2015 Water Quality Monitoring of
Mill and Dividing Creeks
Arnold, MD

Prepared for the Mill Creek Headwaters Restoration Project
Anne Arundel County Dept. of Public Works
Watershed Protection and Restoration Program
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Photo courtesy of BayLand Consultants & Designers, Inc. – Mill Creek, south shore marsh creation site,
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1. Introduction and Background.

Water quality monitoring along Mill and Dividing Creeks was initiated in 2006 in response to a water main failure at the Jones Station Road Pump Station, on December 17, 2005, that resulted in a 3 million gallon wastewater spill into Mill Creek, a tributary that flows into Magothy River. Emergency clean-up efforts were conducted by Anne Arundel County Department of Public Works (DPW) and Bayland Consultants and Designers, Inc. Afterward, the magnitude of the incident prompted the formation of the Mill Creek Restoration Project, including members of the community, DPW, Magothy River Association (MRA), and the Anne Arundel County Department of Health.

Water quality monitoring has been on-going since March 2006. Initially, monitoring was conducted from March 2006 through December 2006, and that work involved comparing water quality parameters between Mill Creek and the unaffected Dividing Creek, which is also a Magothy River tributary flowing parallel to Mill Creek. Three sites were chosen along each waterway, representing sites at the tidal headwaters and two sites further downstream toward the Magothy River (figure 1). The physical parameters measured during the initial study period included nitrate, nitrite, ammonia, phosphate, chlorophyll a, dissolved oxygen, conductivity, salinity, pH, clarity and suspended solids. In addition, enterococci and fecal coliform levels were measured.

![Figure 1. Sampling stations along Mill and Dividing Creeks.](http://gis-world2.aacounty.org/silverlightviewer/?Viewer=WERS&Project=93eae9c4-ebbd-47de-9cc6-e4f61f1c7f39)

During the first season of testing, data generally indicated that there were not significant differences in water quality between the two creeks, and that the pollutant levels were generally consistent with other headwater areas on the Chesapeake Bay western shore.
Between 2006 and 2010, fecal monitoring in the summer swimming season, was performed in Mill and Dividing Creeks and those data have been reported yearly along with several other parameters that were measured by either AACC Environmental employees or Magothy River Association volunteers. Some of those data are included in this report for long-term trend analysis.

Dredging of most of Mill Creek, excluding the headwaters, took place in 2008-2009, and the headwaters were dredged in 2011. The Army Corps of Engineers recommended a six year follow-up study of six sites within Mill and Dividing Creeks. Although the summer of 2016 will be the sixth year of the planned monitoring period, as recommended by the Army Corps of Engineers, a number of changes have occurred along, and upstream, of Mill and Dividing Creeks that have the potential to affect water quality significantly into future years. Included in the plans was re-establishment of healthy marsh along portions of the shore. As of 2015 the plantings along the north and south shore have reached approximately half of the proposed coverage, so work will continue at several sites along Mill Creek shores. Further restoration of the Mill Creek headwaters is planned for summer of 2016, and this process will include dredging. Maintenance dredging along the length of the creek is planned for 2020. In addition, the 2008 Retrofit Assessment conducted by DPW includes several projects in the watershed of both Mill and Dividing Creeks. The Haskell Drive outfall retrofit is complete, one of the projects planned along Dividing Creek on the AACC campus is underway and phase I of the upper Mill Creek restoration project, involving several sites in the watershed is in the design phase (BayLand presentation at Mill Creek Scientific Review Committee Meeting, Nov 3, 2015). All of these projects have the potential to positively affect water quality along Mill and Dividing Creeks. Adverse effects on water quality include the sewage spills that have periodically, but rarely, occurred, including the spill in the summer of 2014. Increased building and paving, including a new development along Ritchie Highway, result in more hard surfaces that contribute to runoff, especially after a rain event (defined as 0.5 inches or more of rain).

