Heavenly Pond Dam Removal

Concept Design Report

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Dept. of Public Works
Bel Air, MD

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Project Scope

Parsons Brinckerhoff was asked by Harford County Department of Public Works, Water Resources Engineering Section to examine the potential to breach an existing dam that impounds Heavenly Pond located in Heavenly Waters/Tollgate Park. The existing embankment dam and spillway riser are in need of maintenance and repair work in order to meet current Maryland Department of the Environment (MDE) 378 dam requirements. An off-line pond was initially built in this location to aerate volatile organic compounds (VOC) levels associated with the upstream landfills during the 1950's. Sometime during the 1980's, the pond was modified and became an in-line facility. In 1992 a groundwater extraction and treatment system was installed at the Tollgate Landfill to treat VOCs in the groundwater. The landfill was capped completely in 1995. Surface water monitoring has been conducted at Heavenly Pond since that time. Because the pond is no longer needed to provide aeration treatment for the upstream flows, a breach of the embankment and restoration to a more natural stream/wetland habitat is being investigated as part of this assessment report. Figure 1 shows the location of the Heavenly Pond site within the Heavenly Waters/Tollgate Park.

Figure 1: Heavenly Waters Project Location Map

This report is divided into the following sections:

- Data collection including condition assessment, stream assessment and natural resource assessment,
- Hydrologic analysis,
- Sediment analysis,
- Agency coordination,
- Alternatives analysis, and
- Recommendations.

Data Collection

Due to the age of the pond, no historical as-built plans have been located by the County. Therefore, the original pond volume, depth of sediment accumulation and pond hydraulic characteristics including the riser and outflow information are unknown. The details of the embankment dam construction, including the type of soils used and the presence, depth, and type of any cut-off present are also not known.

Condition Assessment

In order to assess the current condition of the pond and embankment, PB examined historic aerial photographs of the pond, conducted a visual assessment of the pond and embankment, and obtained bathymetry within the pond.

Historical Pond Analysis

Historical pond aerials were obtained from 1957 through 2007. Figure 2 shows the 1957 aerial photograph. The stream channel is observed to be running along the right side of the figure and there is a small tree line on the northwest side of the pond. The remainder of the area appears to be farmed (or non-forested). By 1977, the amount of forested area adjacent to pond increases significantly. The stream channel can still be seen running along the east side of the pond.

Figure 2: 1957 (left) and 1977 (right) aerial photographs of pond.

Figure 3 shows the 1980 aerial image. Although the image quality is not great, it is clear that a significant amount of work has been done to the pond. The pond is wider and now has an island in the center of it (much like the current pond). It is assumed that the pond became in-line instead of off-line sometime between 1977 and 1980. It is not clear how the pond size was increased; presumably the enlargement of the pond may have involved excavation of additional material to widen the pond. It is unclear if the embankment and riser were raised as part of the widening.

The 2007 image shows the current pond configuration. Since this image was taken, the west fountain is no longer functioning, and there has been an increase is sedimentation at the north end of the pond which extends approximately 80 linear feet south of the wooden pedestrian bridge.

Figure 3: 1980 (left) and 2007 (right) aerial photographs.

Geotechnical Assessment

A visual assessment of the dam was conducted on January 5, 2012. The maximum dam height was approximately 17 to 18 feet high. During the site visit, water was actively flowing out of the outfall pipe. The area at the toe of the dam west of the outfall was wet with standing water for the length of the dam. Based on vegetation in this area, this appears to be a wetland area. The wetlands in this area were confirmed as part of the natural resource assessment portion of this study. It is theorized that this wetland area is being fed by seepage under the dam due to an ineffective or non-existing cutoff. This may be a concern due to the apparent lack of filter or seepage control measures. The area east of the outfall is much shorter and was not observed to be as wet as the west side. Aside from the seepage on the west side of the dam, the dam does not show any clear signs of distress or settlement.

Pond Bathymetry

Because historical records of the pond construction do not exist, an attempt was made to quantify both the depth of water in the pond as well as the depth of loose sediment at the bottom of the pond.

Bathymetry measurements of the pond were taken via canoe on three separate occasions – 01/13/12, 02/08/12 and 05/22/12. Because detailed survey data is not available for the site, the depth of water at a standpipe, located approximately 30 feet from the riser, was used to calibrate each of the measurements and account for variability in water depth during each visit. The depth of water in the pond was greatest in January (4.5') and was fairly constant in February and May (3.6' and 3.8' respectively). The depth of water is shallowest at the northern end of the pond and deepest closest to the embankment.

The depth of the water at the standpipe was calibrated with survey data taken at the bridge deck. The elevation at the pedestrian bridge was estimated from Harford County GIS data. Although this measurement is not survey grade, it does provide a reasonable estimate of the bottom elevation of the pond as well as the invert of the pond outfall pipe. Table 1 provides a summary of the pond bottom elevations and relation to pond embankment. The Bathymetry field data can be found in Appendix F

Table 1: Pond characteristics

Study point	Approximate Elevation (ft)
Pond entrance	233.3'
Pond outfall	223.1'
Pond bottom elevation	Varies between 230.0' and 233.3'
Top of embankment above outfall pipe	240.5'
Height of embankment	17.4'
Bottom of scour pool at outfall	221.0'

Baseflow Monitoring

Monthly baseflow monitoring was conducted by Harford County DPW staff beginning in January 2012. Samples were taken at the pond outfall and in the channel. The results of the County's monitoring are included in Appendix B.

Stream Assessment

The stream assessment consisted of two components, a visual assessment and bank erosion hazard index (BEHI) analysis. The following section details both assessments.

Visual Stream Assessment

The stream channel was assessed from Tollgate Road at the northern limit to the confluence of Winters Run at the southern limit. The channel was divided into four distinct reaches. The reaches are defined as follows and are shown in Figure 4. Photographs of the visual stream assessment can be found in Appendix A.

- Reach 1 – Tollgate Road to north side of pond
- Reach 2 – Pond outfall to Golf Course
- Reach 3 – Golf Course to Golf Course Tributary

- Reach 4 – Gold Course Tributary to Confluence with Winters Run

Reach 1: This reach begins at the Tollgate Road outfall and runs to the northern edge of Heavenly Pond. There is a large drop between the Tollgate Road culvert and the invert of the tributary. This portion of stream has a steep slope (~4.2%). The stream passes through a densely wooded area and is very entrenched with lots of fallen trees. The stream channel invert is below the rooting depth of the adjacent vegetation which has caused toe erosion and trees have fallen in and across the channel. As the channel moves downstream towards the pond and away from Tollgate Road, the slope begins to flatten (~3.7%) and becomes less entrenched. As the channel approaches the pedestrian bridge, the influence of the pond is evident with a much flatter slope and good connection to the channel floodplain.

Reach 2: This reach begins at the Heavenly Pond outfall and continues approximately 900 feet downstream until the channel is near the golf course. The section is meandering and has a wooded stream buffer on both sides. The slope is much flatter (~2.2%) than the stream segment near Tollgate Road. There is a gully that drains the recreational fields on the west side of the park that enters the channel approximately 240 feet downstream of the pond outfall. There are localized sections of moderately to highly eroded stream bank throughout this reach.

Reach 3: Reach 3 begins approximately 900 linear feet downstream of the pond outfall and continues to the confluence with the golf course tributary. The golf course tributary has a 107 ac drainage area compared to the Heavenly Pond tributary drainage area of 238 acres at the bottom of this reach. The stream channel continues to flatten in this reach (~1.4%) and the amount of deposition seen in the channel and on the floodplain is increasing.

Reach 4: Reach 4 begins downstream of the confluence with the golf course tributary and continues to the confluence with Winters Run. This section has the flattest slope of the tributary (0.4%) and this segment of stream exhibits

Figure 4: Visual stream assessment study reaches.

BEHI Analysis

The Bank Erosion Hazard Index (BEHI) is used to evaluate the erosion potential of stream banks through the combined effects of multiple variables such as bank height to bankfull height ratio, root depth to bank height ratio, weighted root density, bank angle, amount of surface protection, bank material, and stratification of bank material. The erosion risk rating indicated by the BEHI can be converted to an annual erosion rate prediction based on empirical formulas which also take into account the Near Bank Stress (NBS) of the bank. Different sets of empirical formulas relating BEHI and NBS to erosion rate have been developed for various regions within the U.S.

Representative BEHI and NBS assessments were performed in each reach for banks along the Tributary that exhibited moderate or higher erosion potential. A total of 6 banks were identified along the Tributary for assessment. Annual lateral erosion rate (ft/yr) predictions can be developed for each bank based on their BEHI and NBS ratings. BEHI-006 was located in Reach 1, BEHI-005 and -004 in Reach 2, BEHI-003 and -002 in Reach 3 and BEHI-004 in Reach 4. Table 2 summarizes the BEHI and NBS ratings for the banks along the Tributary. BEHI summary tables also appear in Appendix B.

Table 2: BEHI and Near Bank Shear Stress Summary

		Bank Erosion Hazard Index (BEHI)					
		Very Low	Low	Moderate	High	Very High	Extreme
Near-Bank Stress (NBS)	Very Low						
	Low				BEHI-002		
	Moderate				BEHI-006 BEHI-005	BEHI-001	
	High				BEHI-003 BEHI-004		
	Very High						
	Extreme						

Natural Resource Assessment

As part of the overall concept design, PB has conducted a GIS desktop investigation of environmental data followed by field investigations involving the identification and delineation of waters of the U.S., including wetlands. A tree survey was also performed involving the identification of trees 12 inches and greater located within a 50 foot radius of the existing pond.

The desktop investigation was conducted using various sources including Harford County GIS data, NWI wetlands and DNR wetland layers. There are no mapped FEMA floodplain wetlands within the study area. As depicted on readily available map sources, the only resource identified on NWI data layer is the Heavenly Pond itself. The DNR layer shows a larger Heavenly Pond and also picks up the forested wetland/pond downstream of the pond embankment and north of the stream channel. Refer to Figure 5 for the NWI/DNR wetland mapping. Neither NWI nor DNR depict the stream system; however, the

Harford County stream layer shows the system upstream and downstream of the pond, but also depicts some tributaries to the main stream channel.

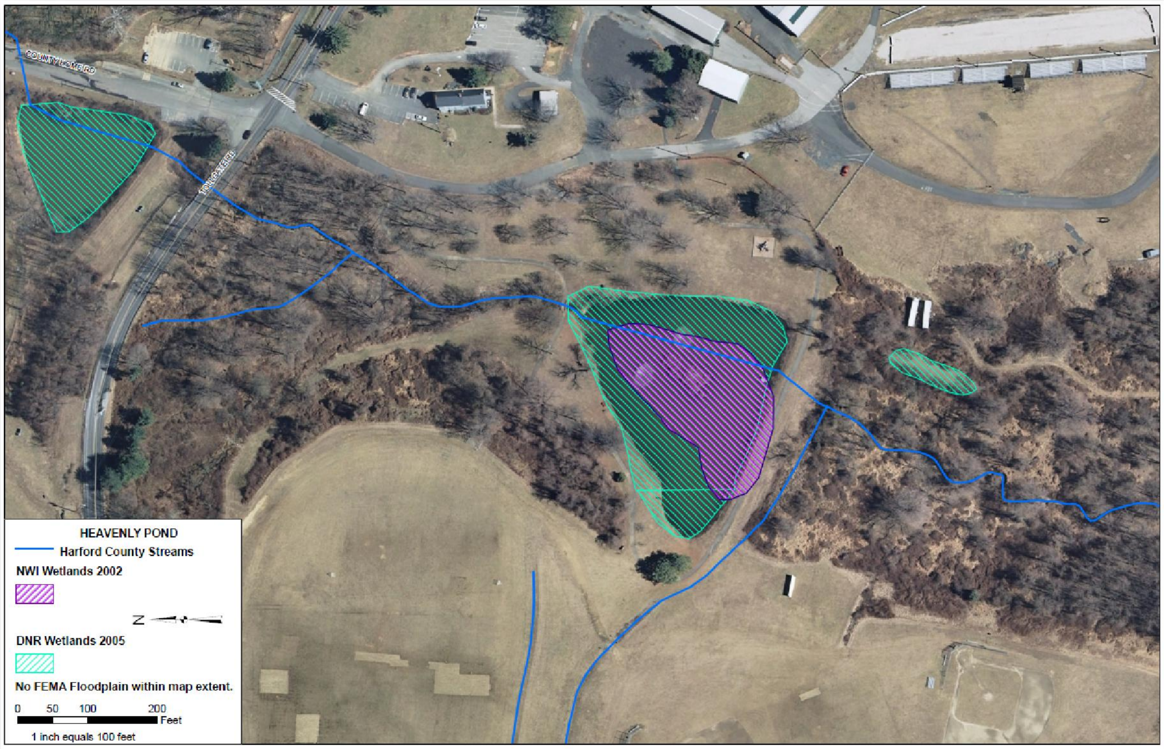


Figure 5: NWI and DNR wetlands in study area.

A review of the Harford County Soil Survey shows that the primary soils within the study area include the Aldino silt loam (AdB) series, 3 to 8 percent slopes. These soils are generally found in uplands, and are not classified as hydric. Refer to Figure 6 for soil types and hydrologic soil groups within the study area.

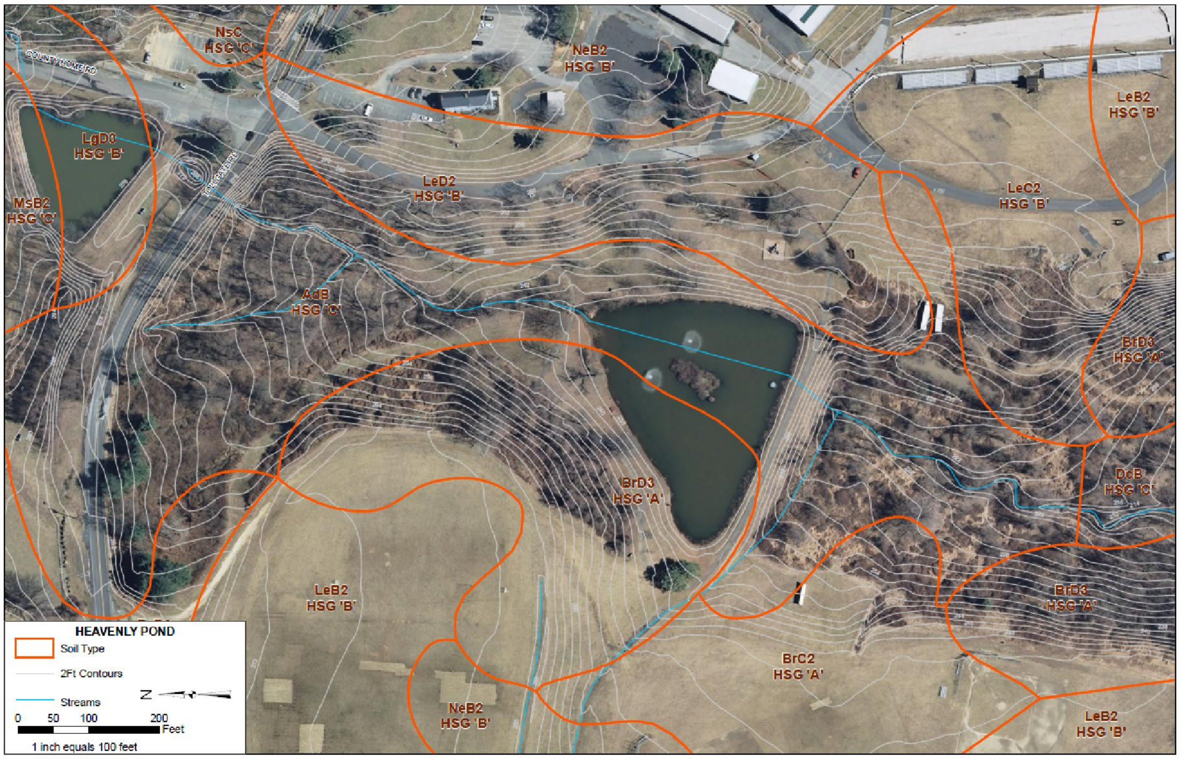


Figure 6: Soils classification within study area.

Wetland Delineation

A Waters of the United States (WUS)/Wetland identification and delineation was conducted on January 13, 2012 in accordance with procedures enumerated in the *1987 Corps Manual* and the *2010 Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont (U.S. Army Corps of Engineers, 2008)*. The findings of the delineation are described below.

Five nontidal wetlands and three Waters of the United States systems were identified during the field investigation (Figure 7). The unnamed tributary to Winters Run flows through the study area, from north to south. Winters Run and its tributaries located upstream of the Atkisson Reservior are designated as IV-P (Recreational Trout Waters) streams, with a stream closure period from March 1 through May 31.

WET 1: WET 1 is a palustrine forested (PFO) wetland located just south of Tollgate Road, east of WUS 1. This wetland originates at the toe of a slope as a groundwater seep and flows into WUS 1. Evidence of hydrology included surface water to a depth of two inches as well as drainage patterns. Dominant vegetation consists of silver maple (*Acer saccharinum*), sedge *(Carex stricta),* and an unidentified grass species. Hydric soils indicators for this wetland included depleted below dark surface and a thick dark surface. This wetland was identified using flags numbered WET 1-1 through WET 1-3.

WET 2: WET 2 is a perennial open water pond, Heavenly Waters Pond. The pond is an in-line dammed impoundment fed by WUS 1 and flows south/southwest into WUS 2 through a large culvert at the base of an earthen dam. This wetland was identified using flags numbered WET 2-1 through WET 2-13. The emergent fringe wetland around the outer perimeter of the open water pond is identified and described separately as WET 2A.

WET 2A: WET 2A is a palustrine emergent (PEM) wetland located along the banks of the Heavenly Waters Pond. This fringe wetland is approximately 10-15 feet in width. Evidence of hydrology included standing surface water to a depth of at least 4 inches. Dominant vegetation identified during the delineation included purple leaved willow herb (*Epilobium coloratum*) and cattail (*Typha latifolia)*. Other dominant vegetation observed in May 2012, after the delineation and data collection included jewelweed *(Impatiens capensis)* and sweetflag *(Acorus americanus).*

WET 3: WET 3 is a palustrine forested (PFO) wetland located southwest of the outfall from the dam at Heavenly Waters Pond. This wetland originates at the toe of slope of the earthen dam receiving water from the west and flows to WUS 3. Evidence of hydrology included water-stained leaves as well as drainage patterns. Dominant vegetation consists of black willow (*Salix nigra*), silver maple *(Acer saccharinum),* small carpgrass (*Arthraxon hispidus*) and boneset *(Eupatorium perfoliatum)*. Hydric soils indicators for this wetland included depletion below a dark surface and a thick dark surface. This wetland was identified using flags numbered WET 3-1 through WET 3-10.

WET 4: WET 4 is a palustrine forested (PFO) wetland located east of WUS 3. This system is a small pond with standing water, but has grown in with trees both within the pond and as canopy over the pond. This system receives hydrology from show rings from the upland equestrian center. A storm drain and drainage swale are piped from the rings, under the Ma and Pa trail, and lead to this system. It appears to be managing for some water quantity but it is an old facility and is not a 11torm water management facility that is maintained or inspected. It was never constructed as a 11torm water management facility. This wetland discharges into WUS 3. Evidence of hydrology included surface water to a depth of two feet. Dominant vegetation consists of black willow (*Salix nigra*) and silky dogwood (*Cornus amomum*).

WUS 1: WUS 1 is a perennial stream flowing south/southwest into Heavenly Waters Pond. Within the study area, this waterway originates at a culvert located under Tollgate Road. Approximately 3 inches to one foot of flowing water was observed at the time of the field visit, and bottom substrate consists of sand and gravel. This feature was identified using flags labeled WUS 1A-1 through WUS 1A-6 and WUS 1B-1 through WUS1 B-7.

WUS 2: WUS 2 is a perennial stream flowing south/southwest from Heavenly Waters Pond. Within the study area, this waterway originates at a culvert located under the dam at Heavenly Waters Pond. A large plunge pool, approximately 3 feet in depth, exists at the outfall of the culvert. Approximately six inches to one foot of flowing water was observed at the time of the field visit, and bottom substrate consists of sand and gravel. This system was identified using flags labeled on the east side as WUS 2-1 through WUS 2-7. To the west, this system extended immediately into an adjacent wetland (WET-3) for about 200 feet from the pond outfall.

WUS 3: WUS 3 is a small unnamed tributary that extends from WET 4 and flows into WUS 2. This system is no more than 2 feet wide and about 4-6 inches deep, and lacks well-defined banks.

