GIS geodatabase, http://www.habitat.noaa.gov/chesapeakebay/gis/Oyster_Restoration_Geodatabases/lafayette/ , maintained by NOAA.
- Water quality: the two Chesapeake Bay Program water-quality monitoring stations (stations #LFA01, downstream near Lamberts Point, and #LFB01, upstream, just below the Granby Street Bridge) showed no summertime bottom dissolved oxygen levels lower than 5 ppm, nor salinities below 8 ppt, from 2001-2006 (an interval covering both wet and dry years).
- Submerged aquatic vegetation (SAV) beds: There is no VIMS record of SAV beds in the Lafayette River. Recent local knowledge by Workgroup members similarly indicates no known SAV beds. Therefore, no areas were excluded as restorable oyster habitat due to interference with SAV beds.

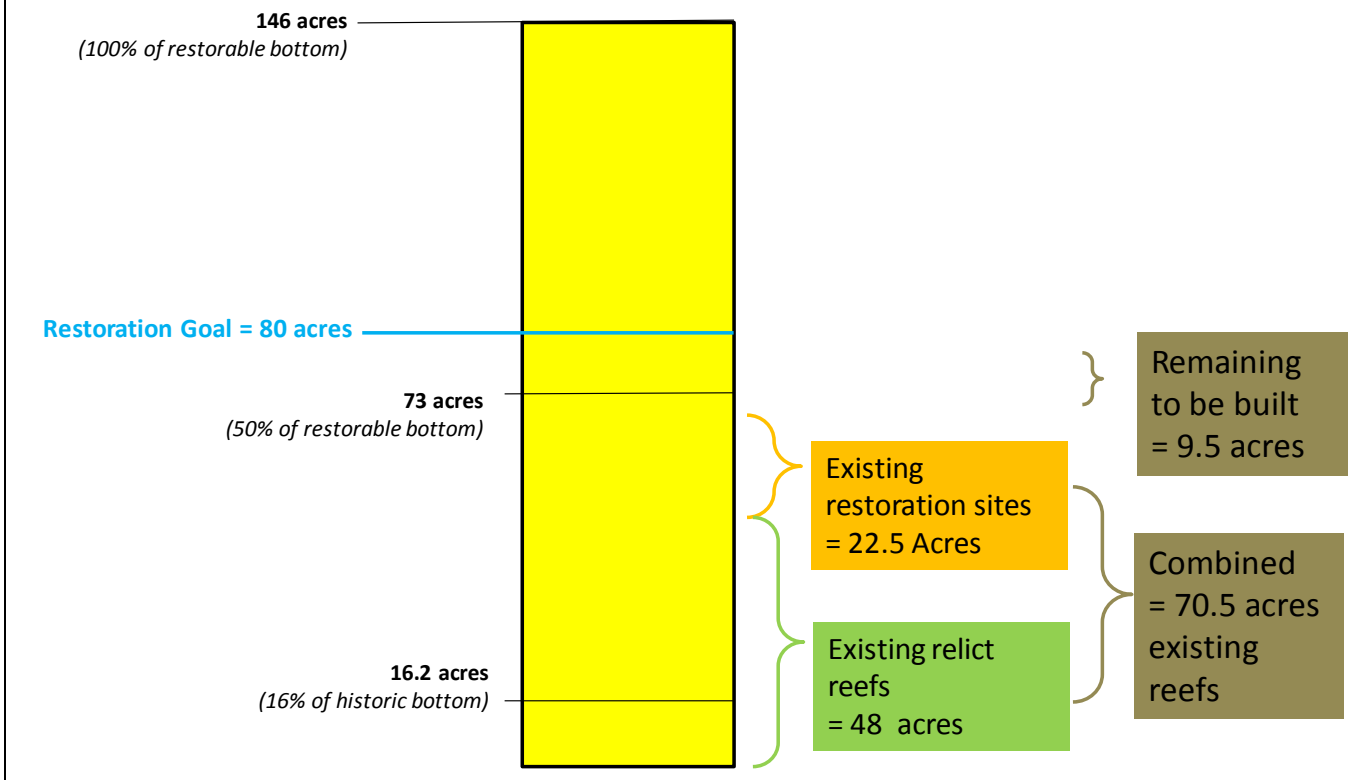
Using the above parameters defined by the Workgroup, NOAA staff developed a 'Restorable Bottom Analysis' and determined that 147 acres within the Lafayette River met the definition of 'currently restorable bottom.' Therefore, to meet the first prong of the Oyster Metrics definition of a restored

tributary, between 73 and 146 acres (50 to 100 percent of the 146 acres of 'currently restorable bottom'), will need to be restored (Fig. 3).

