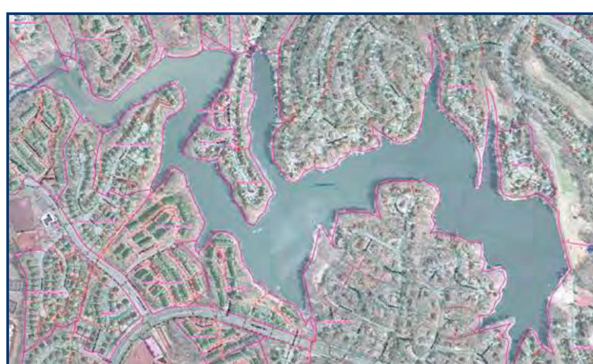
Lake Montclair

PRINCE WILLIAM COUNTY, VA

DEPARTMENT OF PUBLIC WORKS

Sedimentation Control Feasibility Study



July 2008

Whitman, Requardt & Associates, LLP
Engineers • Architects • Planners
9030 Stony Point Parkway, Suite 220
Richmond, Virginia 23235

TABLE OF CONTENT

List of Figures

List of Tables

1.0 INTRODUCTION

Prince William County contracted Whitman, Requardt and Associates, LLP (WR&A) to conduct an assessment study to determine the feasibility of reducing sediment loadings to Lake Montclair. The County initiated this study in responded to concerns expressed by the Montclair Property Owners Association (MPOA) about sedimentation of Lake Montclair.

2.0 PROJECT OVERVIEW

Lake Montclair is a privately owned lake encompassing 108 acres of surface water. It is located on the main channel of Powells Creek, with an upstream drainage of approximately 11 square miles. The lake was created in 1964-1965. Periodically, the lake is dredged to maintain a 4 foot minimum depth and 4:1 horizontal to vertical slope from the shoreline. Historically, the MPOA has dredged portions of Lake Montclair approximately once every 5 years. Sediment removal is a significant financial burden on the MPOA. The volume of sediment removed between 2001 and 2007 appears to exceed the historical rate of sediment accumulation. The MPOA is interested in the feasibility of using a forebay to reduce the cost of sediment removal from the lake.

This report includes:

- Overview of sediment transport and sources
- Review of dredging history
- Field assessments of upstream watershed conditions and conditions at proposed forebay locations
- Development of conceptual design and costs for three forebay options
- Summary and recommendations

3.0 OVERVIEW OF SEDIMENT TRANSPORT AND SOURCES

There are several conceptual approaches to controlling sediment entering Lake Montclair. The effectiveness of these approaches depends in part on the type of sediment reaching the lake and the sources of the sediment. Sediment loads to the lake enter in three different forms:

- **Wash Load** – Fine silts and clays which wash off the surface soil within the watershed and from stream bank erosion. Wash load tends to result in cloudy water, because these particles do not settle easily. In larger impoundments, there is often sufficient settling time to allow the materials to settle out.
- **Suspended Load** – Sands and small gravel (less than 8 mm) tend to become suspended during storm events, and can move a considerable distance downstream. These particles drop out of suspension easily once water velocities have subsided, as in the backwater of a lake or in a settling pond. This material is easily captured by traditional forebays in stormwater management basins or in small settling ponds. In larger impoundments, these materials tend to accumulate where streams enter the lake.
- **Bed Load** – Medium to large gravel and cobble which bounce and move slowly along the stream bed during a storm event. Bed loads can be very high in steep valleys where there is

sufficient gradient to push the large particles downstream. Bed load rarely makes up a significant component of a lake's sediment. These particles tend to drop out further upstream within the stream channel, often resulting in aggradation of the upstream channel over time.

Dredging operations in Lake Montclair typically remove the suspended loads that settle at the head of the lake, as well as the portion of the wash load that settles in the shallow areas of the lake. Some portion of the wash load settle in the deeper sections of the lake and are not removed during dredging. The bed load sediment is deposited upstream of the lake and is not removed by the dredging.

3.1 Natural Sources of Sediment Loads

Every channel has bed loads and suspended loads generated from natural internal erosion processes. These processes are essential to downstream channel processes and the health of the stream. Bed load movement of sediment is important for maintaining healthy riffle habitat, and to prevent down cutting or degradation of a channel. The point bars typical of meandering riffle / pool streams are the result of the movement of bed load.

The interruption of the flow of bed load with an impoundment may result in degradation of downstream channels. Sediment starved water becomes "hungry" for sediment and erodes their own bed and banks to replace the bed load removed by an upstream structure. The bed rock outcrops below the dam at Lake Montclair are an example of this process.

Some streams have a naturally high sediment load. Streams along the fall line often have sufficient slope to generate significant bed loads and suspended loads. As these streams reduce slope and enter the coastal plain, the channel loses the slope (or energy) needed to transport its sediment. This transition between steep piedmont streams and flat coastal plain streams is often a location for large natural accumulations of sediment. Many of the sand and gravel mines in Virginia are located along the fall line to take advantage of the abundant deposits of sediment. The construction of Lake Montclair near the fall line (i.e. I-95) resulted in a similar effect. The sediment from the upper Powells Watershed would normally drop out near the fall line, but instead it is dropping out in the lake.

3.2 Watershed Development and Increased Sediment Loads

The development of watersheds can generate additional loads of sediment above the normal or natural rate of base load and suspended loads. These sources may include:

Surface Runoff Loads

As forested areas are cleared for development, the exposed soils can be carried by sheet flow into streams. Long exposed slopes can become sources of sediment as rill and gully erosion transports sediment to adjacent streams. Erosion control practices, such as silt fences and settling basins, are intended to intercept eroded sediment and prevent it from entering waterways. The effectiveness of erosion and sedimentation control practices is directly related to the level of enforcement provided by the county who administers these regulations. Even with stringent enforcement, large storm events can result in failure of the erosion protection at a construction site, resulting in delivery of significant loads of sediment to adjacent streams.

After construction, most developed lands still produce sediment loads. These loads are typically intercepted by a stormwater management facility where the sediment is trapped. Routine maintenance of the BMP facilities is critical to the continued effective functioning of the stormwater facility. With proper stormwater management and maintenance of facilities, sediment loads from developed lands can be minimized.

Outfall Erosion

A potential source of sediment is from the erosion of any outfall that carries concentrated flows. Culverts and pipe outfalls often are not sufficiently protected to prevent scour and erosion. Downstream channels erode, creating headcuts that undermine the outfalls. Properly designed and maintained outfalls minimize the sediment load transported downstream.

Stream Channel Erosion

One consequence of urbanization is an increase in stormwater runoff. Stormwater BMPs are designed to reduce the peak flows and velocities, but typically do not reduce the total volume of stormwater runoff. Stream channels in developing watersheds adjust to the increase in storm flows by eroding their banks and beds. Typically, channels in developing watersheds may expand by 2 to 4 times in size, resulting in large quantities of sediment being transported downstream. Much of the eroded material may be trapped downstream by beaver dams, in the floodplain, or in impoundments such a Lake Montclair.

Stream channels with bedrock are much less susceptible to erosion, and those with low slopes and well connected floodplains are also less susceptible to erosion. However, many streams in the Piedmont tend to be slightly incised and have a combination of small gravel and sands which are easy to transport. Many watersheds in the Piedmont have excess accumulations of fine sediment in the floodplain from a combination of beaver and man-made dams which trap sediments behind them. The extent of historical dams in Virginia's Piedmont is poorly known, but studies in Pennsylvania indicate that most Piedmont streams were dammed at least once during the colonial era. This fine sediment stored in the floodplains is often called "Legacy Sediments". The increase in sediment loads observed during development of a watershed is often the erosion of the legacy sediments as channels adjust to the increased hydrology.

Techniques such as stabilizing outfalls with energy dissipating devices (level spreaders, step/pools), retrofitting existing BMPS to provide water quality improvement and flow attenuation, and restoring stream channels can help counter the impacts of watershed development on watershed hydrology and sediment loads.

3.3 Effect of Lake Montclair on Sediment Transport

Lake Montclair is located between the high sediment production watersheds of the Piedmont and the natural depositional locations of the upper Coastal Plain. The lake traps the sediment loads, both normal background and those loads generated by increased watershed development. The lake captures bed load, resulting in the channel downstream of the dam being "starved" of bed load (i.e. sands, gravel and cobble). Lake Montclair also captures a large quantity of fine sediments from the upper watershed which otherwise would have been delivered to lower Powells Creek, the Potomac River, and ultimately the Chesapeake Bay. The capturing of fine sediment is a important benefit of the lake to the downstream watershed.

4.0. REVIEW OF DREDGING HISTORY

In order to understand the nature of the sediment in the lake, and past efforts to control and remove the sedimentation, reviews were conducted of the past dredging efforts. WR&A met with the MPOA and obtained the following documents pertaining to dredging of the lake:

- Letter Report - **Location of Forebay Site in Lake Montclair**, dated February 26, 1996.
- **Summary Report of Lake Montclair Hydrographic Survey and Topographic Survey Services** prepared by Gahagan & Bryant Associates, July 2007.
- **Lake Montclair Dredging Plans**, prepared by Gahagan & Bryant Associates, 2007.

In addition, a telephone interview was conducted with Lake Services of Virginia, the firm which has conducted all of the dredging of the lake.