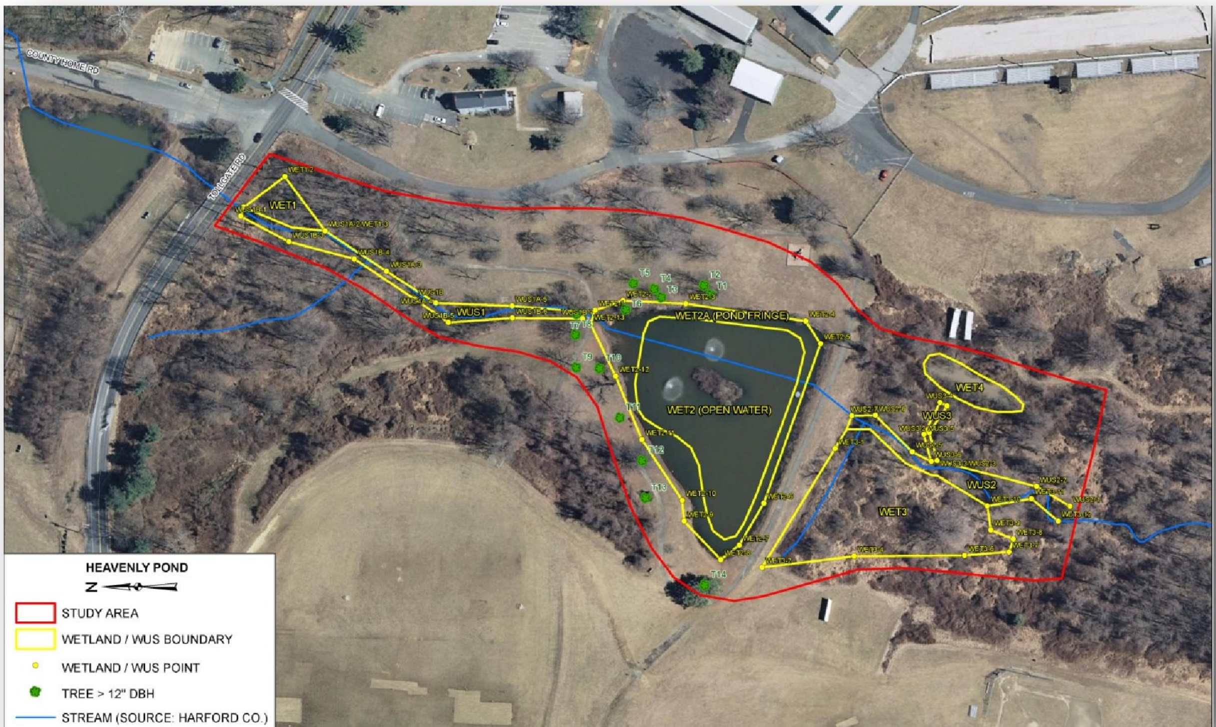


Figure 7: WUS/Wetlands and Tree Locations.

Any temporary or permanent impacts to these wetlands or waterways will require authorization from the Maryland Department of Environment Nontidal Wetlands and Waterways Division (MDE) and, the U.S. Army Corps of Engineers (USACE). Based on coordination with DNR, these tributaries are classified as Use IV streams, and no instream work is permitted in Use IV streams during the period of March 1 through May 31. According to DNR, no anadromous fish have been documented near the project site.

Tree Survey

A tree survey was also performed involving the identification of trees 12 inches and greater located within a 50 foot radius of the existing pond. Data collected for each tree included measurement of diameter at breast height (dbh), canopy, and conditions or comments about each tree identified. The findings of the tree survey identified 14 trees 12 inches or greater within 50 feet of the existing pond. Table 3 presents the data and information for each tree identified, and Figure 7 shows the location of each tree. Tree locations were located using a hand held GPS unit

Table 3: Heavenly Pond Tree Survey Results. Survey conducted on 6/1/2012 for all trees greater than 12" DBH within the 50 foot wetland buffer.

#	Botanical Name	Common Name	DBH Diameter at Breast Height	Canopy In Feet	Condition/Comment
T1	Prunus serotina	Black Cherry	15, 14 ,18	57	Good, multi-stem(3), dead branch
T2	Prunus serotina	Black Cherry	10, 13 ,2	32	Fair, multi-stem (2), narrow crown
T3	Betula nigra	River Birch	11.5, 9.5	26	Good, multi-stem(2)
T4	Betula nigra	River Birch	5, 5, 8	32	Good, multi-stem(3)
T5	Betula nigra	River Birch	11, 10.5, 10.5	41	Good, multi-stem(3)
T6	Salix nigra	Black Willow	10.5 9.5, 11	37	Good, multi-stem(3)dead vines at base
T7	Salix nigra	Black Willow	16, 8.5, 12	26	Poor, multi-stem(3)vines at base
T8	Quercus phellos	Willow Oak	23.5	70	Good
T9	Platanus occidentalis	American Sycamore	19	52	Fair, decay at base
T10	Salix sepulcralis	Weeping Willow	8.4, 4.5	30	Good
T11	Betula nigra	River Birch	5, 3.5, 3.5	16	Good
T12	Quercus rubra	Red Oak	32.5	74	Good, some dead lower branches
T13	Juniperus virginiana	Eastern Red Cedar	8.5, 5.5, 2	19	Good, multi-stem
T14	Pinus rigida	Pitch Pine	21.5	49	Good

Hydrology

The Heavenly Pond watershed falls within the Piedmont physiographic province. Regression analysis was used to determine the 1.25-, 2-, 5-, 10-, 25-, 50- and 100-year discharges at each of four study points. Table 4 describes the study points used in this analysis. Although the proposed dam breach will take place at Study point #2, the impacts of the breach on downstream hydrology were also considered. Therefore, the analysis was continued down to the confluence with Winter's Run.

Table 4: Hydrology Study Points

Study Point	Description	Drainage Area (ac)	Runoff Curve Number	Characteristics
1	At Tollgate Road	48 ac	71	% Impervious = 8.8% % Forested = 34.1%
2	Heavenly Pond Outfall	76 ac	65	% Impervious = 11.1% % Forested = 30.5%
3A	Golf course (includes upstream area + golf course tributary)	238 ac	73	% Impervious = 24.0% % Forested = 19.7%
3B	Golf course tributary	107 ac	61	% Impervious = 10.5% % Forested = 28.4%
4	Confluence with Winters Run	352 ac	75	% Impervious = 19.7% % Forested = 22.0%

Figures 8, 9 and 10 show the drainage area boundaries, landuse composition and hydrologic soil groups associated with each of the subwatersheds respectively.

The Urban Piedmont Fixed Region Regression Equations were used to determine discharges at each of the study points (MD Hydrology Panel Report 2010). The use of these equations is appropriate because the drainage area composition of the watersheds is consistent with the gages used to develop the regression equations.

Table 5: Fixed Region Regression Equations (Urban Piedmont)

Study Pt	$Q_{1.25}$	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
1	14	27	59	91	152	217	300
2	22	42	87	134	219	308	420
3A	72	131	255	372	570	765	997
3B	26	50	105	161	265	374	512
4	83	151	296	436	678	922	1,217

Figure 8: Drainage area map and study points

Figure 9: Landuse map based on 2007 landuse data.

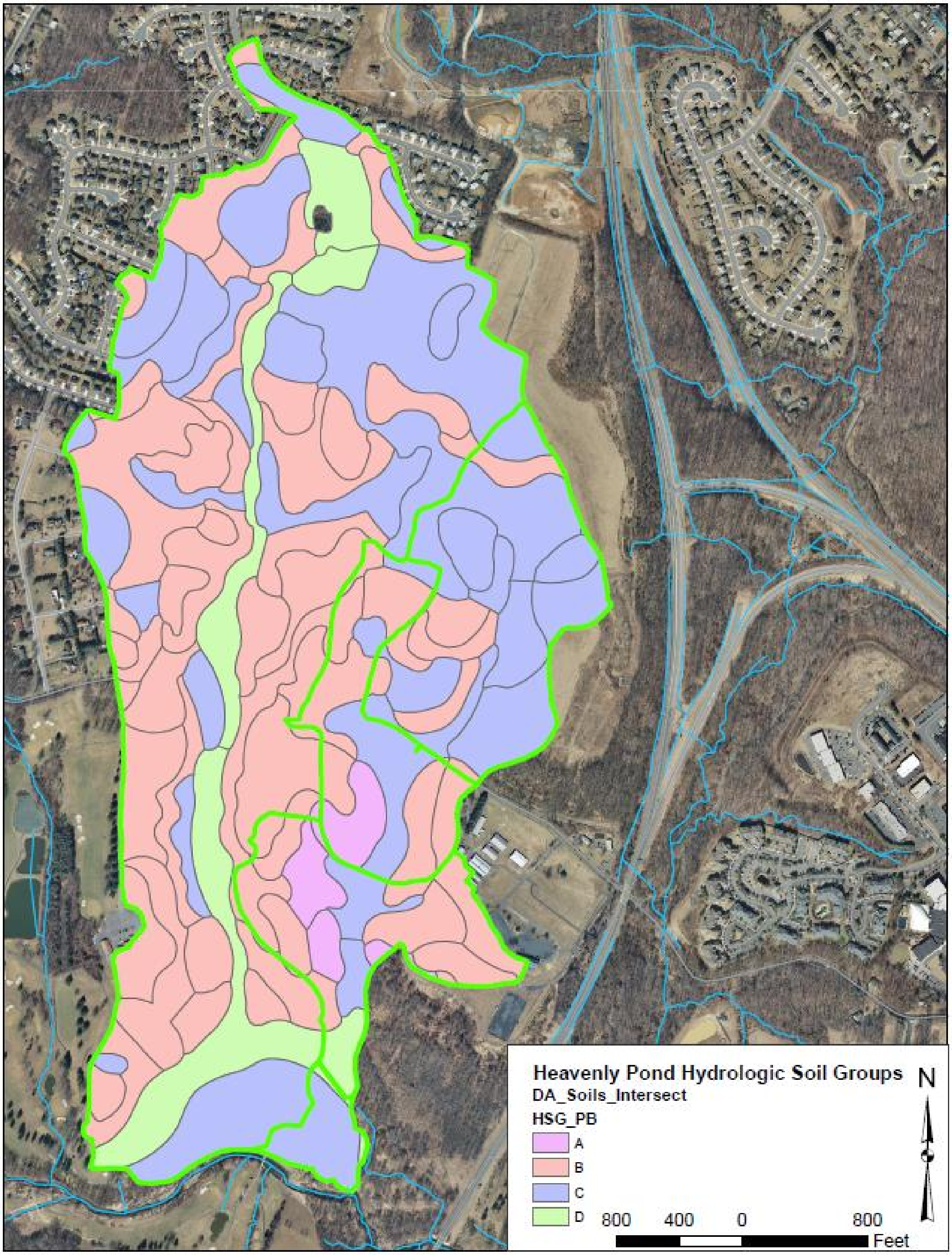


Figure 10: Hydrologic soil groups

Sediment Analysis

A sediment analysis was performed based on data collected during the May 22, 2012 site visit. Two measurements were taken at 12 different locations within the pond. The first measurement was the depth of the water and the second measurement was the depth to the bottom of the soft sediment. The difference between the two measurements is the estimated soft sediment depth. A map was then created displaying the average depth zones of 4', 3.5', 2.5', and 1'. The area of the zones were then measured and resulted in a total volume of sediment in the pond of 192,200 CF (4.4 ac-ft). The analysis is provided in Appendix E.

Table 6: Sediment Survey

Survey Point	Depth of Water	Depth to soft sediment	Soft sediment depth
1	3.7'	6.5'	2.8'
2	3.8'	8.2'	4.4'
3	4.1'	7.9'	3.8'
4	3.7'	7.5'	3.8'
5	3.2'	5.0'	1.8'
6	3.5'	6.7'	3.2'
7	2.7'	5.2'	2.5'
8	2.4'	5.4'	3.0'
9	1.5'	4.5'	3.0'
10	0.8'	4.9'	4.1
11	1.4'	3.9'	2.5'
12	2.8'	6.0'	3.2'

A comparison was also made of the depth of sediment of the pond versus the potential outfall elevations of the pond and channel inverts (Appendix E). In order to remove the classification of the embankment as a MD-378 dam, both of the alternatives propose a channel invert at the breach below the bottom of the soft sediment. Significant excavation, approximated 2,000 CY, of sediment will be removed near the breach and the sediment will be re-used to fill the area between the existing island and the east edge of the pond (See Typical Approach Channel section, Appendix G). The remaining sediment will be stabilized using bioengineering techniques including vegetation and biodegradable fabrics.

Agency Coordination

Harford County prepared and submitted four agency letters initiating coordination with regulatory/resource agencies regarding any resource concerns. The letters included a brief description of the proposed concept design along with a study area location map. Letters were submitted to following agencies:

- Maryland Department of Natural Resources (DNR) Wildlife and Heritage Division – requesting any information regarding known state-listed rare, threatened or endangered species in the study area.
- Maryland Department of Natural Resources (DNR) Environmental Review Unit– regarding known fisheries concerns and stream designations/time of year construction restrictions.
- United States Fish and Wildlife Service (USFWS) – regarding federally-listed threatened or endangered species
- Maryland Historical Trust (MHT) – requesting any information regarding known historic or archeological resources of concern in the study area.

Responses from each of these agencies were received and are included in Appendix C. DNR Wildlife and Heritage responded that there are no State or Federal records of rare, threatened or endangered species within the project study area.

DNR Environmental Review Unit confirmed the Use IV-P stream use designation and the time of year construction restriction period from March 1st through May 31st. DNR Environmental Review also determined that there are no anadromous fisheries that have been documented near the project site; however, these streams may support resident fish species documented by the Maryland Biological Stream Survey (MBSS). The list of nine potential fishes collected at a nearby MBSS sampling location is included as part of their response, and is included in Appendix C.

USFWS responded that except for occasional transient individuals, there are no other federally proposed or listed endangered or threatened species known to occur in the study area. USFWS also requested coordination with DNR Wildlife and Heritage Division regarding the federally threatened bog turtle (Clemmys muhlenbergii). Follow-up coordination with DNR Wildlife and Heritage confirmed that bog turtles do not occur in this area.

The Maryland Historical Trust responded that no historic properties would be affected by this undertaking.

Upon approval of this concept design by Harford County, an on-site interagency field meeting with resource and regulatory agencies will be requested. All interested regulatory/resource agencies will be invited, including US Army Corps of Engineers (Corps), Maryland Department of Environment (MDE) Nontidal Wetlands Division, DNR, USFWS, and MHT. The purpose of this meeting will be to present the conceptual design and encourage agency input at the early concept design phase. This field meeting will also be used to obtain a waterway/wetland preliminary jurisdictional determination from the Corps and MDE. Meeting minutes will be prepared documenting outcomes of meeting.

Alternatives Analysis

Several alternatives were investigated throughout the development of the concept report including a No-action option and a complete removal of the embankment dam. All alternatives considered will have potential impacts to downstream wetlands (Wetland 3). This is due to either the lowering of the proposed water surface by breaching the dam or the potential future failure of the dam due to seepage associated with the no-action option. Two breached options evaluated further however, offer a great opportunity to create large amount of wetlands within the footprint of the existing pond. The complete removal of the embankment was initially considered but was not fully developed due to the potential risk of downstream flooding and sediment concerns. The two alternatives considered in this report consist of a partial breach of the embankment with a culvert and a partial breach of the embankment with a notched opening. Concept Plans are included for both alternatives in Appendix G. In addition, a preliminary HEC-RAS model was used to verify the design sizing.

The landscape planting concept for both alternatives will include planting the bottom of the pond with aquatic plant material appropriate for 18 inches below water level to even with the water level. Riparian plantings will be located along the edges, or fringe, of the pond. The predominantly silt soil of the existing pond bottom should be augmented with a mixture of sand to create a planting soil bed that is suitable to sustain robust vegetation. Improvement of other soil characteristics will also be considered. Wetland plantings will consider use of aquatic vegetation observed in the wetland adjacent to the pond site and may include, for example, Broom Sedge (Andropogon virginicus), Rice Cut Grass (Leersia oryzoides), and Shallow Sedge (Carex lurida).

Both alternatives have the same approach channel geometry. The approach geometry selected (Appendix G) is based on the USFWS Regional Curves and surveyed cross section data. The computations are presented in Tables 7 and Figure 11. The existing sections have a very shallow depth due to the ponding caused by the embankment dam. Therefore, the approach channel selected was based upon the 2-year discharge and the USFWS Regional Curves with an assumed slope of 1.5%.

Table 7: Existing approach cross-sections

	Existing XS-1 31' d/s bridge		Existing XS-2 48' d/s bridge	
Channel Width	6.7'	18.6'	3.05'	12.3'
Hydraulic Radius	0.44'			
Avg. Channel Depth	0.47'	0.35'	0.24'	0.27'
Channel Area	3.12 sf	6.43'	0.74'	3.32'
Q @ Top of Bank	8.3 cfs			
Max. depth	0.76'			
	@ Ex. WSEL 1-13-12	@ top of channel (in Rivermorph)	@ Ex. WSEL 1-13-12	@ top of channel (in Rivermorph)

$Q_{BF} = 84.56\ DA^{0.76}$ DA @ Pond = 76 ac = 0.12 mi^2

$XS_{area} = 17.42\ DA^{0.73}$

$Width = 14.78\ DA^{0.39}$

$depth = 1.18\ DA^{0.34}$

$Q_{BF} = 16.9$ cfs From Regional Regression $Q_{1.25} = 22$ cfs

$XS_{area} = 3.71$ sf

Width = 6.46 ft

depth = 0.57

$A = Ym\ (Wb - 2 * Z * Ym) + ZYm^2$

Design Low flow for 2 yr = 42 cfs

After several iterations with discharge and geometry:

Approach Section Selected: B = 5’, Ym = 1.5’, Wb = 5 + 3(2) = 11, A = 12 sf

Figure 11: Piedmont Regional Curves Calculations

Alternative #1: Partial breach of embankment – culvert

Alternative #1 consists of the new approach geometry with a partial breach of the dam embankment via a 12’ X 8’ Concrete Box Culvert (See plan and sections Appendix G). One advantage of the culvert option is the potential to design backwater or storage behind the culvert. This control would help create new wetlands within the existing pond footprint and would also reduce the risk of sediment release downstream. This option would also allow the trail to remain in place.

There are several draw-backs to this alternative. Primarily, the lack of a natural floodplain connection through the breach. Dams that capture peak flood flows and prevent flood flows from inundating floodplain habitats have reduced the area and frequency of habitat conditions necessary to sustain large populations of a variety of species. The piping, which results in increase velocities over the channel breach option can also exacerbate the scour issues downstream.

Another concern is the potential for seepage along the culvert, which could result in a failure of the culvert. Due to the age of the dam and lack of as-builts, it is unclear what standards were used in the construction of the dam. Depending on the storage behind the culvert, seepage controls may be required.

Another disadvantage of concrete-bottom stream culverts, is that shallow water flows fast over the smooth bottom, making fish passage difficult or impossible. This could be mitigated by over-sizing the culvert and placing natural materials in the culvert bottom, but this option would have an increase in cost.

The cost estimate for Alternative #1 is presented in Table 8

Table 8: Alternative 1 – Cost estimate

Major Items	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilzation	1	LS	$50,000	$50,000
Construction Stakeout	1	LS	$5,000	$5,000
Clearing and Grubbing	1.5	AC	$1,000	$1,500
Class 5 Excavation	2000	CY	$30	$60,000
Select Borrow	1000	CY	$20	$20,000
Approach Channel Stabilization	560	LF	$100	$56,000
12' X 8' Box Culvert	50	LF	$2,500	$125,000
Wingwalls	25	CY	$500	$12,500
Maintenance of Streamflow	1	LS	$70,000	$70,000
Erosion and Sediment Control	1	LS	$35,000	$35,000
Riprap for Slope and Channel Protection	50	SY	$100	$5,000
Plantings	65000	SF	$1	$65,000
Temporary Seeding	375	LB	$30	$11,250
Temporary Mulching	7260	SY	$0.50	$3,630
Subtotal				**$519,880**
Contingency (25%)				$129,970
Total				**$649,850**

Alternative #2: Partial breach of embankment – notched opening

Alternative #2 consists of the new approach geometry with a partial breach of the dam embankment via a low flow channel (5' bottom width, 1.5' deep, 2:1 side slopes) with a 20' wide high flow/floodplain bench (See plan and sections Appendix G). One advantage of this alternative is the new floodplain connection. This connection will provide for lower velocities over the culvert breach option which should provide a reduction in erosion in the downstream channel. The low flow channel will also provide deeper and slower flows, improving the chance of aquatic organism passage upstream. The creation of a floodplain through the embankment should also increase the area and frequency of habitat conditions necessary to sustain large populations of a variety of species downstream.

Due to the unknown nature of the embankment materials, the breach will need to be armored, the type of armoring would be selected based upon the velocities and the geotechnical findings. Finally, this option would require relocation of the trail.