The second prong of the Oyster Metrics success criteria calls for at least eight to 16 percent of the historic acreage of oyster reefs in the river to be restored. In the Lafayette River, per the USACE Native Oyster Restoration Master Plan, 16 percent of historic reef acreage is estimated at 16.2 acres. Thus, meeting the first prong (73 to 146 acres) will also meet the second prong (16.2 acres) (Fig. 3).

Once the Workgroup had determined that the restoration goal range was 73 to 100 acres, its next task was to set a specific goal within that range. By consensus, the Workgroup agreed on a goal of 80 acres. This represents the minimum amount (73 acres), plus an additional ten percent acreage to ensure that the minimum will be met, even if some restored areas eventually fail to meet the reef-level Oyster Metrics success criteria. Given the 80-acre goal, and the 70.5 acres of existing reefs in the river (48 acres of relict reefs, and 22.5 acres of restored reefs), this leaves a balance of 9.5 acres still to be restored (that is, the 80-acre goal minus 70.5 acres already restored = 9.5 acres remaining to be restored) (Fig. 3).

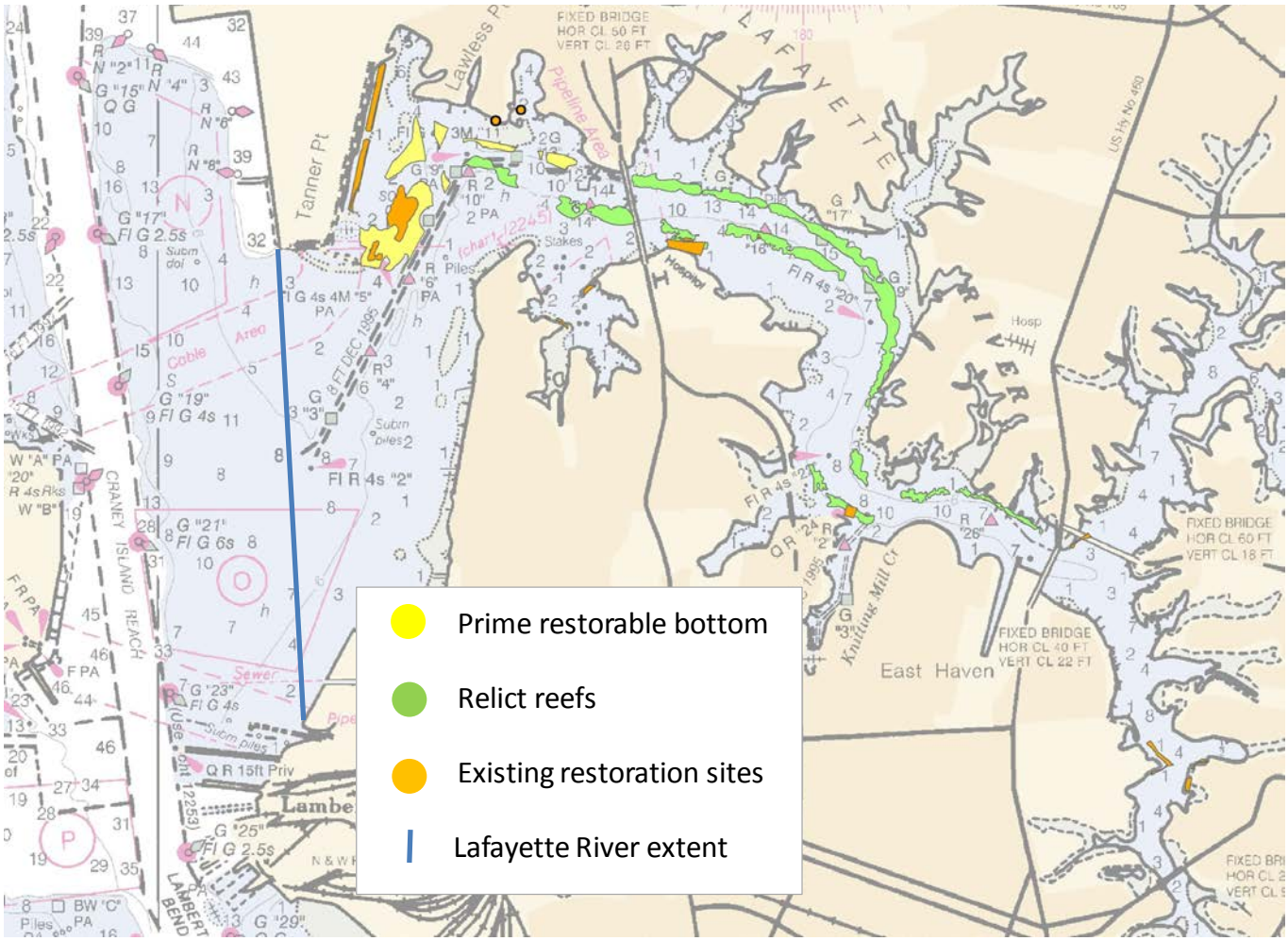
Figure 3: Schematic of Lafayette River oyster restoration goal.