4.1 Review of 1996 Forebay Study Letter Report

The 1996 letter report identified three potential locations for a "forebay" at the head of the lake. In this study, the "forebay" was simply a deeply excavated (6-8 foot) area of the lake in the vicinity of the mouth of Powells Creek. Sediment loads would settle into the forebay through normal settling processes. The forebay would concentrate sediment to increase dredging productivity and lengthen the time between dredging operations, thus saving on mobilization costs. It would not reduce the volume of sediment removed, and the initial excavation would be an additional expense to the MPOA.

A "forebay", in the traditional use of the word, would be accessible from land allowing for the less costly land based excavation of accumulated sediment. The forebay would have stabilized haul roads and work areas to allow for efficient operation of the dredging equipment. Typical excavation equipment would have a maximum reach of 60 feet. The 1996 study identified two locations (#2 and #3) which would be accessed by land and meet the traditional definition of a forebay. Each of these proposed facilities was to have a storage capacity of 2,300 cubic yards (CY). An in-lake Location (#1) would not be accessible from the shoreline and would have a storage capacity of 3,200 CY. The letter report identified Location 2 as the preferred location. However, further considerations by the MPOA determined that the valley side slopes were too steep to permit access from location #2.

During subsequent dredging operations, an in-lake forebay (Location #1) was excavated from barge mounted equipment.

One of the constraints in dredging the upper end of the lake is a buried sanitary sewer which crosses the lake. The clearance over the pipe is 4 feet under normal water elevations, and the depth of a fully loaded dredge barge is 5 feet. All of the locations proposed in the 1996 report would be upstream of the sanitary sewer at the head of the lake, which would have require either a temporary increase in the elevation of the lake to allow barge access, or only partially filling the dredge barges.

4.2 Review of 2007 Dredging Plans and Results of Dredging

The planning for dredging in 2007 included a detailed bathymetric survey and dredging plan for the lake. The 2007 Hydrographic Survey Report identified an estimated 32,537 CY of sediment for potential removal. Of that amount, 16,795 CY (52%) was located at the head of the lake (dredging area A). The remaining 48% of the potential dredge material was located along the shorelines and coves of the lake. The sediment that was deposited at the head of the lake, where Powells Creek enters the lake, is generated from upstream sources. The sediment located in back of coves and along shorelines of the lake was delivered by the local drainage network of pipes, outfalls, culverts and channels.

The 2007 report outlines two options for prioritizing dredging of the lake. Option 1 proposed removal of 10,000 CY, of which 69% would be from upstream sources and 31% from local sources. Option 2 proposed removal of 18,000 CY of sediment of which 61% would be from upstream sources and 39% from local sources. Ultimately, the MPOA decided to dredge a total of 34,000 CYs. The percentage of locally generated sediment for what was actually dredged appears to be between 30 and 50% of the total dredge volume.

4.3 Interview with Lake Services of Virginia

Lake Services of Virginia conducted the dredging in the fall of 2007. Based on direction from the MPOA, Lake Services removed a total of 34,000 CY of material. During the award of the contract, the MPOA decided to expand the dredging work to include excavation of the full 34,000 CY of materials, and creation of an in-lake “forebay” or settling basin. The in-lake forebay was 180 feet by 90 feet and averaged 6.5-7 feet deep. The forebay can store up to 1,800 CY of material and still maintain a minimum of 4 feet of water depth. If it was allowed to fill to within two feet of the surface, it would hold 3,000 CY of materials.

From a dredging operator’s standpoint, the location of the forebay upstream of the sanitary sewer presents some operational constraints, but is still workable. Since mobilization of barge mounted equipment is required to dredge along the coves and shorelines, the use of an in-lake forebay or settling basin is not a significant additional cost compared to a land accessed forebay.

Based on Lake Services' observations, the majority of the dredge material has been fines with increasing sands at the head of the lake. Contrary to the dredging report estimates, Lake Services estimates that 80% of the dredge materials are coming from the head of the lake.

4.4 Estimating Annual Sediment Loadings

Dredging was conducted in 1991, 1996, 2001 and 2007. Lake Services of Virginia, who conducted all dredging operations on Lake Montclair, reported the following volumes:

1991	10,000 CY
1996	14,000 CY
2001	16,000 CY
2007	34,000 CY

The volume of dredge materials reported in the 2007 report is larger than in previous dredging efforts. The extent of dredging varied from year to year and most of the dredging plans were not based on actual bathometry. Therefore, direct comparisons between different dredging events are not accurate. In 2007, the head of the lake was dredged from shore to shore, including a forebay, while in previous years a much narrower channel was excavated. In addition, the 2007 dredging plan was the first comprehensive survey of the bathymetry of the lake, allowing a detailed accounting of sediment volumes removed.

It is the community's observation that there was an increase sediment accumulation between 2001 and 2007, compared to early dredging events. The community has cited a minor dam breach at Lake Terrapin and the widening of Spriggs Road as possible sources of the sediment. However, the increased volumes could be primarily the result of better survey information and a larger area of dredging in 2007.

Without a full survey of past dredging efforts, a fully accurate measure of annual sedimentation is not possible. Based on the 1991, 1996 and 2001 dredge volumes, a reasonable estimate of sediment accumulation which could be removed by dredging would appear to be 3,000 CY per year. There does appear to be an increasing trend in dredge volumes, which may or may not reflect an actual increase in sediment loadings from the upstream watershed. However it would be difficult to accurately quantify the increase given the other variables involved (changes in areas dredged, etc.).

5.0. FIELD ASSESSMENTS

Field assessments were conducted to identify potential locations and constraints to development of a forebay. Constraints could include environmental, infrastructure, and constructability. In addition, field assessments were conducted to determine local potential sources of erosion resulting in sedimentation in the lake.

5.1 Powells Creek from Lake Montclair to Spriggs Road (Subwatershed 720)

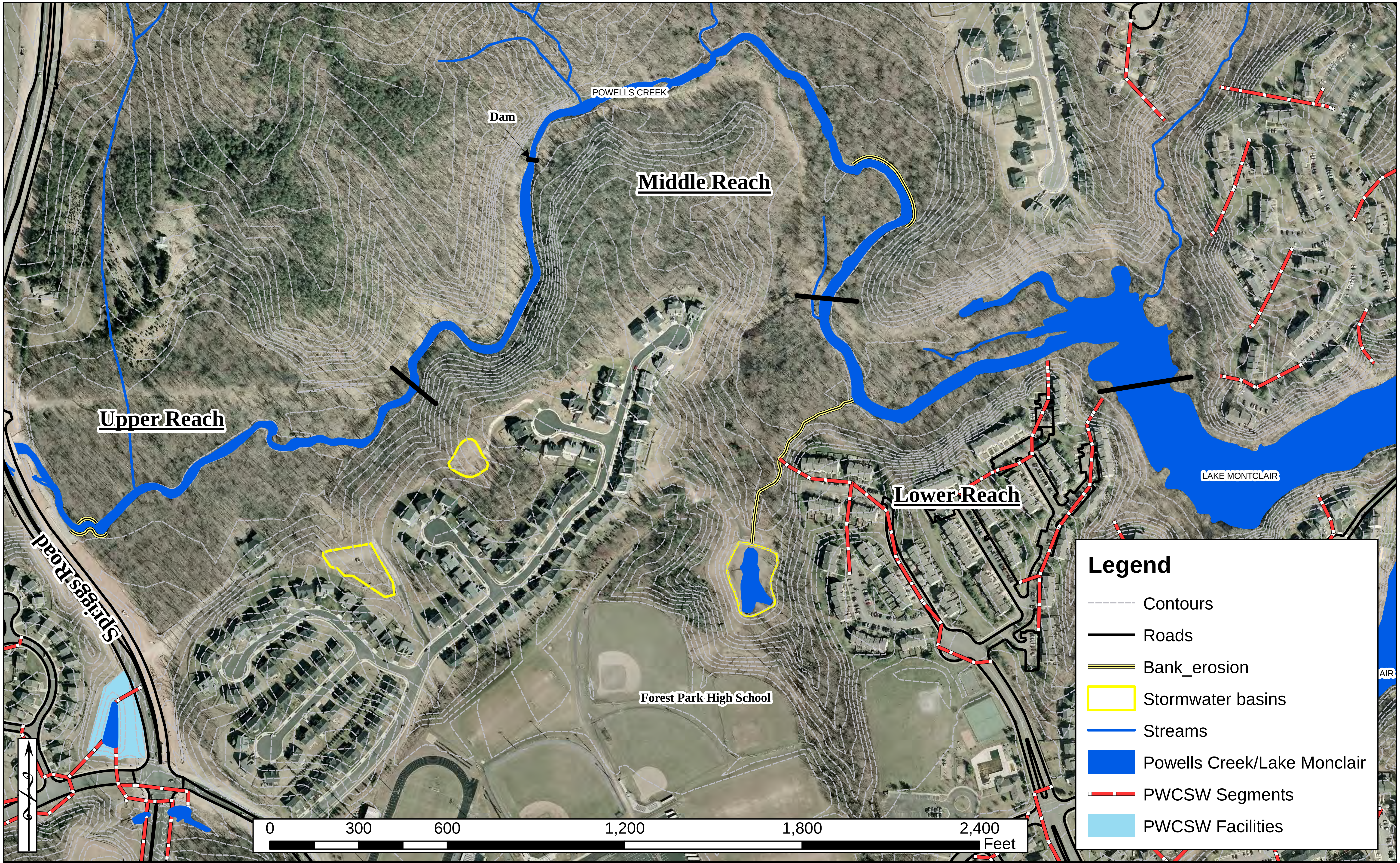
On October 16, 2007, staff from the County and WR&A conducted a reconnaissance of Powells Creek from Spriggs Road to Lake Montclair. The goal was to evaluate the overall stability of the channel and identify reaches, if present, that appear to be contributing significant volumes of sediment to Lake Montclair. The team also wanted to note other features which may affect future planning for a forebay. The length of stream channel was approximately 5,500 linear feet. The County's stream assessment data for subwatershed 720 were also reviewed.

Powells Creek has three distinctive reaches between Spriggs Road and Lake Montclair, as discussed below. None of these reaches appear to supply a significant volume of sediment to Lake Montclair. One side tributary was identified as unstable, and should be stabilized, but it provides a relatively small volume of sediment downstream. Figure 1 identifies the location of the reaches and features identified in the field review.

Upper Reach

The 1,400 foot reach immediately downstream of Spriggs Road has a wide floodplain with a slightly incised channel. The channel banks are moderately widened, but active erosion is limited. During large storm events, this reach has access to its floodplain. The floodplain probably was farmed historically, and the channel may have been straightened. The condition of the channel improves with distance downstream from Spriggs Road.

Upper Reach - Near Spriggs Road



Whitman, Requardt & Associates, LLP.
Engineers Architects Planners
7/1/2008

Source: Prince William County GIS

Location: Prince William County, Virginia

Figure: 1 Field Assessement of Powells Creek

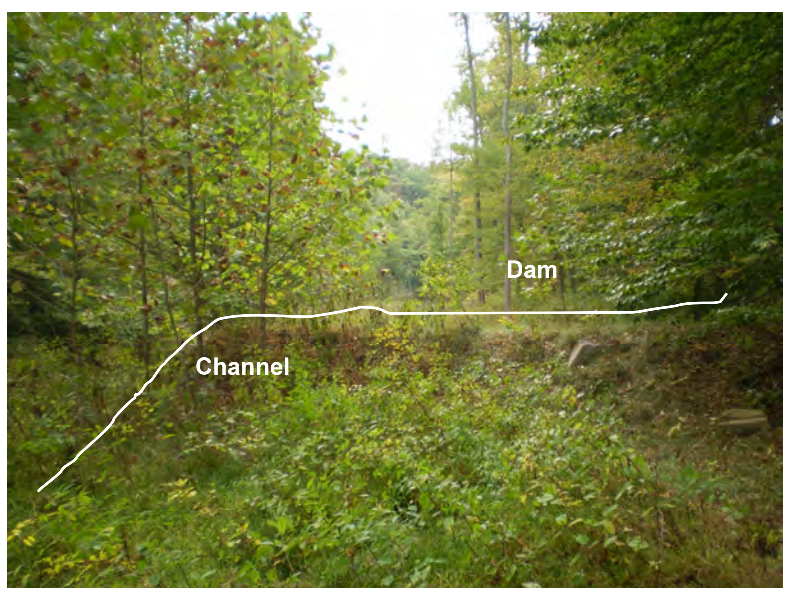
N:\45467-000\GIS\Powells Creek FieldMap

One relatively short reach was identified in the field as having eroding banks. This reach was also identified in the County stream assessment data. This reach may generate a minor amount of sediment from bank erosion, but it is probably offset by deposition along the banks and in the floodplain. This reach is not a major source of sediment to the lake. As the watershed continues to develop, this reach should be monitored for accelerating erosion.

Middle Reach - Bedrock and boulder section

Middle Reach

Located approximately 1,400 feet downstream of Spriggs Road, and extending 3,000 feet further downstream, the majority of the stream channel is heavily armored with bedrock and boulders. The stream valley is relatively narrow, with a narrow floodplain. Active deposition of fine sands was evident along the banks, but sediment storage in this reach is limited by its steepness and lack of floodplains. This reach transports the majority of its sediment directly into the lower reach and Lake Montclair. Because of the abundance of rock, this reach will probably remain stable as the watershed continues to develop.



Middle Reach - Old Dam Site

Within this reach an example of legacy sediment was identified. An old earth and rock dam is evident in the floodplain. When the dam was still functional, it resulted in deposition of sediment at an elevation in the floodplain behind it. The dam resulted in an increase in the floodplain elevation of about 4 feet over a length of about 400 feet. Approximately 3,000 CY of legacy sediment is stored in the floodplain. Currently, a utility line easement is located through this floodplain. The increased floodplain height

Middle Reach - Armored Bank

results in somewhat taller banks which may be more susceptible to erosion. However, rock excavated during the utility line construction has been used to line the stream bank, apparently providing adequate bank protection. This particular legacy sediment site is not an erosion source, but there may be others in the upper watershed.

A utility easement traverses the stream valley. Where the easement is located near the stream channel, the adjacent banks have been armored by native boulders to avoid bank scour.

Approximately 1,500 feet upstream of the lake there is a 300-400 foot long channel meander experiencing bank erosion. While the meander appears to be actively eroding, it is not significantly down cut or incised. There is an old farm ditch across the inner bend which is acting as a chute cut-off during high flows. The ditch provides some hydraulic relief to the eroding bend. Currently, this bend does not warrant stabilization efforts, but it should be periodically inspected to gauge its rate of change.

The outfall for Lake Terrapin occurs within this reach. Despite historical concerns with erosion and sedimentation from Lake Terrapin, particularly during it's breaching, the outfall channel is very narrow and stable with no evidence of erosion or excessive sediment. This BMP appears to be controlling outflow sufficiently to protect the receiving channel from scour.

Lower Reach

The lower 1,000 feet of channel prior to entering the lake is similar to the upper reach, with a wider channel and floodplain. The channel is flatter and there is no bedrock, which was abundant in the middle reach. The backwater from the lake extends approximately 1,000 feet upstream along Powells Creek channel. This reach of Powells Creek functions like an extension of the lake at low flows and as a stream channel during high flows. Turbidity from the lake can be driven up the channel by wind. The lake's backwater reduces stream velocities and sediment transport. While sediment in the middle reach is rapidly transported downstream, sediment in this reach is likely to be deposited in the channel, along the banks, and in the floodplains. The 3.2 acre floodplain along the northern shoreline appears to have been built, in part, upon depositional processes associated with the lake.

Stormwater BMP Outfall Channel at Forest Park High School

The channel draining from the BMP at the high school showed signs of erosion and failure. There was a headcut at the confluence with Powells Creek. Over most of its length, this channel was incised, and had poor bank vegetation. At the head of the channel, past efforts to stabilize this channel have failed. Riprap placed over geotextile fabric has been displaced and large areas of the geotextile are exposed in the bed of the stream. A stormwater outlet from Winding Creek Drive also outfalls into this tributary. Riprap has been dumped at this outlet to address past erosion problems, but stability issues still exist. The volume of sediment from this tributary was probably between 500 and 1,000 CY. This channel is exhibiting numerous signs of instability, which should be addressed in order to avoid additional degradation as well as additional sedimentation in Powells Creek and Lake Montclair.

Outfall Channel from High School Stormwater Pond

5.2 Watershed Upstream of Spriggs Road

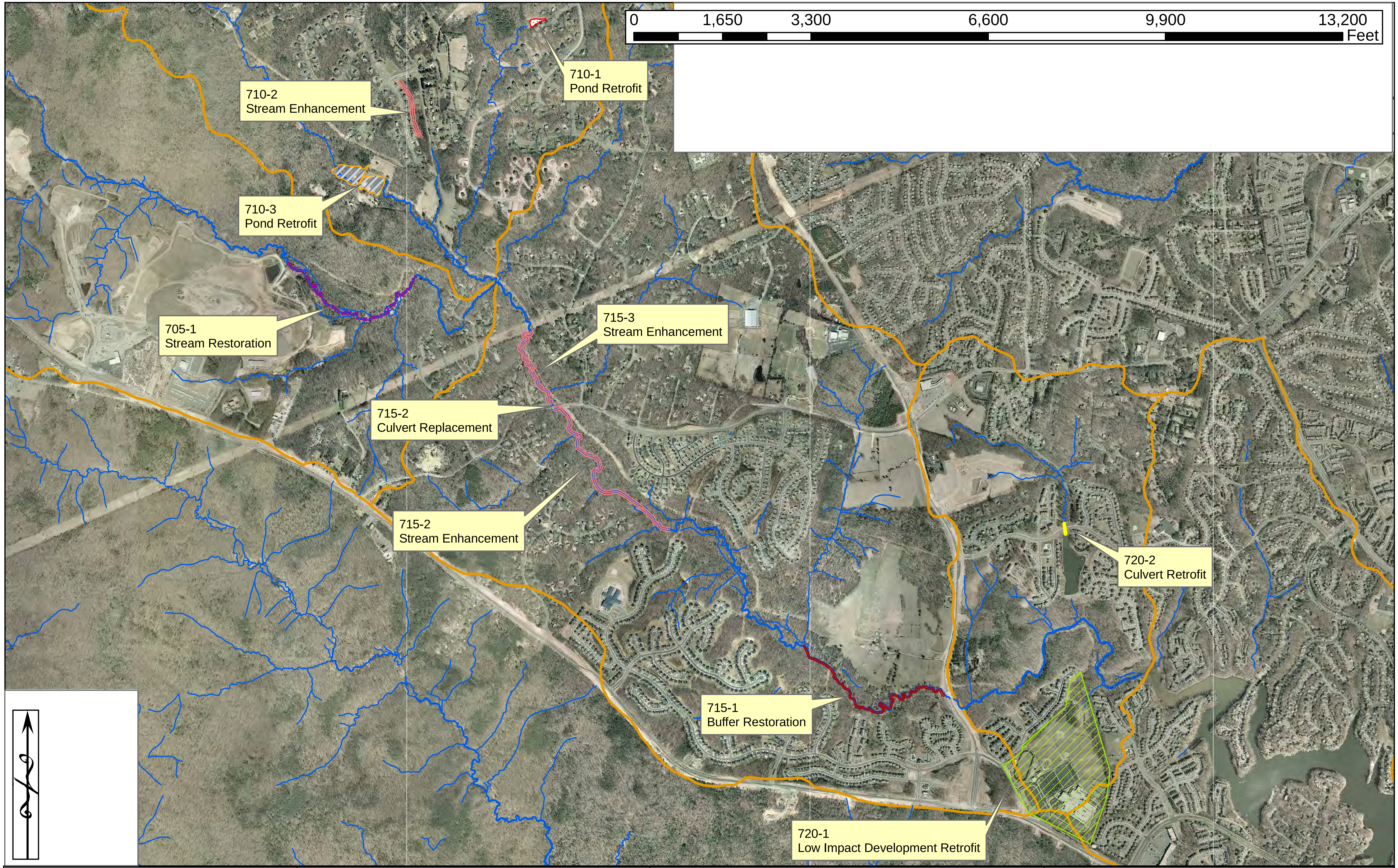
Since Powells Creek between the lake and Spriggs Road does not seem to be a generator of sediment through bed or bank erosion, efforts were extended to include the upper watershed of Powells Creek.