The cost estimate for Alternative #2 is presented in Table 9

Table 9: Alternative 2 – Cost estimate

Major Items	Qty	Unit	Unit Cost	Total Cost
Mobilzation	1	LS	$50,000	$50,000
Construction Stakeout	1	LS	$5,000	$5,000
Clearing and Grubbing	1.5	AC	$1,000	$1,500
Class 1 Excavation	1000	CY	$30	$30,000
Class 5 Excavation	2000	CY	$30	$60,000
Approach Channel Stabilization	560	LF	$100	$56,000
Maintenance of Streamflow	1	LS	$70,000	$70,000
Erosion and Sediment Control	1	LS	$35,000	$35,000
Riprap for Slope and Channel Protection	500	SY	$100	$50,000
Plantings	65000	SF	$1	$65,000
Temporary Seeding	375	LB	$30	$11,250
Temporary Mulching	7260	SY	$0.50	$3,630
Subtotal				**$437,380**
Contingency (25%)				$109,345
Total				**$546,725**

Recommendations

Geotechnical recommendations:

- A review of the embankment and foundation soils should be conducted as part of the next design phase. Two borings are anticipated, one on each side of the proposed breach. The borings shall extend into foundation soils with appropriate lab testing. Based on the maximum dam height of about 17 feet and a penetration into foundation soils of approximately the same depth, a total boring footage of 60 feet (2 borings, maximum depth of 30 feet each) is considered reasonable.
- Based on the results of the boring analysis, an assessment/verification of stable slope configurations for the breach side slopes should be conducted.
- Findings and analysis shall be summarized into a geotechnical report.

Landscaping recommendations:

- The predominantly silt soil of the existing pond bottom should be augmented with a mixture of sand to create a planting soil bed that is suitable to sustain robust vegetation. Improvement of other soil characteristics should also be considered.

Alternative recommendations:

Parsons Brinckerhoff recommends Alternative #2. In addition to being less expensive, the notch breach option can provide many environmental benefits over the culvert option, including:

- Floodplain connection
- Habitat improvement
- Potential for fish passage
- Water quality

The old paved trail should be removed and landscaped. The trail should be relocated north of the pond with a new or improved crossing.

A meeting should be held with Harford County and the regulatory agencies to discuss the selected alternative. It should be determined at this meeting whether the pond should be backwatered to encourage the formation of wetland and if so, to what extent.

Once the geotechnical investigations are completed the design should be advanced with a focus on the bioengineering techniques used in the proposed approached channel and the selection of the side slopes and armoring of the notch breach.

A – Photographs

Pond Photos

Looking west at pond. 8/17/11.

Looking towards east at pond. 8/17/11.

Embankment looking east towards main park. 8/17/11.

Pedestrian bridge at north side of pond. 8/17/11.

Embankment and Downstream Photos

Looking east towards park. Wetland area from potential dam seepage shown in right side of photo. 1/5/12.

Pond outfall pipe and plunge pool. 1/5/12.

Reach 1 – Tollgate Road to North Side of Pond

Tollgate Road outfall and scour pool. 1/5/12.

Channel immediately downstream of Tollgate Road scour pool.

BEHI-006. 1/5/12.

Entrenched channel with downed trees downstream of Tollgate Road. 1/5/12.

Channel becomes more entrenched in the wooded area closest to Tollgate Road. 1/5/12.

Typical channel adjacent to park in reach 1. 1/5/12.

Looking upstream at split channel flow upstream of pedestrian bridge. 1/5/12.

Looking upstream at pedestrian bridge north of pond. 1/5/12.

Looking downstream at pedestrian bridge from channel. 1/5/12.

Area of sediment accumulation between bridge and pond. 1/5/12.

Looking downstream from pedestrian bridge at pond. 1/5/12.

Reach 2 – Downstream of Pond to Golf Course

Looking downstream from plunge pool. Notice dense vegetation. 1/5/12.

Eroded gully located 240’ downstream of pond outfall. Gully drains recreational fields on west side of the park. The right stream bank is eroded approximately 10’ upstream of the confluence and 25’ downstream of the confluence. 1/5/12.

Looking downstream towards tributary from top of eroded gully. 1/5/12.

Typically channel section in reach 2. 1/5/12.

Small bedrock grade control in channel. Drop is approximately 1.0 feet. 1/5/12.

Headcut in reach 2. 1/5/12.

BEHI-005. Notice right bank erosion and mid-channel bar. 1/5/12.

BEHI-004. 1/5/12.

Reach 3 – Golf Course Reach

Typical channel in upper section of Reach 3. 1/5/12.

Reach 3 just north of golf course. 1/5/12.

BEHI-003. 1/5/12.

Reach 3 looking downstream, adjacent to golf course. 1/5/12.

BEHI-002. 1/5/12.

Gabion basket grade control adjacent to golf course. 1/5/12.

Looking downstream at gabion basket grade control. 1/5/12.

Reach 3 between golf course and elevated wooden trail bridge. Section is very entrenched. 1/5/12.

Entrenched channel between golf course and trail. 1/5/12.

Upstream face of existing culvert at confluence with golf course tributary. 1/5/12.

Confluence with golf course tributary and Heavenly Pond tributaries at end of Reach 3. 1/5/12.

Scour pool at confluence of two tributaries. 1/5/12.

Reach 4 – Downstream of Golf Course Tributary to Confluence with Winters Run

Reach 4 immediately downstream of confluence. 1/5/12.

Typical reach 4 channel section. Notice sloughing of right bank and connectivity to floodplain. 1/5/12.

Typical reach 4 bank erosion and evidence of freeze/thaw sloughing. 1/5/12.

Silty sandy channel bottom typical of reach 4. 1/5/12.

BEHI-001. 1/5/12.

Looking upstream at tributary confluence with Winters Run. 1/5/12.

B – Stream Data

BEHI Analysis

Historical Aerials

Monitoring Data


REACH #1
REACH #2
REACH #3
REACH #4
HEAVENLY POND TRIBUTARY
STREAM ASSESSMENT
3
0 90 180 360
Feet

Stream:	Trib to Winters Run	Location:	BEHI-001
Station:		Observers:	KEL/SW
Date:	1/5/12	Stream Type:	Valley Type:

Parameter	Inputs	Result	BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)	Study Bank Height (ft) = 3 (A); Bankfull Height (ft) = 1.6 (B); (A) / (B) =	1.875 (C)	7.8
Root Depth / Study Bank Height (E)	Root Depth (ft) = 0.6 (D); Study Bank Height (ft) = 3 (A); (D) / (A) =	0.2 (E)	7.1
Weighted Root Density (G)	Root Density as % = 15 (F); (F) × (E) =	3 (G)	10
Bank Angle (H)	Bank Angle as *Degrees* =	70 (H)	4.9
Surface Protection (I)	Surface Protection as % =	5% (I)	10

Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment:

Stratification Adjustment

Add 5–10 points, depending on position of unstable layers in relation to bankfull stage:

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **VH** / **39.8**

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run**	Location: **BEHI-001**
Station:	Stream Type: / Valley Type:
Observers: **KEL/SW**	Date: **01/5/12**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})...	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)...	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})............................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I	**(1)**	Transverse and/or central bars-short and/or discontinuous...................................NBS = High / Very High Extensive deposition (continuous, cross-channel)..NBS = Extreme Chute cutoffs, down-valley meander migration, converging flow.....................................NBS = Extreme

Level	Method				
Level II	**(2)**	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
Level II	**(3)**	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
Level II	**(4)**	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
Level III	**(5)**	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Moderate

Level	Method								
Level III	**(6)**	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level	Method		
Level IV	**(7)**	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating	

Stream:	**Trib to Winters Run**	Location:	**BEHI-002**
Station:		Observers:	**KEL/SW**
Date:	**1/5/12**	Stream Type:	Valley Type:

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	5.02 (A)	Bankfull Height (ft) =	1.6 (B)	(A) / (B) =	3.1375 (C)	10

Root Depth / Study Bank Height (E)

Root Depth (ft) =	2.2 (D)	Study Bank Height (ft) =	5.02 (A)	(D) / (A) =	0.438247012 (E)	4.5

Weighted Root Density (G)

Root Density as % =	15 (F)	(F) × (E) =	6.573705179 (G)	8.9

Bank Angle (H)

Bank Angle as *Degrees* =	45 (H)	3

Surface Protection (I)

Surface Protection as % =	15% (I)	7.9

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating	VH
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	and Total Score	34.3

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run** Location: **BEHI-002**

Station: Stream Type: Valley Type:

Observers: **KEL/SW** Date: **01/5/12**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S).....................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I	**(1)**	Transverse and/or central bars-short and/or discontinuous...................................NBS = High / Very High
		Extensive deposition (continuous, cross-channel)...NBS = Extreme
		Chute cutoffs, down-valley meander migration, converging flow...................... ....NBS = Extreme

Level II	**(2)**	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
	(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
	(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Low - Moderate

Level III	**(5)**	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)				
	(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV	**(7)**	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	**Method number**						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

Stream:	Trib to Winters Run	Location:	BEHI-003
Station:		Observers:	KEL/SW
Date:	1/5/12	Stream Type:	Valley Type:

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	3.2 (A)	Bankfull Height (ft) =	1.3 (B)	(A) / (B) =	2.461538462 (C)	8.5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	0.9 (D)	Study Bank Height (ft) =	3.2 (A)	(D) / (A) =	0.28125 (E)	5.9

Weighted Root Density (G)

Root Density as % =	15 (F)	(F) × (E) =	4.21875 (G)	10

Bank Angle (H)

Bank Angle as *Degrees* =	65 (H)	4.5

Surface Protection (I)

Surface Protection as % =	15% (I)	7.9

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)

Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		VH 36.8

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run**	Location: **BEHI-003**	
Station:	Stream Type:	Valley Type:
Observers: **KEL/SW**		Date: **01/5/12**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S).......................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})............................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient...	Level IV	Validation

Level I	(1)	Transverse and/or central bars-short and/or discontinuous.......................................NBS = High / Very High Extensive deposition (continuous, cross-channel)..NBS = Extreme Chute cutoffs, down-valley meander migration, converging flow...................... ....NBS = Extreme

Level	Method								
Level II	(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)				
Level II	(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)				
Level II	(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)				
Level III	(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)				
Level III	(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
Level IV	(7)	Velocity Gradient (ft / sec / ft)		Near-Bank Stress (NBS)					

Dominant Near-Bank Stress
High

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

Stream:	**Trib to Winters Run**	Location:	**BEHI-004**
Station:		Observers:	**KEL/SW**
Date:	**1/5/12**	Stream Type:	Valley Type:

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	3.3 (A)	Bankfull Height (ft) =	1.9 (B)	(A) / (B) =	1.736842105 (C)	6.5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	1 (D)	Study Bank Height (ft) =	3.3 (A)	(D) / (A) =	0.303030303 (E)	5.9

Weighted Root Density (G)

Root Density as % =	20 (F)	(F) × (E) =	6.060606061 (G)	8.9

Bank Angle (H)

Bank Angle as *Degrees* =	75 (H)	4.8

Surface Protection (I)

Surface Protection as % =	20% (I)	7

Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment

Stratification Adjustment

Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	Adjective Rating	**VH**
						Total Score	**33.1**

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run**	Location: **BEHI-004**		
Station:	Stream Type:	Valley Type:	
Observers: **KEL/SW**		Date: **01/5/12**	

Methods for estimating Near-Bank Stress (NBS)

Method	Level	Prediction
(1) Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)..	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})................................	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)
- Transverse and/or central bars-short and/or discontinuous..NBS = High / Very High
- Extensive deposition (continuous, cross-channel)...NBS = Extreme
- Chute cutoffs, down-valley meander migration, converging flow.......................................NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
High

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

Stream:	Trib to Winters Run	Location:	BEHI-005
Station:		Observers:	KEL/SW
Date:	1/5/12	Stream Type:	Valley Type:

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	3.5 (A)	Bankfull Height (ft) =	1.4 (B)	(A) / (B) =	2.5 (C)	8.5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	1 (D)	Study Bank Height (ft) =	3.5 (A)	(D) / (A) =	0.285714286 (E)	6

Weighted Root Density (G)

Root Density as % =	20 (F)	(F) × (E) =	5.714285714 (G)	8.9

Bank Angle (H)

Bank Angle as *Degrees* =	70 (H)	4.9

Surface Protection (I)

Surface Protection as % =	25% (I)	6.5

Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment gravel bed layer — 3

Stratification Adjustment

Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating	VH
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	and Total Score	37.8

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run**	Location: **BEHI-005**	
Station:	Stream Type:	Valley Type:
Observers: **KEL/SW**		Date: **01/5/12**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})............................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I	(1)	Transverse and/or central bars-short and/or discontinuous.................................NBS = High / Very High
		Extensive deposition (continuous, cross-channel)...NBS = Extreme
		Chute cutoffs, down-valley meander migration, converging flow.................................NBS = Extreme

Level II	(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
	(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
	(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Moderate

Level III	(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)				
	(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV	(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

Stream:	Trib to Winters Run	Location:	BEHI-006
Station:		Observers:	KEL/SW
Date:	1/5/12	Stream Type:	Valley Type:

Criterion	Input 1	Value	Input 2	Value	Calculation	Result	BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)	Study Bank Height (ft) =	3.9 (A)	Bankfull Height (ft) =	1.8 (B)	(A) / (B) =	2.166666667 (C)	8
Root Depth / Study Bank Height (E)	Root Depth (ft) =	2.2 (D)	Study Bank Height (ft) =	3.9 (A)	(D) / (A) =	0.564102564 (E)	3.8
Weighted Root Density (G)			Root Density as % =	10 (F)	(F) × (E) =	5.641025641 (G)	10
Bank Angle (H)					Bank Angle as *Degrees* =	90 (H)	7.9
Surface Protection (I)					Surface Protection as % =	30% (I)	5.9

Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment gravel bed layer

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	VH 35.6

Estimating Near-Bank Stress (NBS)

Stream: **Trib to Winters Run**	Location: **BEHI-006**	
Station:	Stream Type:	Valley Type:
Observers: **KEL/SW**		Date: **01/5/12**

Methods for estimating Near-Bank Stress (NBS)

	Method	Level	Prediction
(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S).....................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})............................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)
- Transverse and/or central bars-short and/or discontinuous.....................................NBS = High / Very High
- Extensive deposition (continuous, cross-channel)...NBS = Extreme
- Chute cutoffs, down-valley meander migration, converging flow..................................NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress

Moderate

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)				

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating

Harford County Water Resources
(410) 638-3545

Heavenly Waters Pond (1.5 acres)

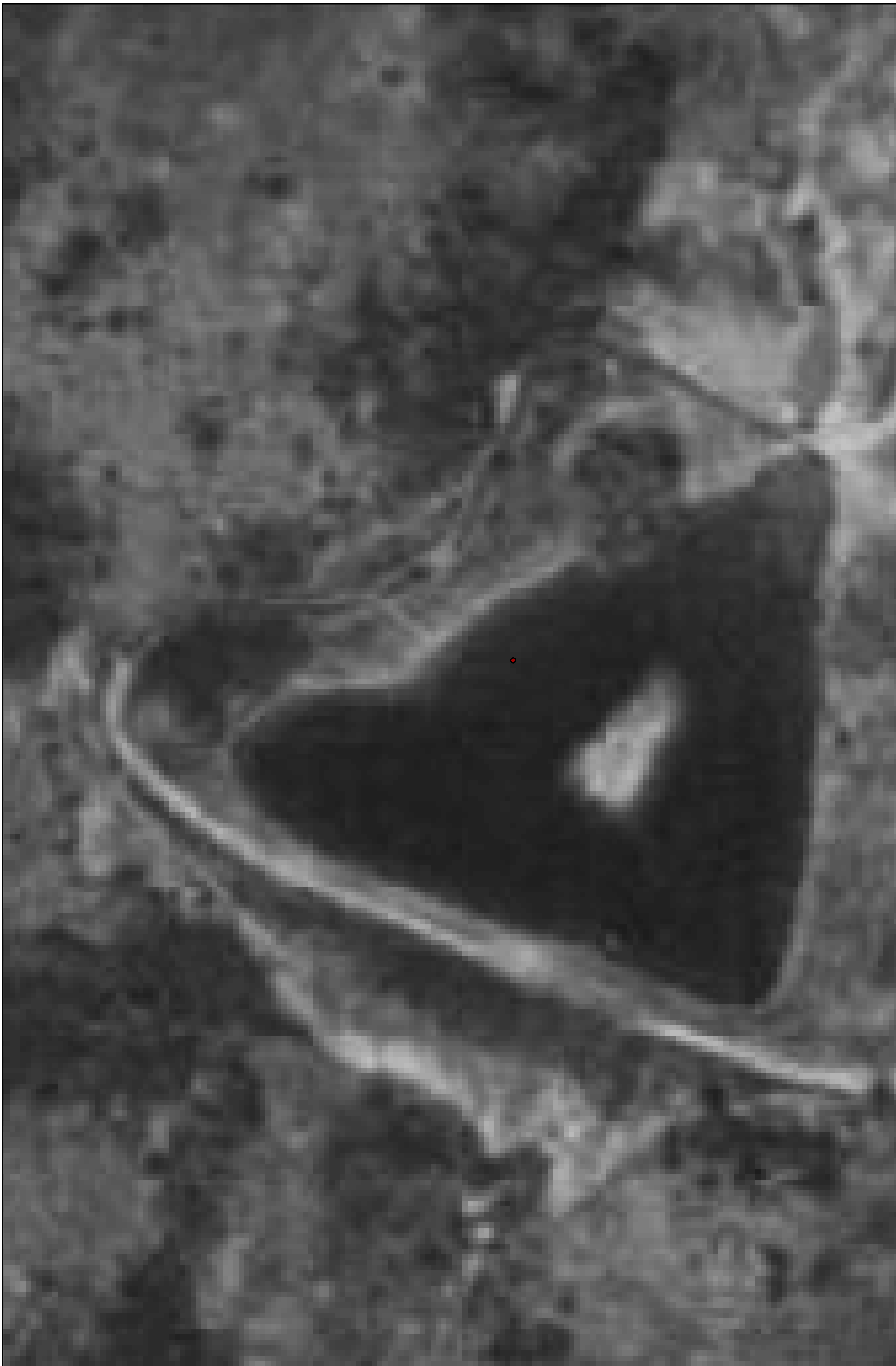
Source: Aerial 1957

0 25 50 Feet

Harford County Water Resources
(410) 638-3545

Heavenly Waters Pond (1.5 acres)

Source: Aerial 1977



Harford County Water Resources
(410) 638-3545

Heavenly Waters Pond (1.5 acres)

Source: Aerial 1980

0 25 50 Feet

Harford County Water Resources
(410) 638-3545

Heavenly Waters Pond (1.5 acres)

Source: Aerial 1986

Harford County Water Resources
(410) 638-3545

Heavenly Waters Pond (1.5 acres)

Source: Aerial 2007

0 25 50 Feet

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A Division of QC Laboratories

630 Churchmans Road
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302-266-9121 • 454-8720 (FAX)
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Harford County Stormwater Program **Order Number: A12011475**

Sample # A12011475-13 **Sample Date: 1/25/2012 8:50**

Site: Heavenly Pond Matrix: Waste Water

Client Sample ID: HP Outfall

Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	1/27/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	0.64		0.1	mg/L	EPA 300.0	1/27/2012 6:53:00 AM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	1/27/2012 11:45:00 AM	Ajurney

Sample # A12011475-14 **Sample Date: 1/26/2012 8:50**

Site: Heavenly Pond Matrix: Waste Water

Client Sample ID: HP Outfall

Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/1/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	1/31/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	0.77		0.15	mg/L	EPA 300.0	2/1/2012 3:24:00 AM	WVanArsdall
Total Kjeldahl Nitrogen as N	< 0.2		0.2	mg/L	EPA 351.2	2/2/2012 9:18:00 AM	WVanArsdall
Total Nitrogen	0.77		0.2	mg/L	Calculation	2/2/2012 9:18:00 AM	WVanArsdall
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	2/6/2012 11:50:00 AM	AWestervelt

Sample # A12011475-15 **Sample Date: 1/25/2012 9:00**

Site: Heavenly Pond Matrix: Waste Water

Client Sample ID: HP Instream

Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	1/27/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	0.74		0.1	mg/L	EPA 300.0	1/27/2012 7:13:00 AM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	1/27/2012 11:45:00 AM	Ajurney

Sample # A12011475-16 **Sample Date: 1/26/2012 9:00**

Site: Heavenly Pond Matrix: Waste Water

Client Sample ID: HP Instream

Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/1/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	1/31/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	1.15		0.15	mg/L	EPA 300.0	2/1/2012 3:44:00 AM	WVanArsdall
Total Kjeldahl Nitrogen as N	< 0.2		0.2	mg/L	EPA 351.2	2/6/2012 11:50:00 AM	AWestervelt
Total Nitrogen	1.15		0.2	mg/L	Calculation	2/6/2012 11:50:00 AM	AWestervelt
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	2/2/2012 9:18:00 AM	WVanArsdall

Approved: Keith A. Hanskrecht

General Manager/Technical Director

Reported: 2/14/2012 3:17:06 PM

CHAIN OF CUSTODY RECORD

PROJECT NAME Wheel Creek
COMPANY HARLO
ADDRESS 212 S. Bond street
PHONE (410)638 3545

ATLANTIC COAST
Laboratories, Incorporated

630 Churchmans Road
Newark, Delaware 19702
302-266-9121 • 454-8720 (FAX)
ACLI@atlanticcoastlabs.com
WWW.ATLANTICCOASTLABS.COM

SAMPLED BY
SIGNATURE
PRINT NAME

SAMPLE COLLECTION FEE:
QUOTED PRICE:

SAMPLE NO.	DATE	TIME	SAMPLE LOCATION	CONTAINER SIZE	CONTAINER G/P	GRAB	COMP	NO. OF CONTAINERS	SAMPLE MATRIX	PRESERVATIVE	BOD TSS	NO2NO3 PO4	TKN Phos NH3	Zn Pb Cu	TPH		TP TN	PO4 NO3			COMMENTS 475
WC002	1/25/12	1000	Wheel Creek			X		4	Sw		X	X	X	X	X						
WC003	1/25/12	1025	↓			X		4	Sw		X	X	X	X	X						
WC004	1/25/12	1050	↓			X		4	Sw		X	X	X	X	X						
HPoutfall	1/26/12	0850	Heavenly Pond			X		3	Sw								X	X			
HPinstream	1/26/12	0900	↓			X		3	Sw								X	X			

Order ID: A12011475

A12011475

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received by:
Michael Out [signature]	1/25/12 1145	[signature]	[signature]	1/26/12 1545	
Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received for Laboratory by: [signature]

Method of Shipment

Remarks:

	YES	NO
Samples Iced 2.5	✓	☐
Samples Preserved	✓	☐

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Harford County Stormwater Program **Order Number: A12021222**

Sample # A12021222-13 **Sample Date: 2/23/2012 11:58**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Outfall
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/24/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	0.45		0.1	mg/L	EPA 300.0	2/24/2012 3:34:00 AM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	2/24/2012 4:50:00 PM	Ajurney

Sample # A12021222-14 **Sample Date: 2/23/2012 11:58**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Outfall
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/24/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	2/29/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	0.90		0.15	mg/L	EPA 300.0	2/24/2012 12:38:00 PM	AWestervelt
Total Kjeldahl Nitrogen as N	0.29		0.2	mg/L	EPA 351.2	3/5/2012 1:40:00 PM	Awestervelt
Total Nitrogen	1.19		0.2	mg/L	Calculation	3/5/2012 1:40:00 PM	Awestervelt
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	3/5/2012 1:40:00 PM	Awestervelt

Sample # A12021222-15 **Sample Date: 2/23/2012 12:10**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Instream
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/24/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	0.65		0.1	mg/L	EPA 300.0	2/24/2012 5:50:00 AM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	2/24/2012 4:50:00 PM	Ajurney

Sample # A12021222-16 **Sample Date: 2/23/2012 12:10**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Instream
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	2/24/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	2/29/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	1.10		0.15	mg/L	EPA 300.0	2/24/2012 12:57:00 PM	AWestervelt
Total Kjeldahl Nitrogen as N	< 0.2		0.2	mg/L	EPA 351.2	3/5/2012 1:40:00 PM	Awestervelt
Total Nitrogen	1.10		0.2	mg/L	Calculation	3/5/2012 1:40:00 PM	Awestervelt
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	3/5/2012 1:40:00 PM	Awestervelt

Approved: Keith A. Hanskrecht
General Manager/Technical Director

Reported: 3/7/2012 11:32:21 AM

CHAIN OF CUSTODY RECORD

PROJECT NAME Wheel Creek
COMPANY HARCO
ADDRESS 212 S. Bond Street
PHONE (410) 638-3545

Michele Dobson
SAMPLED BY: [signature]
SIGNATURE
PRINT NAME

ATLANTIC COAST Laboratories, Incorporated

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Newark, Delaware 19702
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ACLI@atlanticcoastlabs.com
WWW.ATLANTICCOASTLABS.COM

SAMPLE COLLECTION FEE:
QUOTED PRICE:

ANALYSES

SAMPLE NO.	DATE	TIME	SAMPLE LOCATION	CONTAINER SIZE	CONTAINER G/P	GRAB	COMP	NO. OF CONTAINERS	SAMPLE MATRIX	PRESERVATIVE	BOD	TSS	NO2 NO3 PO4	TKN Phos NH3	Zn Cu Pb	TPH	Hardness	TNIP	PO4 NO3	COMMENTS 222
WC002	2/22/12	0945	Wheel Creek			X		4	SW		X	X	X	X	X	X				
WC003	2/22/12	1008	↓			X		4	SW		X	X	X	X	X	X				
WC004	2/22/12	1020				X		4	SW		X	X	X	X	X	X				
HPoutfall	2/22/12	1156	Heavenly Pond			X		2	SW									X	X	
HPinstream	2/22/12	1210	↓			X		2	SW									X	X	

Order ID: A12021222

A12021222

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received by:
[signature]	2/22/12 1315	[signature]	[signature]	2/22/12 1530	

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received for Laboratory by:
					[signature]

Method of Shipment:

Remarks:

		YES	NO
Samples Iced	2.3	✓	☐
Samples Preserved		✓	☐

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Harford County Stormwater Program **Order Number: A12030774**

Sample # A12030774-13 **Sample Date: 3/14/2012 12:00**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Outfall
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	3/15/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	0.76		0.1	mg/L	EPA 300.0	3/15/2012 5:42:00 PM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	3/15/2012 4:10:00 PM	Ajurney

Sample # A12030774-14 **Sample Date: 3/14/2012 12:00**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Outfall
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	3/20/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	3/19/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	0.75		0.15	mg/L	EPA 300.0	3/20/2012 8:26:00 PM	AWestervelt
Total Kjeldahl Nitrogen as N	0.54		0.2	mg/L	EPA 351.2	3/20/2012 9:29:00 AM	Awestervelt
Total Nitrogen	1.29		0.2	mg/L	Calculation	3/20/2012 8:26:00 PM	AWestervelt
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	3/20/2012 9:29:00 AM	Awestervelt

Sample # A12030774-15 **Sample Date: 3/14/2012 12:20**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Instream
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	3/15/12		N/A	Date Completed	EPA 300.0		
Nitrate as N	1.24		0.1	mg/L	EPA 300.0	3/15/2012 6:01:00 PM	AWestervelt
Phosphate (PO4) as P	< 0.05		0.05	mg/L	SM 4500-P E	3/15/2012 4:10:00 PM	Ajurney

Sample # A12030774-16 **Sample Date: 3/14/2012 12:20**

Site: Heavenly Pond Matrix: Waste Water
Client Sample ID: HP Instream
Sample Comments: None

Test	Result	Qualifier	RL	Units	Method	Analysis Date	Analyst
Anions, Date Completed	3/20/12		N/A	Date Completed	EPA 300.0		
Digestion, TKN-TP	3/19/12		N/A	Date Completed	EPA 351.2		
Nitrate/Nitrite as N	1.02		0.15	mg/L	EPA 300.0	3/20/2012 8:45:00 PM	AWestervelt
Total Kjeldahl Nitrogen as N	< 0.2		0.2	mg/L	EPA 351.2	3/20/2012 9:29:00 AM	Awestervelt
Total Nitrogen	1.02		0.2	mg/L	Calculation	3/20/2012 8:45:00 PM	AWestervelt
Total Phosphorus as P	< 0.05		0.05	mg/L	EPA 365.4	3/20/2012 9:29:00 AM	Awestervelt

Approved: Keith A. Hanshrecht
General Manager/Technical Director

Reported: 4/3/2012 11:32:31 AM

CHAIN OF CUSTODY RECORD

PROJECT NAME Wheel Creek - HP003 SW
COMPANY HARLO
ADDRESS 212 S. Bond Street
PHONE (410) 633-3545

ATLANTIC COAST Laboratories, Incorporated

630 Churchmans Road
Newark, Delaware 19702
302-266-9121 • 454-8720 (FAX)
ACLI@atlanticcoastlabs.com
WWW.ATLANTICCOASTLABS.COM

774

Michele Dobson
SAMPLED BY
Michele Dob
SIGNATURE Michele Dobson
PRINT NAME

SAMPLE COLLECTION FEE:
QUOTED PRICE:

SAMPLE NO.	DATE	TIME	SAMPLE LOCATION	CONTAINER SIZE	CONTAINER G/P	GRAB	COMP	NO. OF CONTAINERS	SAMPLE MATRIX	PRESERVATIVE	BOD	TSS	NO2NO3 Poy	TKN Phos NH3	Cu Zn Pb	TPH	Hardness	TN TP	NO3 Poy	COMMENTS
WC002	3-14-12	0940	Wheel Creek			X		4	SW		X	X	X	X	X	X				
WC003	3-14-12	1005	↓			X		4	SW		↓	↓	↓	↓	↓	↓				
WC004	3-14-12	1030	↓			X		4	SW		↓	↓	↓	↓	↓	↓				
HPoutfall	3-14-12	1200	Heavenly Pond			X		2	SW									X	X	
HPinstream	3-14-12	1220	↓			X		2	SW									X	X	

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received by:
Michele Dobson	3/14/12 1320	[signature]			

Relinquished by:	Date / Time	Date / Time	Received for Laboratory by:
		3/14/12 14:30	[signature]

Method of Shipment:

Order ID: A12030774

A12030774

	YES	NO
Samples Iced 4.7	✓	
Samples Preserved	✓	

C – Natural Resource Data and Agency Coordination

20120065 6

F
COE
DLH

DAVID R. CRAIG
HARFORD COUNTY EXECUTIVE

MARY F. CHANCE
DIRECTOR OF ADMINISTRATION

ROBERT B. COOPER, P.E.
DIRECTOR OF PUBLIC WORKS

H. HUDSON MYERS, III, P.E.
DEPUTY DIRECTOR OF PUBLIC WORKS

HARFORD COUNTY GOVERNMENT

RECEIVED
FEB 1 4 2012
BY:

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS AND WATER RESOURCES

February 9, 2012

RE: Heavenly Waters Pond Dam Removal
Conceptual Plan Development
Harford County, Maryland

Mr. Rodney Little
State Historic Preservation Officer
Maryland Historic Trust
100 Community Place
Crownsville, MD 21032-2023

Dear Mr. Little:

The Harford County Department of Public Works proposes development of a conceptual plan for the removal of the existing dam at Heavenly Waters Pond, located in Heavenly Waters/Tollgate Park, Harford County. Sometime during the 1980's, the pond was modified and became an in-line facility. The proposed work will consist of removal of the pond, and restoration of the stream and pond to a more natural stream/wetland habitat. All work will be completed on land owned by Harford County. A map of the project location has been included for your reference.

Bel Air

We request any information concerning historic or archeological resources within the study area. Please send your response to the attention of:

Pam McNicholas
Parsons Brinckerhoff
100 S. Charles Street
Tower 1, 10th Floor
Baltimore, MD 21201

If you have any questions regarding this request, please contact me at (410) 638-3545 ext. 1176 or Pam McNicholas at (410)752-9637 or mcnicholasps@pbworld.com.

Very truly yours,

Christine M. Buckley, P.E.
Environmental Engineer
Harford County Department of Public Works

The Maryland Historical Trust has determined that there are no historic properties affected by this undertaking.

Dixie Henry Date 3/7/12

Archeo, DLH 3/7/12 (1a)

Preserving Harford's past; promoting Harford's future

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, *Governor*
Anthony G. Brown, *Lt. Governor*
John R. Griffin, *Secretary*
Joseph P. Gill, *Deputy Secretary*

12-MIS-129

March 1, 2012

Pam McNicholas
Parsons Brinckerhoff
100 S. Charles Street
Baltimore, MD 32302

Subject: Fisheries Information for the Proposed Removal of the Existing Dam at Heavenly Waters Pond, in Heavenly Waters/Tollgate Park in Harford County, Maryland.

Dear Ms. McNicholas,

The above referenced project has been reviewed to determine fisheries species in the vicinity of the proposed project. The proposed activities include the removal of the existing dam at Heavenly Waters Pond, in Heavenly Waters/Tollgate Park in Harford County, Maryland.

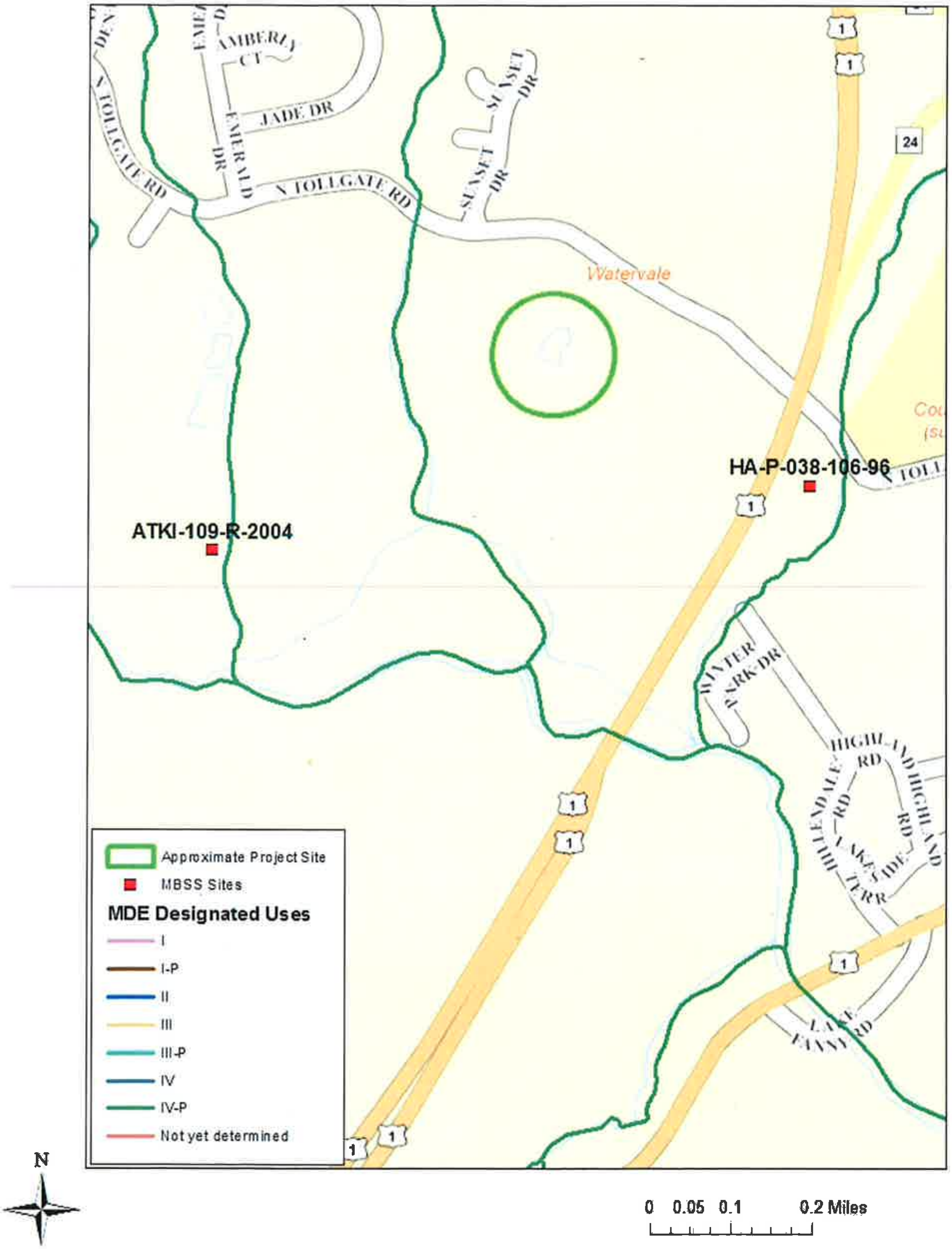
Heavenly Waters and Winter Run (Bush River Basin) and tributaries near the site are classified as Use IV-P streams (Recreational Trout Waters and Public Water Supply). Generally, no instream work is permitted in Use IV streams during the period of March 1 through May 31, inclusive, during any year.

No anadromous fish have been documented near the project site. However, these streams may support many resident fish species documented by our Maryland Biological Stream Survey. There are Maryland Biological Stream Survey (MBSS) stations near the project location. The species collected at one of these stations has been itemized in the attached list. MBSS data can be accessed via the MDDNR web page at http://mdimap.towson.edu/streamhealth/, allowing access to resource surveys in neighboring tributaries.

If you have further questions, please contact the Environmental Review Program at 410-260-8799.

Sincerely,

Ken Yetman
Environmental Review Program



Approximate Project Site
MBSS Sites
MDE Designated Uses
I
I-P
II
III
III-P
IV
IV-P
Not yet determined
ATKI-109-R-2004
HA-P-038-106-96
Watervale
N TOLLGATE RD
JADE DR
EMERALD DR
SUNSET DR
WINTER PARK DR
HIGHLAND RD
LAKESIDE TERR
24
1
N
0 0.05 0.1 0.2 Miles

The following fishes were collected at ATKI-109-R-2004

Common name	Percent of total
BLUE RIDGE SCULPIN	72.2
CREEK CHUB	11.1
BLACKNOSE DACE	9.4
BLUNTNOSE MINNOW	3.1
BLUEGILL	1.1
FALLFISH	1.1
COMMON SHINER	0.9
ROSYSIDE DACE	0.9
WHITE SUCKER	0.2

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, Governor
Anthony G. Brown, Lt. Governor
John R. Griffin, Secretary
Joseph P. Gill, Deputy Secretary

March 8, 2012

Christine Buckley
Harford County DPW
212 South Bond St. 3rd Floor
Bel Air, MD 21014

RE: Environmental Review for dam removal at Heavenly Waters Pond, Tollgate Park, restore stream and pond, Harford County, MD.

Dear Ms. Buckley:

The Wildlife and Heritage Service has determined that there are no State or Federal records for rare, threatened or endangered species within the boundaries of the project site as delineated. As a result, we have no specific comments or requirements pertaining to protection measures at this time. This statement should not be interpreted however as meaning that rare, threatened or endangered species are not in fact present. If appropriate habitat is available, certain species could be present without documentation because adequate surveys have not been conducted.

Thank you for allowing us the opportunity to review this project. If you should have any further questions regarding this information, please contact me at (410) 260-8573.

Sincerely,

Lori A. Byrne,
Environmental Review Coordinator
Wildlife and Heritage Service
MD Dept. of Natural Resources

ER# 2012.0238.ha

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
http://www.fws.gov/chesapeakebay

March 27, 2012

Harford County Government
Department of Public Works
Division of Highways and Water Resources
212 south Bond Street, 3rd Floor
Bel Air, MD 21014

RE: Heavenly Waters Pond Dam Removal Harford County MD

Dear Christine M. Buckley:

This responds to your letter, received February 9, 2012, requesting information on the presence of species which are federally listed or proposed for listing as endangered or threatened within the above referenced project area. We have reviewed the information you enclosed and are providing comments in accordance with section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*).

The federally threatened bog turtle (*Clemmys muhlenbergii*) may be present within the project area or within the vicinity of the project. Bog turtles primarily inhabit palustrine wetlands comprised of a muddy bottom or shallow water, and tussocks of vegetation. A survey for bog turtle habitat and bog turtles may be appropriate. These surveys should be conducted at any location where the Maryland Wildlife and Heritage Division recommends. Upon completion, survey reports should be forwarded to both the Service and the Maryland Wildlife and Heritage Division for review. If you have not already sent a copy of your request for threatened and endangered species information to the Maryland Department of Natural Resources Wildlife and Heritage Division (580 Taylor Avenue, E-1, Annapolis MD 21401), please do so. Ms. Lori Byrne of the Wildlife and Heritage Division will provide additional information regarding the need for surveys and a list of experts who are qualified to perform such surveys.

Except for occasional transient individuals, no other federally proposed or listed endangered or threatened species are known to exist within the project impact area. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For information on the presence of other rare species, you should contact Lori

Byrne of the Maryland Wildlife and Heritage Division at (410) 260-8573.

Effective August 8, 2007, under the authority of the Endangered Species Act of 1973, as amended, the U.S. Fish and Wildlife Service (Service) removed (delist) the bald eagle in the lower 48 States of the United States from the Federal List of Endangered and Threatened Wildlife. However, the bald eagle will still be protected by the Bald and Golden Eagle Protection Act, Lacey Act and the Migratory Bird Treaty Act. As a result, starting on August 8, 2007, if your project may cause "disturbance" to the bald eagle, please consult the "National Bald Eagle Management Guidelines" dated May 2007.

If any planned or ongoing activities cannot be conducted in compliance with the National Bald Eagle Management Guidelines (Eagle Management Guidelines), please contact the Chesapeake Bay Ecological Services Field Office at 410-573-4573 for technical assistance. The Eagle Management Guidelines can be found at:
http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf.

In the future, if your project can not avoid disturbance to the bald eagle by complying with the Eagle Management Guidelines, you will be able to apply for a permit that authorizes the take of bald and golden eagles under the Bald and Golden Eagle Protection Act, generally where the take to be authorized is associated with otherwise lawful activities. This proposed permit process will not be available until the Service issues a final rule for the issuance of these take permits under the Bald and Golden Eagle Protection Act.

An additional concern of the Service is wetlands protection. Federal and state partners of the Chesapeake Bay Program have adopted an interim goal of no overall net loss of the Basin's remaining wetlands, and the long term goal of increasing the quality and quantity of the Basin's wetlands resource base. Because of this policy and the functions and values wetlands perform, the Service recommends avoiding wetland impacts. All wetlands within the project area should be identified, and if construction in wetlands is proposed, the U.S. Army Corps of Engineers, Baltimore District, should be contacted for permit requirements. They can be reached at (410) 962-3670.