Section IV: Areas Selected for Oyster Restoration and Plans for Implementation

The Workgroup determined which areas within the River are most suitable for oyster restoration (deemed 'prime restorable bottom'; Fig. 4). This area is a subset of the 'currently restorable bottom,' per the parameters listed in Section III. The selection was based on: larval transport; consensus; and proximity to navigation channels, aids to navigation, bridges, pipelines, and cable crossings (including appropriate buffers). The 'prime restorable bottom' area will be used as a general guide; actual project implementation may occur adjacent to, or slightly outside of, the prime restorable bottom, so long as the area is suitable for restoration.

Figure 4: Map of the Lafayette River, showing existing restoration projects, relict reefs, prime restorable river bottom, and the river boundary.



The following work is planned to complete the remaining acreage on the Lafayette River:

• The City of Norfolk will construct approximately 1.5 acres of reefs in 2017 with funding via NFWF's Hurricane Sandy Coastal Resiliency Program. These acres were already accounted for in the 70.5 acres of existing oyster projects on the Lafayette, as funding and plans have been in place.

• ERP plans to construct 4.5 acres of reefs in 2017, with funding from NOAA and NFWF. These will incorporate strips, or windrows, of substrate across each reef site, and a new design to provide structural complexity while maximizing substrate and minimizing cost. A similar design has been used successfully for oyster restoration in Texas, and is also being used in Virginia's Piankatank River. CBF, with funding from NOAA via NFWF, plans to place reef balls between the substrate strips on these 4.5 acres. This project is slated to be constructed in two sections, just inside Tanner's Point, near the Norfolk International Terminal.

• ERP and CBF are seeking funds to construct and seed the final 5.5 acres of oyster reefs needed to restore the river. The Lafayette Workgroup is providing guidance on the reef designs, which will also likely include the use of substrate 'strips.'

When completed, these restoration projects will result in the Lafayette River becoming Virginia's first restored tributary under the Chesapeake Bay Watershed Agreement oyster outcome. The WorkgroupWorkgroup recognizes that, once the Lafayette is considered restored per the Oyster Metrics criteria, there will still be ecological and social value in doing additional oyster restoration work in the Lafayette River. Continued future efforts in the tributary are encouraged by the Workgroup.

Section V: Cost Estimate and Time Frame for Completion

The Workgroup, assisted particularly by ERP, initially developed a cost estimate of $1.35 million to complete the remaining 9.5 acres on the Lafayette River. This estimate has been reduced substantially by plans to place strips, or windrows, of reef-building substrate across a site, rather than covering the full site with substrate.