2. Methods

The following parameters were monitored weekly at M1, M2, M3, D1, D2, and D3 from May 20 through August 19 of 2015 using a YSI Model 556 meter: 1) water temperature, 2) dissolved oxygen, 3) conductivity, 4) salinity, 5) pH. At stations M1 and D1, with depths less than 1 m, the values were measured at 0.1 m (surface). At the remaining stations, parameters were measured at the surface and just above bottom, with depths ranging from 1.3 to 2.5 m. Secchi Disk depth and turbidity tube depth were measured at each station each week. Water samples for enumeration of enterococci were collected weekly at a depths of approximately 0.5 m. The samples were collected between 9 am and noon, immediately placed on ice, transported back to the lab within four hours of collection and maintained on ice until processing was completed. Enterococci enumeration was conducted using EPA Method 1600 using membrane filtration and selection on indoxyl-β-D-glucoside (mEI) agar.
On alternate weeks beginning on May 27, 2015, additional water samples were collected for analysis of total suspended solids (TSS), measured at AACC, and measurement of inorganic nutrients and chlorophyll, measured at the University of Maryland Chesapeake Biological Laboratory (CBL) for analysis. Samples were filtered at AACC, frozen and periodically sent to CBL for analysis, where the following parameters were measured: 1) dissolved ammonia (NH$_4$) by the phenate method, 2) dissolved nitrate (NO$_3$) plus nitrite (NO$_2$) by the cadmium reduction method, 3) dissolved phosphate (PO$_4$) by the ascorbic acid method, 4) and chlorophyll a by the spectrophotometric method.

Rainfall was tracked by referring to multiple sources: Dr. Sally Hornor, the Community Collaborative Rain, Hail and Snow Network (www.cocorahs.org) and the National Weather Service (http://www.srh.noaa.gov/ridge2/RFC_Precip/).

Statistical comparisons between paired stations were determined with the Wilcoxon matched-pairs nonparametric two-tailed tests using SPSS software (version 21, IBM). Significance is reported for P<0.05. Comparisons were made for the matched station pairs in 2015 such as M1 compared to D1 and also for the mean data values for M1 of 2015 compared to the M1 mean for 2014. All 2015 raw data are included in the appendix of this report.

3. Results and Discussion.

A. Water Temperature. The maximum surface water temperature in 2015 was 29.72 Celsius and 29.14 Celsius at bottom (Figs. 2 and 3, respectively). These maxima were nearly a full degree above the maximum in 2014 and the overall means for the season were more similar to those measured in 2012 (Figs. 4 and 5).

Generally, higher water temperatures are associated with lower dissolved oxygen levels and increased occurrence of algal growth, as will be discussed in later sections.
B. Salinity. Salinity, measured weekly at each site, can be significantly affected by rainfall. Table 1 lists rain events that occurred in the vicinity of Mill and Dividing Creek during the period of May 20- August 19, 2015 that were 0.1 inch or greater.

Table 1. Rainfall of 0.1 inches or greater recorded in Arnold, MD during the 2015 sampling season (data obtained from www.cocorahs.org).

<table>
<thead>
<tr>
<th>Date</th>
<th>Rainfall (inches)</th>
<th>Date</th>
<th>Rainfall (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 19</td>
<td>1.17</td>
<td>July 3</td>
<td>0.19</td>
</tr>
<tr>
<td>May 22</td>
<td>0.26</td>
<td>July 5</td>
<td>0.27</td>
</tr>
<tr>
<td>June 2</td>
<td>1.58</td>
<td>July 9</td>
<td>0.52</td>
</tr>
<tr>
<td>June 5</td>
<td>0.27</td>
<td>July 10</td>
<td>0.69</td>
</tr>
<tr>
<td>June 9</td>
<td>1.55</td>
<td>July 14</td>
<td>0.25</td>
</tr>
<tr>
<td>June 15</td>
<td>0.11</td>
<td>July 27</td>
<td>0.13</td>
</tr>
<tr>
<td>June 21</td>
<td>2.11</td>
<td>July 28</td>
<td>0.22</td>
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<tr>
<td>June 24</td>
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<td>July 31</td>
<td>0.33</td>
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<td>June 26</td>
<td>0.94</td>
<td>August 5</td>
<td>0.13</td>
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<tr>
<td>June 27</td>
<td>0.12</td>
<td>August 11</td>
<td>0.21</td>
</tr>
<tr>
<td>July 1</td>
<td>1.21</td>
<td>August 12</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Surface Salinities varied widely in 2015, with a low value of 0.12 ppt up to a high of 7.55 ppt (Fig. 6). As expected, heavy rain was associated with low salinity readings, with over 3 inches of rain in the 3 days prior
to the low reading on June 24. As seen in previous years, the salinity at M1, being close to the headwaters, is most affected by rainfall.

Interestingly, surface salinity and conductivity (data included in appendix) were significantly different between paired stations in Mill and Dividing Creeks (p< 0.05 at for each site), with Mill Creek sites being fresher at each site. The larger watershed area for Mill Creek (1156 acres) when compared with Dividing Creek (891 acres), with a slightly higher percentage of impervious surfaces around Mill Creek (23% versus 22% for Dividing Creek; DPW Mill Creek Sewage Spill Report, May 2014), results in the potential for more runoff, decreasing the overall salinity.

Bottom salinity ranged from 4.59 ppt to 7.99 ppt. The lowest bottom salinity, surprisingly, was not associated with any significant rainfall within a week of testing, however, there had been several days of steady rain that fell just two weeks prior to the low reading. The low salinity values observed at the bottom, and even relatively low salinity at the surface, during mid-July is different than the trend observed in 2014, during which both surface and bottom salinity, increased throughout June and July.

Overall, surface and bottom mean salinities were somewhat higher at all sites in 2015 when compared with 2014 values. This was not due to a higher rainfall causing more dilution, since the rain total during the sampling season in 2015 was higher than the same period in 2014, 13.95 inches and 11.42 inches respectively (www.cocorahs.org). Instead, the generally higher water temperatures likely affected salinity levels.

Although salinity was higher during the summer of 2015, there were definitely signs that dark false mussels (DFM), *Mytilopsis leucophaeta*, were present during the summer. There were several reports of pets that were sickened by the ingestion of the mussels (Capital Gazette, Nov
3, 2015), but there were no reports specifically associated with Mill or Dividing Creeks. Anecdotal reports for these creeks is that the DFM population was much reduced in 2015 compared to 2014 (SG Hornor, personal communication). Although salinity increased significantly between 2014 and 2015 (p <0.05), the mean salinity is still well within the range that can sustain DFM survival and potentially reproduction.

C. Secchi Disk Depth. Both Secchi Disk depth and turbidity tube measurements were conducted at all sites each week. Turbidity tube measurements are reported in the appendix with raw data, but are not included in graphs, as the data agreed well with those measured with the Secchi Disk. Figure 10 shows the results of the Secchi Disk measurements for 2015. The dramatic decrease in clarity at the end of June, was likely related to an observed increase in algal presence as noted by increased levels of chlorophyll that corresponded to this date (Fig. 14). In direct comparisons, only D2 versus M2 resulted in statistically significant differences in clarity (p = .007).

As noted in previous reports, water clarity in Mill and Dividing Creeks is often not sufficient to support photosynthesis at depths required for submerged aquatic vegetation (SAV). At the M1 and D1 depths of approximately 0.5 m, a Secchi Disk depth of about 0.4 m is necessary to support the photosynthesis required to support SAV growth (Batiuk et al., 1992). During the 2015 season, M1 met or exceeded 0.4 m Secchi depth 57% of the time, a 26% increase from 2014. However, D1 only met the minimum Secchi depth 50% of the time, a 19% decrease from 2014. The results at M1 are encouraging, with 2 of three sites along Mill Creek, demonstrating slight, although not statistically significant, increases in clarity, although all three sites along Dividing Creek showed a slight decrease in clarity (p> 0.05) (Fig. 11).
D. Total Suspended Solids (TSS). Again in 2015, the mean TSS levels were above the 15 mg/L cut off for growth of SAV (Batiuk et al., 1992) (Fig. 12). In general, there was little overall change in the mean TSS at all stations except M1, which had a noticeable, but statistically insignificant, decrease in TSS for the season. The very high TSS mean for 2014 was mainly driven by one extremely high TSS mid-June 2014. In 2015, M1, along with the other 5 stations, demonstrated generally more consistent levels of TSS (Fig. 13). Of note, the increased TSS seen at D1, M1 and M2, followed by a spike at D2, D3, and M3, reflected the rainy weather late May and early June that caused significant runoff and sediment from surfaces. The July and August peaks were more likely associated with algae, as noted by a change in water sample color and increased chlorophyll levels (Fig. 14). Comparison of dates and stations demonstrating low water clarity, as determined by Secchi Disk depths, correlate well with dates having increased levels of TSS (compare Figs. 10 and 13).

E. Chlorophyll A. Figure 14 shows the chlorophyll a concentrations for the 2015 sampling season. Chlorophyll a content is an indicator of phytoplankton biomass, as it is the photosynthetic pigment in algae. During the 2015 season, there was a statistically significant difference between the data at D2 and M2, but no difference between the other paired sites.
The Chesapeake Bay Program has determined that chlorophyll a concentrations below 15 \( \mu g/L \) are required for SAV growth. Although there were a handful of individual measurements during the summer of 2015 that fell below that value, the seasonal mean for each site was significantly above the 15 \( \mu g/L \) cut-off (Fig. 15). There were no significant differences in mean chlorophyll a levels at each site between 2014 and 2015.

**F. Nutrients: Nitrate and Nitrite.** There is a clear relationship between chlorophyll and nutrient levels, since algal growth depends on high nutrient content. During the 2015 season, nutrient level varied widely with high values over 600 \( \mu g/L \), higher than any values in 2014, and peaks at mid-June and mid-July. This pattern was very different than was observed in 2014, with peaks at the very beginning and very end of the sampling season. Overall, there were statistically significant values over the season between D1 and M1 and between D2 and M2. As mentioned in previous reports, there are often large numbers of waterfowl near the M1 and M2 sampling sites, which may contribute to the higher nutrient levels.

Although there are apparent decreases in mean nutrient content at 5 of 6 test sites, none of the differences were statistically significant when Wilcoxon analysis
was performed. The small number of values in the test group may be a factor in the high p value obtained from the statistical analysis.

G. Nutrients: Ammonia. Values for ammonia during 2015 are shown in figure 18. There is a very distinct peak on June 24 that coincides with a peak in TSS, total nitrate/nitrite, decreased clarity, and a significant rain event. The smaller peak on July 22 also reflects increased TSS, total nitrate/nitrite and a large chlorophyll a spike. Overall, Wilcoxon matched pair analysis did not reveal any significant differences between matched sites in Dividing and Mill Creek, nor did it reveal any difference in means between 2014 and 2015 (Fig. 19). Although there is an apparent decrease in values in 2015, as seen on the graph, the small number of samples likely decreases the probability of having a statistically significant difference.

H. Dissolved Inorganic Nitrogen (DIN). The Chesapeake Bay Program sets water quality parameters associated with nitrogen as less than 150 μg/L of total dissolved inorganic nitrogen, defined as the sum nitrate, nitrite and ammonia. Sites M1 and M2 exceeded that value 3 of 7 sample days,
which is an improvement over 2014, during which M1 and M2 exceeded 150 μg/L 5 of 7 weeks (Fig 20 and data from 2014 report). Not surprisingly, there is a statistically significant difference in the values when comparing D1 and M1. Again, there is a distinct peak at June 24, potentially related to significant rain before sampling.

Looking at the DIN trend over the five years of the study, there was a general trend downward at all sites in 2015, although the decreases were not statistically significant.

I. Nutrients: Phosphate. There are basically two forms of phosphorus that are present in waterways, inorganic phosphate (PO₄) and organic phosphorous. Of the two, PO₄ is the form utilized by phytoplankton and SAV. Less than 20 μg/L is the criterion set by the Chesapeake Bay Program. During the 2015 season, the limit was only surpassed once at the D3 site.

It is encouraging to see that the consistently low mean values observed in 2014, have continued in 2015 (Fig. 23).
J. pH. pH values in 2015 ranged from 6.3 to 8.1, a slightly larger range that observed in 2014 (Fig. 24 and 2014 data). Bicarbonate is a major buffer system in the Magothy, so pH changes can reflect differences in CO$_2$, so algal photosynthesis, which uses CO$_2$ play a role in pH peaks. In addition, significant rain events can cause a drop in pH, as seen in late June.

For the bottom pH levels, there was a significant difference between the values at D2 and M2 (Fig. 25). The significant increase in pH at many of the sites that occurred at the beginning of July may reflect the dilution of rain that occurred mid-June followed by an increase in algal growth in early July. pH has remained relatively stable from 2014 through 2015 (Fig. 27 and Fig. 28). There was a statistically significant difference between bottom pH means when
K. Dissolved Oxygen (DO). Dissolved oxygen levels in area waters, especially surface waters, is of great concern, due to the quick and dramatic detrimental effects of hypoxia in a given area. Levels of DO below 5 mg/L are not suitable for survival of most aquatic organisms, and the level of DO can be significantly affected by algal blooms that initially produce oxygen during photosynthesis, but eventually block photosynthesis in SAV underwater, reducing oxygen production by those organisms. In addition, rapid algal death results in further use of oxygen in the process of algal degradation. Oxygen can also diffuse into water from the atmosphere. During the 2015 season, there was a statistically significant difference between D2 and M2 (p=.006). Regardless, pH values all remain within optimum range for aquatic organisms.

Fig. 29 Surface Dissolved Oxygen (mg/L)

Surface DO levels were above 5 mg/L approximately half of the time, with D1 and M2 showing the most sample days below 5 mg/L. DO levels, as expected are significantly lower in bottom waters, and only D2 waters were above the 5 mg/L level for the majority of sample days. Much of the season, bottom waters at M2, M3, and D3 were hypoxic, at less than 2.0 mg/L. In no case, in either surface of bottom waters, did values fall to anoxic levels (below 0.2 mg/L).
There were no observed statistically significant differences in DO levels at the surface or at the bottom between 2014 and 2015. However, at the surface, there were noticeable increases at D2, D3 and M3 that brought the mean values above the 5 mg/L cut-off limit. Bottom DO means stayed stable from 2014 through 2015.

The reason for the apparent increase in surface DO at 5 of the 6 sites is unclear. Water temperatures in 2015 were about the same as in 2014, and there was not an increase in clarity. There was more rain overall, which can often bring additional sediment into water and decrease DO. Possibly, mixing activity caused by wind during and tidal mixing, could potentially bring more oxygen into the surface waters.

**L. Fecal bacteria: Enterococci.** After the December 2005 wastewater spill at the Arnold Pumping Station, there was significant concern by residents, and the county, about fecal contamination in Mill Creek. Fecal bacterial monitoring was initiated by Anne Arundel County soon after the spill and continued through the winter months. There was a rapid decline in the first week following the spill, however fecal bacterial counts remained well above the limit set for recreational use throughout the winter. Enterococci monitoring became a parameter in the Mill and Dividing study and has been on-going throughout the study period. Over the period of the study, several observations have been made. First, after a spill, including the 2014 spill, enterococci counts have initially been very high but decreased significantly within 48 hrs (2014 report and unpublished data from additional sampling after the 2014 spill). Second, after a rain event of about 0.5 inches or more, enterococci counts spike significantly, but decrease rapidly within 48 hours. Third, the sample sites at M1, M2, D1 and D2 have consistently higher baseline enterococci counts than many other similar sampling sites along the Magothy tributaries (data obtained as part of Operation Clearwater). Some of the reasons associated with these higher than typical counts were discussed in the 2014 report and include wildlife feces, septic systems (of which there are several hundred along both Mill and Dividing Creeks).

The 2015 data are shown in figure 34. This representation shows the significant effect of stormwater run-off since there were rain events of over 1 inch of rain within the 24 hours prior to the June 3rd and July 1st sampling dates. Figure 35 shows the same data graphed on a logarithmic scale. This representation illustrates that samples from M1, M2, and D1 were frequently near, or above the EPA limit of 104 cfu/100 ml for safe swimming in recreational waters. In Wilcoxon analyses, there were significant, or near significant differences between values compared at each matched pair (D1/M1, p= 0.013; D2/M2, p= 0.084; D3/M3, p= 0.038). The reason for the differences may be related to higher animal activity, greater septic failure, and an accumulation of sediment. Since the 2011 dredging that was done along Mill Creek, aerial photography has shown that a significant amount of sediment has since accumulated (BayLand presentation at Mill Creek Scientific Review Committee Meeting, Nov 3, 2015).

Although there were not significant differences between geometric means when comparing 2014 and 2015, in general, none of the sites fall...
below the EPA limit of 35 cfu/100 ml, corrected for geometric mean calculations. The geometric mean calculation removes the extreme values and is useful when analyzing data that varies widely, such as the enterococci counts.

4. Conclusions. The short-term goal of monitoring the parameters described in this report is to study the effect of the large sewage spill from the Arnold Pumping Station that significantly impacted water quality in Mill Creek, especially near the headwaters, and further to analyze the effect on quality due to the dredging and replanting done along parts of Mill Creek. After the initial emergency response, a specific plan of action was decided upon that involves additional maintenance dredging and additional plantings at several sites near the shoreline.

One goal of the long-term restoration in Mill Creek is the successful re-establishment of marshy regions along the shore. However, as reported in November of 2015 at the Mill Creek Scientific Committee Meeting, the goal of 85% coverage has not been met yet (BayLand presentation at Mill Creek Scientific Review Committee Meeting, Nov 3, 2015).

SAV growth is another concern, and the conditions along Mill Creek often fall short in terms of water clarity and DO levels. Algal blooms occur in both Mill and Dividing Creeks, temporarily increasing DO levels, but quickly causing water turbidity and later hypoxic conditions. While there have been improvements nitrogen levels still remain above the limit for SAV growth at M1 and M2. In general, phosphate levels, pH, and temperature are within the parameters necessary for SAV growth. In surveys of SAV growth along the Magothy tributaries, there have not been significant gains, although pockets of SAV growth have been noted.

Dark false mussels made a resurgence in 2014, and although some were seen in 2015, there were no reports of pets becoming ill from ingestion of DFM in either Mill or Dividing Creek. The levels are not what they were in 2014, and there did not appear to be any significant effect due to their presence on water clarity.

Overlapping the timing of the plans specific to Mill Creek, the Anne Arundel County Department of Public Works conducted a comprehensive assessment of the county waterways and developed a master plan for restoration at many sites along the Magothy River, with a number of sites targeted for restoration in the Mill Creek watershed. Additionally, the comprehensive assessment has identified a number of sites within the Dividing Creek watershed, highlighting the fact that Dividing Creek is affected by a number of stressors common to Mill Creek. Some of the work has begun at several sites. In particular, the Haskell Drive Retrofit, which reversed significant erosion at an outflow site that feeds directly into Mill Creek, was completed early in 2015. The retrofit is projected to prevent 89.1 pounds of nitrogen, 39.3 pounds of phosphorus and 5.3 tons of sediment from making its way into Mill Creek and further into Magothy River and Chesapeake Bay (BayLand presentation at Mill Creek Scientific Review Committee Meeting, Nov 3, 2015). Though there were not sufficient data points to demonstrate statistically significant drops in most parameters, there were some noticeable downward trends in TSS, DIN and phosphate from 2014 to 2015, with the most noticeable drops at the M1 site (Table 2- top of next page). The water from the area of the outfall enters Mill Creek between
sites M1 and M2, so whether the downward trend in several parameters is due, in any part, to the Haskell Drive Retrofit will require additional testing and larger data sets, potentially including sampling closer to the site at which water from the retrofit area enters Mill Creek.

Table 2. Comparison of Pre- and Post- Haskell Outfall Retrofit Values at site Mill Creek sites.

<table>
<thead>
<tr>
<th></th>
<th>Total Inorganic Nitrogen (µg/L)</th>
<th>Phosphate (µg/L)</th>
<th>Total Suspended Solids (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M1</td>
<td>M2</td>
<td>M3</td>
</tr>
<tr>
<td>2014 (pre-)</td>
<td>390.81</td>
<td>203</td>
<td>149.14</td>
</tr>
<tr>
<td>2015 (post-)</td>
<td>233.53</td>
<td>176.73</td>
<td>46.56</td>
</tr>
</tbody>
</table>

The choice of Dividing Creek sites as the control group was based on the similarities in length, depth, development around the creeks and proximity to each. The results have illustrated that Dividing Creek is a suitable pair for comparison to Mill Creek. Additionally, the comprehensive assessment conducted by Anne Arundel County DPW has identified a number of sites within the Dividing Creek watershed, highlighting the fact that Dividing Creek is affected by a number of stressors common to Mill Creek. Additionally, work in the Dividing Creek watershed has recently begun, which may affect parameters in Dividing Creek in the next season/s. The restoration work being conducted along both creeks highlights the fact that additional data sets may be useful in tracking positive outcomes from such projects.

5. Acknowledgements and References.

Acknowledgements. Much of the data gathered and analyzed in this report was obtained by Greg Wolf, a student working at AACC Environmental Center. In addition, Michael Norman, AACC Environmental Center Manager, and Eileen Davids, put significant effort into the bookkeeping and equipment maintenance needed to keep this project functioning. Dr. Sally Hornor has generously provided on-going support and advice over the two-year transition period.
References.


Mill Creek Headwaters Restoration Project Joint Application Permit, March 2010, BayLand Consultants and Design, Inc.

Mill Creek Scientific Review Committee Meeting, Nov 3, 2015, Anne Arundel Community College.