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Andy Moser at (410) 573-4537.

Sincerely,

G. La Rouche

Genevieve LaRouche
Supervisor

D – Hydrology Analysis

	PARSONS BRINCKERHOFF TR-55 WORKSHEETS	
		Page: 1
		Made by: SCW
		Date: 1/27/2012
		Checked by:
		Date:

Project: HEAVENLY POND

Location: PI #1

Conditions: EXISTING

Composite Runoff Curve Number Determination:

Hydrologic Soil Group	Cover Description		Curve Number (CN)	Area, A (acres)	Product CN x A
C	16	Institutional	86	0.48	41.51
C	16	Institutional	86	0.00	0.15
C	16	Institutional	86	0.91	77.84
C	16	Institutional	86	0.47	40.33
C	16	Institutional	86	3.27	281.08
C	16	Institutional	86	0.48	41.36
B	18	Open Urban Land	61	0.29	17.98
B	18	Open Urban Land	61	0.33	19.89
B	18	Open Urban Land	61	0.55	33.81
B	18	Open Urban Land	61	1.03	62.65
B	18	Open Urban Land	61	0.01	0.49
B	18	Open Urban Land	61	0.03	1.79
C	18	Open Urban Land	74	2.68	198.08
C	18	Open Urban Land	74	1.40	103.52
B	41	Deciduous Forest	55	0.67	37.03
B	41	Deciduous Forest	55	2.25	123.80
B	41	Deciduous Forest	55	1.64	90.05
B	41	Deciduous Forest	55	0.09	4.75
B	41	Deciduous Forest	55	0.42	22.97
B	41	Deciduous Forest	55	0.03	1.39
B	41	Deciduous Forest	55	0.30	16.31
C	41	Deciduous Forest	70	0.52	36.67
C	41	Deciduous Forest	70	0.45	31.67
C	41	Deciduous Forest	70	0.19	13.24

C	41	Deciduous Forest	70	5.43	379.95
C	41	Deciduous Forest	70	2.64	184.91
C	41	Deciduous Forest	70	0.19	13.44
C	41	Deciduous Forest	70	1.17	82.07
C	41	Deciduous Forest	70	0.00	0.04
B	42	Evergreen Forest	55	0.00	0.14
C	42	Evergreen Forest	70	0.19	13.16
C	42	Evergreen Forest	70	0.26	17.95
B	44	Brush	55	1.84	101.47
C	44	Brush	70	11.05	773.21
C	44	Brush	70	2.62	183.32
C	44	Brush	70	0.03	2.06
C	44	Brush	70	1.01	70.39
C	44	Brush	70	0.42	29.33
C	44	Brush	70	0.12	8.20
B	50	Water	100	0.44	43.76
C	50	Water	100	0.00	0.00
C	50	Water	100	0.02	2.03
C	50	Water	100	0.18	17.58
C	50	Water	100	0.08	8.45
C	50	Water	100	0.01	1.42
C	73	Bare Ground	91	1.23	112.27
C	73	Bare Ground	91	0.73	66.60
			Totals =	**48.14**	**3410.12**

Composite Curve Number (CN)	**= (total product) (total area)**	**=**	**70.84**	**Use**

PARSONS BRINCKERHOFF
TR-55 WORKSHEETS

Page: 1
Made by: SCW
Date: 1/27/2012
Checked by:
Date:

Project: HEAVENLY POND

Location: PI #2

Conditions: EXISTING

Composite Runoff Curve Number Determination:

Hydrologic Soil Group	Cover Description		Curve Number (CN)	Area, A (acres)	Product CN x A
B	12	Medium Density Residential	75	0.00	0.03
B	12	Medium Density Residential	75	0.61	46.11
B	12	Medium Density Residential	75	0.19	13.90
B	12	Medium Density Residential	75	1.57	117.91
B	12	Medium Density Residential	75	1.46	109.36
B	12	Medium Density Residential	75	0.00	0.34
C	12	Medium Density Residential	83	0.00	0.25
A	18	Open Urban Land	39	2.45	95.44
B	18	Open Urban Land	61	0.65	39.78
B	18	Open Urban Land	61	1.77	107.67
B	18	Open Urban Land	61	3.14	191.51
B	18	Open Urban Land	61	2.11	128.54
C	18	Open Urban Land	74	2.60	192.70
B	21	Cropland	78	0.01	0.61
B	21	Cropland	78	1.20	93.76
C	21	Cropland	85	0.55	46.80
A	41	Deciduous Forest	30	0.92	27.52
B	41	Deciduous Forest	55	0.73	40.09
B	41	Deciduous Forest	55	0.05	2.71
B	41	Deciduous Forest	55	0.28	15.48
B	41	Deciduous Forest	55	0.13	7.40
C	41	Deciduous Forest	70	0.02	1.11
C	41	Deciduous Forest	70	0.82	57.75
C	41	Deciduous Forest	70	2.47	172.70

B	42	Evergreen Forest	55	1.31	71.97
B	42	Evergreen Forest	55	0.03	1.63
C	42	Evergreen Forest	70	0.11	7.76
B	44	Brush	55	0.07	3.94
B	44	Brush	55	0.80	44.01
C	44	Brush	70	0.83	58.29
A	50	Water	100	0.57	57.06
C	50	Water	100	0.85	84.82
			Totals =	**28.31**	**1838.94**

Composite Curve Number (CN)	**= (total product) (total area)**	**=**	**64.97**	**Use**

PARSONS BRINCKERHOFF
TR-55 WORKSHEETS

Page	1
Made by:	SCW
Date:	1/27/2012
Checked by:	
Date:	

Project: HEAVENLY POND

Location: PI #3A

Conditions: EXISTING

Composite Runoff Curve Number Determination:

Hydrologic Soil Group	Cover Description		Curve Number (CN)	Area, A (acres)	Product CN x A
B	11	Low Density Residential	70	7.33	512.89
B	11	Low Density Residential	70	0.78	54.92
B	11	Low Density Residential	70	1.19	83.00
B	11	Low Density Residential	70	0.86	60.13
B	11	Low Density Residential	70	0.92	64.67
B	11	Low Density Residential	70	1.14	79.78
B	11	Low Density Residential	70	0.74	52.06
B	11	Low Density Residential	70	0.54	37.88
B	11	Low Density Residential	70	0.00	0.24
C	11	Low Density Residential	80	3.67	293.37
C	11	Low Density Residential	80	1.22	97.37
C	11	Low Density Residential	80	1.27	101.73
B	12	Medium Density Residential	75	1.36	102.23
B	12	Medium Density Residential	75	1.40	105.08
B	12	Medium Density Residential	75	3.56	266.84
B	12	Medium Density Residential	75	0.41	30.69
B	12	Medium Density Residential	75	1.19	89.07
B	12	Medium Density Residential	75	1.08	80.74
B	12	Medium Density Residential	75	4.98	373.65
B	12	Medium Density Residential	75	2.10	157.27
B	12	Medium Density Residential	75	2.35	176.38
B	12	Medium Density Residential	75	2.02	151.58
B	12	Medium Density Residential	75	0.74	55.84
B	12	Medium Density Residential	75	6.60	494.71

B	12	Medium Density Residential	75	0.07	5.28
B	12	Medium Density Residential	75	0.48	35.91
B	12	Medium Density Residential	75	2.64	198.26
B	12	Medium Density Residential	75	1.97	147.53
B	12	Medium Density Residential	75	1.08	80.96
C	12	Medium Density Residential	83	5.39	447.11
C	12	Medium Density Residential	83	3.94	326.70
C	12	Medium Density Residential	83	5.34	443.63
C	12	Medium Density Residential	83	2.61	216.65
C	12	Medium Density Residential	83	0.80	66.55
C	12	Medium Density Residential	83	0.00	0.26
C	12	Medium Density Residential	83	3.42	283.49
C	12	Medium Density Residential	83	5.53	458.61
D	12	Medium Density Residential	87	1.06	92.23
D	12	Medium Density Residential	87	0.22	19.50
D	12	Medium Density Residential	87	3.34	290.93
D	12	Medium Density Residential	87	1.82	158.75
W	12	Medium Density Residential	100	0.06	6.05
B	13	High Density Residential	84	2.10	176.30
B	13	High Density Residential	84	2.24	188.24
B	13	High Density Residential	84	2.90	243.85
B	13	High Density Residential	84	2.30	193.00
B	13	High Density Residential	84	0.29	24.53
C	13	High Density Residential	90	11.23	1010.87
C	13	High Density Residential	90	1.02	91.60
C	13	High Density Residential	90	2.37	213.46
C	13	High Density Residential	90	0.00	0.27
B	14	Commercial	92	0.43	39.79
B	14	Commercial	92	1.09	100.30
B	14	Commercial	92	0.00	0.05
B	14	Commercial	92	1.40	128.87
B	14	Commercial	92	0.91	83.62
C	14	Commercial	94	0.12	11.61
A	18	Open Urban Land	39	0.17	6.48

A	18	Open Urban Land	39	0.00	0.00
B	18	Open Urban Land	61	0.32	19.62
B	18	Open Urban Land	61	0.27	16.50
B	18	Open Urban Land	61	5.71	348.59
B	18	Open Urban Land	61	0.59	36.22
B	18	Open Urban Land	61	0.02	0.93
B	18	Open Urban Land	61	0.08	5.04
B	41	Deciduous Forest	55	0.46	25.54
B	41	Deciduous Forest	55	0.01	0.30
B	41	Deciduous Forest	55	0.34	18.57
B	41	Deciduous Forest	55	0.32	17.61
B	41	Deciduous Forest	55	0.00	0.11
B	41	Deciduous Forest	55	3.47	190.68
B	41	Deciduous Forest	55	1.24	68.35
B	41	Deciduous Forest	55	1.40	76.82
B	41	Deciduous Forest	55	3.66	201.38
B	41	Deciduous Forest	55	0.93	51.21
B	41	Deciduous Forest	55	2.25	123.71
B	41	Deciduous Forest	55	0.10	5.67
B	41	Deciduous Forest	55	0.95	52.38
B	41	Deciduous Forest	55	1.39	76.50
B	41	Deciduous Forest	55	2.06	113.38
B	41	Deciduous Forest	55	0.00	0.06
B	41	Deciduous Forest	55	0.21	11.44
B	41	Deciduous Forest	55	0.00	0.15
B	41	Deciduous Forest	55	0.46	25.17
B	41	Deciduous Forest	55	0.01	0.52
B	41	Deciduous Forest	55	0.05	2.76
B	41	Deciduous Forest	55	0.08	4.26
B	41	Deciduous Forest	55	1.75	96.37
B	41	Deciduous Forest	55	2.08	114.36
B	41	Deciduous Forest	55	0.55	30.19
B	41	Deciduous Forest	55	0.13	7.42
B	41	Deciduous Forest	55	0.30	16.43

B	41	Deciduous Forest	55	0.00	0.08
C	41	Deciduous Forest	70	0.16	10.99
C	41	Deciduous Forest	70	0.03	2.38
C	41	Deciduous Forest	70	0.30	21.00
C	41	Deciduous Forest	70	0.44	30.74
C	41	Deciduous Forest	70	0.09	6.18
C	41	Deciduous Forest	70	1.43	100.38
C	41	Deciduous Forest	70	5.16	361.55
C	41	Deciduous Forest	70	0.85	59.25
C	41	Deciduous Forest	70	0.54	37.77
C	41	Deciduous Forest	70	0.14	9.86
C	41	Deciduous Forest	70	0.14	9.79
D	41	Deciduous Forest	77	0.10	7.48
D	41	Deciduous Forest	77	6.49	499.98
D	41	Deciduous Forest	77	1.84	141.71
D	41	Deciduous Forest	77	2.20	169.47
D	41	Deciduous Forest	77	2.10	161.45
D	41	Deciduous Forest	77	0.79	61.08
W	41	Deciduous Forest	100	0.12	11.85
B	44	Brush	55	1.23	67.67
B	44	Brush	55	0.63	34.90
B	44	Brush	55	0.02	1.32
B	44	Brush	55	0.00	0.16
C	44	Brush	70	10.89	761.99
C	44	Brush	70	0.34	23.63
C	44	Brush	70	0.82	57.69
D	44	Brush	77	0.00	0.06
B	50	Water	100	0.01	0.66
B	50	Water	100	0.15	14.56
B	50	Water	100	0.05	5.43
C	50	Water	100	0.02	1.98
D	50	Water	100	0.12	11.84
D	50	Water	100	0.02	2.04
D	50	Water	100	0.00	0.01

D	50	Water	100	0.17	16.65
W	50	Water	100	0.20	19.90
B	18	Open Urban Land	61	0.13	7.85
B	18	Open Urban Land	61	0.10	6.40
B	18	Open Urban Land	61	2.73	166.52
B	18	Open Urban Land	61	0.42	25.82
B	18	Open Urban Land	61	2.82	172.08
B	18	Open Urban Land	61	5.70	347.79
B	18	Open Urban Land	61	5.24	319.42
B	18	Open Urban Land	61	0.01	0.85
B	18	Open Urban Land	61	2.64	161.12
B	18	Open Urban Land	61	0.04	2.30
B	18	Open Urban Land	61	0.86	52.28
B	18	Open Urban Land	61	0.76	46.65
B	18	Open Urban Land	61	1.99	121.48
B	18	Open Urban Land	61	2.70	164.83
B	18	Open Urban Land	61	1.40	85.18
C	18	Open Urban Land	74	1.79	132.39
C	18	Open Urban Land	74	9.99	739.33
C	18	Open Urban Land	74	1.69	125.23
C	18	Open Urban Land	74	0.52	38.14
D	18	Open Urban Land	80	0.51	40.89
D	18	Open Urban Land	80	12.09	967.55
			Totals =	**238.75**	**17519.21**

Composite Curve Number (CN)	**= (total product) (total area)**	**=**	**73.38**	**Use**

PARSONS BRINCKERHOFF
TR-55 WORKSHEETS

Page 1
Made by: SCW
Date: 1/27/2012
Checked by:
Date:

Project: HEAVENLY POND

Location: PI #3B

Conditions: EXISTING

Composite Runoff Curve Number Determination:

Hydrologic Soil Group	Cover Description		Curve Number (CN)	Area, A (acres)	Product CN x A
A	18	Open Urban Land	39	0.28	11.08
A	18	Open Urban Land	39	3.08	119.94
A	18	Open Urban Land	39	0.47	18.23
A	18	Open Urban Land	39	0.21	8.04
A	18	Open Urban Land	39	0.00	0.11
B	18	Open Urban Land	61	2.21	134.57
B	18	Open Urban Land	61	0.86	52.44
B	18	Open Urban Land	61	0.66	40.56
B	18	Open Urban Land	61	3.23	197.15
B	18	Open Urban Land	61	1.49	90.69
B	18	Open Urban Land	61	3.45	210.32
B	18	Open Urban Land	61	2.06	125.85
B	18	Open Urban Land	61	0.03	2.04
B	18	Open Urban Land	61	2.45	149.43
B	18	Open Urban Land	61	0.17	10.60
C	18	Open Urban Land	74	1.06	78.27
A	41	Deciduous Forest	30	0.00	0.02
B	41	Deciduous Forest	55	0.00	0.01
B	41	Deciduous Forest	55	0.01	0.41
B	41	Deciduous Forest	55	0.45	24.60
C	41	Deciduous Forest	70	0.55	38.81
D	41	Deciduous Forest	77	0.67	51.88
A	43	Mixed Forest	45	0.19	8.45
A	43	Mixed Forest	45	1.36	61.06

A	43	Mixed Forest	45	0.43	19.27
B	43	Mixed Forest	66	0.08	5.40
B	43	Mixed Forest	66	0.26	17.14
B	43	Mixed Forest	66	0.00	0.07
B	43	Mixed Forest	66	0.11	7.35
C	43	Mixed Forest	77	1.95	150.14
C	43	Mixed Forest	77	1.15	88.54
D	44	Brush	77	0.00	0.25
D	50	Water	100	0.16	16.00
D	50	Water	100	0.00	0.01
B	18	Open Urban Land	61	0.41	25.27
C	18	Open Urban Land	74	0.09	6.56
D	18	Open Urban Land	80	1.48	118.72
			Totals =	**31.07**	**1889.28**

Composite Curve Number (CN)	**= (total product) (total area)**	**=**	**60.80**	**Use**

PARSONS BRINCKERHOFF
TR-55 WORKSHEETS

Page 1
Made by: SCW
Date: 1/27/2012
Checked by:
Date:

Project: HEAVENLY POND

Location: PI #4

Conditions: EXISTING

Composite Runoff Curve Number Determination:

Hydrologic Soil Group	Cover Description		Curve Number (CN)	Area, A (acres)	Product CN x A
C	41	Deciduous Forest	70	0.00	0.11
D	41	Deciduous Forest	77	0.02	1.84
C	44	Brush	70	0.59	41.38
C	44	Brush	70	2.18	152.74
D	44	Brush	77	0.22	17.15
D	44	Brush	77	0.00	0.08
C	50	Water	100	0.56	56.17
D	50	Water	100	0.01	0.77
C	18	Open Urban Land	74	2.24	166.05
D	18	Open Urban Land	80	0.25	20.27
			Totals =	**6.09**	**456.55**

Composite Curve Number (CN) **= (total product) / (total area)** **= 74.98** **Use**

Fixed Region Regression Equations for Piedmont Region
Source: Application of Hydrologic Methods in Maryland, Maryland Hydrology Panel, 2010.

Range of watershed characteristics Per Table 2-2 of Hydrology Panel Report (page 2-13):
Drainage Area (DA)= 0.49 to 102.05 Sq m. for Urban, 0.11 to 820 Sq m. for Rural
Impervious Area (IA)= 10% to 37.5% Forest Area (FOR) = 2.7% to 100% Limestone (LIME) = 0% to 81.7%

Regression Equations for the Piedmont Region (Urban) Per Hydrology Panel Report (page A3-5):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Impervious Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=17.85 $DA^{0.652}$ $(IA+1)^{0.635}$	0.08	8.79	41.7	14.06	19.93	8.20
Q_{2}=37.01 $DA^{0.635}$ $(IA+1)^{0.588}$	0.08	8.79	35.1	27.37	36.98	17.76
Q_{5}=94.76 $DA^{0.624}$ $(IA+1)^{0.499}$	0.08	8.79	28.5	58.86	75.63	42.08
Q_{10}=169.2 $DA^{0.622}$ $(IA+1)^{0.435}$	0.08	8.79	26.2	91.29	115.21	67.37
Q_{25}=341.0 $DA^{0.619}$ $(IA+1)^{0.349}$	0.08	8.79	26	152.39	192.02	112.77
Q_{50}=562.4 $DA^{0.619}$ $(IA+1)^{0.284}$	0.08	8.79	27.7	217.40	277.62	157.18
Q_{100}=898.3 $DA^{0.619}$ $(IA+1)^{0.222}$	0.08	8.79	30.7	300.49	392.74	208.24

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	14.06	19.93	8.20
2	2-yr	27.37	36.98	17.76
5	5-yr	58.86	75.63	42.08
10	10-yr	91.29	115.21	67.37
25	25-yr	152.39	192.02	112.77
50	50-yr	217.40	277.62	157.18
100	100-yr	300.49	392.74	208.24

Regression Equations for the Piedmont Region (Rural) Per Hydrology Panel Report (page A3-4):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Forested Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=287.1 $DA^{0.774}$ $(LIME+1)^{-0.118}$ $(FOR+1)^{-0.418}$	0.08	34.14	42.1	8.75	12.44	5.07
Q_{2}=396.9 $DA^{0.743}$ $(LIME+1)^{-0.124}$ $(FOR+1)^{-0.332}$	0.08	34.14	35.6	17.81	24.15	11.47
Q_{5}=592.5 $DA^{0.705}$ $(LIME+1)^{-0.133}$ $(FOR+1)^{-0.237}$	0.08	34.14	31.4	41.13	54.05	28.22
Q_{10}=751.1 $DA^{0.682}$ $(LIME+1)^{-0.138}$ $(FOR+1)^{-0.183}$	0.08	34.14	30.9	67.07	87.79	46.34
Q_{25}=996.0 $DA^{0.655}$ $(LIME+1)^{-0.145}$ $(FOR+1)^{-0.122}$	0.08	34.14	32.2	118.50	156.66	80.34
Q_{50}=1218.8 $DA^{0.635}$ $(LIME+1)^{-0.150}$ $(FOR+1)^{-0.082}$	0.08	34.14	34.5	176.08	236.82	115.33
Q_{100}=1471.1 $DA^{0.617}$ $(LIME+1)^{-0.154}$ $(FOR+1)^{-0.045}$	0.08	34.14	37.5	254.00	349.25	158.75

Note: LIME = 0 for watershed

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	8.75	12.44	5.07
2	2-yr	17.81	24.15	11.47
5	5-yr	41.13	54.05	28.22
10	10-yr	67.07	87.79	46.34
25	25-yr	118.50	156.66	80.34
50	50-yr	176.08	236.82	115.33
100	100-yr	254.00	349.25	158.75

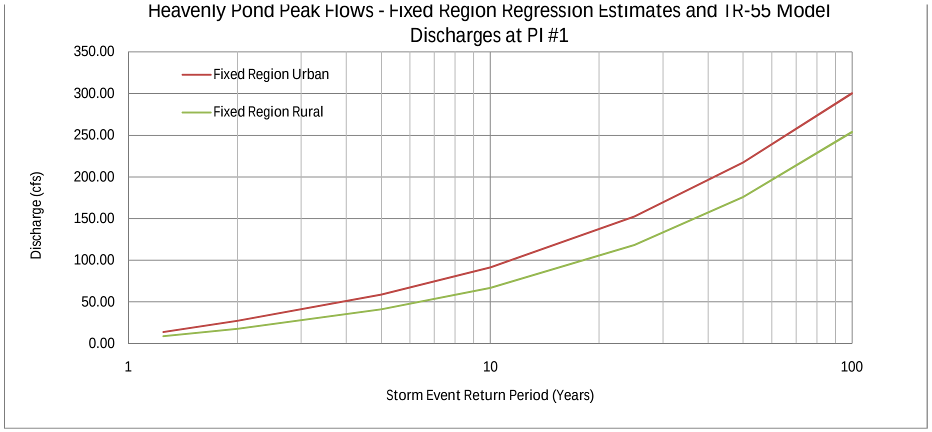
[illegible] Road Peak Flows - Fixed Region Regression Estimates and TR-55 Model

PI#1 Drainage Area, % Impervious, and % Forested Information:

Land Use Description	Area (acres)	% Impervious*	Impervious Area (acres)
Residential - Low Density	0.00		
Residential - Medium Density	0.00		
Residential - High Density	0.00		
Commercial	0.00		
Institutional	5.61	50	2.81
Open Urban	6.32	11	0.70
Cropland	0.00		
Deciduous Forest	15.99	0	0.00
Evergreen Forest	0.45	0	0.00
Mixed Forest	0.00		
Brush	17.08	0	0.00
Water	0.73	100	0.73
Bare Ground	1.97	0	0.00
Urban/Recreation Grasses	0.00		
Total	48.15		4.23
Sq Mi	0.08		

Total Percent Impervious = 8.79%
Total Percent Forested = 34.14%

* Source: NRCS TR-55, 1986.