The four-acre project planned by CBF and ERP for construction in summer 2017, using a windrow design, will cost $300,000. As of summer 2017, CBF and ERP are seeking funds to construct the final 5.5 acres of oyster reefs needed to restore the river. The cost estimate for these 5.5 acres is approximately $500,000. These two projects together total 10 acres, which is one-half acre more than the 9.5 required to complete the river. The in-water cost for the two projects combined (10 acres) is estimated at $800,000 ($300,000 for the 4.5-acre reef CBF and ERP will build in summer 2017, and $500,000 for the 5.5-acre reef for which CBF and ERP are seeking funding).

Construction of the 4.5-acre project is under way as of the drafting of this document. Construction of the remaining 5.5 acres is dependent upon funding. Assuming funding is procured, the 5.5-acre reef could likely be completed in 2018 or 2019.

Section VI: Public Outreach

The Lafayette River Oyster Restoration Workgroup, which drafted this plan, is comprised of representatives from local watershed groups, scientists, and personnel from local, state, and federal agencies. The group represents an array of viewpoints and stakeholders, and their ideas were incorporated into this plan. Additionally, CBF and ERP have consistently worked with the local community on the siting of specific oyster restoration projects, and have continued to do so for the remaining 9.5 acres of projects planned for the river. Input received from the local community was incorporated into this plan, and into the project designs for the remaining 9.5 acres. This included focusing restoration efforts in the lower, wider portion of the river to minimize navigational impacts, and moving the 9.5 acres of planned reefs farther away from the navigational channel than originally planned.

Section VII: Monitoring

VII.1 Monitoring Relative to Oyster Metrics Success Criteria

The main objective of monitoring efforts in the Lafayette River is to determine if restored reefs can be considered successful per the Oyster Metrics standards. According to the Oyster Metrics report, several biological parameters (oyster density, oyster biomass, and presence of multiple year classes), and structural parameters (reef height, reef areal extent, shell budget), should be monitored to determine reef-level success. For each parameter, the Oyster Metrics report recommends the assessment protocols and monitoring intervals described in Table 1.

Table 1: Reef-level success criteria for oyster restoration projects (adapted from the Oyster Metrics report).

Goal	Success Metric	Assessment Protocol	Frequency
Significantly enhanced live oyster density and biomass	*Target:* An oyster population with a minimum mean density of 50 oysters and 50 grams dry wt/m^2 covering at least 30% of the target restoration area at 3 years post restoration activity. Evaluation at 6 years and beyond should be used to judge ongoing success and guide adaptive management. *Minimum threshold:* An oyster population with a mean density of 15 oysters and 15 grams dry wt biomass/ m^2 covering at least 30% of the target restoration area at 3 years post restoration activity. Minimum threshold is defined as the lowest levels that indicate some degree of success and justify continued restoration efforts.	Patent tong or diver grabs	Minimum 1, 3 and 6 years post restoration
Presence of multiple year classes of live oysters	Minimum of 2 year classes at 6 yrs post restoration.	Patent tong or diver grabs	Minimum 3 and 6 years post restoration
Positive shell budget	Neutral or positive shell budget.	Quantitative volume estimates shell (live and dead) per unit area	Minimum 1, 3 and 6 years post restoration
Stable or increasing spatial extent and reef height	Neutral or positive change in reef spatial extent and reef height as compared to baseline measurements.	Multi-beam sonar, direct measurement, aerial photography	Within 6 -12 months post-restoration, and 3 and 6 years post restoration

In keeping with the Oyster Metrics report, and assuming funding can be secured, these parameters will be monitored on Lafayette River oyster reefs, likely in partnership with scientists, nongovernmental organizations, private contractors, and government agencies. Results will be used to determine reef success and to implement adaptive management actions as necessary.

VII.2 Diagnostic Monitoring

In addition to monitoring to evaluate restored reefs per the oyster metrics criteria, it is wise to include further monitoring that will help determine the causes of the success or failure. These are deemed "diagnostic" monitoring parameters. These include water quality and oyster disease parameters. Understanding these parameters alongside metrics of restoration success will allow practitioners to understand not only whether or not the project succeeded, but why. Water quality will be monitored using the two existing Chesapeake Bay Program water-quality monitoring stations on the Lafayette River (stations #LFA01, downstream near Lawless Point, and #LFB01, upstream, just below the Granby Street Bridge). Oyster disease information will be obtained where available from VMRC and various academic and research programs.

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