Review of the Draft Powells Creek Watershed Management Plan

To potentially identify areas of erosion generating sediment, the November 2007 Draft Powells Creek Watershed Management Plan, prepared by Baker Engineering, was reviewed. The watershed upstream of the lake is divided into four subwatersheds.

Subwatershed 720	From Lake Montclair to Spriggs Road
Subwatershed 715	From Spriggs Road to upstream of Minnieville Road
Subwatershed 710	Northwest Corner of Watershed Upstream 715
Subwatershed 705	Southwest Corner of Watershed Upstream 715

The plan provides proposed or recommended watershed management projects including riparian buffer enhancements, stream restoration and enhancements, culvert retrofits and replacements and pond retrofits (Figure 2).



Whitman, Requardt & Associates, LLP.
Engineers Architects Planners
7/1/2008

Source: Draft Powells Creek Watershed Management Plan (Baker Engineering (2007))
Prince William County GIS Data

Location: Prince William County, Virginia

Figure: 2 Potential Watershed Management Projects in the Upper Powells Creek Watershed

N:\45467-000\GIS\Powells_Creek_Watershed_Map

To supplement the Watershed Management Plan, the County's stream assessment data were also evaluated to help identify specific locations of erosion and sediment. The stream assessment data for subwatersheds 720 and 715 were reviewed. There were no data from subwatersheds 710 and 705.

Subwatershed 720 From the head of Lake Montclair to Spriggs Road

The Plan includes two projects within this subwatershed. Project 720-1 would be a Low Impact Development stormwater retrofit at Forest Park High School. No projects are proposed on the main channel of Powells Creek. The County stream assessment data and the field assessment from this study identified only limited erosion in the main channel. However, this study also identified an eroding stormwater outfall channel at Forest Park High School, which should be addressed as part of the stormwater retrofit proposed in the Plan. The second project (720-2) would be the construction of a culvert modification to create a forebay upstream of Lake Terrapin. This project would not benefit Lake Montclair, but would provide better sediment control for Lake Terrapin.

Subwatershed 715 From Spriggs Road to upstream of Minnieville Road

Subwatershed 715 is 3.45 square miles in area and composed of residential development, some of which is serviced with stormwater facilities. There are several large, undeveloped blocks of land which are currently undergoing development. Powells Creek extends from Spriggs Road upstream to Minnieville Road. This reach of channel contains numerous beaver dams which tend to trap sediment and to keep the channel connected to its floodplain. This reach of Powells Creek probably acts as a net sink for excessive sediment generated in the upper watershed. Possible exceptions to this would be when a large beaver dam breaches during a major storm event, and the stored sediment behind it is released and transported downstream.

The main channel of Powells Creek at Minnieville Road is dominated by a sand bed, which is a significant change from the reach downstream of Spriggs Road. Minnieville Road is downstream of watersheds 705 and 710, both of which appear to be generators of sediment. The fine sediments moving past Minnieville Road may become trapped by beaver dams along the main channel, become stored in the floodplain during major storm events, or potentially be transported past Spriggs Road and into Lake Montclair. More detailed studies would be required to better map the fate and transport of sediment in these watersheds.

Photo of Powells Creek downstream of Minnieville Road. The culverts are not aligned with the stream channel, and there is significant deposition of sediment within the culverts.

Subwatershed 710 Northwest Corner of Watershed Upstream of Subwatershed 715

Subwatershed 710 is 2.09 square miles in area and composed of primarily residential development. The Plan identifies three watershed management projects in this subwatershed. The most significant is a 9 acre pond which has filled with sediment and has fallen into disrepair (710-3). The Watershed Management Plan recommends repairing and retrofitting this pond to capture sediment from upstream sources, which may significantly contribute to a reduction in sediment loadings to Lake Montclair. This pond receives drainage from 615 acres, or approximately 8-10% of the watershed upstream of the lake. This project could provide reductions in long term sediment loadings to Lake Montclair, although its distance from the lake reduces its effectiveness. The other projects include a small pond retrofit (710-1) and a buffer project (710-2). Other ponds exist in this watershed and could be retrofitted to provide stormwater management and reduction in sediment loadings.

Subwatershed 705 Southwest Corner of Watershed Upstream of Subwatershed 715

Subwatershed 705 is 2.45 square miles, composed primarily of the County landfill operations and some residential land use. The Watershed Management Plan identifies one project within this Subwatershed. Project 705-1 consists of 3,500 linear feet of stream channel which warrant restoration efforts.

A brief field review of the stream channel directly inside of the landfill did not identify significant erosion issues. A number of the streams are dammed by beavers, which acts to trap sediment. Some areas of past erosion problems were reviewed and appear to be recovering quickly. Downstream of the landfill operations along the main channel of Powells Creek, the stream is experiencing alternating zones of incision and erosion. There appeared to be a high load of sediment in the channel from bank and bed erosion. A number of small headcuts were observed in the bed of the stream, indicating vertical incision was occurring. The bed is composed of a clay hardpan in many locations, which is prone to incision. The condition of the channel appears to reflect historical land uses and sedimentation along the floodplain. The main channel is relocated in a wide floodplain with deep, fine sediments. These sediments are unstable, probably being deposited by either beaver activity or historical mill dams. The stream is re-working the floodplain sediments, generating a large load of fine gravel, sand, and silts.

5.3 Local Sources of Sediment

The 2007 dredging report indicated that a substantial amount of the sediment identified for removal was located along shorelines and coves of Lake Montclair. Between 30% and 50% of the total volume of sediment identified was located along shorelines and in coves. The source of this material is from the local drainage area network within the Lake Montclair community.

To better identify the types of sources generating these sediment inputs, a representative sample of outfall locations were reviewed in the field by WR&A and County staff. Pipe outfalls, culverts and open channels were evaluated. The conditions varied considerably, but there were a significant number of cases of substantial erosion occurring at culverts and along natural channels. Headcuts were observed at several locations, some as tall as 3 feet. In some channels, there were a series of headcuts between the lake and the closest culvert outfall. Such headcuts can generate large loads of sediment as they erode upstream. For example, a 3 foot head cut in an 8 foot wide channel could result in 1-2 CY of sediment erosion for each foot of headcut migration upstream. Several failing pipe outfalls had severely eroded channels which ultimately could compromise the pipe itself.

Example of severely eroded outfall from a pipe.

Example of an eroding stream channel with a large 3 foot tall head cut.

6.0. FOREBAY CONCEPTUAL DESIGN AND COST

The repeated dredging of Lake Montclair is a financial burden on the MPOA, but it is one common to all owners of impoundments, lakes or ponds. Typically, headwater streams generate sediment loads, streams in the middle reaches of a watershed transport the sediment, and sediment accumulates in the lower reaches of a watershed. Any impoundment located below the headwaters of a watershed will receive a sizable sediment load.

However, as watersheds develop, sediment loads increase through construction site erosion, bank and bed erosion, and erosion at outfalls. The erosion generated by development of a watershed is also trapped by impoundments and increases the financial burdens on homeowners associations that maintain impoundments like Lake Montclair.

A forebay has been one solution that has been mentioned to address the sediment loads and cost of dredging. A forebay would not reduce the volume of dredging but may make it more cost efficient.

Sediment Forebay Options

Assuming that total annual sediment loads to the lake would be 2,000 to 3,000 CYs, and 60-80% was from upstream sources, then annual loadings to the forebay would be between 1,200 to 2,400 CY. A single facility that could handle this volume of sediment on an annual basis would be relatively large. Alternatively, a smaller facility could be dredged more frequently in order to trap and remove the same volume of sediment as a larger facility.

As has been proposed in the past, an in-lake sediment forebay would be an obvious option to consider. Instead of being located in open water requiring barge mounted excavators, this option would be located to allow excavation from the shoreline. Theoretically, there are alternatives to excavation of a forebay within the lake. A portion of Powells Creek upstream of the lake could be dredged deeper to capture sediment prior to reaching the lake. Another potential alternative would be to trap sediment from the watershed in its floodplain. The conversion of any existing floodplain into a sediment storage area, through construction of depressions or basins, would have to contend with constraints due to wetlands, mature forests, cultural resources, and utilities.

This study evaluated three options: In-lake, In-channel and Floodplain. For generating the three options, the following assumptions were used:

- Prince William County would design and construct a facility to capture sediment from Powells Creek.
- Prince William County would dredge the basin on an as-needed basis, typically several times per year.
- All dredging will be conducted using a long-arm excavator with a 50 foot reach.
- Land ownership has not been addressed in the site selection or feasibility study
- Maximum depth of dredging would be 8 feet
- Maximum side slopes would be 2:1
- Access would be provided with a 15 foot wide road constructed of #1 stone or similar materials, capped with gravel and fines
- An estimated annual sediment loading of approximately 1,200 to 1,800 CY is delivered from Powells Creek to Lake Montclair.

Appendix A contains schematic conceptual designs for the three forebay options. Appendix B contains the cost estimates for the three conceptual designs.

6.1 In-Lake Forebay Option

The in-lake forebay option would provide shoreline access to an excavated basin located at the mouth of Powells Creek. The basin is located below the Southlake townhouses at the end of Ebb Tide Court. This basin is in approximately the same location as was identified as Location #3 in the 1996 forebay study. However, the proposed basin would conform to the topography of the shoreline, allowing access from the shore. The basin would extend from the mouth of Powells Creek downstream along the shore, capturing much of the creek's flow and diverting it along the shoreline. During high flows, a portion of the storm flows could bypass the basin, preventing scouring of previously deposited sediments.

The shoreline would require stabilization to prevent erosion and slumping and to allow use of excavators close to the shoreline. The shore line could be stabilized with riprap.

The possibility of excavation within the stream channel immediately upstream of the lake was evaluated under this study. Since the channel is only 35 feet wide, and maintains a depth of 4-5 feet, relatively little additional storage could be generated from dredging the channel to 8 feet. Only 1 CY of storage per linear foot of channel could be provided by deepening the existing channel. To generate 600 CY or more of storage would require clearing the shoreline and excavating the creek for over 600 linear feet. This option was not deemed feasible.

Storage Capacity
The basin would be 200 feet in length, 50 feet wide and have a maximum depth of 8 feet. The basin would be allowed to fill with 4 feet of sediment between dredging events, thus maintaining a minimum of 4 feet of water depth. Each maintenance dredging would remove approximately 890 CY of dredge material. This basin would probably require dredging 2-3 times per year, depending on the actual sediment loads.

Access
A 1,597 foot long access road would have to be built from the stormwater basin at Forest Park High School to the in-lake basin. The road would require clearing of forested floodplain, although if this route was selected it would take advantage of exiting openings in the forested stand. This access is significantly longer than the other proposed options. However, the road would also provide access to the eroded channel downstream of the high school stormwater basin. This channel needs restoration to reduce current erosion that contributes sediment to Powells Creek. The proposed road would require two culvert crossings of the stormwater basin outlet channel. Access from the high school stormwater facility would avoid conflicts with local residences or impacts to local roads and parking lots.

The previous forebay study suggested access from the townhomes, which would require a 225 foot road with a retaining wall. The 35 foot vertical drop over the 225 foot length would result in a 15% grade. Fully loaded dump trucks may have significant problems climbing such a steep incline from a dead stop. In addition, this access option would be highly visible from the adjacent townhouses, and truck traffic would have to be routed through the residential roads and parking areas of the townhomes. Damage to the pavement and curbing would be expected during each dredging operation. Based on the steep grade and conflict with residential roads, this access option is not recommended.

6.2 In-Channel Forebay Option

The in-channel forebay option would provide shoreline access to an excavated basin located upstream from Spriggs Road. The basin would be constructed by excavation of the existing stream channel and adjacent stream bank and floodplain. The floodplain on the north side of the stream is relatively narrow, and contains limited wetlands. There is a sanitary sewer that runs parallel to the stream channel that would have to be avoided. The floodplain on the south side contains wetlands, but not immediately adjacent to the stream channel. Thus the basin would be created by staging on the north bank and excavation of the southern floodplain area.

Because this basin is located in line with the channel, it would capture sediment during all flow events, from base flows to high storm flows. This basin's location would make it suitable for capturing the bed load and larger suspended loads (sands and small gravel). Depending on flow rates through the basin, fine sediment may not have the time to settle during larger storm events. During high flows, a portion of the storm flows and associated sediment could by pass the basin though the adjacent floodplain wetlands. In addition, high flows routed through the basin may result in re-suspension and export of previously deposited material.

To prevent a head cut from developing as a result of the excavation of the stream channel, a weir structure mimicking a riffle would be constructed at the upstream end of the basin. A similar structure would also be constructed at the down stream end to insure the channel remained vertically stable.

The shoreline of the basin would require stabilization to prevent erosion and slumping as well as to allow the use of excavators close to the shoreline. The shore line could be stabilized with riprap.

The in-channel forebay option may be vulnerable to beaver impoundment. The excavated basin would function as a small pond (1/4 acre) which could attract beavers. A beaver dam could be build to block the lower end of the basin, flooding a wider area of floodplain and making access and dredging difficult.

Storage Capacity

The basin would be 410 feet long and 50 feet wide, with a maximum depth of 8 feet. There is bedrock present in the stream bed, so excavation could be limited in depth over some portions of the basin. The basin would be allowed to fill with 3 feet of sediment between dredgings, thus maintaining a minimum of 5 feet of depth between the pool surface and the top of the bank. Each maintenance dredging would be approximately 850 CY. This basin would require dredging 2-3 times per year due to its relatively small size and high capture efficiency.

Access

An 850 foot long access road would have to be built from Spriggs Road to the basin. Because of the open land and reasonable grades, this road would be the least costly of the three alternatives.

6.3 Floodplain Forebay Option

The floodplain forebay option would be located downstream of Spriggs Road. It would provide a basin that is not located in-line with Powells Creek. This basin would capture flow during storm events, and route it through a detention basin in the floodplain of Powells Creek. Berms in the basin would create a flow path to increase deposition, and provide access for dredging the sediments.

Because this basin is located off-line from the channel, it would not capture sediment during baseflows or smaller storm events. This basin's location would not make it suitable for capturing the bed load and larger suspended loads (small gravel). During baseflows, the stream would flow through its original channel. During flows high enough to enter the basin, suspended sediment (sands and silt) would be transported into the basin. A reduction in velocity and increased residency time would allow a portion of the suspended sediment to settle out in the basin. The majority of the suspended sand load would settle out and some fraction of the silt load, dependent on flow velocity and basin depth. During storm events a significant portion of the storm flows would continue to transport through the existing stream channel, including most of the bedload sediment. The passage of bedload provides continuation of a critical ecological/geological process.

Between storm events that would enter the basin, the basin would hold water as a small floodplain pool. Groundwater will probably enter the basin, keeping it ponded between storm events.

The floodplain forebay option may be vulnerable to beaver impoundment. The excavated basin would function as a small pond (1/4 acre) which might attract beavers. A beaver dam could be built to block the outlet channel. However, the lack of permanently flowing water through the basin would probably make this possibility less likely than in the in-channel option.

Storage Capacity
The basin would be 150 feet long and 100 feet wide, with an average depth of 7 feet. The basin would be allowed to fill with 3 feet of sediment between dredgings. Each maintenance dredging would be approximately 1044 CY. This basin would have the largest capacity of the three basins. It would require dredging once per year due to its larger storage capacity and lower capture efficiency.

Access
A 584 foot long access road would have to be built from Spriggs Road to the basin through a mature forest, including a wetland area. This access route is the shortest of the three options but would require clearing of mature floodplain hardwood forest.

Table 1 compares the various forebay options.

TABLE 1: FOREBAY OPTION COMPARISON CHART

		In-Lake	In-Channel	Floodplain
Location		In-line	In-line	Off-line
Efficiency		High-Moderate	Highest	Lowest
Basin Depth to water surface	Ft	8	8	7
Basin Size	Ft	200x50	410x50	150x100
Excavation Volume	CY	2667	3425	3,100
Storage Depth	Ft	4	3	3
Storage Volume	CY	889	850	1044
Frequency of Dredging		2-3/yr	2-3/yr	1/yr
Access	lf	1,597 through forest	846 through pasture	584 through forest
Wetland Impacts	acres	0.16	0.03	0.12
Stream Impacts	lf	30	410	None
Permit Difficulty		Moderate	High to Very High	Moderate
Utility Conflicts		Potential sewer conflicts, but avoidable	Potential sewer conflicts, but avoidable	Buried utility, but probably avoidable

6.4 Construction and Maintenance Costs

The construction costs for the forebay options would range from $162,000 to $223,000 based on conceptual design. Construction cost estimates are detailed in Appendix B. The in-lake option would have the highest cost for access, while the in-channel option would have the highest costs for construction of the basin. Overall, the construction costs for the in-lake option would be less than the in-channel option, and somewhat more than the floodplain option.

TABLE 2: CONSTRUCTION COSTS FOR FOREBAY OPTIONS

	In-Lake	In-Channel	Floodplain
Mobilization/Survey	$25,277	$29,100	$21,159
Site Prep	$9,150	$7,150	$1,550
Basin Work	$122,785	$162,682	$117,790
Access Work	$36,577	$17,968	$14,722
Stream Work	$0	$6,200	$7,000
Total	**$193,788**	**$223,100**	**$162,221**

The maintenance dredging costs are estimated in the following table. A unit cost of $25/CY was used for excavation, which would include working in the wet, and hauling the dredge material off-site for disposal. The in-lake and in-channel options will have high sediment capture efficiencies, so dredging was accounted for three times per year. The floodplain option would have a lower capture efficiency, requiring dredging only once per year. Actual frequency of dredging would vary year to year based on storm flows and sedimentation rates. Over a ten year period, dredging costs for the in-lake and in-channel options would exceed $600,000.

TABLE 3: MAINTENANCE COSTS

	In-Lake	In-Channel	Floodplain
Excavation Volume	890	850	1,044
Excavation Costs ($25/CY)	$22,225	$21,250	$26,100
Times Per Year	3	3	1
Total Annual Costs	$66,750	$63,750	$26,100
10-year Costs	**$667,500**	**$637,500**	**$261,000**

Note: In-Channel and In-Lake basins have high efficiency, capturing sediment during all flows thus requiring frequent removal.

If dredging was required only twice per year, the maintenance costs for the in-lake option would be reduced by $222,500 to $445,000.

7.0 GENERAL PERMITTING/REGULATORY ISSUES

This "forebay" basin will most likely be considered by the regulatory agencies as a form of stormwater management facility. However, the location of the facility will determine the level of effort to negotiate regulatory acceptance. The Virginia Department of Environmental Quality and the U.S. Army Corps of Engineers have explicitly expressed to other localities that stormwater facilities within a stream or wetland will not be permitted. Excavation of an existing lake would mostly not be considered stormwater management activity.

Three options for locating the forebay within the Powells Creek watershed were evaluated. Locating the forebay within Lake Montclair would be the most favorable option from a regulatory and sediment trapping efficiency standpoint. The in-channel option has high sediment capturing efficiency, but would be more difficult to obtain a permit. The floodplain option would have less effective sediment capturing capability than the other two options, but would be easier to obtain a permit.

For each option the following regulatory steps would be required:

- Wetland Delineation – Would include field delineation, survey of wetland boundaries, completion of a wetland delineation letter report, conducting a preliminary jurisdictional determination with U. S. Army Corps of Engineers, and conducting a Pre-application Meeting.
- Stream Assessment – Conduct VADEQ procedure to evaluate quality of stream being impacted.
- Design Development – Conceptual graphics for forebays would have to be more fully developed to provide required engineering data for the Joint Permit Application.
- Avoidance/Minimization/Mitigation Analysis – Discussion of options to avoid and minimize impacts, and mitigation for unavoidable impacts. May require discussion of all options considered. Analysis would identify the type of mitigation proposed for the project.

- Mitigation Design or Coordination – If mitigation was going to a bank or the Trust fund, then coordination would be required for that transaction. If on-site mitigation was proposed, mitigation design would be required.
- Joint Permit Application – Include preparation of permit application, permit plates and graphics, and vicinity map. In addition, coordination for cultural resources and rare, threatened and endangered species would be completed.
- Agency Negotiation – For each option, the level of effort required to respond to agency requests for additional information and negotiate the permit approval will vary considerably with the regulatory acceptance of the option.

7.1 In-Lake Forebay Option

The in-lake forebay option would provide shoreline access to an excavated basin located at the mouth of Powells Creek. The excavation of the basin would impact 0.16 acres of forested/scrub wetlands. In addition, two minor stream crossing would be required for the access road. Stream mitigation could be conducted on site to reduce costs. The wetlands being impacted were originally created from sediment depositing at the mouth of Powells Creek within the backwater of the lake. While this may make permitting easier, it would not eliminate the need for compensation. An in-lake option would probably be preferable to an in-channel option by the regulatory agencies. The in-lake option would have the least overall costs associated with permitting.

7.2 In-Channel Forebay Option

The in-channel forebay would impact 0.024 acres of emergent wetlands and 410 feet of stream channel. Although the wetland impacts are minor, the stream impacts may represent a significant regulatory hurdle. Standing regulatory policy is to deny stormwater management located on perennial streams. Because of its location, this option would be the most difficult for which to obtain a permit, possibly requiring considerable negotiations with the agencies.

7.3 Floodplain Forebay Option

The floodplain forebay option would impact 0.12 acres of forested wetlands and require tie-ins to the stream channel. The floodplain option avoids the regulatory concerns over in-line basins, but it would still be considered a stormwater management facility located, at least in part, in a wetland. A significant benefit of the off-line option is dredging and construction could be done with minimal release of sediment into the stream. In addition, the basin would provide wetland/pond habitat between dredging cycles. This option would require additional design work to refine the current concept sufficient for a permit application.

7.4 Cost Estimates for Permitting and Mitigation

The approach taken to estimate costs was to determine a general level of effort for each major component of the permitting process. Then the generalized costs were adjusted to reflect site specific characteristics of each option. These costs would provide a best effort at obtaining a permit for a particular option. Ultimately, project acceptance and permit approval would be at the discretion of the regulatory agencies. Pursuing a permit on an option that the regulatory agencies find difficult to permit may require significant additional engineering, environmental, and other studies.

For the three forebay options, the easiest form of mitigation would be to purchase of off-site mitigation credits or contribution to the 'Trust' Fund. Alternatively, permitee-sponsored mitigation could be proposed. However, on-site mitigation may not be available at each site. Off-site mitigation could be proposed at an alternative location within the County. With permitee-sponsored mitigation, there would be additional design and monitoring efforts required, which are not included in this cost estimate.

Permitting costs would range from $25,000 to $35,000, depending on the resources located at each site and the level of difficulty of obtaining a permit for each option. The In-lake option would have the lowest permitting costs.

TABLE 4: ESTIMATED PERMITTING COSTS

	General	In-Lake	In-Channel	Floodplain
Wetland Delineation and Stream Assessment	$5,256	$5,500	$5,500	$5,500
Design Development	$8,416	$5,000	$8,400	$10,000
Avoidance/Minimization/Mitigation Analysis	$4,176	$4,200	$4,200	$4,200
Joint Permit Application	$4,544	$4,500	$4,500	$4,500
Agency Negotiation	$6,176	$6,200	$12,000	$5,000
Total	**$28,568**	**$25,400**	**$34,600**	**$29,200**

Mitigation costs were estimated based on $65,000 per wetland credit and $500 per linear foot of stream credit. The In-channel option would have significantly higher mitigation costs due to the impacts required in order to construct this option.

TABLE 5: ESTIMATED MITIGATION COSTS

	In-Lake		In-Channel		Floodplain	
Wetland Credits ($65,000 acre)	0.16	$10,400	0.02	$1,560	0.12	$7,800
Stream Credits ($500 lf)	30.00	$15,000	410.00	$205,000	0.00	$0
Total		**$25,400**		**$206,560**		**$7,800**

In-Lake Option - Impacts of stream crossings could be mitigated by restoration of existing channel

8.0 SUMMARY AND RECOMMENDATIONS

Sedimentation of Lake Montclair is a natural process resulting from the normal transport of sediment in the streams that feed the lake. That natural process can be accelerated by the long term adjustments of a watershed to development. Lake maintenance should be a combination of sediment removal and control of excessive sedimentation. The dredging of Lake Montclair removes sediment generated from the following sources:

- Normal (natural) bed load and suspended load from Powells Creek.
- Locally generated sediment from adjacent stormwater outfalls and channels
- Watershed generated sediment load (primarily suspended sands and silts) from Powells Creek.

The following efforts are recommended to reduce sedimentation of Lake Montclair:

- Construction of an In-lake Sediment Forebay to intercept a portion of the natural bed load and the watershed generated sediment.
- Assessment and repair of sources of locally generated sediment.

8.1 Recommendations for a Sediment Forebay

The In-lake Forebay Option is the recommended alternative among three option investigated in this report. The In-lake option has high sediment trapping efficiencies, minimal permitting and mitigation costs, and reasonable construction costs. The In-channel option has significant mitigation and permitting costs. The Flooplain option has lower sediment trapping efficiency, so it would not provide the same level of protection from sediment as the in-lake option.

TABLE 6: TOTAL COSTS

	In-Lake	In-Channel	Floodplain
Permitting	$25,400	$34,600	$29,200
Final Design (10% of Construction)	$19,388	$22,300	$16,200
Mitigation	$25,400	$206,560	$7,800
Construction	$193,788	$223,000	$162,221
Subtotal	$263,976	$486,460	$215,451
Ten Year Maintenance Costs	$667,500	$637,500	$261,000
TOTAL OVER 10 YEARS	**$931,476**	**$1,123,960**	**$476,421**

8.2 Recommendations to Control Locally Generated Sediment

Controlling locally generated sediment is a cost effective solution to controlling sediment loads and dredging costs. The MPOA has control of the land generating the sediment, which will make implementation of solutions relatively easy. The channels and outfalls that are eroding are relatively small, and costs to repair these sources of erosion would be relatively cost effective compared to addressing erosion on the main channel of Powells Creek. Control of the local erosion problems is highly effective because of the close proximity to the lake.

Local erosion appears to be contributing 20-40% of the sediment removed each dredging cycle. That equates to between 3,000 and 8,000 CY per dredging cycle. Implementing local projects to control erosion of streams, culverts and other areas within the community could reduce locally generated sediment by 50%, reducing future dredging volumes by 1,500 to 4,000 CY per 5 year cycle. The steps in addressing this significant source of sediment include:

- Conducting an assessment of culverts, pipe outfalls, existing BMPs and stream channels within the Lake Montclair community to identify the location and severity of erosion.
- Prioritizing which sites are the most eroded and which are resulting in the greatest amount of sediment deposition.
- Developing conceptual and final designs for the repair and stabilization of major sources of locally generated sediment.

A community watershed assessment of the channels, culverts, and pipe outfalls is an ideal project to be funded by a grant program such as the Water Quality Improvement Fund. Such a study is a key step in documenting a potential water quality problem, and targeting solutions. The solution to controlling erosion from local sources depends on the severity of the erosion, the location, and the ease of access for construction equipment. The types of solutions that could be used to control sediment from these local sources include:

- Maintain and/or upgrade existing stormwater BMPS.
- Install new BMPs in easily accessible locations to intercept sediment prior to reaching the lake.
- Stabilize pipe outfalls with properly designed and placed riprap
- Stabilize culvert outfalls with plunge pools to dissipate energy and protect downstream channels.
- Repair headcuts with grade control structures that mimic natural riffles or step/pools
- Grade back eroding banks and stabilize with matting, seeding, and plantings.

8.3 Recommendations to Control Watershed Generated Sediment

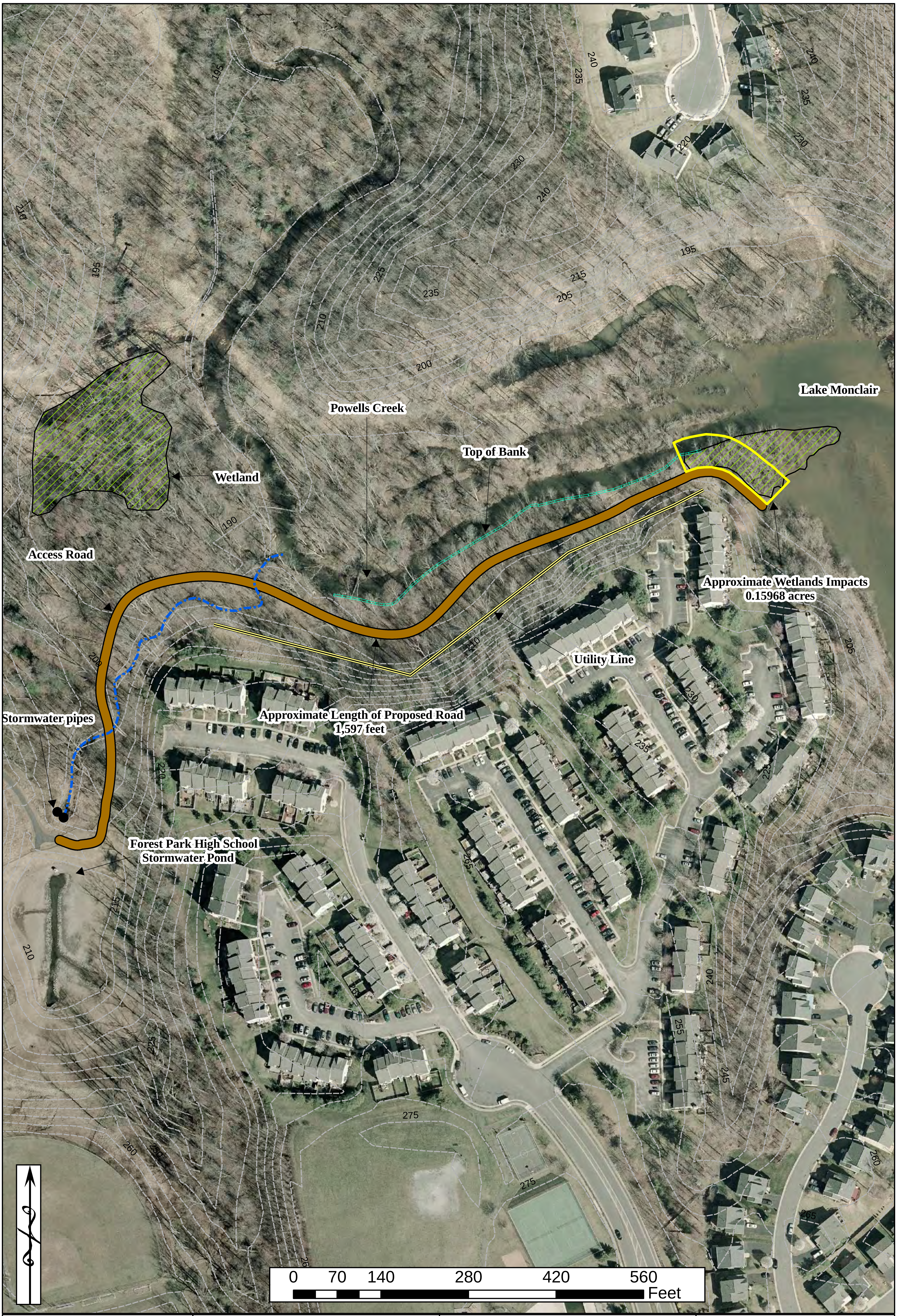
The watershed generated sources of sediment upstream of the lake include erosion from active construction sites, sediment from existing stormwater BMPs, stream channel erosion, and developed lands. With over 11 square miles of watershed, the potential sources of sediment are large and varied. The Powells Creek Watershed Management Plan provides an initial vehicle to address increasing sediment loads from the watershed. However, due to their distance from the lake, individual projects may not have an immediate impact on sediment loads to the lake. Cumulatively, the projects in the plan should reduce overall sediment loads.

Many County programs are already addressing the need to control watershed generated sediment, including the erosion and sedimentation program, stormwater management, and stream restoration program. The following projects would help to address the watershed generated sediment.

- Repair the outfall channel from the Stormwater BMP at Forest Park High School. This channel is eroding, and past repairs have not been successful. The close proximity of this channel to the head of Lake Montclair would make it a high priority for attention since much of the sediment lost from this channel would deposit in the lake. This BMP is also identified in the Watershed Management Plan as a potential Low Impact Development retrofit site.
- The County should implement components of the Watershed Management Plan for Powells Creek. Based on the draft report, the project that would have the most potential benefit to Lake Montclair is the retrofit of the 9 acre pond. This project (710-3) could provide some reduction in long term sediment loadings to Lake Montclair, although its distance from the lake reduces its effectiveness.
- Other projects in the watershed which would reduce downstream loadings of sediment would be stream restoration in the upper portion of subwatershed 705.

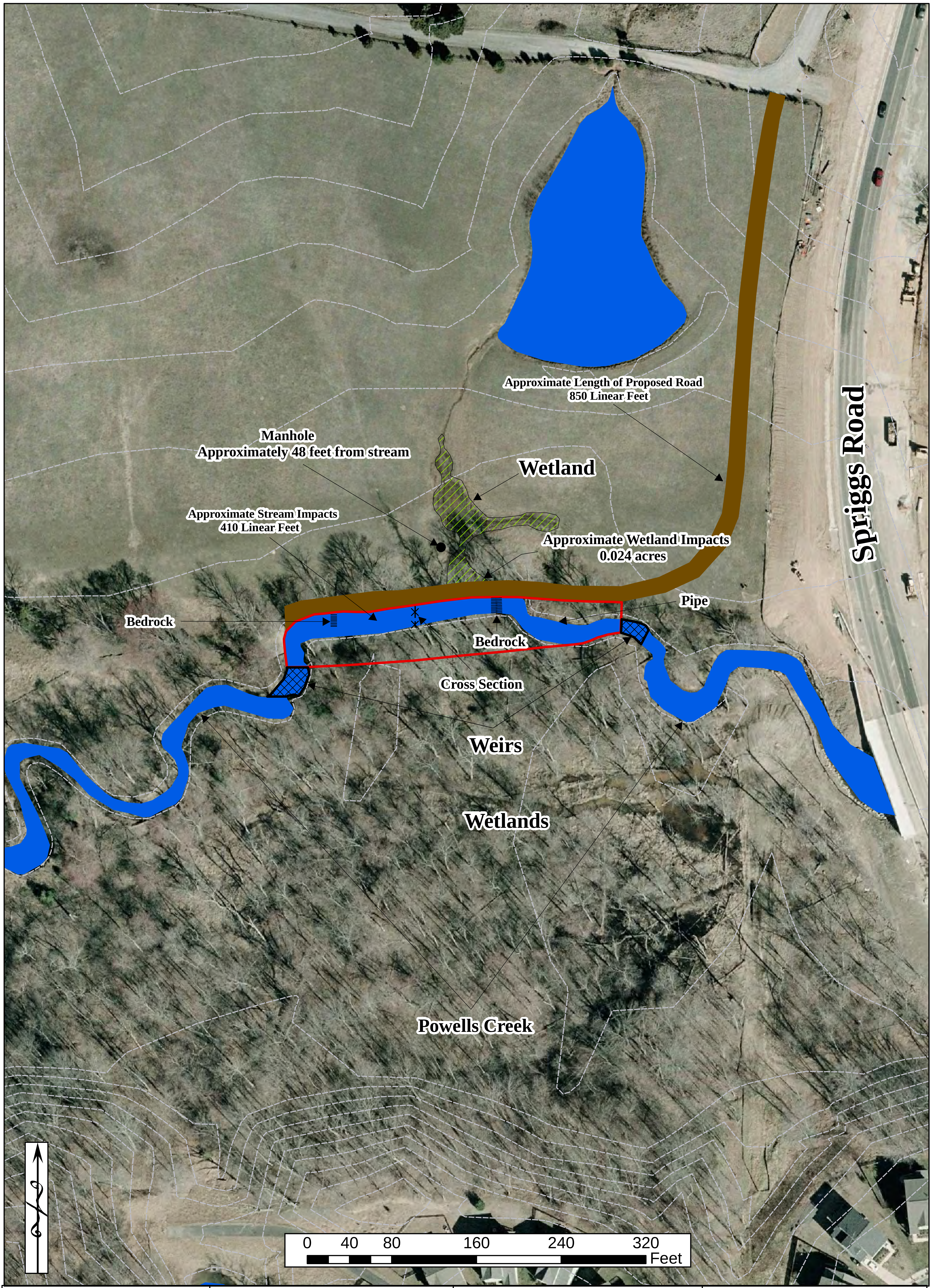
APPENDIX A

CONCEPTUAL DESIGN SCHEMATIC PLANS



Whitman, Requardt & Associates, LLP. Engineers Architects Planners 7/1/2008	**Source:** Prince William County GIS Data and WRA Topcon GPS Data	**Location:** Prince William County, Virginia	**Figure:** In-Lake Forebay Option

N:\45467-000\GIS\Lake_Monclair_Forebay_opt_1_11X17



WR&A Whitman, Requardt & Associates, LLP. Engineers Architects Planners 7/1/2008	Source: Prince William County GIS Data	Location: Prince William County, Virginia	Figure: In-channel Forebay Option

N:\45467-000\GIS\Powells_Creek_Upper_opt_11X17

WR&A Whitman, Requardt & Associates, LLP. Engineers Architects Planners 7/1/2008	Source: Prince William County GIS Data	Location: Prince William County, Virginia	Figure: Floodplain Forebay Option

N:\45467-000\GIS\Lake Monclair floodplain forebay 11X17

APPENDIX B

CONCEPTUAL DESIGN COST ESTIMATES

PRINCE WILLIAM COUNTY
LAKE MONCLAIR FOREBAY STUDY
IN-LAKE ALTERNATIVE
CONCEPTUAL DESIGN COST ESTIMATE

DESCRIPTION	UNIT	ITEM COST	QNTY	COST	
Mobilization @ 10%	LS			$16,851.17	
Construction Surveying @ 5%	LS			$8,425.58	$25,276.75
Site Preparation					
Stabilized Construction Entrance	EA	$750.00	1	$750.00	
Silt Fence	LF	$2.00	200	$400.00	
Orange Safety Fence (staging area, etc)	LF	$2.00	0	$0.00	
Stream Crossing	EA	$4,000.00	2	$8,000.00	
Stream Diversion - Pumping/Week	WK	$600.00	0	$0.00	
Repair Outlet Pipe for Pond	LS	$5,000.00	0	$0.00	
Dirt Bag	Ea	$200.00	0	$0.00	
					$9,150.00
Site Work for Basin					
Excavation	CY	$45.00	2667	$120,015.00	
Clearing & Grubbing	AC	$7,500.00	0	$0.00	
Stone Revetment	LF		200		
Class 1 riprap	Ton	$25.00	100	$2,500.00	
Geotextile	SY	$3.00	90	$270.00	
					$122,785.00
Site Work for Access Road					
Access Road	LF		1600		
Grading/Clearing	AC	$7,500.00	0.55	$4,132.23	
#1Stone, 6 inches deep	Ton	$30.00	444	$13,333.33	
Crusher Run, 3 inches deep	Ton	$25.00	444	$11,111.11	
Geotextile	SY	$3.00	2667	$8,000.00	
					$36,576.68
Stream Work - Grade Control Structures					
Riffle Grade Control					
Cobble/Gravel mix	TON	$50.00	0	$0.00	
Riffle Base stone (Class 1 or Gabion)	TON	$25.00	0	$0.00	**$0.00**
TOTAL					**$193,788**

ASSUMPTIONS & NOTES:

No clearing cost associated with excavating lake/wetlands

PRINCE WILLIAM COUNTY
LAKE MONCLAIR FOREBAY STUDY
IN-CHANNEL ALTERNATIVE
CONCEPTUAL DESIGN COST ESTIMATE

DESCRIPTION	**UNIT**	**ITEM COST**	**QNTY**	**COST**	
Mobilization @ 10%	LS			$19,399.99	
Construction Surveying @ 5%	LS			$9,699.99	$29,099.98
Site Preparation					
Stabilized Construction Entrance	EA	$750.00	1	$750.00	
Silt Fence	LF	$2.00	200	$400.00	
Orange Safety Fence (staging area, etc)	LF	$2.00	0	$0.00	
Stream Crossing	EA	$4,000.00	0	$0.00	
Stream Diversion - Pumping/Week	WK	$600.00	1	$600.00	
Repair Outlet Pipe for Pond	LS	$5,000.00	1	$5,000.00	
Dirt Bag	Ea	$200.00	2	$400.00	
					$7,150.00
Site Work for Basin					
Excavation	CY	$45.00	3475	$156,375.00	
Clearing & Grubbing	AC	$7,500.00	0.25	$1,875.00	
Stone Revetment	LF		320		
Class 1 riprap	Ton	$25.00	160	$4,000.00	
Geotextile	SY	$3.00	144	$432.00	
					$162,682.00
Site Work for Access Road					
Access Road	LF		850		
Grading/Clearing	AC	$2,500.00	0.29	$731.75	
#1Stone, 6 inches deep	Ton	$30.00	236	$7,083.33	
Crusher Run, 3 inches deep	Ton	$25.00	236	$5,902.78	
Geotextile	SY	$3.00	1417	$4,250.00	
					$17,967.86
Stream Work - Grade Control Structures					
Riffle Grade Control					
Cobble/Gravel mix	TON	$50.00	24	$1,200.00	
Riffle Base stone (Class 1 or Gabion)	TON	$25.00	200	$5,000.00	**$6,200.00**
TOTAL					**$223,100**

ASSUMPTIONS & NOTES:

Assumed lower cost for grading/clearing of pasture for access road

PRINCE WILLIAM COUNTY
LAKE MONCLAIR FOREBAY STUDY
FLOODPLAIN ALTERNATIVE
CONCEPTUAL DESIGN COST ESTIMATE

DESCRIPTION	UNIT	ITEM COST	QNTY	COST	
Mobilization @ 10%	LS			$14,106.21	
Construction Surveying @ 5%	LS			$7,053.11	$21,159.32
Site Preparation					
Stabilized Construction Entrance	EA	$750.00	1	$750.00	
Silt Fence	LF	$2.00	200	$400.00	
Orange Safety Fence (staging area, etc)	LF	$2.00	0	$0.00	
Stream Crossing	EA	$4,000.00	0	$0.00	
Stream Diversion - Pumping/Week	WK	$600.00	0	$0.00	
Repair Outlet Pipe for Pond	LS	$5,000.00	0	$0.00	
Dirt Bag	Ea	$200.00	2	$400.00	
					$1,550.00
Site Work for Basin					
Excavation	CY	$35.00	3100	$108,500.00	
Clearing & Grubbing	AC	$7,500.00	0.5	$3,750.00	
Stone Revetment	LF		400		
Class 1 riprap	Ton	$25.00	200	$5,000.00	
Geotextile	SY	$3.00	180	$540.00	
					$117,790.00
Site Work for Access Road					
Access Road plus Berm	LF		644		
Grading/Clearing	AC	$7,500.00	0.22	$1,663.22	
#1Stone, 6 inches deep	Ton	$30.00	179	$5,366.67	
Crusher Run, 3 inches deep	Ton	$25.00	179	$4,472.22	
Geotextile	SY	$3.00	1073	$3,220.00	
					$14,722.11
Stream Work - Grade Control Structures					
Riffle Grade Control					
Cobble/Gravel mix	TON	$50.00	40	$2,000.00	
Riffle Base stone (Class 1 or Gabion)	TON	$25.00	200	$5,000.00	**$7,000.00**
TOTAL					**$162,221**

ASSUMPTIONS & NOTES:

Clearing and Grubbing includes basin and inlet/outlet channels

WHITMAN, REQUARDT & ASSOCIATES, LLP

Engineers • Architects • Planners

Baltimore Office
801 South Caroline Street
Baltimore, Maryland 21231
Office: (410) 235-3450

Richmond Office
9030 Stony Point Parkway, Suite 220
Richmond, Virginia 23235
Office: (804) 272-8700
Fax: (804) 272-8897

Fairfax Office
3701 Pender Drive, Suite 210
Fairfax, Virginia 22030
Office: (703) 293-9717
Fax: (703) 273-6773

Newport News Office
11870 Merchants Walk, Suite 100
Newport News, Virginia 23606
Office: (757) 599-5101
Fax: (757) 599-5320

Pittsburgh Office
300 Seven Fields Boulevard, Suite 130
Seven Fields, Pennsylvania 16046
Office: (724) 779-7940
Fax: (724) 779-7943

York Office
224 St. Charles Way, Suite 140
York, Pennsylvania 17402
Office: (717) 741-5057
Fax: (717) 741-5124

Wilmington Office
Three Mill Road, Suite 309
Wilmington, Delaware 19803
Office: (302) 571-9001
Fax: (302) 571-9011