Heavenly Pond Peak Flows - Fixed Region Regression Estimates and TR-55 Model Discharges at PI #1
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Discharge (cfs)
Fixed Region Urban
Fixed Region Rural
1
10
100
Storm Event Return Period (Years)

Fixed Region Regression Equations for Piedmont Region
Source: Application of Hydrologic Methods in Maryland, Maryland Hydrology Panel, 2010.

Range of watershed characteristics Per Table 2-2 of Hydrology Panel Report (page 2-13):

Drainage Area (DA)= 0.49 to 102.05 Sq m. for Urban, 0.11 to 820 Sq m. for Rural

Impervious Area (IA)= 10% to 37.5% Forest Area (FOR) = 2.7% to 100% Limestone (LIME) = 0% to 81.7%

Regression Equations for the Piedmont Region (Urban) Per Hydrology Panel Report (page A3-5):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Impervious Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}=17.85\ DA^{0.652}\ (IA+1)^{0.635}$	0.12	11.13	41.7	21.79	30.87	12.70
$Q_{2}=37.01\ DA^{0.635}\ (IA+1)^{0.588}$	0.12	11.13	35.1	41.65	56.27	27.03
$Q_{5}=94.76\ DA^{0.624}\ (IA+1)^{0.499}$	0.12	11.13	28.5	87.42	112.34	62.51
$Q_{10}=169.2\ DA^{0.622}\ (IA+1)^{0.435}$	0.12	11.13	26.2	133.62	168.63	98.61
$Q_{25}=341.0\ DA^{0.619}\ (IA+1)^{0.349}$	0.12	11.13	26	218.68	275.53	161.82
$Q_{50}=562.4\ DA^{0.619}\ (IA+1)^{0.284}$	0.12	11.13	27.7	307.64	392.85	222.42
$Q_{100}=898.3\ DA^{0.619}\ (IA+1)^{0.222}$	0.12	11.13	30.7	419.60	548.41	290.78

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	21.79	30.87	12.70
2	2-yr	41.65	56.27	27.03
5	5-yr	87.42	112.34	62.51
10	10-yr	133.62	168.63	98.61
25	25-yr	218.68	275.53	161.82
50	50-yr	307.64	392.85	222.42
100	100-yr	419.60	548.41	290.78

Regression Equations for the Piedmont Region (Rural) Per Hydrology Panel Report (page A3-4):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Forested Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}=287.1\ DA^{0.774}\ (LIME+1)^{-0.118}\ (FOR+1)^{-0.418}$	0.12	30.49	42.1	13.11	18.63	7.59
$Q_{2}=396.9\ DA^{0.743}\ (LIME+1)^{-0.124}\ (FOR+1)^{-0.332}$	0.12	30.49	35.6	26.04	35.32	16.77
$Q_{5}=592.5\ DA^{0.705}\ (LIME+1)^{-0.133}\ (FOR+1)^{-0.237}$	0.12	30.49	31.4	58.49	76.86	40.13
$Q_{10}=751.1\ DA^{0.682}\ (LIME+1)^{-0.138}\ (FOR+1)^{-0.183}$	0.12	30.49	30.9	93.81	122.79	64.82
$Q_{25}=996.0\ DA^{0.655}\ (LIME+1)^{-0.145}\ (FOR+1)^{-0.122}$	0.12	30.49	32.2	162.59	214.94	110.23
$Q_{50}=1218.8\ DA^{0.635}\ (LIME+1)^{-0.150}\ (FOR+1)^{-0.082}$	0.12	30.49	34.5	238.31	320.53	156.09
$Q_{100}=1471.1\ DA^{0.617}\ (LIME+1)^{-0.154}\ (FOR+1)^{-0.045}$	0.12	30.49	37.5	339.54	466.87	212.21

Note: LIME = 0 for watershed

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	13.11	18.63	7.59
2	2-yr	26.04	35.32	16.77
5	5-yr	58.49	76.86	40.13
10	10-yr	93.81	122.79	64.82
25	25-yr	162.59	214.94	110.23
50	50-yr	238.31	320.53	156.09
100	100-yr	339.54	466.87	212.21

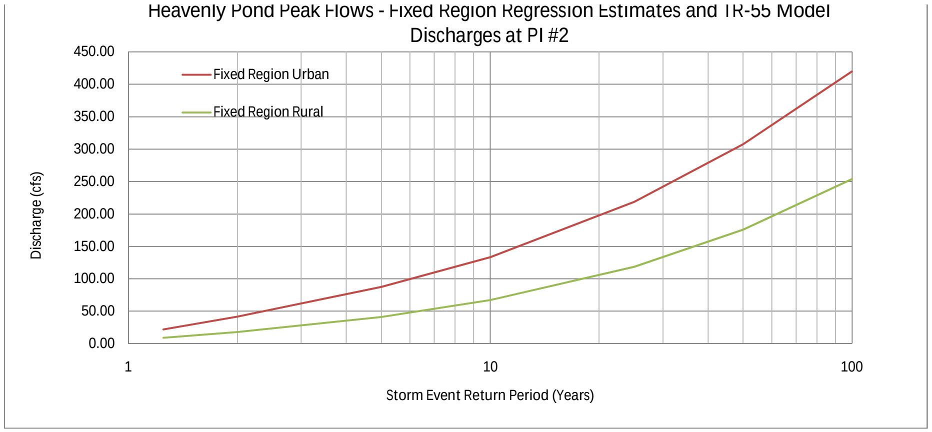
PI#2 Drainage Area and Impervious % Information:

Land Use Description	Area (acres)	% Impervious*	Impervious Area (acres)
Residential - Low Density	0.00		
Residential - Medium Density	3.84	38	1.46
Residential - High Density	0.00		
Commercial	0.00		
Institutional	5.61	50	2.81
Open Urban	19.03	11	2.09
Cropland	1.76	0	0.00
Deciduous Forest	21.41	0	0.00
Evergreen Forest	1.90	0	0.00
Mixed Forest	0.00		
Brush	18.79	0	0.00
Water	2.15	100	2.15
Bare Ground	1.97	0	0.00
Urban/Recreation Grasses	0.00		
Total	76.46		8.51
Sq Mi	0.12		

Total Percent Impervious = 11.13%

Total Percent Forested = 30.49%

* Source: NRCS TR-55, 1986.


Heavenly Pond Peak Flows - Fixed Region Regression Estimates and TR-55 Model
Discharges at PI #2
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Fixed Region Urban
Fixed Region Rural
Discharge (cfs)
1
10
100
Storm Event Return Period (Years)

Fixed Region Regression Equations for Piedmont Region
Source: Application of Hydrologic Methods in Maryland, Maryland Hydrology Panel, 2010.

Range of watershed characteristics Per Table 2-2 of Hydrology Panel Report (page 2-13):

Drainage Area (DA)= 0.49 to 102.05 Sq m. for Urban, 0.11 to 820 Sq m. for Rural

Impervious Area (IA)= 10% to 37.5% Forest Area (FOR) = 2.7% to 100% Limestone (LIME) = 0% to 81.7%

Regression Equations for the Piedmont Region (Urban) Per Hydrology Panel Report (page A3-5):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Impervious Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=17.85 $DA^{0.652}$ $(IA+1)^{0.635}$	0.37	24.01	41.7	72.48	102.71	42.26
Q_{2}=37.01 $DA^{0.635}$ $(IA+1)^{0.588}$	0.37	24.01	35.1	131.37	177.48	85.26
Q_{5}=94.76 $DA^{0.624}$ $(IA+1)^{0.499}$	0.37	24.01	28.5	255.31	328.07	182.55
Q_{10}=169.2 $DA^{0.622}$ $(IA+1)^{0.435}$	0.37	24.01	26.2	371.72	469.11	274.33
Q_{25}=341.0 $DA^{0.619}$ $(IA+1)^{0.349}$	0.37	24.01	26	569.66	717.77	421.55
Q_{50}=562.4 $DA^{0.619}$ $(IA+1)^{0.284}$	0.37	24.01	27.7	764.57	976.35	552.78
Q_{100}=898.3 $DA^{0.619}$ $(IA+1)^{0.222}$	0.37	24.01	30.7	997.06	1303.15	690.96

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	72.48	102.71	42.26
2	2-yr	131.37	177.48	85.26
5	5-yr	255.31	328.07	182.55
10	10-yr	371.72	469.11	274.33
25	25-yr	569.66	717.77	421.55
50	50-yr	764.57	976.35	552.78
100	100-yr	997.06	1303.15	690.96

Regression Equations for the Piedmont Region (Rural) Per Hydrology Panel Report (page A3-4):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Forested Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=287.1 $DA^{0.774}$ $(LIME+1)^{-0.118}$ $(FOR+1)^{-0.418}$	0.37	19.74	42.1	37.68	53.55	21.82
Q_{2}=396.9 $DA^{0.743}$ $(LIME+1)^{-0.124}$ $(FOR+1)^{-0.332}$	0.37	19.74	35.6	69.71	94.53	44.89
Q_{5}=592.5 $DA^{0.705}$ $(LIME+1)^{-0.133}$ $(FOR+1)^{-0.237}$	0.37	19.74	31.4	144.11	189.35	98.86
Q_{10}=751.1 $DA^{0.682}$ $(LIME+1)^{-0.138}$ $(FOR+1)^{-0.183}$	0.37	19.74	30.9	220.11	288.13	152.10
Q_{25}=996.0 $DA^{0.655}$ $(LIME+1)^{-0.145}$ $(FOR+1)^{-0.122}$	0.37	19.74	32.2	360.66	476.79	244.53
Q_{50}=1218.8 $DA^{0.635}$ $(LIME+1)^{-0.150}$ $(FOR+1)^{-0.082}$	0.37	19.74	34.5	508.17	683.49	332.85
Q_{100}=1471.1 $DA^{0.617}$ $(LIME+1)^{-0.154}$ $(FOR+1)^{-0.045}$	0.37	19.74	37.5	698.48	960.40	436.55

Note: LIME = 0 for watershed

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	37.68	53.55	21.82
2	2-yr	69.71	94.53	44.89
5	5-yr	144.11	189.35	98.86
10	10-yr	220.11	288.13	152.10
25	25-yr	360.66	476.79	244.53
50	50-yr	508.17	683.49	332.85
100	100-yr	698.48	960.40	436.55

PI#3A Drainage Area and Impervious % Information:

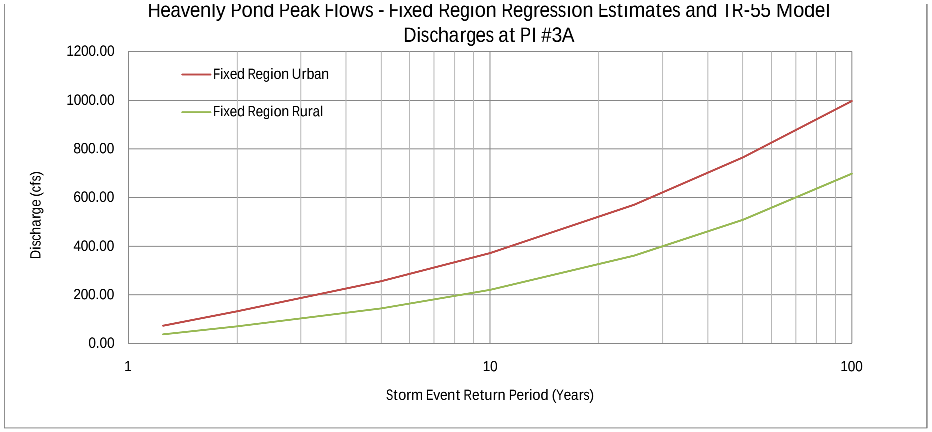
Land Use Description	Area (acres)	% Impervious*	Impervious Area (acres)
Residential - Low Density	19.66	25	4.92
Residential - Medium Density	67.56	38	25.67
Residential - High Density	24.46	65	15.90
Commercial	3.96	85	3.37
Institutional	0.00		
Open Urban	7.16	11	0.79
Cropland	0.00		
Deciduous Forest	47.13	0	0.00
Evergreen Forest	0.00		
Mixed Forest	0.00		
Brush	13.94	0	0.00
Water	0.73	100	0.73
Bare Ground	0.00		
Urban/Recreation Grasses	54.14	11	5.96
Total	238.74		57.33
Sq Mi	0.37		

Total Percent Impervious = 24.01%

Total Percent Forested = 19.74%

* Source: NRCS TR-55, 1986.

[illegible] Road Peak Flows - Fixed Region Regression Estimates and TR-55 Model



Heavenly Pond Peak Flows - Fixed Region Regression Estimates and TR-55 Model Discharges at PI #3A
Fixed Region Urban
Fixed Region Rural
Discharge (cfs)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1
10
100
Storm Event Return Period (Years)

Fixed Region Regression Equations for Piedmont Region
Source: Application of Hydrologic Methods in Maryland, Maryland Hydrology Panel, 2010.

Range of watershed characteristics Per Table 2-2 of Hydrology Panel Report (page 2-13):
Drainage Area (DA)= 0.49 to 102.05 Sq m. for Urban, 0.11 to 820 Sq m. for Rural
Impervious Area (IA)= 10% to 37.5% Forest Area (FOR) = 2.7% to 100% Limestone (LIME) = 0% to 81.7%

Regression Equations for the Piedmont Region (Urban) Per Hydrology Panel Report (page A3-5):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Impervious Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}=17.85\ DA^{0.652}\ (IA+1)^{0.635}$	0.17	10.48	41.7	26.29	37.25	15.33
$Q_{2}=37.01\ DA^{0.635}\ (IA+1)^{0.588}$	0.17	10.48	35.1	50.09	67.67	32.51
$Q_{5}=94.76\ DA^{0.624}\ (IA+1)^{0.499}$	0.17	10.48	28.5	105.26	135.25	75.26
$Q_{10}=169.2\ DA^{0.622}\ (IA+1)^{0.435}$	0.17	10.48	26.2	161.33	203.60	119.06
$Q_{25}=341.0\ DA^{0.619}\ (IA+1)^{0.349}$	0.17	10.48	26	264.99	333.89	196.09
$Q_{50}=562.4\ DA^{0.619}\ (IA+1)^{0.284}$	0.17	10.48	27.7	374.11	477.74	270.48
$Q_{100}=898.3\ DA^{0.619}\ (IA+1)^{0.222}$	0.17	10.48	30.7	511.99	669.17	354.81

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	26.29	37.25	15.33
2	2-yr	50.09	67.67	32.51
5	5-yr	105.26	135.25	75.26
10	10-yr	161.33	203.60	119.06
25	25-yr	264.99	333.89	196.09
50	50-yr	374.11	477.74	270.48
100	100-yr	511.99	669.17	354.81

Regression Equations for the Piedmont Region (Rural) Per Hydrology Panel Report (page A3-4):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Forested Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}=287.1\ DA^{0.774}\ (LIME+1)^{-0.118}\ (FOR+1)^{-0.418}$	0.17	28.38	42.1	17.57	24.97	10.17
$Q_{2}=396.9\ DA^{0.743}\ (LIME+1)^{-0.124}\ (FOR+1)^{-0.332}$	0.17	28.38	35.6	34.33	46.56	22.11
$Q_{5}=592.5\ DA^{0.705}\ (LIME+1)^{-0.133}\ (FOR+1)^{-0.237}$	0.17	28.38	31.4	75.62	99.36	51.87
$Q_{10}=751.1\ DA^{0.682}\ (LIME+1)^{-0.138}\ (FOR+1)^{-0.183}$	0.17	28.38	30.9	119.87	156.92	82.83
$Q_{25}=996.0\ DA^{0.655}\ (LIME+1)^{-0.145}\ (FOR+1)^{-0.122}$	0.17	28.38	32.2	205.00	271.01	138.99
$Q_{50}=1218.8\ DA^{0.635}\ (LIME+1)^{-0.150}\ (FOR+1)^{-0.082}$	0.17	28.38	34.5	297.61	400.28	194.93
$Q_{100}=1471.1\ DA^{0.617}\ (LIME+1)^{-0.154}\ (FOR+1)^{-0.045}$	0.17	28.38	37.5	420.36	577.99	262.72

Note: LIME = 0 for watershed

	Storm event	Q (from Fixed Region Regression Equations)		
		Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	17.57	24.97	10.17
2	2-yr	34.33	46.56	22.11
5	5-yr	75.62	99.36	51.87
10	10-yr	119.87	156.92	82.83
25	25-yr	205.00	271.01	138.99
50	50-yr	297.61	400.28	194.93
100	100-yr	420.36	577.99	262.72

[illegible] Road Peak Flows [illegible] Fixed Region Regression Estimates and TR-55 Model

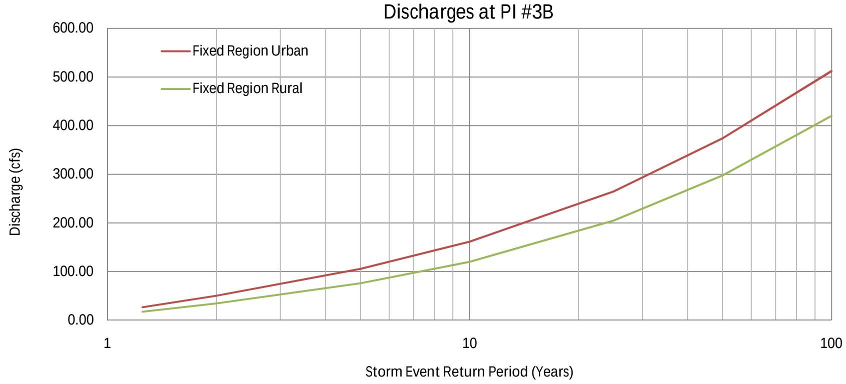
PI#3B Drainage Area and Impervious % Information:

Land Use Description	Area (acres)	% Impervious*	Impervious Area (acres)
Residential - Low Density	0.00		
Residential - Medium Density	3.84	38	1.46
Residential - High Density	0.00		
Commercial	0.00		
Institutional	5.61	50	2.81
Open Urban	40.74	11	4.48
Cropland	1.76	0	0.00
Deciduous Forest	23.09	0	0.00
Evergreen Forest	1.90	0	0.00
Mixed Forest	5.53	0	0.00
Brush	18.79	0	0.00
Water	2.31	100	2.31
Bare Ground	1.97	0	0.00
Urban/Recreation Grasses	1.99	11	0.22
Total	107.53		11.27
Sq Mi	0.17		

Total Percent Impervious = 10.48%
Total Percent Forested = 28.38%

* Source: NRCS TR-55, 1986.

Heavenly Pond Peak Flows - Fixed Region Regression Estimates and TR-55 Model Discharges at PI #3B



Fixed Region Regression Equations for Piedmont Region
Source: Application of Hydrologic Methods in Maryland, Maryland Hydrology Panel, 2010.

