Biohabitats
Incorporated

The Stables Building
2081 Clipper Park Road
Baltimore, Maryland 21211
410.554-0156
410.554-0168 (fax)

MEMORANDUM

Date: October 10, 2011

To: Kim Boris and John Boris, Oyster Harbor
Claire Dillon and Board of Directors of Oyster Harbor Citizens Association
Lindsay Vacek and Brendan McIntyre, National Fish and Wildlife Foundation

From: Phil Jones, PE, Ed Morgereth, and Sarah Roberts, Biohabitats, Inc.

RE: Oyster Harbor Natural Drainage Assessment and Planning Project

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This memorandum provides a series of observations and recommendations related to drainage improvements, water quality treatment, and habitat enhancement in Oyster Harbor. Field visits and homeowner meetings between March and October 2011 served as the basis for this effort, which is funded by the Technical Assistance Program of the National Fish and Wildlife Foundation (NFWF).

INTRODUCTION

Background

Oyster Harbor is a private community located in Anne Arundel County, Maryland on Annapolis Neck. The community is bordered by Fishing Creek, Oyster Creek, and the Chesapeake Bay. Over 400 homes on 12 streets are located on approximately 100 acres. Arundel-on-the-Bay Road is the main road through the community.

Within the community boundaries, elevations range from 0 to 19 feet with an average of approximately 6 ft. High points are clustered along and east of Arundel-on-the-Bay Road. Areas with elevations of 0 to 2 ft are primarily located at the southwest corner of the community boundary at the head of Fishing Creek. The east side of the community generally has greater topographic relief. Land cover within the community is generally a mix of turf, impervious cover (roof and roadway), tree canopy, and residential landscaping. In addition, the west side of the community contains contiguous areas of forest, freshwater or non-tidal wetlands, and tidal marsh at the head of Fishing Creek.

The aim of this study is to perform assessments and offer recommendations for natural drainage improvements within Oyster Harbor to address ponding and watershed impairments from uncontrolled stormwater runoff. The list of recommended retrofit sites included in this memorandum emphasizes projects that have relatively high impact and high visibility, many of which are in the right-of-way. These projects can be pursued through additional grant funding for assessment, design and construction; or in conjunction with county-funded drainage improvements. However, many of the on-lot retrofit concepts discussed below can be implemented at relatively low cost by homeowners or volunteers.

As in many low-lying coastal communities, stormwater management in Oyster Harbor is currently limited to a system of roadside drainage swales and driveway culverts of varying design and functionality. In addition, the east side of the community has a small number of inlets and short storm drains segments along Washington Drive.

The nature of uncontrolled runoff and standing water varies by location and ranges from isolated nuisance conditions to systematic drainage issues that can create road safety hazards such as winter icing. The primary causes of standing water are undersized or non-functioning roadway drainage networks, and, on the west side of the community, interaction with tidal and non-tidal wetlands. Low topographic relief compounds these drainage issues.

Persistent roadway ponding in winter on Creek Drive

Soils and groundwater also play an important role in Oyster Harbor's hydrology. Initial assessments by Biohabitats found significant spatial variation in soil texture and depth to groundwater. As a result, site-specific investigations are highly recommended for each retrofit design. Soil texture (e.g., clay, silt, sand) and depth to groundwater affect the rate of infiltration and the below-grade storage capacity, which in some areas may be too small to provide a significant source of volume reduction. In winter months, saturated soils and a high groundwater table will further reduce infiltration capacity, leading to persistent ponding. When infiltration is not significant, conveyance will typically be the most practical way to alleviate ponding. At the same time, evapotranspiration should not be overlooked as a means to reduce runoff volume, primarily in the growing months. A key element of the water cycle, evapotranspiration is the loss of water through the combined effects of evaporation and plant transpiration. Revegetating with native vegetation will maximize the potential for evapotranspiration. Selection of vegetation appropriate for each site depends in part on local moisture levels, which in turn are affected by soil texture and depth to groundwater.

Restoring natural hydrologic processes and improving water quality is another key goal of this assessment. The current drainage network emphasizes conveyance, which is appropriate and necessary. As in many communities, however, the focus on conveyance allows non-point source pollutants such as oil and grease, nutrients, bacteria, sediment, and metals to reach local wetlands and waterways with little or no treatment. The community has numerous opportunities to move beyond straightforward conveyance improvements and make meaningful reductions in runoff volume and pollutant loads through processes such as filtration, shallow or deep infiltration, and evapotranspiration. Every improvement to the drainage network represents a chance to provide water quality treatment and volume reduction through low impact development techniques such as bioretention, pocket wetlands, and conservation landscaping. By doing so, Oyster Harbor will reduce its stormwater impacts to the Bay while providing community landscape amenities.

Coastal resiliency

The notion of coastal resiliency underlies all of these efforts. Coastal resiliency includes considerations such as adapting to sea level rise, managing for the increased frequency and magnitude of storms, reversing the trend of habitat loss, controlling invasive species, and strengthening natural hydrologic processes. By pursuing these goals, coastal communities will increase their ability to withstand future storms, strengthen property values, minimize reliance on expensive infrastructure, and contribute to overall Bay restoration.

NATURAL DRAINAGE OBSERVATIONS AND RECOMMENDATIONS

Conveyance along streets

The system of roadside swales and driveway culverts is critical to drainage in the community. The east side of Oyster Harbor generally drains to the large swales along Shore Drive or the boat launch, or to a series of outfalls along Washington Drive. Where present, outfalls on the west side of the community generally serve individual streets and drain to Fishing Creek.

Many roadside swales in Oyster Harbor have been filled with stone, leading to flow along the edge of the roadway during storm events, followed by ponding afterward. Driveway culverts that are undersized or not functional (e.g., crushed) also contribute significantly to the problem. These conditions have greatly reduced the capacity of the primary local drainage network, causing runoff to instead follow the roadway edge in a somewhat haphazard fashion. An underperforming drainage network is especially problematic in winter, when infiltration and evapotranspiration are low, making conveyance even more important.

Stone-filled swales on Cross Drive

Systematic drainage problems generally result from a combination of an inadequate drainage system and very low relief, as observed on Fishing Creek Road, which has an average slope of 0.7%. Drainage on these streets could be significantly improved by restoring the capacity of existing swales and repairing driveway culverts as needed.

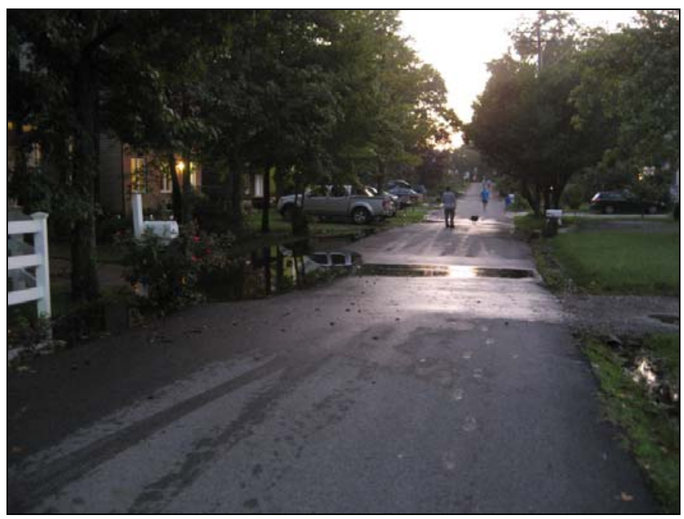
By contrast, several streets appear to have relatively good drainage, despite having filled swales, because they have adequate relief. Examples include Cross Road, Louis Avenue, and Booker Road. Nevertheless, the swales on these well-drained streets provide a valuable opportunity to alleviate drainage problems and water quality impacts downstream. As discussed in the swale retrofits section, integrating bioretention or wetland features into these swales will help to provide distributed stormwater management in the community.

A third scenario involves streets that either have no roadside swales or have swale segments that are not connected. These streets do drain despite the drainage limitations, but ponding may persist in depressions long after the storm. The roadway edge is generally the low point in the roadway cross-section, collecting water that drains from the crown of the road on one side and the lot on the other. In the absence of an adequate outlet (e.g., roadside swale), subtle elevation differences such as the roadway edge and crown create local depressions that trap water. Such depressions are often either paved or compacted and sparsely vegetated from tire movement, limiting infiltration. Sump pump drainage, if present, will also exacerbate ponding.

Examples of streets that lack swales or have disconnected swales include:

- Creek Drive: The open swale on the north side of the road ends at the edge of the community-owned Harbor lots. Beyond this point and in front of 1276 Creek Drive, flow crosses to the preferential flow path on the south side of the road.
- Eastern half of Ellis Road: This half of the road has little relief, with a slope of approximately 0.6%. The south side of the road lacks drainage swales, causing flow to cross to the north side of the road in front of 1413 Ellis Road. The swale on the north side feeds into the Shore Drive swale, which is the ultimate drainage point for both sides of Ellis Road.
- Arundel-on-the-Bay Road between Thomas Point Road and Louis Avenue: The ground in this area slopes very gradually to the north-northeast toward the head of Oyster Creek. However, the north side of the road lacks a roadside swale or any other defined outlet for runoff, leading to ponding along the roadway edge.

The most comprehensive approach in these areas, but also the most expensive, would be to expand the capacity of the drainage network. One key measure would be to remove stone from the swales, and at a minimum stabilize the swale and restore its original cross-section. (The stone may be suitable for re-use as a permeable pavement base course.) In addition, culverts could be installed to carry flow under the road instead of across it. However, the cost and complexity of such projects would likely be high because of vertical and horizontal constraints. A relatively low impact alternative would be to explore the use of a rolling dip to convey water across the road. To avoid ponding, the dip would need a continuous slope across the width of the road.



Drainage on eastern half of Ellis Road

If changes to the drainage network or road surface are not practical, chronic nuisance ponding at the roadway edge can be managed through source controls such as small roadside bioretention cells or pocket wetlands. Minor regrading can be used to move the low point away from the roadway edge into an intentionally designed, vegetated depression that can dissipate captured water through shallow infiltration and vegetative uptake. These source controls can also be expanded to manage runoff from the roof or driveway. By necessity, these designs will often need to occupy both the public right-of-way as well as a portion of the private lot. Other on-lot measures such as rainwater harvesting, turf replacement with conservation landscaping, and redirecting sump pump outflow will also help to reduce the volume of runoff that collects at the roadway edge.

Swale water quality retrofits

Every roadside swale project should be approached not only as a means to improve conveyance, but also as an opportunity to integrate water quality treatment into the landscape. When an undersized or rock-filled swale is expanded or restored, a linear bioretention or wetland feature can be incorporated into the project if space allows. These designs will provide upland source control for the adjacent roadway, reducing the volume and pollutant load of runoff for small, frequently-occurring events. Other important benefits of this approach are enhanced biodiversity and habitat, as well as creation of community landscape amenities. Retrofits along the drainage network or within the right-of-way will generally require a higher level of planning, coordination, and design than projects within private lots.

The selection of a wet or dry system (i.e., wetland or bioretention) and the appropriate vegetation depends in part on the soil and groundwater table conditions below the swale. Another factor is the presence or absence of positive drainage downstream, which can be influenced by swale slope, condition of driveway culverts, or continuity of the drainage system. For instance, the swale at the southwest corner of the Harbor lot, adjacent to 1276 Creek Drive, is chronically wet in part because the swale has no outlet, other than sheet flow across the road. On the east side of the community, the relatively high relief and occasional presence of inlets and storm drains greatly increases the feasibility of underdrains and therefore bioretention.

Potential bioretention swale retrofit location on Louis Ave

The available space between the roadway edge and the lot line varies from nearly zero in some areas to over 15 feet in others. The potential for overlap with private lots will need to be addressed in swale retrofits. Bioretention cells or pocket wetlands can be graded as "bumpouts" from the main swale to gain additional storage and treatment, where feasible. Any designs adjacent to the roadway edge will need to minimize the potential for tire rutting: for instance, by placement of rocks. Depending on the size of the upstream contributing area and the slope of the street, these water quality features can be designed as a series of stable step pools (e.g., regenerative stormwater conveyance) to convey flows and minimize scouring.

On-lot stormwater management

On-lot stormwater retrofits such as bioretention, rain barrels and cisterns, pocket wetlands, and conservation landscaping are a critical tool for meeting larger stormwater management, water quality, and ecological restoration goals in Oyster Harbor. Given the physical and logistical challenges of retrofitting rights-of-way, such as narrow shoulder widths, driveways, and street trees, as well as the lack of opportunities for centralized stormwater management on paper streets and undeveloped or community-owned lots, the community should look to on-lot practices as a significant element of a holistic and comprehensive stormwater management strategy. Another benefit of on-lot retrofits is that many projects can be completed at relatively low cost using volunteer or homeowner labor. Permitting requirements will generally be low for projects with little site disturbance. Larger projects with more grading may require mechanical equipment, contractor labor, and potentially permitting approvals.

On-lot retrofits allow homeowners to provide source control of runoff from small, frequently-occurring storms (generally one inch of rain or less). They can improve existing drainage and ponding issues, provide habitat and visual amenities, and reduce chemical and energy inputs associated with turf maintenance. By managing runoff from roofs and driveways at the source, on-lot retrofits also help to alleviate overall drainage and water quality issues in Oyster Harbor.

Rain barrels and cisterns provide an opportunity for sustainable water collection and reuse. They can be placed on any side of the house where a downspout is present. If a certain location is highly desired for a rain barrel or cistern, it may be possible to relocate a downspout or re-pitch a gutter. A variety of commercial products for rain barrels, cisterns, and accessories such as flow diverters are available. The primary use for rain barrels and cisterns is rainwater harvesting for re-use in gardening, exterior washing (e.g., vehicles), or other non-potable uses. To ensure that collected water is used and storage capacity is restored before the next rain event, homeowners should ascertain whether they have a consistent use for harvested water during non-winter months. Rain barrels and cisterns can also be used as detention devices by collecting and slowly releasing rainwater.

Bioretention is one of the most popular low impact development techniques and can be adapted to a variety of settings and design constraints. Bioretention cells are vegetated filters that collect 6-12 inches of water and draw it down within 48 hours or less. Front yards are generally the most suitable locations for bioretention cells because overflow will drain to the street if the existing lot grading allows. Homeowners should investigate the potential for lot-to-lot drainage, especially for bioretention cells planned in side or rear yards.

Front yard bioretention cell, Cohasset Ave, Arundel-on-the-Bay

Bioretention cells are intended to act as dry upland systems, not wetlands. Accordingly, bioretention cells should not be placed in chronic "wet spots" on yards. Plants in bioretention systems must be tolerant of brief periods of total inundation as well as extended dry periods. The wettest-adapted wetland plants are not appropriate in bioretention systems. Given the observed presence of high groundwater and restrictive clay layers, homeowners are highly encouraged to perform a simple perc test using hand-dug test pits before committing to a bioretention design. Locations that infiltrate poorly will be more suitable for a pocket wetland or conservation landscaping with wet-tolerant plants.

Pocket wetlands can be an important alternative to bioretention cells in yards that have slow drainage. Existing, informal "wet spots" can be re-purposed as intentional landscape and habitat amenities through minor regrading and revegetation. Pocket wetlands can allow homeowners to sidestep drainage and grading projects that may be more expensive by working with the existing topography, soils, and drainage patterns on site. Wetland vegetation will have higher transpiration rates than turf, helping to reduce ponding. By holding water on the landscape, on-lot pocket wetlands also contribute to community-wide goals of reducing runoff volume, peak flow rate, and pollutant loading.

Conservation landscaping (e.g., Bayscaping) involves the replacement of turf with native grasses, perennials, and possibly woody plants. Native plants should be used whenever possible because they are best adapted to local conditions, providing resiliency and reducing maintenance demands. In addition to reducing chemical and energy inputs for turf maintenance, conservation landscaping creates habitat, restores native vegetation and suppresses invasive species, and helps to manage stormwater runoff by increasing evapotranspiration and the moisture-holding capacity of the soil. Plants may be selected to provide visual interest throughout the growing season; for instance, using plants that blossom at different times. Perennials and grasses can be left standing over winter to provide habitat and forage. They should be mowed in the spring (early April at the latest) before the start of new plant growth and bird nesting.

Wet meadow, Ann Arbor, MI. Credit: www.wetmeadow.org

Conservation landscaping may be pursued on a larger scale on private or community-owned lots to provide a contiguous area of native meadow. This will introduce a more naturalistic landscape design element that may be novel to some residents. A cared-for appearance can be instilled through selective mowing, in addition to the wide-scale mowing recommended in springtime. For instance, a mowed border or a series or mowed paths can be used to better define the boundary of the conservation landscape area and provide access.

The selection of wet-tolerant or dry-tolerant plants should be based on the existing drainage characteristics of the site. There may be variation in moisture levels within an individual site based on microtopography. Homeowners may also follow an adaptive management approach by observing plant success rates and modifying the planting plan accordingly. In some cases, selective soil amendments with compost or wood chips may be appropriate to improve growing conditions, although this will not typically change the basic moisture regime.

Filling of “wet spots” should be pursued with caution, as there are functional and potential regulatory implications. While such areas can undoubtedly be a nuisance, they may also have the unintended benefit of holding water on the landscape and providing distributed stormwater management. In some cases, persistent wet spots in front yards can be alleviated by restoring the capacity of roadside swales and providing adequate drainage away from the site. Sites should be evaluated on a case-by-case basis to determine if the ponding is primarily the result of inadequate lot grading or an indicator of wetland conditions.

Interaction with wetlands

A number of lots on the west side of the community are adjacent to wetlands. A non-tidal forested wetland is located between Arundel-on-the-Bay Road and Creek Drive, generally west of the Harbor lot. Two tidally-influenced wetland areas are located at the head of Fishing Creek. Properties adjacent to wetlands are characterized by low elevation and low relief as well as the potential for high groundwater and restrictive soil layers, such as clay. Ponding in rear and side yards is common, especially in winter months.

Managing the interaction with wetlands is arguably the most complicated challenge for homeowners in the community, requiring a balance between resource protection and increased utility of the property. In many cases, presence of water is intrinsic to the site, and to some extent inevitable without significant regrading. However, any grading or filling activities that are contemplated for a site should fully account for regulatory permitting, drainage, and ecological impact implications.

If the wetland jurisdictional status of an area is in doubt, homeowners are strongly encouraged to contact a wetland professional. Assuming that all applicable regulatory considerations are addressed, homeowners should adopt a policy of no net loss of wetlands on their property, including wetland function and water storage volume. Doing so will minimize downstream and lot-to-lot stormwater impacts, as well as habitat loss and fragmentation.

Backyard ponding in a lot adjacent to Fishing Creek

A common challenge is maintaining turf areas that have shallow surface ponding for many months of the year. One way to manage ponding while enhancing ecological function and habitat value is to replace chronically wet turf areas with conservation landscaping. Conservation landscaping projects help to reverse the trend of wetland loss and habitat fragmentation in coastal areas. Invasive species removal should be pursued at the same time where appropriate. Native plants used in conservation landscaping projects will generally have higher evapotranspiration rates than turf, reducing ponding more rapidly. In addition, they will significantly reduce the chemical and energy inputs to the site and help to maintain soil health and nutrient cycling.

RETROFIT CONCEPTS

The ten retrofit concepts presented below focus primarily on linear conveyance and water quality improvements (e.g., in the right-of-way). Several candidate sites for conservation landscaping are also identified. Most of these projects will require financial and logistical support from future grants and/or county agencies, but several can be implemented through homeowner or community funding and labor.

1. Ponding at north roadway edge on Arundel-on-the-Bay Road

1. Arundel-on-the-Bay Road (north)

Extending northwest from a local high point near Louis Avenue to the intersection with Thomas Point Road at the community entrance, this section of Arundel-on-the-Bay Road has very low relief (approximately 0.6%) and lacks a well-defined outlet. Overland drainage generally runs to the north toward the head of Oyster Creek. However, lot grading prevents roadway runoff on the north side of the road from easily flowing in that direction, leading to persistent ponding at the front of the lot or the roadway edge. A prime example is 3287 Arundel-on-the-Bay Road, where a lot spot at the front of the lot is hemmed in by two driveways, the house, and the road. Considering the relatively high speeds and traffic volume along this road, ponding along the roadway edge is a potential roadway safety hazard, especially in winter. The most comprehensive approach would be to pursue a county-funded drainage study along this section of road. A parallel effort would be to better manage ponding and move water away from the roadway edge by grading pocket stormwater wetlands into adjacent lots. Additional soil analysis could help to determine the extent to which infiltration can play a larger role in alleviating ponding. Close coordination would be needed with adjacent owners because the available width between the lot line and the roadway edge is approximately 5 feet or less.

2. Potential bioretention swale location on Booker Road

2. Booker Road – The shortest road in the community, Booker Road connects Arundel-on-the-Bay Road and Washington Drive. The southeast side of Booker Road is a good location for restoration of conveyance capacity and a water quality retrofit. A sewer line also runs on this side of the road, but apparently along the roadway edge, reducing the potential for a direct conflict. A culvert under Washington Drive is located at the downstream end of the swale. To restore capacity and provide water quality treatment, the swale can be re-configured as a bioretention swale with an open cross-section. An area approximately 125 ft long and 8 ft wide is available without driveway conflicts. The Booker Road swale receives runoff from approximately 270 feet of the north side of Arundel-on-the-Bay Road; accordingly, it would likely need to be designed as a series of stabilized step pools to avoid scouring.

A soil core taken at this site retrieved loam to a depth of 40 inches before finding evidence of groundwater. Although additional soil analysis is needed, this observation suggests that reasonably good infiltration capacity may exist along this swale. Alternately, an underdrain could be tied into the downstream culvert or catch basin to ensure adequate drawdown. This project could provide a model for other bioretention cells on the east side of the community. The catch basins in this area (e.g., near 1312 Washington Drive) provide an opportunity to construct bioretention cells with underdrains, which largely eliminates the dependence on existing soil conditions for adequate drawdown.

3. Existing grass swale along lot line, 1258-1260 Creek Dr

3. 1258-1260 Creek Drive – As observed in numerous locations in the community, a simple grass swale runs along the lot line between the two properties. Runoff ultimately crosses under Creek Drive and drains to the south. As a demonstration project and a model for wider implementation, the swale could be planted to create a linear wetland feature. The project is simple enough to be funded and constructed by homeowners or volunteers. The retrofit would provide water quality treatment for the contributing area, and the vegetation would help to reduce ponding through higher evapotranspiration rates. As with any project located entirely on private lots, homeowner interest and willingness to provide modest long-term maintenance, such as invasive removal and springtime mowing, is a prerequisite for moving forward.

4. Existing swale on north side of Arundel-on-the-Bay Road

4. Arundel-on-the-Bay Road (south)
The section of interest runs approximately 270 feet northwest from a crest near Howard Road to the intersection with Booker Road. Drainage from the south side of the road, where the sewer line is located, is picked up by a culvert near #3346 and conveyed to the southwest into the interior forested wetland. As discussed in the Booker Road swale concept, the swale north side of the road drains to the Booker Road swale. The bottom 200 ft of the north swale is an open section with frequent ponded water, likely resulting from a combination of soil and groundwater conditions, low relief, and potential obstructions in the culverts for

the Booker Road lots. No driveways conflict with this section of swale, although one fenceline creates a pinch point. This swale could be retrofitted as a wetland or bioretention swale (dependent on further soil and drainage analysis) with improved capacity. The project would require coordination with the county and homeowners on both Arundel-on-the-Bay Road and Booker Road, in part because the available right-of-way width between the lot line and roadway edge is minimal (approximately 5 feet). Retrofit implementation should be coordinated with any future county-funded drainage improvements along the road.

5. Potential conservation landscaping area over three lots

5. 1309 Washington Drive and adjacent lots
A large, contiguous area of mature trees with turf understory is a strong candidate for conservation landscaping/turf conversion. These three lots are held by the same private owner and span the width between Arundel-on-the-bay Road and Washington Drive. Two of the lots currently have no houses. The grass is well maintained. Owing to their contiguous and open nature, these parcels represent a unique opportunity for large-scale conservation landscaping on private lots in Oyster Harbor. Conservation landscaping would likely reduce maintenance demands significantly, as well as restore habitat and native plant diversity on the east side of the community. Dependent on owner interest and the prospect for development in the next five years, a conservation landscaping project could be pursued in phases and expanded over time. A cared-for appearance can be maintained by regularly mowing a border around the planted area. If desired, walking paths could also be mowed through the interior.

6. Harbor lot conservation landscaping – This community-owned site has good potential for a volunteer-driven conservation landscaping project. Any design would need to account for this area's occasional use as overflow parking during major storms or residents' parties, as well as potential plans for a basketball court. Areas not needed for parking could be revegetated as a conservation landscape to reduce energy and chemical inputs, provide habitat and native plant diversity, and serve as a model for conservation landscaping elsewhere in the community. This project could showcase both wet- and dry-adapted plant communities. The highest ground located at the center of the lot likely tends toward relatively well-drained upland conditions. The northeast and southwest edges of the property face the interior forested wetland and the Creek Drive swale,

6. Potential conservation landscaping area to left of swale

7. View downstream of lower section of Harbor lot swale

respectively, which are both low, frequently wet locations that would support wetland plants. Potential revegetation zones include the northeast lot line and the area to the southwest of the gravel parking lot. Conservation landscaping could be extended to the triangular portion of right-of-way across the street, located between Creek Drive and Harbor Drive, which is a local low point and chronically wet area.

7. Harbor lot swales – An open, grassed swale runs along the south side of two community-owned lots at the northeast corner of Creek Road and Harbor Road. The culvert for the parking lot driveway divides the swale into upper and lower sections. Both sections appear to have adequate conveyance capacity, but are strong candidates for water quality retrofits. A sewer line runs on the opposite side of the road. The upper section of the swale (140 ft) is relatively well-drained and could likely be retrofitted as either a bioretention or a wetland system, pending further investigation.

The lower section (180 ft) has persistent ponding after storms, especially in winter. The ponding is caused by a relatively high water table (measured at 11" depth in one location in September 2011) and a clay layer with low permeability. Any meaningful infiltration into the existing soils would likely be limited to shallow infiltration in the top 12-24 inches at most. In addition, as discussed above, the lower section of the swale lacks a true outlet. The swale ends at the first driveway downstream, forcing runoff to fill the swale and sheet flow across Creek Drive. In the absence of major drainage improvements to provide an outlet, the lower section can be managed as a chronically wet location and retrofitted as a linear wetland feature. In addition, wetland "bumpouts" can be graded to the northeast into the community lot to provide additional storage and treatment if desired. Replacing turf with native wetland vegetation is a key design element that will increase evapotranspiration, leading to more rapid volume reduction in the growing season.

8. Potential bioretention swale location on Washington Drive

8. 1337-1339 Washington Drive
This site is well-suited for a bioretention swale in the right-of-way. No swale currently exists at this location, although nuisance ponding was observed at the roadway edge. This project would be an example of swale creation primarily for the purposes of runoff source control and water quality treatment, as opposed to conveyance. The roadway slope in front of these two lots is minimal, avoiding the need for check dams. Further investigation is needed regarding potential conflicts with a sewer line on this side of the road.

9. 1311 Harbor Road – The southern half of this low-lying lot is dominated by Common reed (*Phragmites australis*), a non-native invasive species. Ponding also occurs regularly in the adjacent swales along Harbor Road and Fishing Creek Road, in part because the crowned roads act as berms. This site provides an opportunity both to remove invasive species and better manage ponding. Invasive species removal and native vegetation establishment is of particular interest at this site because of its proximity to the wetlands along Fishing Creek. Future investigations should determine the potential to re-establish positive drainage in the swale system, possibly in conjunction with comprehensive drainage and water quality improvements along Fishing Creek Road. Parallel with that effort, the southern end of the lot could be re-graded to pull ponded water away from the roadway edge and create a large pocket wetland with native vegetation. Property owner interest and approval is critical to moving forward with this effort. Pocket wetland creation could be extended to adjacent lots with similar areas of trapped water, such as 1317 Harbor Road, for interested owners.

9. Phragmites and ponding at southwest corner of lot

10. Fishing Creek Road – Roadway drainage is a significant problem along the entire road as a result of swales that are generally rock-filled, very low relief, and expected low infiltration capacity. The road drains west to Fishing Creek. A sewer line follows the middle of the road. The foremost objective of any project along this road should be to re-establish positive drainage and consistent swale cross-sections. As with other drainage improvement projects, water quality treatment – likely wetland as opposed to bioretention here – should be incorporated whenever feasible. The north side of the road has an unusually wide right-of-way width (15-20 feet or more) whose storage and treatment potential should be maximized. In particular, an approximately 300 ft long, 20 ft wide section of right-of-way on the east end of Fishing Creek Road has potential for storage and treatment because there are no driveway conflicts and two lots are currently wooded. Unfortunately, this section of road is also near the top of the local drainage area, limiting the volume that could be treated.

10. View west of ponding on Fishing Creek Road

CONCLUSION

Summary recommendations

The recommendations provided below may be used as a framework for future drainage, water quality, and ecological improvements in Oyster Harbor.

- With respect to drainage system improvements, place a priority on streets with low relief, including Creek Drive, Fishing Creek Road, and the eastern half of Ellis Road.
- Look for collaboration and cost-sharing opportunities with the county on roadways that lack adequate drainage infrastructure.
- Incorporate water quality treatment into all drainage system improvements.
- Pursue all efforts with an eye toward increasing coastal resiliency and wetland health.
- Look to both private lots and roadway rights-of-way for opportunities for runoff source control and water quality treatment.
- Maximize the ecological and water quality treatment benefit of projects on community-owned property, as well as their value as demonstration projects.
- Design retrofits and select vegetation appropriate to the soil and groundwater conditions at each site.
- Pursue a long-term goal of capturing and treating and/or reusing the water quality volume (runoff from the 1” event) from all impervious surfaces. Alternately, remove unneeded impervious cover.

Next steps toward implementation

The site investigation, needs assessment, and concept development described in this memorandum represent a first step toward effective implementation of retrofits that will serve the needs of the Oyster Harbor community. Community member support, funding resources, and materials and labor will be needed to implement any of the recommendations in this memorandum. Within the recommendations are project types that are geared toward implementation by homeowners within their own properties, collective community/volunteer efforts for shared open space, and a set of more complex projects that would require professional design, permitting, and contractor construction.

Some of the recommended drainage improvements, stormwater management practices, and greening initiatives can be accomplished with pre-planning, purchase of materials, and labor from homeowners or volunteers, including:

- Purchasing and installing cisterns or rain barrels to collect roof runoff for re-use
- Bioretention cell creation as amenities on community property or private lots
- Conservation landscaping (e.g., Bayscaping) including purchase, planting, and maintenance of native vegetation, with a focus on turf conversion to native meadow or woodland understory

More formal practices or facilities, such as larger bioretention cells, renovated drainage swales, and pocket stormwater wetlands will require additional engineering and feasibility studies, construction drawings, permitting, and contractor installation. Next steps for more complex projects include:

- Feasibility studies, hydrologic analysis, and structural/geotechnical analysis, as necessary
- Limited site-specific topographic and utility surveys (professional land surveyor)
- Preliminary and final construction drawings, specifications, and cost estimates
- Contractor bidding and procurement, and construction implementation and management

- Follow-up inspection, repair, and maintenance; and adaptive management based on monitoring and assessment

The natural- and water resources management challenges that Oyster Harbor is taking on require a great deal of vision, commitment, and collaboration among community leaders and supportive homeowners. Based on the ultimate community-wide benefit of finding solutions, the greatest cumulative value may be realized by partnering with other collaborators and leveraging available resources. One example is the support provided by the National Fish and Wildlife Foundation for this natural drainage assessment and planning project. Future support and funding may be available from:

- Chesapeake Bay Stewardship Fund – Small Watershed Grant Program – Full proposals for 2011 were due June 3, 2011. The 2012 Request for Proposals deadline is yet to be announced. (Brendan McIntyre: brendan.mcintyre@nfwf.org, 202-857-0166)
- Chesapeake Bay Trust Grant Programs – Community Greening (Deadline: December 9, 2011), and Restoration (Deadline: December 9, 2011)
- Grant Workshop – October 25, 2011 (La Plata Public Library) by the Chesapeake Bay Trust to learn more about funding opportunities available for environmental education, outreach, and restoration (Kacey Wetzel: 410-974-2941)

APPENDIX A – SOILS IN OYSTER HARBOR

Overall soil map unit coverage

The Natural Resources Conservation Service (NRCS) Soil Survey indicates that the majority of soils within the Oyster Harbor community boundary are Colemantown-Urban land complex, 0 to 5 percent slopes (CnB); and Annapolis-Urban land complex, 0 to 5 percent slopes (AuB); comprising 37% and 29% of the total community area, respectively. Other soil map units within the community boundary include:

- 4% Colemantown fine sandy loam, 0 to 2 percent slopes (CkA)
- 8% Annapolis loamy sand, 2 to 5 percent slopes (AoB)
- 7% Annapolis-Urban land complex, 5 to 15 percent slopes (AuD)
- 8% Udorthents, loamy, sulfidic substratum, 0 to 5 percent slopes (UxB)
- 7% Mispillion and Transquaking soils, 0 to 1 percent slopes, tidally flooded (MZA)

Annapolis and Colemantown soil series

Annapolis soil series, the major component of AoB, AuB, and AuD soil map units, is a well-drained soil in which water is readily removed from the soil, but not rapidly. The seasonal high water table in the Annapolis soil series is not within rooting zone long enough during the growing season to inhibit root growth. Annapolis typically has loamy textures including silt loam, silty clay loam, loam, clay loam, sandy loam, and sandy clay loam.

By contrast, Colemantown, the major component of CkA and CnB, is a poorly-drained soil in which the soil is wet at shallow depths either periodically or for long periods. Colemantown has more clayey textures in comparison to Annapolis including silty clay loam, silty clay, clay loam, clay, and sandy clay. Both Annapolis and Colemantown soil series have quartz rock fragments and iron stone fragments (iron rich material that has cemented together) throughout the soil profile.

Both the AuB and CnB soil map units have an urban land component, which in Oyster Harbor comprise the majority of the land area. The urban land component of the soil map unit indicates areas of soil disturbed by development activities (e.g., grading, filling) or covered by asphalt, concrete, buildings, and other impervious surfaces. No drainage class or texture is identified for the urban land component. As a result, site-specific soil investigations at the beginning of the planning and design process are particularly important in areas with urban land soil map units.

Other soil series

The Udorthents, the major component of the UxB soil map unit, indicate an area of disturbed soil that has been altered by excavation, filling, and other construction activities. Udorthents in the UxB soil map unit are a well-drained soil in which water is readily removed from the soil, but not rapidly. The seasonal high water table is not within the rooting zone long enough during the growing season to inhibit root growth. The UxB soil map unit typical has a sulfuric layer beginning between 18 to 80 inches below the soil surface. This sulfuric layer can create acidic conditions caused by sulfuric acid.

Mispillion and Transquaking soil series, the major components of the MZA soil map unit, are derived from organic material over estuarine deposits. The surface of these soil series are dominantly organic and then transition to clayey mineral textures in the subsurface. These soil series are both very poorly drained, with the seasonal high water table at or near the surface during much of the growing season. The soil map unit experiences very frequent flooding. The MZA soil map unit is mapped in the southwest corner of Oyster Harbor and is not expected to be relevant to drainage improvements or retrofit activities because of its distance from developed areas of the community.

Field investigation
Biohabitats performed a cursory soil investigation on September 29, 2011. Soil profiles 1 and 2 were observed at two locations in the lower section of the swale adjacent to the Harbor lot (Retrofit 7). Soil profile 3 was observed in the back yard of 1263 Creek Drive, next to the drainage swale that follows the western lot line. Soil profile 4 was observed on the east side of the community, adjacent to the Booker Road swale described in Retrofit 2. Field notes are reproduced on the following pages.

These initial assessments generally found a shallow groundwater table on the west side of the community (on the order of 1 to 2 feet) in conjunction with restrictive soil layers. The single sample observed on the east side revealed soil characteristics that are likely more favorable to infiltration. While the sample size is far too small to generalize, the observations on the west side of the community are largely consistent with soil mapping as well as observed drainage patterns and hydrologic behavior. At the same time, the findings reinforce the need for site-specific investigations at the start of the retrofit planning and design process, especially given the variable nature of soils in developed areas.

Recommendations for future actions
The most important soil characteristics to investigate at the beginning of the planning and design process are the water table elevation and soil texture. A very poorly-drained or poorly-drained soil will have a water table at or near the soil surface during much of the growing season, while a well-drained soil will have a water table lower in the soil profile. The location of the water table will influence the choice of retrofit approach and plant palette at each site. In regards to texture, the primary consideration is the amount of clay present in the soil.

Another important factor to note is the pH or acidity of the soils. Because some of these soil series, such as Annapolis and Colemantown, formed in marine sediments containing glauconite, there is potential for these soils to create acidic soil conditions when exposed to the air. In addition, the Udorthents have a sulfuric layer within the soil profile that can create acidic conditions due to the presence of sulfuric acid. Both situations may only be of concern if excavation is required and the soil is to be reused on site. Possible solutions may include furnishing soils from off-site, amending the salvaged soils, or selecting plants that can tolerate acidic conditions.

Although the typical characteristics of each soil series have been described above, it is strongly recommended that further on-site investigations be conducted prior to implementation. Soil characteristics observed at a particular location may differ from those indicated by the NRCS Soil Survey mapping. A soil profile description can be performed and a soil sample can be taken for basic soil testing using a test pit dug with a soil auger or a shovel. A soil profile description and basic soil test results can be used to help identify key factors such as soil texture and its variation with depth, presence of layers that may limit infiltration, evidence and extent of soil modification through land development, soil pH or acidity, and indicators of the seasonal high water table. The number and depth of soil descriptions or tests will depend on the size of the project and the degree to which soil characteristics are critical to the design. For a front or back yard project, two test pits dug with a soil auger or shovel will generally be sufficient.

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Project: Oyster Harbor
No:
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Subject: Site Visit - Soil Investigation
Completed By: SMR

Location: 36' downstream from parking lot culvert outfall, bottom of swale

Sample #1 taken @ 3-18"

Sample #2 taken @ 26-30"

OH Community Park @ Harbor Rd / Creek Rd

- 1st soil hole west of parking lot in swale
  - no surface water
  - mowed grass and herbaceous species
  - rained ~2 days ago
  - park was a dumping ground yrs. ago

Soil Profile #1

A 0-3" SL-L 10YR3/2 matrix
- no redox mottles

B1 3-17" SL-L 10YR5/4 matrix
10YR5/8 redox concentrations
- slight pick up in clay from surface

B2 17-21" SL-L 10Y 3/1 matrix
10YR5/8 redox conc. - few
- pockets of sand

→ B3 21-27" SCL N 3/1 matrix
7.5YR 5/8 + various colors of mottles
- significant increase in clay
- signs of ironstone forming

B4 27"+ SCL 5G 3/1 matrix
- start of H_2O table; no redox conc.

* watertable @ 28" below surface
* mapped in AuB - Annapolis - Urban land,
* soil profile similar to Colemantown

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Soil Profile #2 (further west in swale from #1)
*very similar profile in comparison to #1

A	0-2"	L-SL	10YR 3/2 matrix no redox mottles
B1	2-7"	L-SL	10YR 5/4 matrix
B2	7-12"	L-SL	10YR 3/1 matrix (w/ redox conc.) °increased moisture
→ B3	12-23"+	SCL-CL	5G 3/1 matrix (w/ redox conc.)

*profile next to 1.5" of ponding in lowest point of swale
*watertable at 11" below surface
*soil mapped in AUB; most similar to Colemantown series

Location: 76' downstream (N) of profile #1
1' E of bottom of swale to avoid ponding

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Project: Oyster · Harbor | No: | Date: 9/29/11
Telephone ☐ Meeting ☐ Notes ☐ Other: | File: | Page: 2
Subject: Site Visit - Soil Investigation | Completed By: SMR

Location: 1263 Creek Dr. back yard

Behind home next to drainage path on Creek Rd.

Soil Profile #3

A 0-11" L 10YR 3/3 matrix
B1 11-18" LS-SL 10YR 4/1 or 4/2 matrix
°increase in moisture
B2 18-24" SCL-L 10YR 5/4 matrix
7.5YR 5/6 redox. conc.
B3 24-28"+ SCL 5G 3/1 matrix
5YR 4/6 and 5/8 mottles
°pockets of sand
°signs of ironstone forming

* water table @ 24" below surface
* mapped in AuB or CnB; more similar to Colemantown

Brooker St. adjacent to rock lined swale

Location: 50' upstream (W) of Wash. Dr. culvert, upper end, 4' S of swale centerline
Sample #3 taken @ 8-14"
Sample #4 taken @ 24-34"

Soil Profile #4

A 0-7" L 10YR 4/3 or 4/4 matrix
no redox conc.
B1 7-14" SL 10YR 5/4 matrix (no redox)
B2 14-34" L-SCL 10YR 5/6 matrix (no redox)
B3 34-40" L-SCL 10YR 5/6 matrix (no redox)
°increase in clay content
B4 40-43" SCL 10YR 5/6 matrix
10YR 7/2 depletions (~20%)
7.5YR 5/8 conc. (~5%)
°redox features indicating water table reaches this horizon

* no water table observed

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APPENDIX B – PLANT LIST

A list of native plants suitable for retrofit and restoration projects in Oyster Harbor is provided below.

Canopy/Shade Trees
Acer rubra **Red maple**
Betula nigra **River birch**
Fagus grandifolia **American beech**
Liquidambar styraciflua **Sweet gum**
Nyssa sylvatica **Black gum**
Quercus alba **White oak**
Quercus coccinea **Scarlet oak**
Quercus phellos **Willow oak**
Quercus falcata **Southern red oak**
Quercus rubra **Northern red oak**

Understory/Flowering Trees
Amelanchier canadensis **Serviceberry**
Carpinus caroliniana **Ironwood**
Cercis canadensis **Eastern redbud**
Chionanthus virginicus **Fringe tree**
Cornus alternifolia **Alternate leaf dogwood**
Cornus florida **Flowering dogwood**
Oxydendrum arboreum **Sourwood**
Sassafras albidum **Sassafras**

Evergreen Trees
Ilex opaca **American holly**
Juniperus virginiana **Eastern red cedar**
Magnolia virginiana **Sweetbay magnolia**
Pinus taeda **Loblolly pine**
Chamaecyparis thyoides **Atlantic white cedar**

Shrubs
Baccharis halimifolia **Groundsel**
Calycanthus floridus **Carolina allspice**
Clethra alnifolia **Sweet pepperbush**
Cornus amomum **Silky dogwood**
Hammamelis virginiana **Witchhazel**
Hydrangea arborescens **Smooth hydrangea**
Ilex glabra **Inkberry**
Ilex verticillata **Winterberry**
Itea virginica **Virginia sweetspire**
Iva frutescens **Sweet pepperbush**
Kalmia latifolia **Mountain laurel**
Leucothoe axillaris **Coastal doghobble**
Lindera benzoin **Spicebush**

Morella pensylvanica **Northern bayberry**
Photinia pyrifolia **Red Chokeberry**
Rhododendron viscosum **Swamp azalea**
Rhus glabra **Smooth sumac**
Rhus typhina **Staghorn sumac**
Sambucus canadensis **Common elderberry**
Spirea tomentosa **Steeplebush**
Vaccinium corymbosum **Highbush blueberry**
Viburnum dentatum **Southern arrowwood viburnum**
Viburnum lentago **Nannyberry**

Grasses – Sun
Schizachyrium scoparium **Little bluestem**
Andropogon gerardii **Big bluestem**
Elymus canadensis **Canada wild rye**
Panicum virgatum **Switchgrass**
Muhlenbergia capillaris **Pink muhly grass**
Tripsacum dactyloides **Eastern gama grass**

Grasses – Shade
Chasmanthium latifolium **Northern sea oats**
Deschampsia cespitosa **Tufted hair grass**
Dichanthelium clandestinum **Deer-tongue**
Elymus virginicus **Virginia wild rye**

Herbaceous – Sun
Asclepias tuberosa **Butterfly weed**
Aster oblongifolius **Aromatic aster**
Echinacea purpurea **Purple coneflower**
Eupatorium dubium **Joe pye weed**
Liatris spicata **Gayfeather**
Lobelia cardinalis **Cardinal flower**
Monarda didyma **Beebalm**
Monarda fistulosa **Wild bergamot**
Penstemon digitalis **Foxglove beardtongue**
Penstemon digitalis **Foxglove beardtongue**
Rudbeckia fulgida **Orange coneflower**
Rudbeckia laciniata **Green-headed coneflower**
Solidago rugosa **Wrinkle-leaf goldenrod**
Symphyotrichum novae-angliae **New England aster**
Symphyotrichum novi-belgii **New York aster**
Verbena hastata **Blue verbena**
Vernonia noveboracensis **New York ironweed**

Herbaceous – Shade
Phlox maculata **Meadow phlox**

Phlox paniculata **Summer phlox**
Tiarella cordifolia 'Brandywine' **Tiarella**
Tiarella cordifolia var. collina 'Oakleaf' **Tiarella**
Aquilegia canadensis **Wild columbine**
Dryopteris marginalis **Evergreen wood fern**
Onoclea sensibilis **Sensitive fern**
Osmunda cinnamomea **Cinnamon fern**
Polystichum acrostichoides **Christmas fern**
Eupatorium rugosum **Snakeroot**
Solidago caesia **Bluestem goldenrod**