Range of watershed characteristics Per Table 2-2 of Hydrology Panel Report (page 2-13):

Drainage Area (DA)= 0.49 to 102.05 Sq m. for Urban, 0.11 to 820 Sq m. for Rural

Impervious Area (IA)= 10% to 37.5% Forest Area (FOR) = 2.7% to 100% Limestone (LIME) = 0% to 81.7%

Regression Equations for the Piedmont Region (Urban) Per Hydrology Panel Report (page A3-5):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Impervious Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=17.85 $DA^{0.652}$ $(IA+1)^{0.635}$	0.55	19.71	41.7	82.87	117.43	48.31
Q_2=37.01 $DA^{0.635}$ $(IA+1)^{0.588}$	0.55	19.71	35.1	150.53	203.37	97.70
Q_5=94.76 $DA^{0.624}$ $(IA+1)^{0.499}$	0.55	19.71	28.5	296.25	380.68	211.82
Q_{10}=169.2 $DA^{0.622}$ $(IA+1)^{0.435}$	0.55	19.71	26.2	436.23	550.52	321.94
Q_{25}=341.0 $DA^{0.619}$ $(IA+1)^{0.349}$	0.55	19.71	26	678.67	855.13	502.22
Q_{50}=562.4 $DA^{0.619}$ $(IA+1)^{0.284}$	0.55	19.71	27.7	922.12	1177.55	666.70
Q_{100}=898.3 $DA^{0.619}$ $(IA+1)^{0.222}$	0.55	19.71	30.7	1216.68	1590.21	843.16

	Storm event	Q (from Fixed Region Regression Equations) Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	82.87	117.43	48.31
2	2-yr	150.53	203.37	97.70
5	5-yr	296.25	380.68	211.82
10	10-yr	436.23	550.52	321.94
25	25-yr	678.67	855.13	502.22
50	50-yr	922.12	1177.55	666.70
100	100-yr	1216.68	1590.21	843.16

Regression Equations for the Piedmont Region (Rural) Per Hydrology Panel Report (page A3-4):

Fixed Region Regressional Equation	Draiange Area (sq. m)	Forested Percent (%)	Standard Error (%)	Q computed	Q with standard error (upper)	Q with standard error (lower)
$Q_{1.25}$=287.1 $DA^{0.774}$ $(LIME+1)^{-0.118}$ $(FOR+1)^{-0.418}$	0.55	22.04	42.1	48.74	69.26	28.22
Q_2=396.9 $DA^{0.743}$ $(LIME+1)^{-0.124}$ $(FOR+1)^{-0.332}$	0.55	22.04	35.6	89.90	121.90	57.89
Q_5=592.5 $DA^{0.705}$ $(LIME+1)^{-0.133}$ $(FOR+1)^{-0.237}$	0.55	22.04	31.4	184.95	243.02	126.87
Q_{10}=751.1 $DA^{0.682}$ $(LIME+1)^{-0.138}$ $(FOR+1)^{-0.183}$	0.55	22.04	30.9	281.58	368.58	194.57
Q_{25}=996.0 $DA^{0.655}$ $(LIME+1)^{-0.145}$ $(FOR+1)^{-0.122}$	0.55	22.04	32.2	459.48	607.44	311.53
Q_{50}=1218.8 $DA^{0.635}$ $(LIME+1)^{-0.150}$ $(FOR+1)^{-0.082}$	0.55	22.04	34.5	645.10	867.67	422.54
Q_{100}=1471.1 $DA^{0.617}$ $(LIME+1)^{-0.154}$ $(FOR+1)^{-0.045}$	0.55	22.04	37.5	883.93	1215.41	552.46

Note: LIME = 0 for watershed

	Storm event	Q (from Fixed Region Regression Equations) Q computed per RRE	Q with standard error (upper)	Q with standard error (lower)
1.25	1.25-yr	48.74	69.26	28.22
2	2-yr	89.90	121.90	57.89
5	5-yr	184.95	243.02	126.87
10	10-yr	281.58	368.58	194.57
25	25-yr	459.48	607.44	311.53
50	50-yr	645.10	867.67	422.54
100	100-yr	883.93	1215.41	552.46

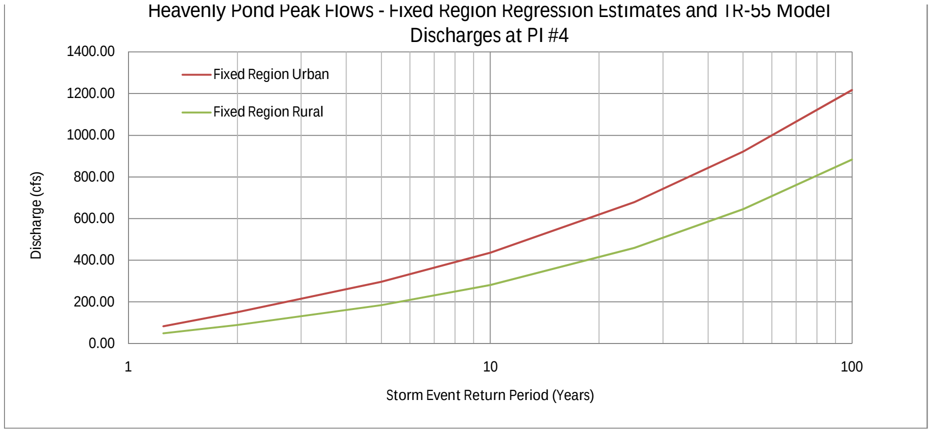
PI#4 Drainage Area and Impervious % Information:

Land Use Description	Area (acres)	% Impervious*	Impervious Area (acres)
Residential - Low Density	19.66	25	4.92
Residential - Medium Density	71.40	38	27.13
Residential - High Density	24.46	65	15.90
Commercial	3.96	85	3.37
Institutional	5.61	50	2.81
Open Urban	47.91	11	5.27
Cropland	1.76	0	0.00
Deciduous Forest	70.25	0	0.00
Evergreen Forest	1.90	0	0.00
Mixed Forest	5.53	0	0.00
Brush	35.73	0	0.00
Water	3.61	100	3.61
Bare Ground	1.97	0	0.00
Urban/Recreation Grasses	58.63	11	6.45
Total	352.38		69.45
Sq Mi	0.55		

Total Percent Impervious = 19.71%

Total Percent Forested = 22.04%

* Source: NRCS TR-55, 1986.


Heavenly Pond Peak Flows - Fixed Region Regression Estimates and TR-55 Model Discharges at PI #4
Fixed Region Urban
Fixed Region Rural
Discharge (cfs)
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
1
10
100
Storm Event Return Period (Years)

E – Sediment Analysis of Pond

4' AVG. DEPTH X 3,800 SF = 15,200 CF

3.5' AVG. DEPTH X 31,900 SF = 111,650 CF

2.5' AVG. DEPTH X 24,500 SF = 61,250 CF

1' AVG. DEPTH X 4,100 SF = 4,100 CF

50' 0 50' 100'

SCALE: 1" = 50'

PARSONS BRINCKERHOFF Computation Sheet

page 1 of 2 173198A/01

made by K. Lennon

date 7/10/12

checked by E Kanner

date 7/26/12

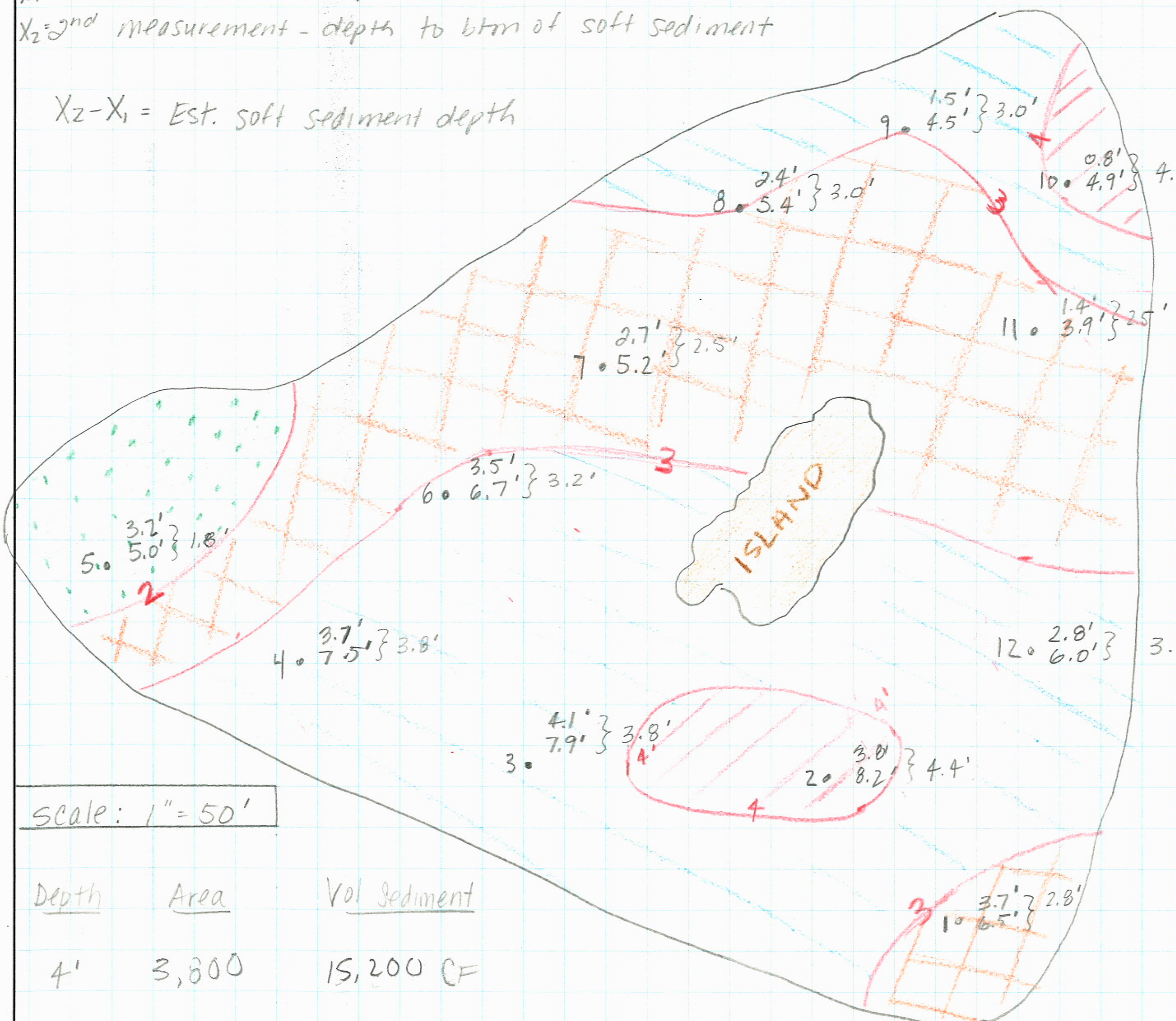
subject Heavenly Pond Sediment Analysis

Pond measurements were taken via canoe on 5/22/12 by S. Wang & K. Stanka.

X_1 = 1st measurement - depth of water

X_2 = 2nd measurement - depth to btm of soft sediment

$X_2 - X_1$ = Est. soft sediment depth



Scale: 1" = 50'

Depth	Area	Vol Sediment
4'	3,800	15,200 CF
3.5'	31,900	111,650 CF
2.5'	24,500	61,250 CF
1.0'	4,100	4,100 CF

TOTAL VOLUME OF SEDIMENT (CF) = 192,200 CF

Assume 4' depth

Assume 3.5' depth

Assume 2.5' depth

Assume 1.0' depth

PARSONS BRINCKERHOFF Computation Sheet

subject: Heavenly Pond Sediment Analysis

 173198A/01

made by: K. Lennon

date: 7/10/12

checked by:

date:

Areas measured in PDF exchange.

overall pond area = 66,688 SF
island area = 2,254 SF
> WET POND AREA = 64,434 SF

4' depth = 2,677 SF
1,101 SF
> 3,778 SF Round up to 3,800 SF

3.5' depth = 5,365 SF
29,220 SF - 2,677 SF
> 31,908 SF ⇒ Round to 31,900 SF

2.5' depth = 2,268 SF
22,183 SF
> 24,451 SF ⇒ Round to 24,500 SF

1.0' depth = 4,080 SF ⇒ Round to 4,100 SF

PARSONS BRINCKERHOFF Computation Sheet

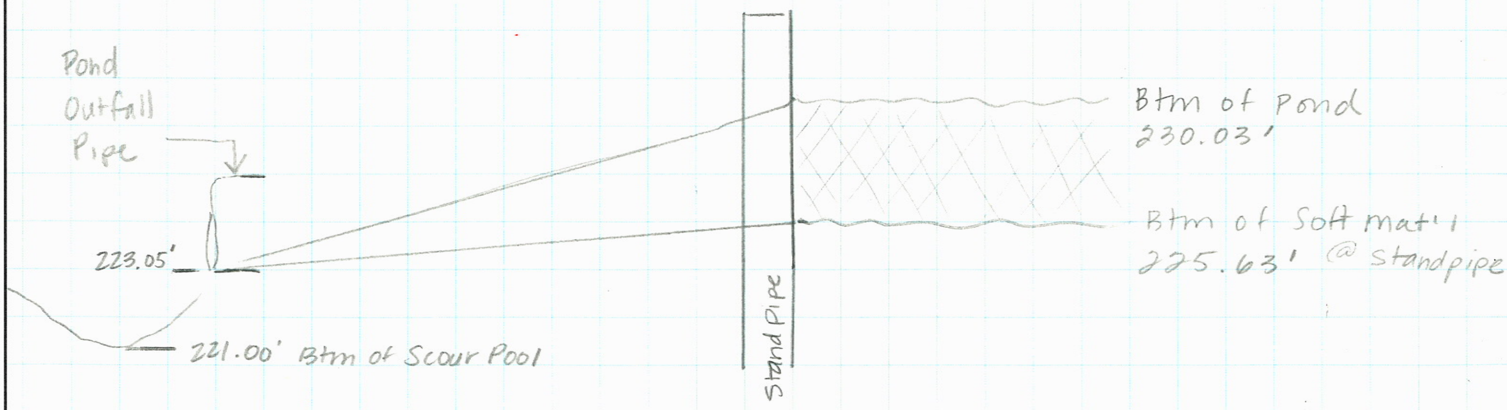
page ____ of ____
made by K. Lennon
date 7/13/12
checked by
date

subject Heavenly Pond Sediment Analysis

Objective: compare depth of sediment versus potential outfall elevation of pond and channel inverts.

Heavenly Pond Survey - 1-13-12 : Pond WSEL = 234.53'
Pond outfall = 223.05'
depth of water @ standpipe = 4.5'
Pond btm @ standpipe = 234.53-4.5'
= 230.03'

Survey 5/22/12 : depth of water @ standpipe = 3.8'
depth of soft sediment @ standpipe = Pond Btm - 4.4'
= 230.03 - 4.4'
= 225.63'



Conclusion: Btm of soft material will be above overall channel invert at breach site.

PARSONS BRINCKERHOFF Computation Sheet

page ______ of ______

made by K. Lennon

date 5/14/12

checked by

date

subject Heavenly Pond aerial analysis

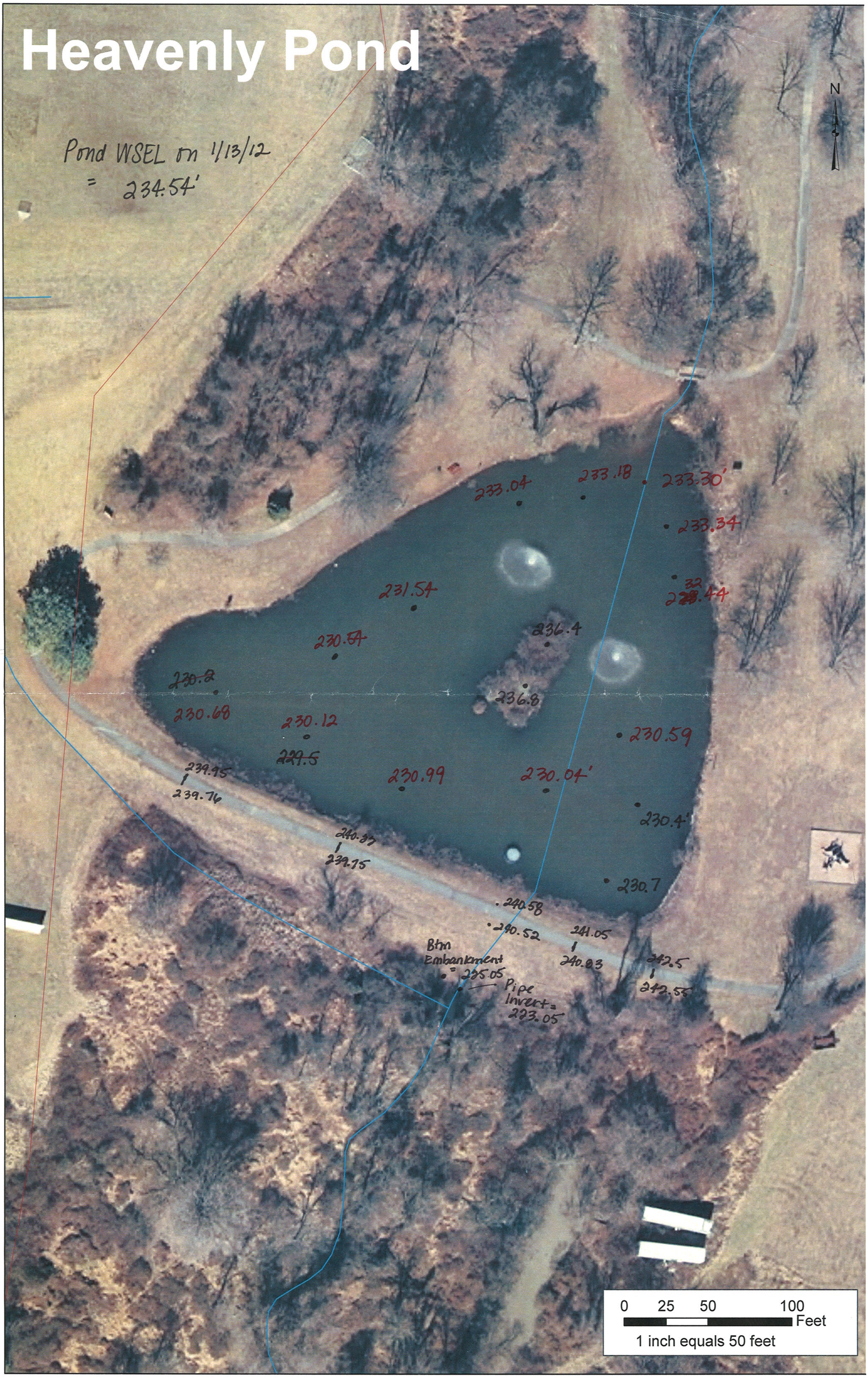
Pond Areas over time

2008	aerial	-	64.650 SF
2000		-	60.080
1990		-	62.400 SF
1986			56,000 SF
1980			57,000 SF
1977			24,200 SF
1971			21,000
1967			26,000 SF
1964			24,000
1957			26,000
1952			24,000

1980 — Pond was expanded.

1952–1977: Aerial quality is difficult to read. Also, there is georeferencing error. Assume ~25,000 SF

F – Bathymetry Data

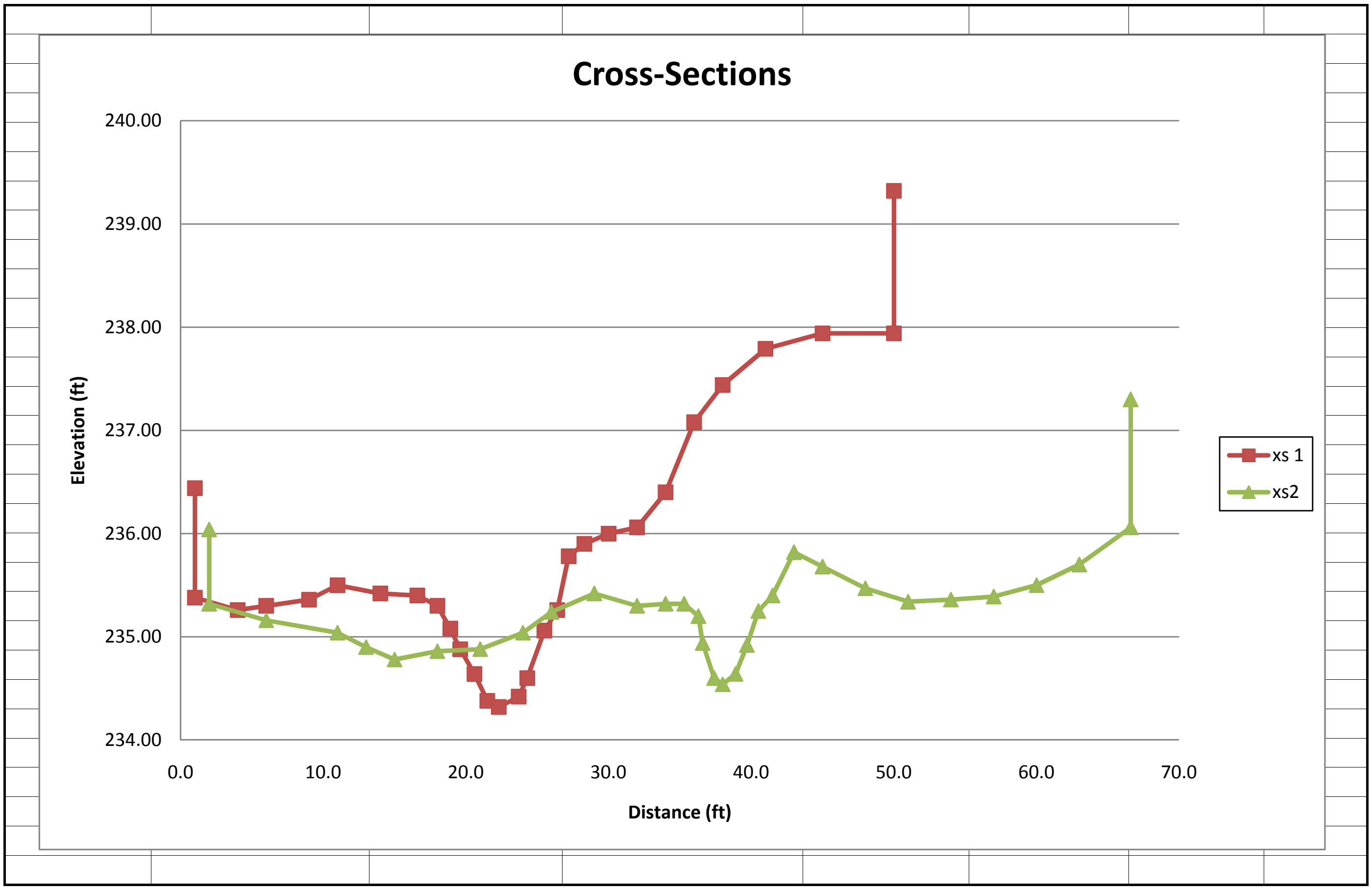

Heavenly Pond
Pond WSEL on 1/13/12
= 234.54'
N
233.04
233.18
233.30'
233.34
231.54
236.4
230.2
236.8
230.68
230.12
230.59
230.99
230.04'
230.4'
230.7
240.58
240.52
241.05
240.03
242.5
Btm Embankment = 235.05
Pipe Invert = 223.05
0 25 50 100
Feet
1 inch equals 50 feet

HEAVENLY POND							
13-Jan-12							
Assume Benchmark Elev. =		**238**	**ft at Bridge Deck**				
STA	**FS**	**ELEVATION**	**NOTES**				
--	8.00	238.00	Reference Point - Bridge Deck (right side, downstream side)				
--	13.08	232.92	Stream Thalweg @ Bridge, Water depth 2.39 ft				
Cross-Section 1 (31 ft downstream of Bridge Deck)							
1.0	9.56	236.44	Top of Left Pin				
1.0	10.62	235.38	Bottom of Left Pin				
4.0	10.74	235.26					
6.0	10.70	235.30					
9.0	10.64	235.36					
11.0	10.50	235.50					
14.0	10.58	235.42					
16.6	10.60	235.40					
18.0	10.70	235.30					
18.9	10.92	235.08	Left EOW				
19.6	11.12	234.88					
20.6	11.36	234.64					
21.5	11.62	234.38					
22.3	11.68	234.32					
23.7	11.58	234.42					
24.3	11.40	234.60					
25.5	10.94	235.06	Right EOW				
26.4	10.74	235.26					
27.2	10.22	235.78					
28.3	10.10	235.90					
30.0	10.00	236.00					
32.0	9.94	236.06					
34.0	9.60	236.40					
36.0	8.92	237.08					
38.0	8.56	237.44					
41.0	8.21	237.79					
45.0	8.06	237.94					
50.0	8.06	237.94	Bottom of Right Pin				
50.0	6.68	239.32	Top of Right Pin				

Field Data
1/13/12

Cross-Section 2 (48 ft downstream of Bridge Deck)							
2.0	9.96	236.04	Top of Left Pin				
2.0	10.68	235.32	Bottom of Left Pin				
6.0	10.84	235.16					
11.0	10.96	235.04					
13.0	11.10	234.90					
15.0	11.22	234.78					
18.0	11.14	234.86					
21.0	11.12	234.88					
24.0	10.96	235.04					
26.0	10.76	235.24					
29.0	10.58	235.42					
32.0	10.70	235.30					
34.0	10.68	235.32					
35.3	10.68	235.32					
36.3	10.80	235.20					
36.6	11.06	234.94	Left EOW				
37.4	11.40	234.60					
38.0	11.46	234.54					
38.9	11.36	234.64					
39.7	11.08	234.92	Right EOW				
40.5	10.75	235.25					
41.5	10.60	235.40					
43.0	10.18	235.82					
45.0	10.32	235.68					
48.0	10.53	235.47					
51.0	10.66	235.34					
54.0	10.64	235.36					
57.0	10.61	235.39					
60.0	10.50	235.50					
63.0	10.30	235.70					
66.6	9.94	236.06	Bottom of Right Pin				
66.6	8.70	237.30	Top of Right Pin				
Tributary Entry Point to Pond (90 ft downstream of Bridge Deck)							
--	12.70	233.30	Water depth is 1.25 ft				
<u>POND EMBANKMENT</u>							
Top of Embankment							
POINT	DIST. FROM RISER	FS-UPSTREAM PT.	ELEV-UPSTREAM PT.	FS-DOWNSTREM PT.	ELEV-DOWNSTREM PT.	WIDTH	
A	100 ft Left	3.50	242.50	3.45	242.55	10	
B	50 ft Left	4.95	241.05	5.17	240.83	12	
C*	0 ft	5.42	240.58	5.48	240.52	12	
D	100 ft Right	5.78	240.22	6.25	239.75	12	
E	200 ft Right	6.05	239.95	6.24	239.76	13	
* In line with Rser and Outfall							
Bottom of Embankment							
FS	ELEVATION	LOCATION					
22.95	223.05	Invert of Culvert Outfall					
25.00	221.00	Bottom of Scour Pool					
22.72	223.28	Edge of Scour Pool					
20.95	225.05	Bottom of Embankment Downstream Side					
11.47	234.53	Edge of Water Upstream of Embankment Near Riser					

Field Data
1/13/12




HEAVENLY POND
2/8/12 Field Work
Pond Bathymetry
Pond WSEL on 2/8/12
= 233.64
56.6'
36.3'
35.5'
34.4'
65.9'
46.1'
46.7'
47.9'
233.18
0.46
233.34
0.3
233.04
0.60
231.54
2.10
232.44
1.20
230.68
2.96
230.54
3.10
230.59
3.05
230.12
3.52
230.09
3.55
230.54
3.10
3.60
STAND PIPE
230.56
3.08
50'
0
50'
100'
SCALE: 1" = 50'

PARSONS BRINCKERHOFF Computation Sheet

subject: Heavenly Pond Bathymetry

page ___ of ___
made by: K. Lennon
date: 5/11/12
checked by:
date:

Pond measurements were taken on 2 days 1/13/12 and 2/8/12.

Pond WSEL on 1/13/12 = 234.54'

water depth @ stand pipe was control to compare depths on both days

1/13/12 = 4.5'
2/8/12 = 3.6'

Δ = 0.9'

$\therefore$ Pond Btm $Elev_{2/8}$ = $WSEL_{1/13}$ − Pond $Depth_{2/8}$ − 0.9'

= 234.54 − 3.6 − 0.9

= 230.04'

ASSUMPTION:
Because weather conditions were extremly windy on 1/13/12, any time a discrepancy exits btwn the two dates - the 2/8/12 data will be used.

PARSONS BRINCKERHOFF Computation Sheet

page ______ of ______

made by K. Lennon

date 5/11/12

checked by

date

subject Heavenly Pond Notes

Bathymetry surveys were completed on 1/13/12 and 2/8/12.

→ Partial data was collected on 1/13/12 due to field contraints (ie high winds) and WSEL was tied in to depths on this date.

→ resurvey of depths was completed on 2/8/12 however field crews did not resurvey pond WSEL.

∴ will need to make assumption regarding the WSEL on this date. Field crews noted that the WSEL was much lower during the second survey.

Pt #'s	Measured depths 1/13/12	Measured depths 2/8/12	DIFF
1	4.35	2.96	1.39'
2	5.0	3.52	1.48'
3	4.5	3.55	0.95'
4	3.8	3.08	0.72'
7	4.1	3.10	1.0'

1.1' Avg (of 3 middle values)

1.1' Avg (all values)

Pond WSEL on 1/13/12 = 234.54'

$$\text{Pond Btm}_{2/8} = \text{WSEL}_{1/13} - \text{Pond Depth}_{2/8} - 1.1'$$

G – Design Alternatives

HARFORD COUNTY, MARYLAND
DEPARTMENT OF PUBLIC WORKS
BID NO. __-___

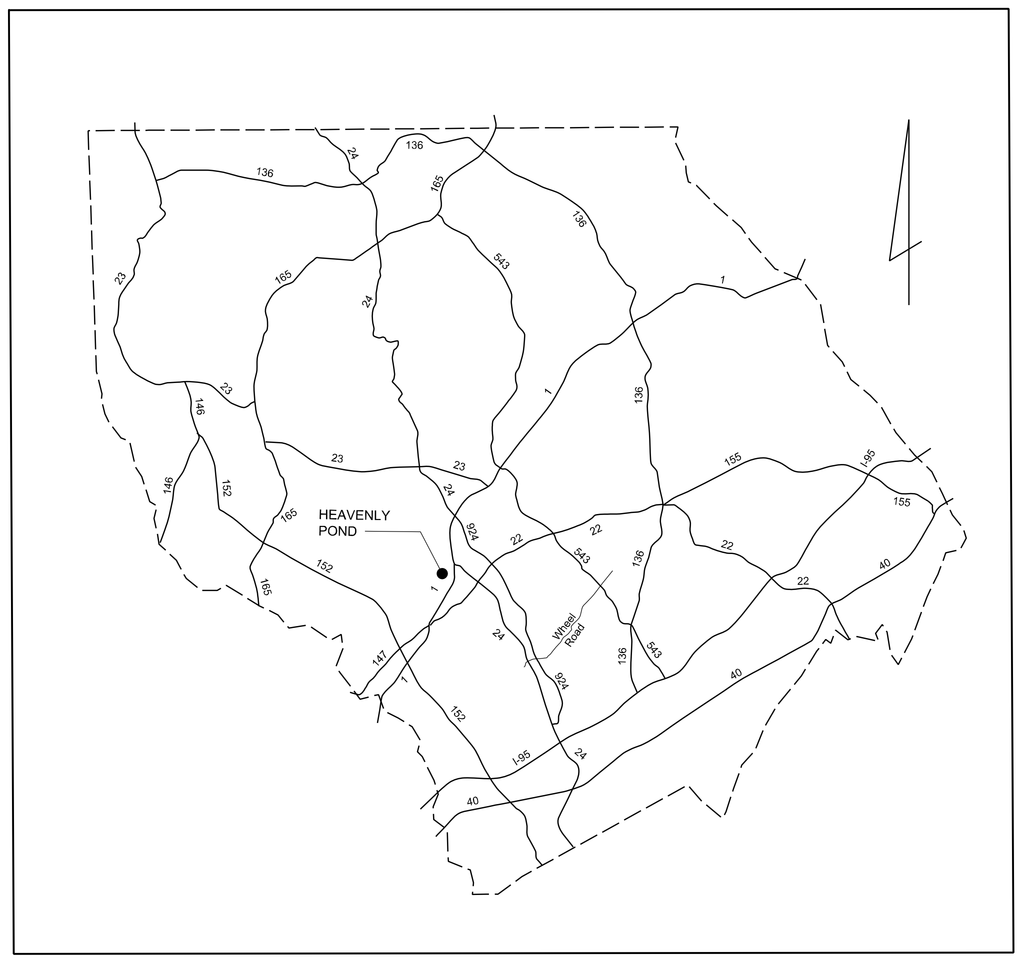
___

HEAVENLY POND

___

___

INDEX OF SHEETS



LOCATION MAP

SCALE 1" = 15,000'

GENERAL NOTES

1. SPECIFICATIONS: THE HARFORD COUNTY CODE AND SPECIFICATIONS SHALL GOVERN THE CONSTRUCTION OF THIS PROJECT. FOLLOWED BY THE STATE OF MARYLAND STATE HIGHWAY ADMINISTRATION STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS LATEST ADDITION.

2. UTILITIES: UTILITY LOCATIONS SHOWN ON THE PLANS ARE BASED ON LIMITED INFORMATION AVAILABLE. HOWEVER, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY THE ACCURACY OF THIS INFORMATION. THE COST OF REPAIR OR REPLACEMENT OF ANY SUCH FACILITIES DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE BORNE BY HIM.

3. UTILITY RELOCATIONS: UTILITY RELOCATIONS MADE NECESSARY BY THE HIGHWAY WORK WILL BE ACCOMPLISHED BY THE UTILITY OWNERS AT NO COST TO THE CONTRACTOR. WHEN SUCH WORK IS NECESSARY, THE CONTRACTOR SHALL NOTIFY APPROPRIATE PERSONNEL AS FOLLOWS:

CONTACT "MISS UTILITY" PHONE 1-800-257-7777, 48 HOURS IN ADVANCE FOR LOCATION OF ANY UTILITIES.

CONTACT BALTIMORE GAS & ELECTRIC CO. - PHONE NO. 1-410-291-3119, 48 HOURS IN ADVANCE OF BEGINNING ANY CONSTRUCTION.

4. STANDARD DETAILS: REFERENCE MADE TO STANDARDS ARE TAKEN FROM THE HARFORD COUNTY ROAD CODE "SPECIFICATIONS FOR CONSTRUCTION AND MATERIAL, STANDARD DETAILS FOR DESIGN AND CONSTRUCTION" AND FROM "THE MARYLAND STATE HIGHWAY ADMINISTRATION'S BOOK OF STANDARDS-HIGHWAY AND INCIDENTAL STRUCTURES", IT WILL BE THE CONTRACTOR'S RESPONSIBILITY THAT THE STANDARD DRAWINGS IN HIS POSSESSION ARE THE LATEST REVISED STANDARDS UP TO AND INCLUDING THE DATE OF THE ADVERTISEMENT OF THIS CONTRACT.

5. RIGHT-OF-WAY LINES: RIGHT-OF-WAY LINES SHOWN ON THESE PLANS DO NOT INCLUDE EASEMENTS. THEY ARE FOR ASSISTANCE IN INTERPRETING THE PLANS ONLY. THESE LINES DO NOT REPRESENT THE OFFICIAL PROPERTY ACQUISITION LINES. FOR OFFICIAL FEE RIGHT-OF-WAY AND EASEMENT INFORMATION, SEE THE APPROPRIATE RIGHT-OF-WAY PLATS.

6. SOIL CONSERVATION: THE CONTRACTOR SHALL TAKE EXTREME CAUTION NOT TO DISTURB THE EXISTING VEGETATION OUTSIDE THE LIMITS OF CONSTRUCTION. STOCKPILING AND STAGING WILL NOT BE ALLOWED ON SITE, THE CONTRACTOR MUST SECURE AN OFF-SITE AREA AND ANY NECESSARY PERMITS. SOIL STABILIZATION WILL CONFORM TO 1994 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. THE CONTRACTOR WILL OBTAIN APPROVAL OF THE HARFORD COUNTY SOIL CONSERVATION DISTRICT FOR HIS PLANS IN CONTROLLING SEDIMENT EROSION FOR THE BORROW AREA AND DISPOSING OF ANY WASTE EXCAVATION.

7. EXISTING MAILBOXES AND EXISTING SIGNS: ALL EXISTING MAILBOXES, SIGNS AND PAPER BOXES DISTURBED DURING CONSTRUCTION SHALL BE TEMPORARILY RESET IMMEDIATELY AND PERMANENTLY RESET AS DIRECTED BY THE ENGINEER. THIS WORK WILL BE INCIDENTAL TO ALL OTHER ITEMS IN THE CONTRACT.

8. NEW INLETS SHALL BE BACKFILLED WITH NO. 57 AGGREGATE FOR A WIDTH OF 1.5 FEET OUTSIDE PERIMETER OF STRUCTURE AS PER SECTION 603 OF THE HARFORD COUNTY ROAD CODE.

9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO AND MAINTENANCE AND PROTECTION OF EXISTING UTILITIES AND STRUCTURES.

10. PRIOR TO ANY LAND DISTURBANCE, 48 HOURS ADVANCE NOTICE SHALL BE GIVEN TO THE DPW INSPECTION SECTION BY CONTACTING THE CHIEF INSPECTOR AT 410-638-3561. A PRE-CONSTRUCTION MEETING SHALL BE HELD PRIOR TO ANY ON-SITE LAND DISTRUBANCE.

11. ALL DISTURBED AREAS AS A RESULT OF ROADWAY AND STORM DRAIN CONSTRUCTION SHALL BE SEEDED AND MULCHED WITHIN 14 DAYS AFTER COMPLETION.

12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTENANCE OF TRAFFIC & TRAFFIC CONTROL DURING CONSTRUCTION AND PRIOR TO ACCEPTANCE BY THE COUNTY, CONSISTENT WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (LATEST EDITION).

REVIEWED AND APPROVAL RECOMMENDED:

PROJECT ENGINEER

REVIEWED AND APPROVAL RECOMMENDED:

CHIEF ENGINEER

APPROVAL RECOMMENDED:

DEPUTY DIRECTOR OF PUBLIC WORKS

APPROVED:

DIRECTOR OF PUBLIC WORKS

Prepared By :
PARSONS BRINCKERHOFF, INC.
100 S. Charles St., Tower 1, 10th Floor
Baltimore, MD 21201

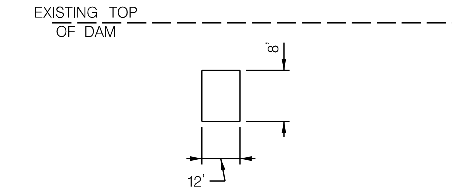
DATE 3/19/12

ADC MAP :

TAX MAP :

HCG BILLING ID No.:

HCG DWG ID No.:

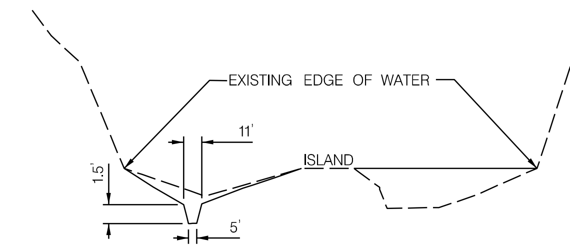


PROPOSED CULVERT BREACH SECTION

SECTION A-A

HORIZ. 1" = 60'

VERT. 1" = 30'



TYPICAL APPROACH CHANNEL

N.T.S.

NOTES:
EXISTING CONTOURS GENERATED FROM GIS AND SUPPLEMENTED WITH PB SURVEY

ADC MAP :

TAX MAP :

HCG BILLING ID No.:

HCG DWG ID No.:

Revisions

HARFORD COUNTY, MARYLAND

PLAN SHEET
ALTERNATIVE 1 – CULVERT BREACH

Drawn By : ____

Designed By : ____

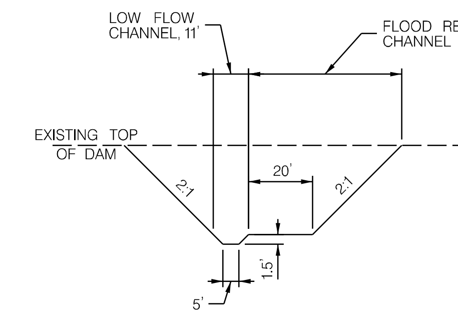
Reviewed By : ____

Contract No : ____

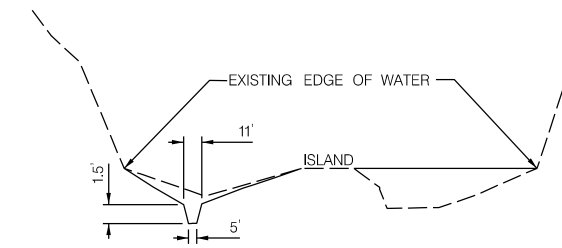
Scale : ____

Sheet ____ Of ____

Date : ____



PROPOSED CHANNEL BREACH SECTION
SECTION A-A
HORIZ. 1" = 60'
VERT. 1" = 30'



TYPICAL APPROACH CHANNEL
N.T.S.

NOTES:
EXISTING CONTOURS GENERATED FROM GIS AND SUPPLEMENTED WITH PB SURVEY

Revisions

HARFORD COUNTY, MARYLAND

PLAN SHEET
ALTERNATIVE 2 - CHANNEL BREACH

Drawn By :	Contract No :
Designed By :	Scale :
Reviewed By :	Sheet ____ Of ____
	Date :

ADC MAP :
TAX MAP :
HCG BILLING ID No.:
HCG DWG ID No.: