9.0 Permit Requirements

F. Watershed Assessment and Planning

Baltimore County shall continue to update and revise watershed assessments that have been developed for its 10 urban watersheds (Baltimore Harbor, Bird River, Back River, Gwynns Falls, Jones Falls, Little Gunpowder, Loch Raven, Lower Gunpowder River, Middle River, and the Patapsco River). The overall goal is to ensure that each County watershed is thoroughly evaluated and has an action plan to maximize water quality improvements. Additionally, the County shall encourage the public to participate in the development and implementation of watershed restoration activities. At a minimum, the County shall:

1. Continue to perform and update detailed assessments in all of its urban watersheds. These watershed assessments shall include:
    a. Determining current water quality conditions;
    b. Identifying and ranking water quality problems;
    c. Identifying all structural and non-structural water quality improvements opportunities;
    d. Reporting the results of a visual watershed inspection;
    e. Specifying how the restoration efforts will be monitored; and
    f. Providing an estimated cost and a detailed implementation schedule for those improvement opportunities identified above.

H. Assessment of Controls

Assessment of controls is critical for determining the effectiveness of the NPDES stormwater management program and progress toward improving water quality. Therefore, Baltimore County shall use chemical, biological, and physical monitoring to document work toward meeting the watershed restoration goals identified above.

9.1 Introduction

In order to meet the permit requirements detailed in section F (1. a.-e) and section H, Baltimore County has initiated chemical, biological, and geomorphological monitoring programs in addition to the specific monitoring required by the permit and detailed in Section 8. The chemical monitoring program (9.2) consists of two elements, stream baseflow monitoring and tidal water monitoring. A third element consisting of storm event monitoring at USGS gage sites has been sporadic and will not be included in this report. The stream geomorphological monitoring program (9.3) includes monitoring of stream restoration projects and conducting stream assessments in support of the Small Watershed Action Plan preparation. The biological monitoring program (9.4) has four elements including probabilistic monitoring, CIP monitoring, reference site monitoring, and submerged aquatic vegetation monitoring.

9.2 Chemical Monitoring Program

In order to determine the chemical condition of Baltimore County waters two chemical monitoring programs have been implemented. The chemical monitoring program is intended to provide information on ambient chemical conditions and, over time, to assess trends in both chemical concentrations and chemical loads. The information will be used to better target restoration activities, to provide data for the calibration of pollutant load models, and to provide local data to assess the results of the Chesapeake Bay Program modeling efforts and TMDL modeling. The data will be used to assess water quality improvements that are the result of restoration efforts. It will also be used to determine progress in meeting the pollutant load reductions required by the Chesapeake Bay restoration efforts and as determined by the development of Total Maximum Daily Loads (TMDLs). These programs will partially fulfill the restoration effectiveness monitoring required under NPDES Permit section F.1 and H above.

The two current, chemically oriented programs, the Baseflow Monitoring Program and the Tidal Waters Monitoring Program are described in Sections 9.2.1 and 9.2.2, respectively.

9.2.1 Baseflow Monitoring

A baseflow monitoring program was initiated in 1999. The initial effort was targeted at watersheds that were undergoing or about to undergo the preparation of a Water Quality Management plan. The targeted watersheds included the Lower Gunpowder, the Little Gunpowder, the Middle River and the Baltimore Harbor watersheds. The limited data was used in the calibration of the SWMM pollutant load models that were included in the Water Quality Management plans. In the fall of 2000, the baseflow monitoring was shifted to the Back River, Jones Falls and Gwynns Falls watersheds. The shift was intended to address the lack of chemical monitoring information available for these watersheds. These watersheds were monitored until the spring of 2001. The data collected was presented in the NPDES – 2001 Annual Report. Staffing levels curtailed the continuance of the baseflow monitoring program until the spring of 2003.

The baseflow monitoring program, which resumed in 2003 was also redesigned. Baseflows are monitored in the Patapsco/Back River Basin in odd-numbered years, while the Gunpowder Basin/Deer Creek are monitored in the even-numbered years. A total of fifty-three (53) sites in the Patapsco Back River Basin, and fifty-six (56) sites in the Gunpowder Basin/Deer Creek have been selected for monitoring. The points were chosen to maximize the number of subwatersheds monitored. The monitoring points within the Patapsco/Back River Basin are displayed in Figure 9-1, while the Gunpowder Basin/Deer Creek monitoring points are displayed in Figure 9-2. Appendix 9-1, at the end of this section, displays the watersheds and subwatersheds associated with each monitoring point.

The target number of baseflow samples is six to eight samples per year at each site. The actual number sampled will vary depending on weather conditions, staffing and other duties. The standard set of monitored pollutants includes (TSS, TS, TKN, Nitrate/Nitrite, Total Phosphorus, Ortho-phosphorus, Cadmium, Copper, Lead, Zinc, BOD, COD, and Chlorides, Sodium, Hardness) as well as temperature and pH determined in *situ*. Discharge measurements are taken during each sample collection. A minimum of three days of dry weather is required prior to monitoring any baseflow site.

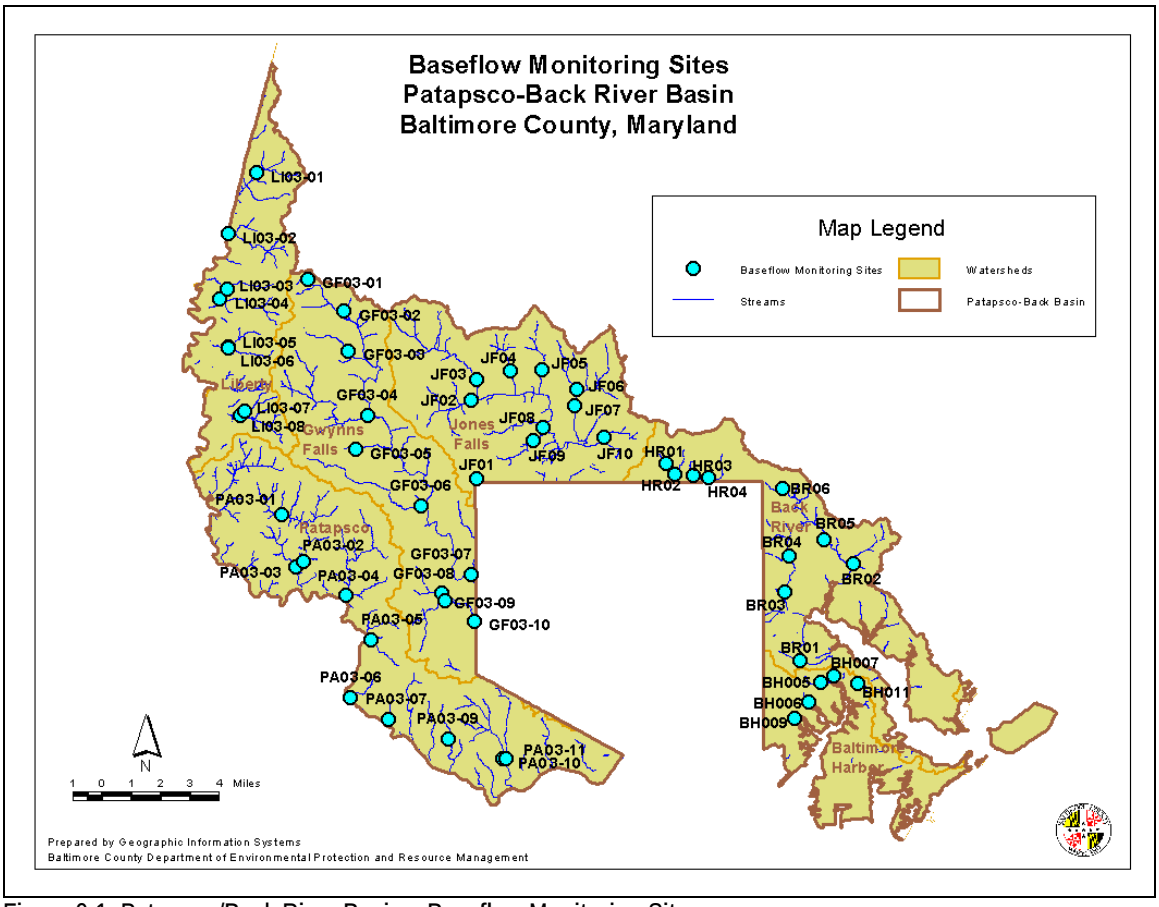

Figure 9-1: Patapsco/Back River Basin – Baseflow Monitoring Sites

The design will allow determination of ambient water quality for major portions of each watershed. The two-year sampling cycle will allow an analysis of baseflow water quality trends for the pollutant parameters analyzed.

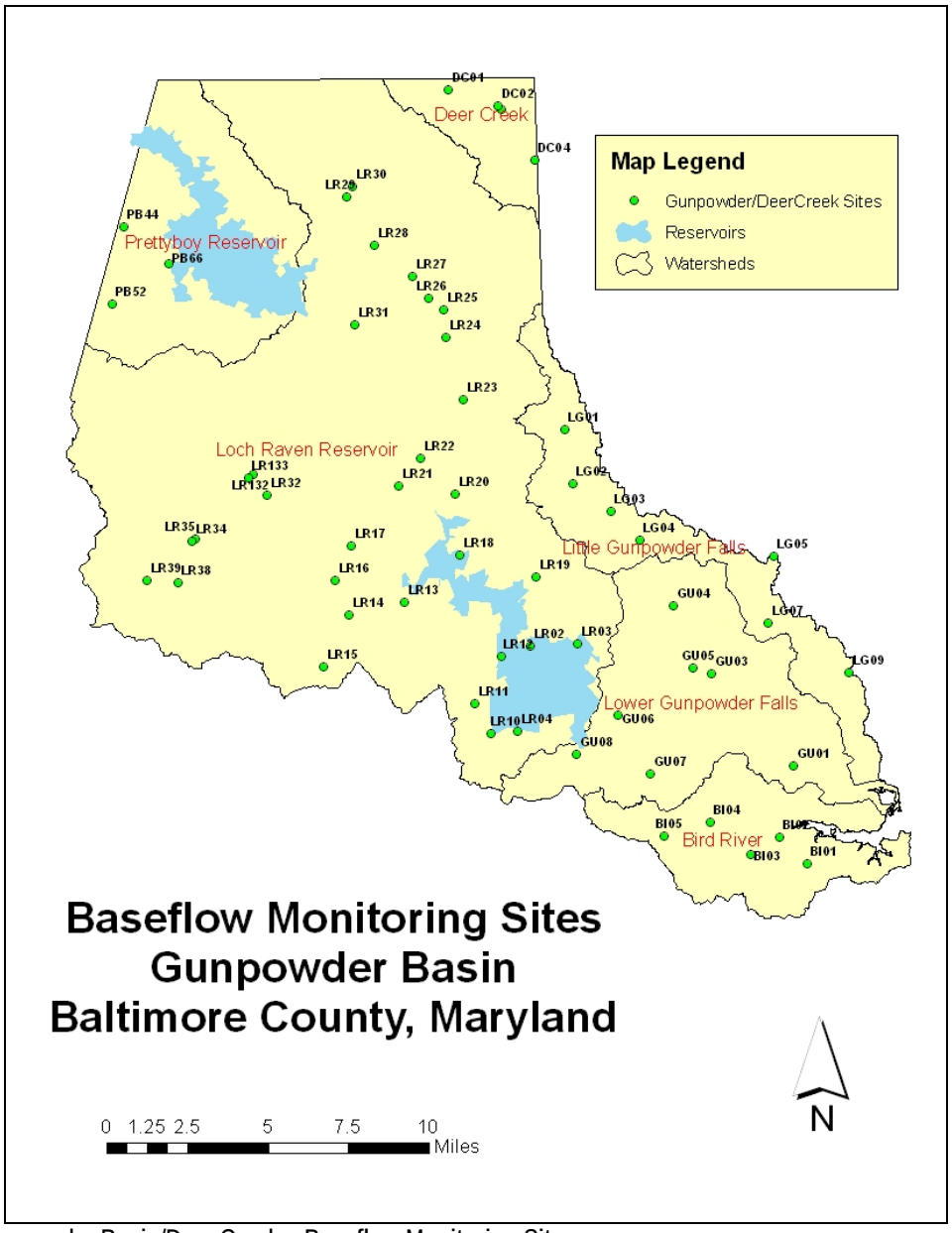

Figure 9-2: Gunpowder Basin/Deer Creek – Baseflow Monitoring Sites

A total of 98 baseflow samples were collected in the Gunpowder/Deer Creek in 2006. The number of samples per site varied from one to three, with the majority of the sites falling in the range of one to two samples per site. In addition to the baseflow samples, 20 field blanks and 14 duplicate samples were collected. The mean, number of samples and the standard deviation for each site are presented at the end of this section in Appendix 10-2 for each parameter analyzed.

A frequency analysis was conducted on the metals data to determine exceedance of water quality criteria. Figure 9-3 displays the frequency distribution for both total copper and dissolved copper. Maryland Department of the Environment water quality criteria were used. Approximately 28% of the total copper samples exceeded the chronic criteria and 23% of the samples exceeded the acute criteria for aquatic life. The standards are based on dissolved metals.

For dissolved copper, 19% of the samples exceeded the chronic standard and none exceeded the acute criteria. The sample results for zinc indicated it do not exceed the water quality standards in baseflow samples. Cadmium exceeded the chronic standard (.00025 mg/L) once for total metals and once for dissolved metals. Lead exceeded the chronic standard (.0025 mg/L) twice for total metals.

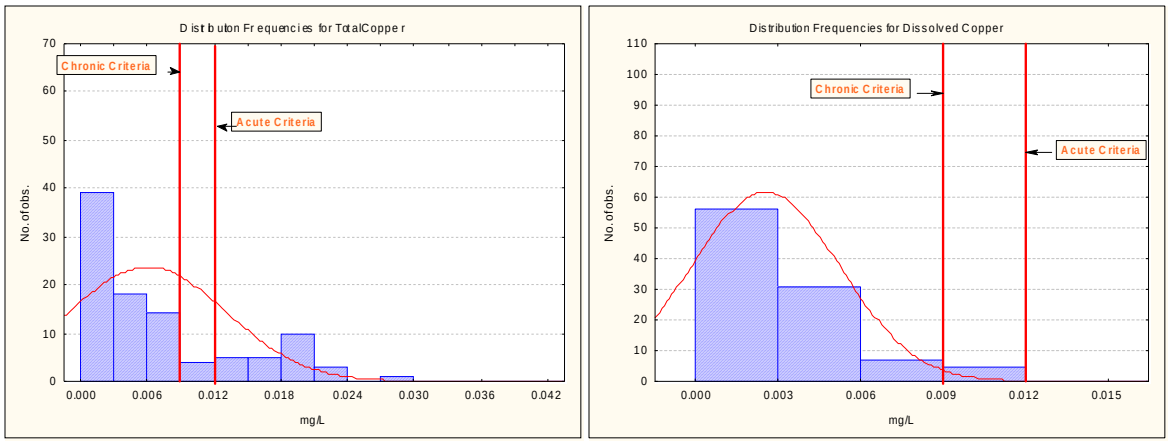

Figure 9-3: Frequency distributions by concentration for Total Copper and Dissolved Copper for the 2006 Gunpowder/Deer Creek samples.

The baseflow data collected in 2006 were analyzed for differences in concentration for each pollutant between the six watersheds sampled. ANOVA and Duncan's Multiple Range tests were used to examine relationships among the watersheds. The results are displayed in Table 9-1. The results of the Duncan's Multiple Range Test are displayed with the watersheds having the highest concentrations to the left and progressing in order to the lowest concentrations on the right. The watersheds joined by the same line are not significantly different.

Table 9-1: Baseflow Pollutant ANOVA and Duncan's Multiple Range Test Results

Pollutant Parameter	df Effect	Df Error	F	P
pH	5	72	2.08	<.05
TSS	5	92	2.13	NS
TS	5	92	.20	NS
TKN	5	92	8.38	<.001
Nitrate/Nitrite	5	92	14.64	<.001
TP	5	92	2.41	<.05
Cadmium	5	92	.143	NS
Dissolved Cadmium	5	92	.143	NS
Total Copper	5	92	9.07	<.001
Dissolved Copper	5	92	3.38	<.01
Lead	5	92	68.9	<.001
Zinc	5	92	8.95	<.001
Dissolved Zinc	5	92	6.97	<.001
BOD	5	92	2.85	<.05
COD	5	92	3.49	<.01
Chloride	5	90	5.35	<.001
Hardness	5	74	1.36	NS
Sodium	5	72	1.59	NS
TN	5	92	13.15	<.001

Duncan's Multiple Range Test

pH	DC BI LR PB GU LG
Total Kjedahl Nitrogen (TKN)	BI GU PB DC LR LG
Nitrate/Nitrite	PB DC LG GU LR BI
Total Phosphorus (TP)	GU BI DC LR LG PB
Total Copper	GU LG LR PB BI DC
Dissolved Copper	GU LG LR BI PB DC
Total Lead	GU BI LG DC LR PB
Total Zinc	BI DC GU LR PB LG
Dissolved Zinc	BI DC LR GU PB LG
Chemical Oxygen Demand (COD)	BI LR GU DC PB LG
Biological Oxygen Demand (BOD)	GU LR DC BI LG PB
Chloride	BI GU LR LG PB DC
Total Nitrogen (TN)	PB DC LG GU LR BI

The concentrations of twelve parameters were found to differ significantly between watersheds. The Lower Gunpowder Falls and Bird River watersheds had the highest concentrations for eleven of the parameters, including Total Kjedahl Nitrogen, Total Phosphorus, Total and Dissolved Copper, Total Lead, Total and Dissolved Zinc, COD, BOD, and Chloride. The Deer Creek watershed was highest in pH and Total Nitrogen, while the Prettyboy Reservoir was highest in Nitrate/Nitrite. In contrast, the Little Gunpowder Falls exhibited low concentrations for five of the pollutants: pH, TKN, Total and Dissolved Zinc and COD. Figure 9-4 displays the results of the Duncan's Multiple Range Test for TKN, Total Phosphorus, Dissolved Copper, and Chlorides.

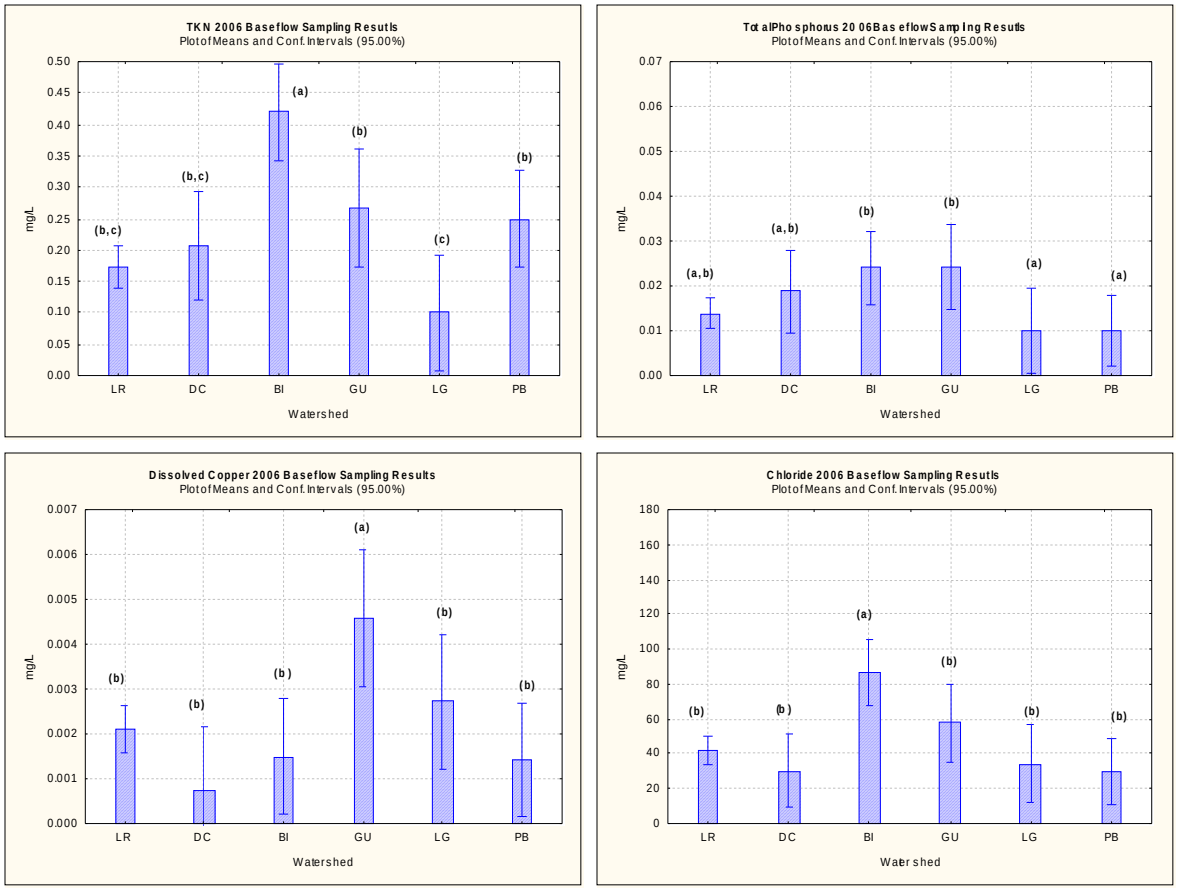

Figure 9-4: Duncan's Multiple Range Test results for TKN, Total Phosphorus, Dissolved Copper, and Chlorides.

Figure 9-5 displays the results for Dissolved Copper, Nitrate/Nitrite, Chloride, and Dissolved Lead, as these are pollutants of major concern.

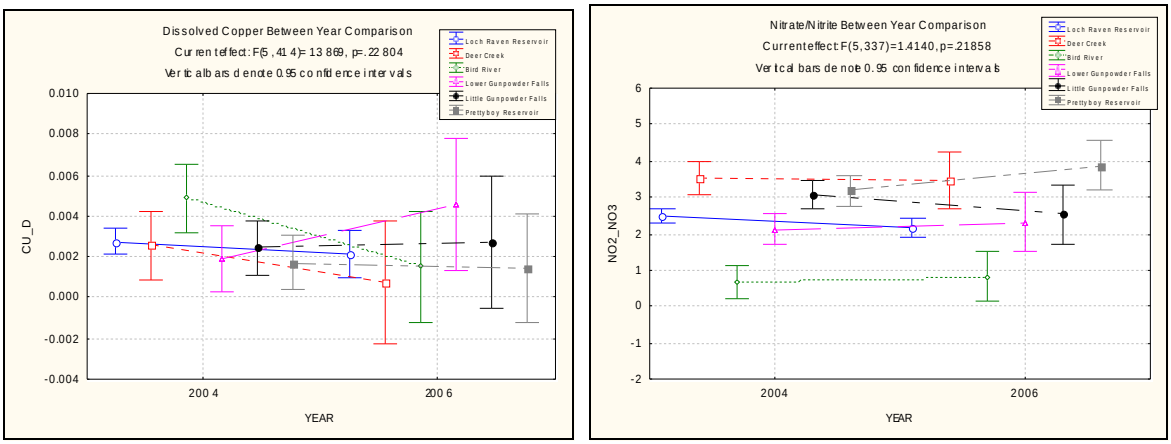

Figure 9-5: Baseflow Dissolved Copper, Nitrate/Nitrite, Chloride, and Dissolved Lead for sampling years 2004 and 2006.

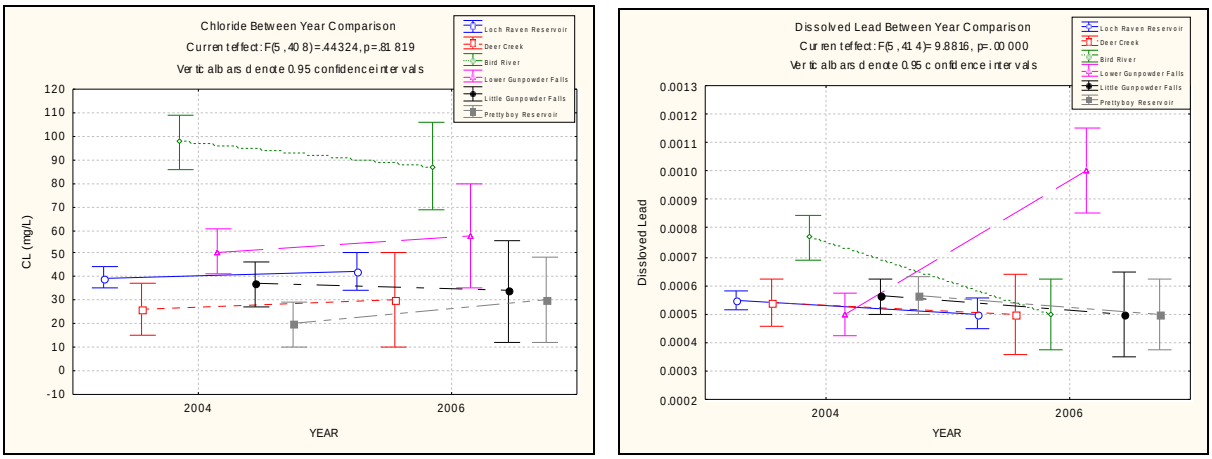

Figure 9-5: Baseflow Dissolved Copper, Nitrate/Nitrite, Chloride, and Dissolved Lead for sampling years 2004 and 2006 (continued).

The 95% confidence intervals for sampling year 2006 are relatively large for all watersheds for Dissolved Copper, Nitrate/Nitrite, Chloride, and Dissolved Lead, in comparison with 2004. The Lower Gunpowder Falls and was the only watershed to show a decrease in dissolved copper. Nitrate/Nitrite only had a slight increase in the Bird River, Prettyboy Reservoir and Lower Gunpowder Falls. Chlorides decreased in Bird River and Little Gunpowder Falls. Dissolved Lead increased dramatically in the Lower Gunpowder Falls. The large confidence intervals in 2006 cannot be explained by rainfall amounts, since the totals were the same for each year (41.94 inches). Different sample sizes for each watershed may explain the large confidence intervals.

Two map displays showing the Total Nitrogen and Total Phosphorus mean concentrations are shown in Figures 9-6 and 9-7 on the following two pages. As can be seen from Figure 9-6, the highest concentrations of Total Nitrogen predominate in the agricultural portions of the County. These increased Total Nitrogen concentrations may be the result of agricultural activities, septic system inputs, or a combination of both. The upper Gwynns Falls, a predominately urban area shows high values of Total Nitrogen, while several other urban areas, scattered in the various watersheds, show elevated Total Nitrogen concentrations.

The distribution of Total Phosphorus concentrations conversely shows elevated to very high concentrations predominately in the urban areas, with several notable exceptions, including upper Lower Gunpowder Falls, and the rural portion of the Patapsco River and Loch Raven watersheds. The majority of Total Phosphorus is delivered during storm events, associated with sediment. Thus the concentrations measured in baseflow sampling are much lower than during storm event sampling. The elevated concentrations in the urban areas are likely the result of increases in orthophosphate, which occurs in a dissolved form. The source is currently not known, but may be associated with sewage and various industrial processes. The elevated and very high concentrations in rural areas may be associated with animal operations where livestock have access to the stream.

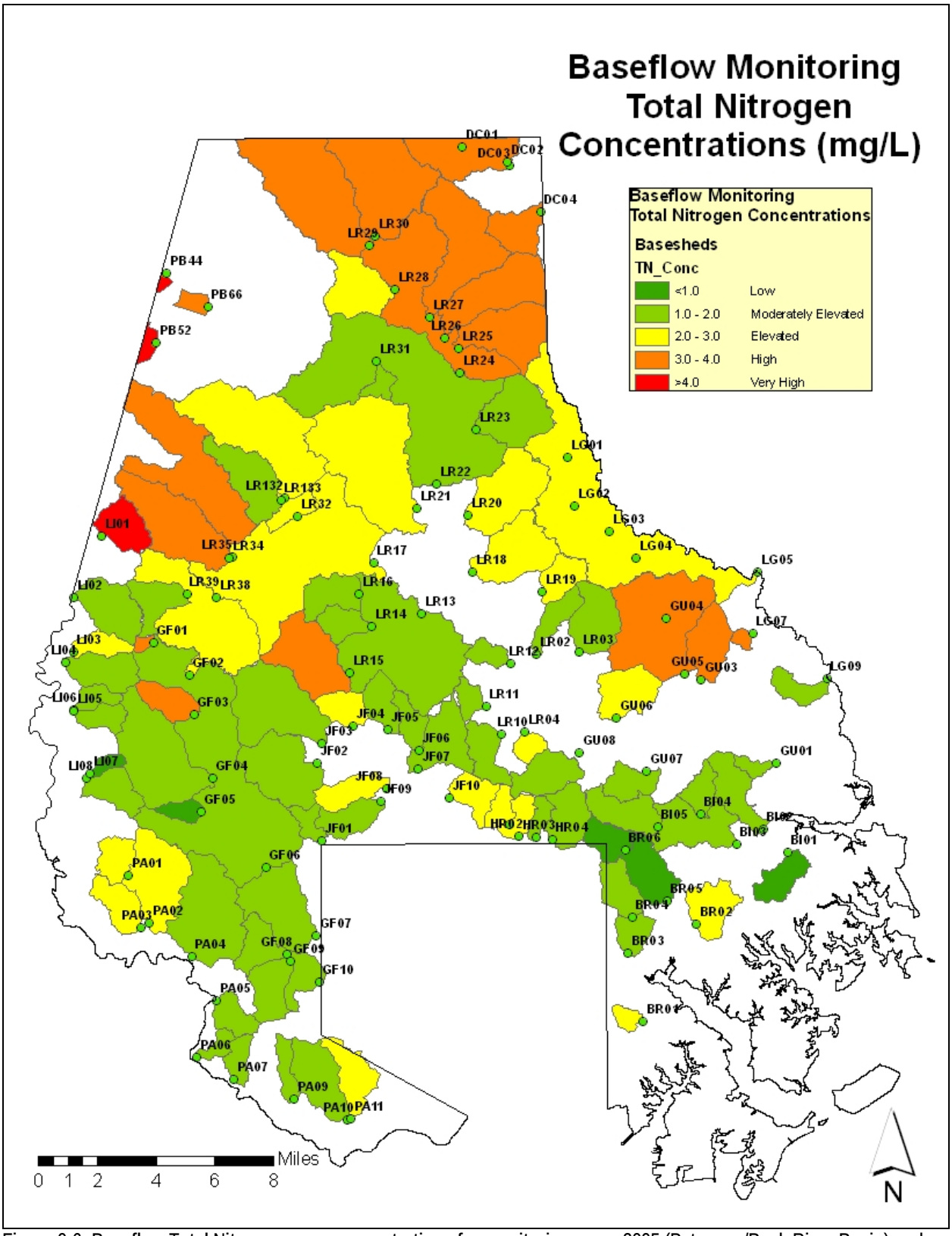

Figure 9-6: Baseflow Total Nitrogen mean concentrations for monitoring years 2005 (Patpasco/Back River Basin) and 2006 (Gunpowder Basin). **PB26, PB28, PB33, PB43, and PB54 not shown on map. They were part of the Prettyboy Reservoir Watershed Restoration Strategy project and located outside the county.

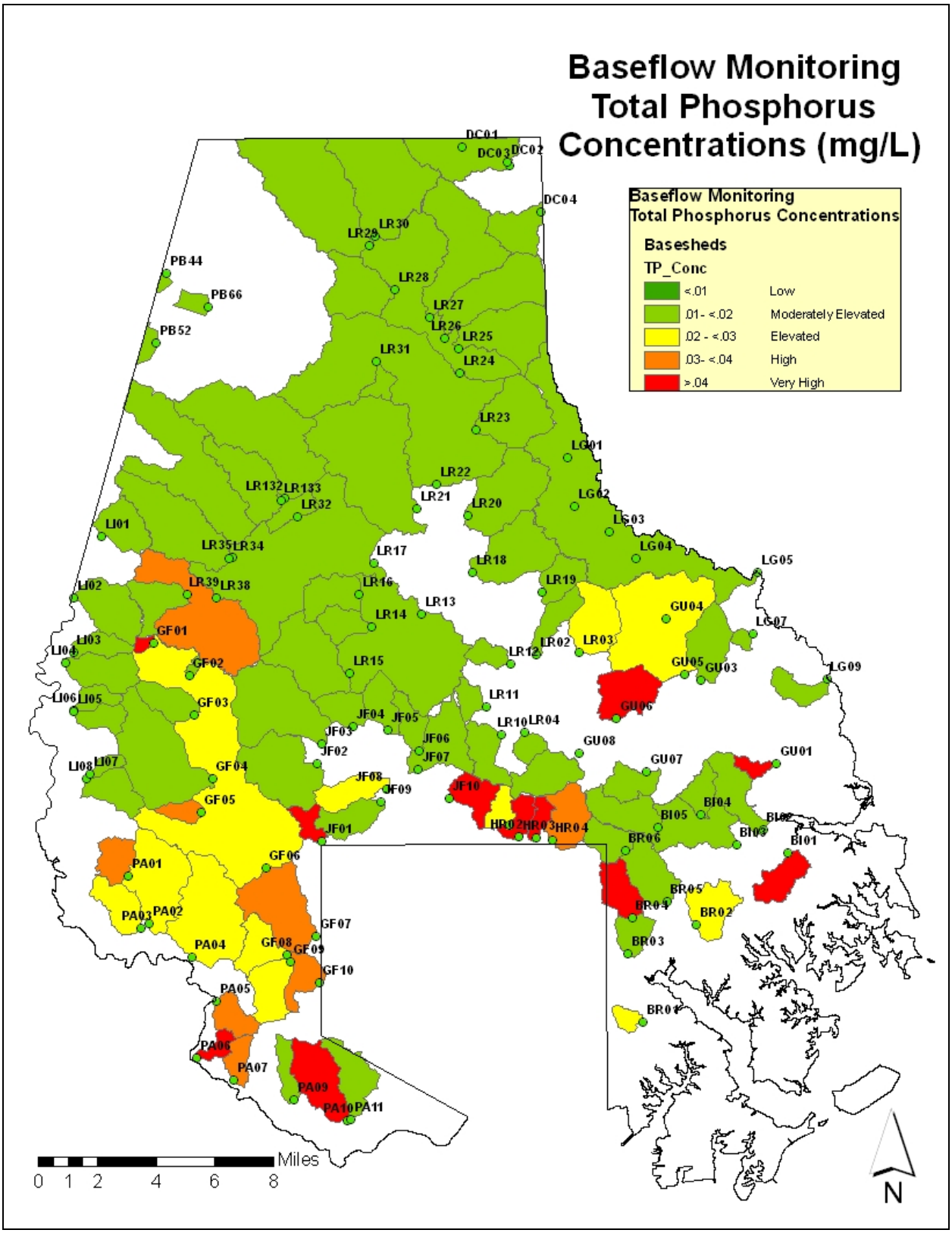

Figure 9-7: Baseflow Total Phosphorus mean concentrations for monitoring years 2005 (Patpasco/Back River Basin) and 2006 (Gunpowder Basin). **PB26, PB28, PB33, PB43, and PB54 not shown on map. They were part of the Prettyboy Reservoir Watershed Restoration Strategy project and located outside the county.

9.2.2 Tidal Waters Monitoring Program

Baltimore County has had a tidal recreational water monitoring program since 1990. The program is administered by the Department of Environmental Protection and Resource Management – Environmental Health Section. The program has historically focused on fecal coliform concentrations and recently switched to Enterococci as the bacteriological indicator. The beach swimming standard of 35 MPN is used for comparison purposes to assess the general bacteriological water quality. Fecal coliform and E. coli may be measured in the event of a sewage spill/release to provide as much information as possible to characterize the potential public health threat. Starting in 2002 surface water quality samples were obtained at seven tidal water sites representing the various major tidal basins in Baltimore County. The number of sites monitored was subsequently expanded to ten. This sampling continued in 2006. Figure 9-8 shows approximately where the water quality samples were taken. Table 9-2 provides the site codes and the tidal water body they represent.

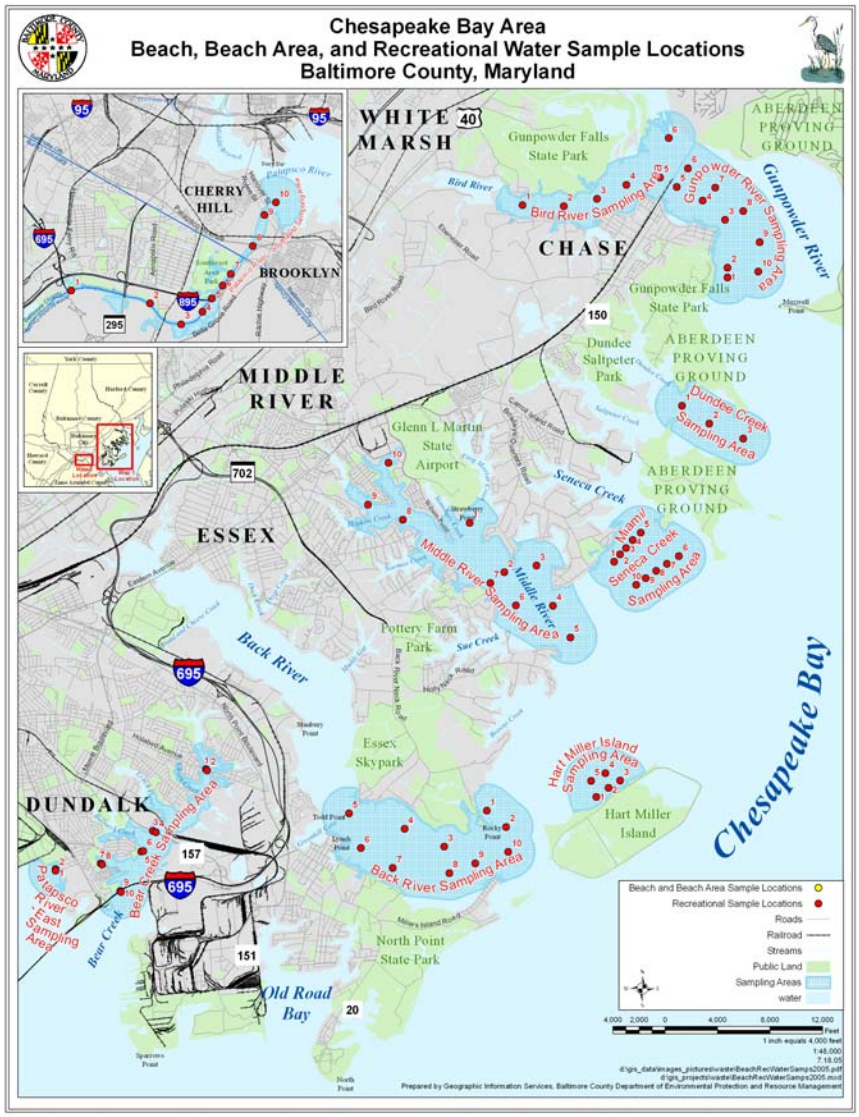

Figure 9-8: Tidal Waters Monitoring Site Locations.

Table 9-2: Site Codes and the Associated Tidal Water body

Code	Water Body
BC	Bear Creek
PR	Patapsco River - Outer
GR	Gunpowder River
MS	Miami Beach/Seneca Creek
MR	Middle River
BR	Back River
HM	Hart Miller Island
BD	Bird River
PS-F	Patapsco River – Fresh Water
PS-E	Patapsco River – Estuarine

All ten stations were monitored between fourteen and seventeen times during the time period of April 2006 through November 2006. The same standard set of pollutant parameters detailed in Section 9.1.1, were monitored in the tidal waters. The data are summarized by site in Appendix 9-3, which presents the means, number of samples and the standard deviation for each pollutant parameter presented.

An analysis of variance (ANOVA) was used for each pollutant to determine if there were significant differences between the seven sites. The results of the ANOVA are displayed in Table 9-3. If a significant difference was found a post hoc Duncan's Multiple Range Test was used to determine which sites were significantly different. The results of the Duncan's Multiple Range Test are presented at the end of Table 9-3. When interpreting the results of the Duncan's Multiple Range Test, the sites are arranged from highest concentration of the parameter to the lowest concentration. The sites that are significantly different are not joined by the same line. All statistical analyses were conducted using Statistica (Ver. 6.0).

Table 9-3: ANOVA and Duncan's Multiple Range Test Results

Pollutant Parameter	df Effect	Df Error	F	P
TSS	9	154	5.02	<.001
TS	9	154	52.55	<.001
TKN	9	144	14.45	<.001
Nitrate/Nitrite	9	146	6.55	<.001
TN	9	20	3.31	<.05
TP	9	144	19.41	<.001
Cadmium	9	148	.99	NS
Dissolved Cadmium	9	148	.99	NS
Total Copper	9	148	1.94	NS
Dissolved Copper	9	148	1.83	NS
Total Lead	9	148	2.17	<.05
Dissolved Lead	9	148	2.02	<.05
Total Zinc	9	148	1.95	<.05
Dissolved Zinc	9	148	2.18	<.05
BOD	9	154	11.3	<.001
COD	9	154	3.32	<.001
Chloride	9	154	5.81	<.001
Fluoride	9	154	1.31	<.05
Sulfate	9	154	37.43	<.001

Duncan's Multiple Range Test

Total Suspended Solids (TSS)	BC PR BD BR HM GR MS MR PS-E PS-F
Total Solids (TS)	PR BC HM MR MS BR PS-E GR BD PS-F
Chloride	PR BC HM MS MR BR PS-E GR BD PS-F
Total Kjedahl Nitrogen (TKN)	BR BD BC PS-E PR MR PS-F HM GR MS
Nitrate/Nitrite	PS-F PS-E BR BD HM PR GR BC MS MR
Total Nitrogen	PS-F PS-E BR BD BC PR MS GR HM MR
Total Phosphorus (TP)	BR BD BC GR PR PS-E HM MR MS PS-F
Total Lead	BC PR BR PS-E HM MS BD PS-F MR GR
Dissolved Lead	BC PR BR MS HM BD MR PS-E PS-F GR
Total Zinc	BC PR BR BD PS-E MS HM MR GR PS-F
Dissolved Zinc	BC PR BR HM BD PS-E MS GR MR PS-F
Biological Oxygen Demand (BOD)	BC BR BD PR MR HM PS-E GR MS PS-F
Chemical Oxygen Demand (COD)	PR BC BR MR PS-E HM MS GR BD PS-F
Fluoride	BC PR BR BD PS-E MS HM MR GR PS-F
Sulfate	BC PR BR BD PS-E MS HM MR GR PS-F

Sampling results for 2006 indicated that fifteen of the parameters (TSS, TS, chlorides, TKN, Nitrate/nitrite, Total Nitrogen, TP, Total Lead, Dissolved Lead, Total Zinc, Dissolved Zinc,

BOD, COD, Fluoride, and Sulfate had mean concentrations that differed among sites. Three additional sites (BD, PS-F, and PS-E) were added to the analysis last year.

There were few changes in the relative ranking of the sites from highest to lowest between years for the fifteen parameters that were found to have a significant difference among sites. Both the TS and chloride parameters for the Patapsco River (PR) and Bear Creek (BC) sites had the highest concentrations. This would indicate that these sites had the highest mean salinity. Back River (BR), again, had significantly higher TKN concentrations than the other nine sites. This is probably due to the presence of the Back River WWTP. BD (Bird River) and BC (Bear Creek) also have relatively high TKN concentrations and were joined by PS-E (Patapsco River – Estuarine). This may also be related to the relatively poorer connection with open bay waters and the presence of algal populations, which would increase the organic nitrogen concentration. Nitrate/nitrite concentrations were found to differ among sites with the PS-F (Pataspco River – Fresh) exhibiting significantly higher concentrations than all the other sites. Total Nitrogen (TKN + Nitrate/nitrite nitrogen) was found to vary among sites with site PS-F having the highest concentration and MR (Middle River) having the lowest. Total Phosphorus mean concentrations displayed a different pattern than Total Nitrogen with BR (Back River) having the highest concentration and PS-F dropping to the lowest concentration. The presence of the Back River WWTP could account for the elevated concentrations of Total Phosphorus. Middle River rose from the lowest concentration last year to the eighth place spot this year.

The Bear Creek (BC) site had the highest mean concentration of total and dissolved lead and total and dissolved zinc. This site along with the Patapsco River (PR), Back River (BR), and Patapsco River – Estuarine (PS-E) have significant amounts of industrial activity in the watershed, which may account for the relatively higher metal concentrations.

Bear Creek (BC) followed by the Back River (BR), Bird River (BD), and Patapsco River (PR) sites had significantly higher biological oxygen demand than the other six sites. All four of these sites had elevated TKN levels. This could indicate that all four sites had a greater algal population than the other sites. This would result in an increase in the biological oxygen demand. The Patapsco River (PR), Back River (BR), and Bear Creek (BC) all had the highest concentrations for COD, Fluoride, and Sulfate.

A graphical comparison between years for site and select pollutants was conducted. Bird River (BD), PS-F (Pataspco River – Fresh), and PS-E (Patapsco River – Estuarine) were excluded because there is only two years of data. The results are presented in Figure 9-9.

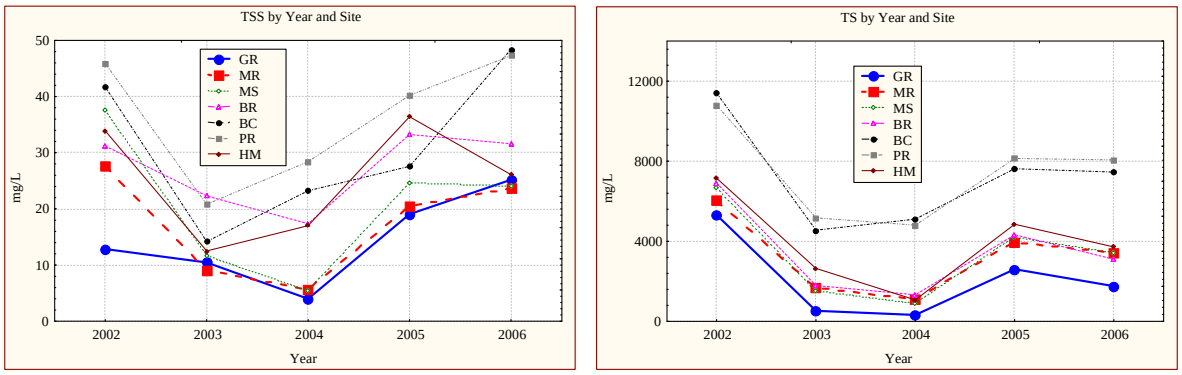

Figure 9-9: Pollutant Between Year Variation by Site

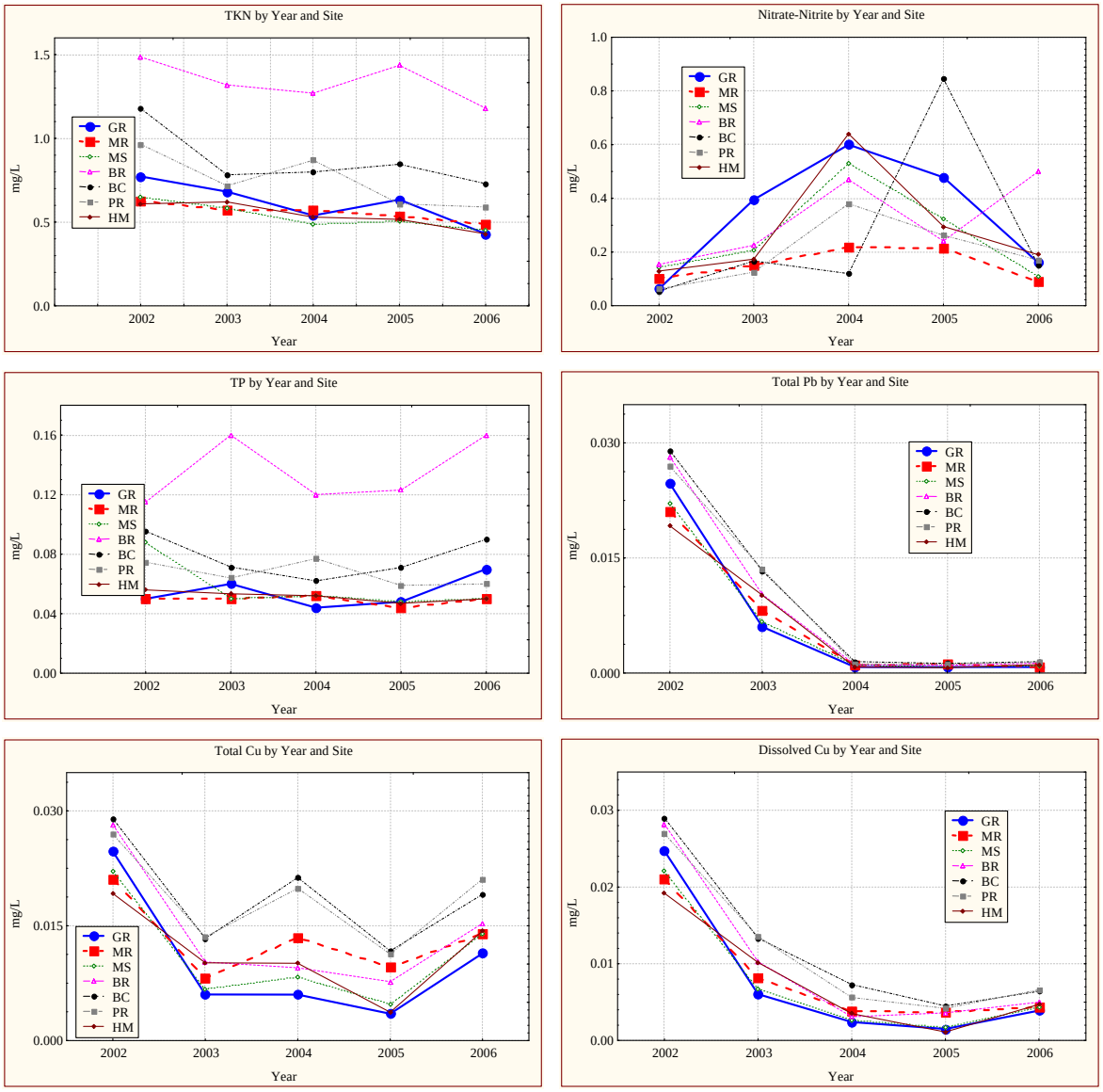

Figure 9-9: Pollutant Between Year Variation by Site (continued).

For Total Suspended Solids (TSS) and Total Solids (TS), as well as metals (represented by copper and lead) a noted decrease in concentrations for all sites can be noted between 2002 and 2003. In 2004 these Total Solids had approximately the same concentration as in 2003. The TS increased in 2005 and then fell slightly last year. TSS and Total Copper had some sites with a slight increase in concentration and some with a slight decrease in 2004 relative to 2003; however, in 2005 all sites exhibited an increase in TSS concentrations while at the same time displaying a decrease in Total Copper concentrations. This year both TSS and Total Copper increased greatly. Dissolved Copper and Total Lead continued to decrease in 2004 and 2005. Dissolved Copper increased slightly and Total Lead held steady in 2006. The TS reduction between 2002 and 2003 is undoubtedly related to the reduced salinity that resulted from the increased runoff. In 2004 the annual rainfall (45.67 inches), while still above the long-term average was much less than in 2003 (62.66 inches). The rainfall in 2004 was 41.94 and 49.13 in 2005 and the TS increased whereas it should have decreased due to more precipitation in 2005.

In 2006, the pattern continues with TS dropping and rainfall amount of 41.94 inches. The results from 2005 suggest that something else besides precipitation was a factor in TS levels that year. Results in 2006 rose as expected due to less rain than the previous year.

Nitrate/nitrite concentrations increased 2004 (with the exception of Bear Creek) relative to the 2003 and 2002 concentrations, but decreased in 2005 (except for the HM site). Nitrate/nitrite concentrations saw a large decrease in 2006, with the exception of Back River (BR), which increased by 48%. TKN concentrations continue to slightly decrease. Total Phosphorus concentrations have varied little over the years, however there was a slight increase in 2006.

9.3 Stream Geomorphological Monitoring

Baltimore County DEPRM performs post-project monitoring of its completed stream restoration projects in accordance with applicable federal and state waterway construction permit requirements. The field monitoring and reports are either done completely in-house or by consulting firms competent in this work. These monitoring activities also provide compliance with the NPDES permit requirement to monitor effectiveness of restoration projects.

9.3.1 Stream Restoration Project Monitoring

The U.S. Army Corps of Engineers authorization for stream restoration activity is generally required pursuant to Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act of 1899. Additionally, projects are normally eligible for authorization by the Maryland State Programmatic General Permit (MDSPGP) as published in the Special Public Notice 96-19 issued in June, 1996. For these projects, the conditions of the (MDSPGP) authorization normally require the development of a monitoring plan that will be used to identify and evaluate changes in the completed stream restoration project and to take remedial measures as necessary in coordination with the regulatory agencies. For each project, specific elements of the monitoring plan are identified as determined by the regulatory agencies. See Exhibit 5-1 of the 2003 NPDES Report for an example of an authorization document/permit and monitoring criteria. Periodic field monitoring followed by a written report of findings and any proposed remedial measures are submitted to the Army Corps of Engineers, Maryland Section Northern and to the Maryland Department of the Environment (MDE) Non-Tidal Wetland and Waterways Division as called for in the monitoring plans. Monitoring is also utilized to determine if the capital project implementation meets the goals of the project. Further, the DEPRM believes that the post construction monitoring program provides valuable feed-back information that enables it to improve the effectiveness of its future project design and construction approaches.

The post construction monitoring plans require periodically collecting field data – usually annually for 2 to 5 years. Additional monitoring may be required after large storms. In most cases, monumented and surveyed channel cross-sections located at strategic points along the project are required. Occasionally, longitudinal profiles are required or elected to be done by DEPRM. Field data are collected using Standard Operating Procedures for pebble counts, cross sectional surveys, and longitudinal surveys. Data from the cross-sections and longitudinal surveys are entered into a computer program and plotted. For multi-year surveys these plots are overlayed (current over prior year(s)) to detect any changes in morphology that may have occurred between these periods. Bed material characterization via. the Wolman pebble count procedure, inspection of the condition of any riparian plantings, visual inspection of the degree of channel erosion or deposition etc., and photographing the channel and banks at key locations are other components that may be included in the monitoring plan and report.

Table 9-4 summarizes the streams and stream restoration projects monitored and/or reported to the regulatory agencies in 2006 and early 2007. Copies of the completed reports submitted and listed in Table 9-4 are on file at the Maryland Department of the Environment (MDE) Non-Tidal Wetland and Waterways Division and at the DEPRM CIP Section where they are available for inspection.

Table 9-4: Summary of Capital Improvements Projects Monitoring Reports Submitted for 2006 & 2007 (mid year)

Project	Submitted	Responsible Personnel
White Marsh Run Wetland	2006 & 2007	Sub KCI
Minebank Run Stream Restoration I	2006	Biohabitats
Ben's Run Stream Restoration & Water Quality Improvements	2006	In-House WMM
Hampton Branch Stream Restoration	2006	In-House WMM
North Fork Stream Restoration	2006 & 07	KCI
Redhouse Run Stream Restoration	2006	In-House WMM
Stemmers Run Stream Restoration	2006	In-House WMM
Stemmers Run at Glenwest Stream Restoration	2006 & 2007	In-House WMM

9.3.2 Stream Stability Assessments

DEPRM is utilizing consulting assistance through a multi-year on-call contract to perform planning level stream stability assessments on various streams in Baltimore County. These assessments entail field teams who "cruise", by walking, assigned stream reaches collecting morphological, riparian, habitat quality, and other data useful in making evaluative assessments of stream condition and evidence of change. Other information will be collected related to infrastructure conflicts, pollution sources, fish blockages, etc. The stream assessments will be in support of the Small Watershed Action Plan (SWAP) process, TMDL's, and for comparison of baseline conditions and stream management/restoration needs, and for consideration of potential stream restoration projects. Two stream stability assessments have been completed to date; *Hunt Valley Area O Stream Stability Assessment* and *Prettyboy Reservoir Stream Stability Assessment (Compass Run and Frog Hollow Subwatersheds)*. An electronic copy of these reports was submitted with the NPDES 2006 Annual Report. These assessments have identified potential restoration projects by category, including:

- Stream restoration/stabilization,
- Buffer enhancement,
- Bank plantings,
- Utility conflict resolution,
- Habitat enhancement,
- Trash cleanup,
- Yard waste cleanup, and
- Invasive species removal.

Stream Stability Assessments are currently underway in support of the Lower Jones Falls and the Upper Back River Small Watershed Action Plans. It is anticipated that the reports will be finalized in the fall of 2007. Electronic copies will be submitted with next years report.

9.3.3 Geomorphological Monitoring Summary

In summarizing the results of the in-house monitoring completed through 2006 and mid year 2007, it can be stated that the stream restoration projects have been successful in achieving the goals of self-maintaining channel stability, reduction of bed and bank erosion, protection of

private and public infrastructure, and habitat improvement. Improvements in aesthetics and public safety aspects have been additional benefits. Most of the problems observed have been localized and minor in scale such as shifting of rock elements in grade control structures, bank scouring at the downstream end of bank protection structures, depositional bar build-up in the vicinity of grade control structures, and channel erosion at intra project segments that were not restored or modified during the overall project. The information gained from the monitoring has enabled DEPRM to improve its stream restoration approaches such as increasing the size of the rock elements in grade control structures subject to high tractive forces, and more closely relating the height of bank protection structures to bank full elevation. The challenges of effective stream improvement in an urban setting are formidable. Through the knowledge and experience gained with its design, construction, and monitoring efforts, DEPRM continues to build upon a successful stream restoration program.

9.4 Biological Monitoring

In addition to the biological monitoring required at Scotts Level Branch under Baltimore County's NPDES permit, the County has four additional biological monitoring programs. These programs use the biological community to assess the ecological health of the streams within the County (Probabilistic Monitoring Program, Section 9.4.1), assess the effectiveness of stream restoration projects (CIP Monitoring Program, Section 9.4.2), provide data on the best streams in Baltimore County to serve as bench marks for other stream assessments (Reference Site Monitoring Program, Section 9.4.3), and assess Submerged Aquatic Vegetation (Submerged Aquatic Vegetation (SAV) Monitoring Program, Section 9.4.4). The first three programs use assessments based on the benthic macroinvertebrate community and, in some cases, the fish assemblage. It is widely accepted that the biological community of streams is sensitive to anthropogenic perturbations. By monitoring the biological community, the County can assess the amount of change due to anthropogenic activities and the benefit of stream restoration to stream organisms. The SAV Monitoring Program provides an assessment of the coverage of SAV and progress made in meeting the new water quality standards for water clarity and SAV coverage in Baltimore County tidal waters.

9.4.1 Probabilistic Monitoring

The County adopted Maryland Biological Stream Survey (MBSS) methodologies in 2003, which has allowed for direct comparisons with State generated data. This has expanded upon the available data for assessing County waters. Probabilistic monitoring (randomly selected monitoring sites) has allowed statistically valid statements regarding the state of the waters. Using the targeted site monitoring design, as was conducted previously by Save Our Streams (SOS), did not allow for statistical analysis or direct data comparability with the State.

The County has contracted a consultant to perform the probabilistic monitoring. Each year a different basin is sampled, with the Patapsco/Back River Basin monitored in odd years and the Gunpowder River Basin and Deer Creek watersheds monitored in the even years. One hundred sites are selected at random for each year's sampling effort. The contractor samples these 100 sites during the spring index period, March 1 to April 30, for macroinvertebrates using the MBSS protocols. These samples are sub-sampled to 100 organisms and identified to Genus or the lowest possible taxonomic level. A Benthic Index of Biotic Integrity (BIBI) is calculated. The BIBI describes the biological condition of the streams in the County. Starting in the 2006 sampling season, a subset of previously sampled sites was selected to serve as sentinel sites. The

sites selected will be those random sites that were located towards the base of major subwatersheds. No more than 25 sentinel sites will be selected per basin. The sentinel sites will be used to monitor biological condition over a range of watershed and stream conditions.

The current BIBI uses six metrics. These six metrics, what they measure and the expected response to stressors are displayed in Table 9-5.

Table 9-5: BIBI Metrics

BIBI Metric	Metric Measure	Expected Response
Number of Taxa	Species Richness	Decrease
Number of EPT	Species Richness	Decrease
Number of Ephemeroptera	Species Richness	Decrease
Percent Intolerant to Urban	Tolerance/Intolerance	Decrease
Percent Chironomidae	Taxonomic Composition	Increase
Percent Clingers	Habit	Decrease

The results for each site from the 2006 probabilistic monitoring are displayed in Appendix 9-4 at the end of this section. The sites are grouped by 8-digit and 12-digit watershed, along with their respective BIBI and condition rating. The sites are assigned condition ratings based on the BIBI scores, with 1.00 – 1.99 being "Very Poor," 2.00 – 2.99 being "Poor," 3.00 – 3.99 being "Fair," and 4.00 – 5.00 being "Good." Figure 9-10 displays the site condition by color code for each of the 192 sites sampled in 2003 and 2004, and Figure 9-11 displays the site condition by color code for the 200 sites sampled in 2005 and 2006.

Table 9-6 shows the results, by watershed, as the percentage of sites within each BIBI range. The Patapsco/Back River Basin data suggest an improvement in biological condition. Sites within the Good and Fair categories increased from 15% in 2003 to 35% in 2005. This may be the result of natural stress from the drought of 2002 and record wet year of 2003, with a subsequent recovery in 2005. With the exception of Back River, the percentage of sites in the Fair and Good categories increased between 2003 and 2005 (Table 9-7). Liberty Reservoir had the highest percentage of Fair and Good sites (64%), followed by Jones Falls (52%).

The 2004 and 2006 sampling results for the Gunpowder Basin/Deer Creek watersheds indicated a decrease in water quality. In 2004, 79% of sites were in the Fair and Good categories, while in 2006 only 66% of sites rated Fair and Good. The biological condition of Baltimore County streams was better in the Gunpowder River/Deer Creek watersheds than in Patapsco/Back River. Gunpowder River/Deer Creek streams had higher percentages of sites rated Fair and Good, and Patapsco/Back River had higher percentages of streams rated Very Poor and Poor. This is likely a reflection of higher population density and greater development pressure in Patapsco/Back River.

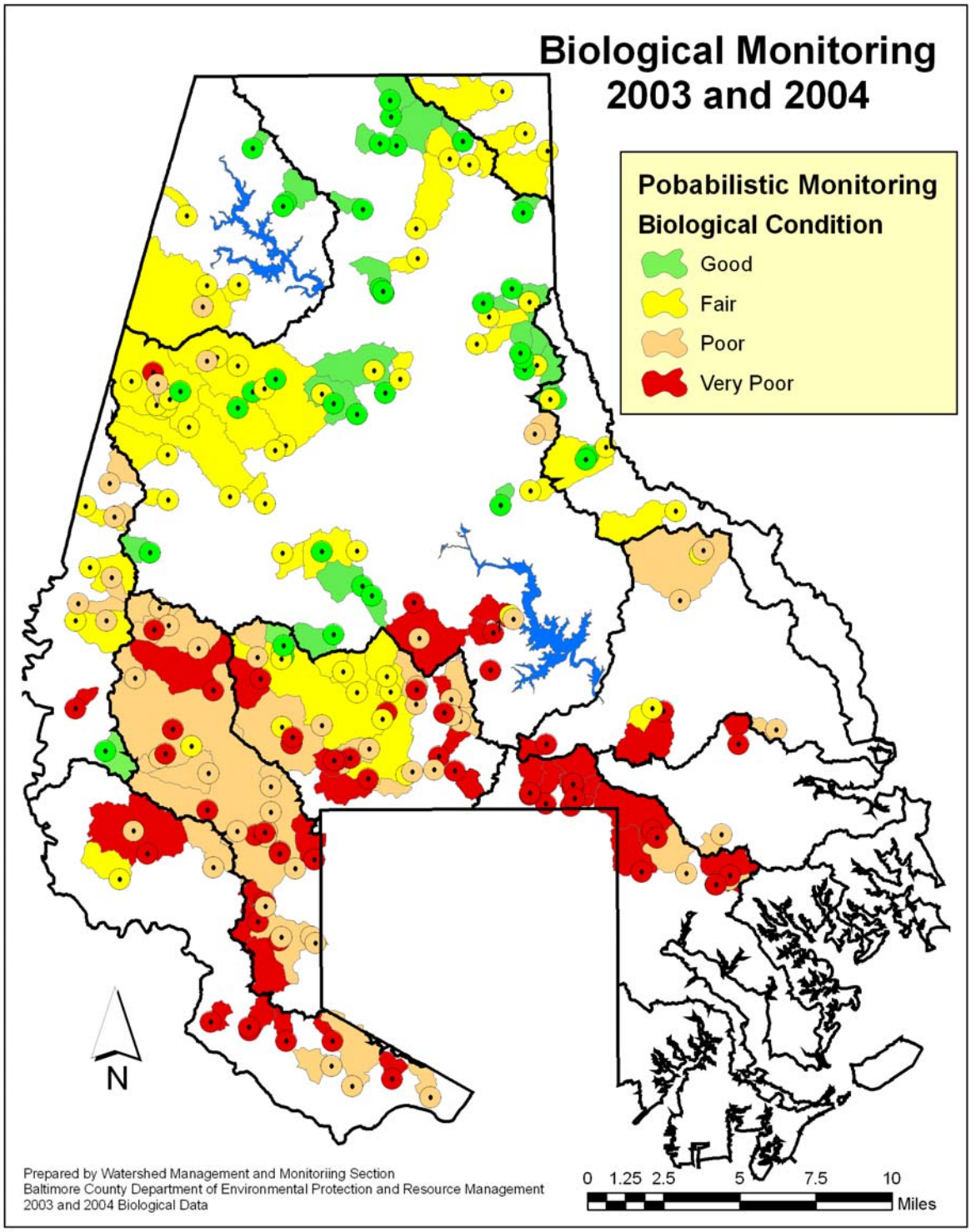

Figure 9-10: Probabilistic Biological Monitoring results for 2003 and 2004.

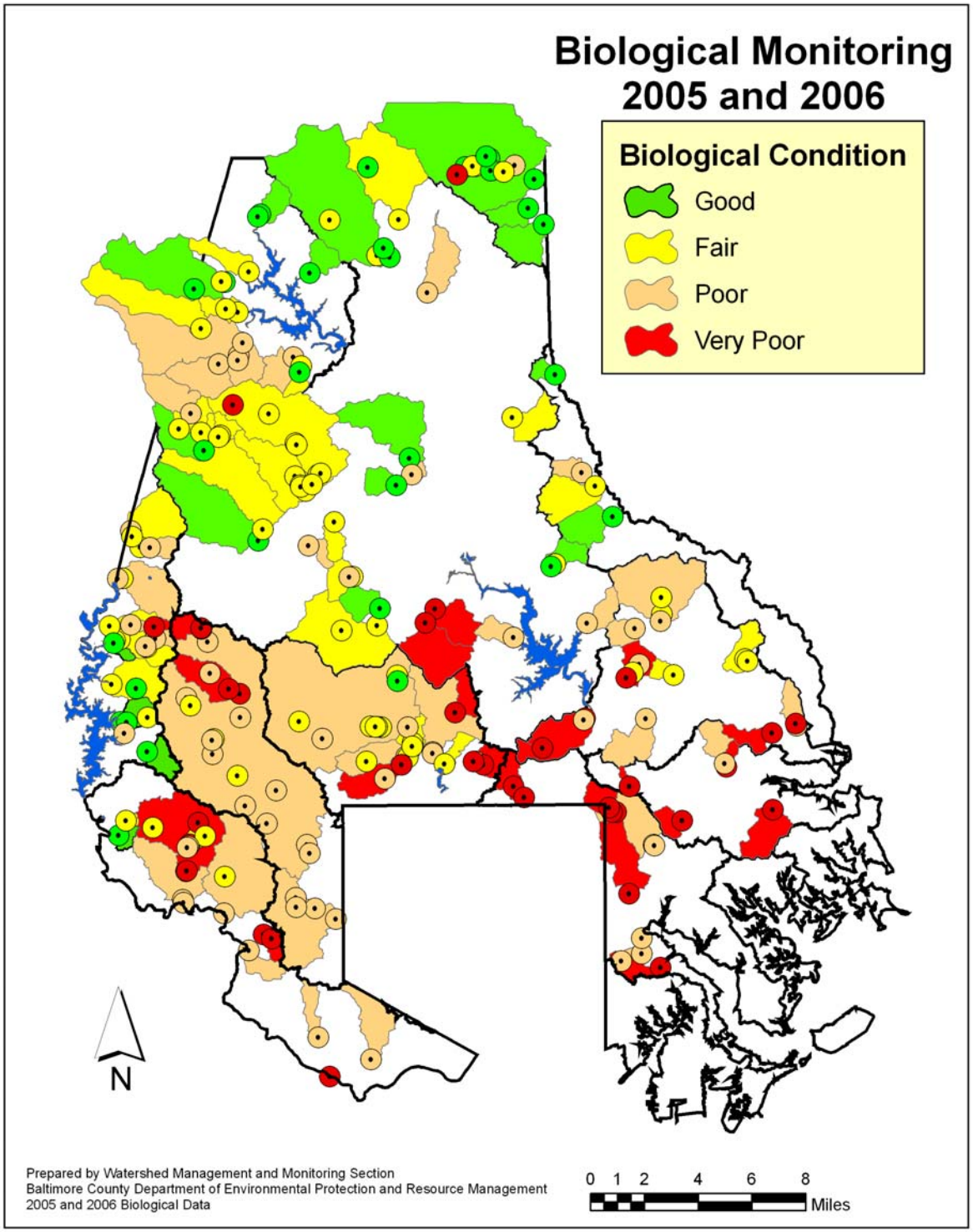

Figure 9-11: Probabilistic Biological Monitoring results for 2005 and 2006.

Table 9-6: BIBI Score Distribution by Watershed (% by Category)

Watershed	N	1.00-1.99 Very Poor	2.00-2.99 Poor	3.00-3.99 Fair	4.00-5.00 Good
Patapsco/Back River Basin – Sampled in 2003					
Liberty Reservoir	10	10	50	30	10
Patapsco River	13	54	46	0	0
Gwynns Falls	30	43	53	3	0
Jones Falls	32	38	31	25	6
Back River	15	87	13	0	0
Total	**100**	**46**	**39**	**12**	**3**
Gunpowder River Basin/Deer Creek – Sampled in 2004					
Deer Creek	3	0	33	67	0
Prettyboy Reservoir	7	0	14	43	43
Loch Raven Res.	67	6	9	43	42
Lower Gunpowder	7	29	43	29	0
Little Gunpowder	6	0	0	50	50
Bird River	2	50	50	0	0
Total	**92**	**8**	**13**	**42**	**37**
Patapsco/Back River Basin – Sampled in 2005					
Liberty Reservoir	22	5	32	41	23
Patapsco River	21	29	43	24	4
Gwynns Falls	22	18	68	14	0
Jones Falls	23	17	30	48	4
Back River	12	58	42	0	0
Total	**100**	**22**	**43**	**28**	**7**
Gunpowder River Basin/Deer Creek – Sampled in 2006					
Deer Creek	13	8	8	31	53
Prettyboy Reservoir	17	0	30	35	35
Loch Raven Res.	44	7	16	57	20
Lower Gunpowder	17	30	35	35	0
Little Gunpowder	4	0	25	25	50
Bird River	5	80	20	0	0
Total	**100**	**13**	**21**	**42**	**24**
County Total	**392**	**22**	**29**	**31**	**18**

Table 9-7 shows the means, number of samples, and standard deviations of the BIBI scores for each watershed. The mean scores for the 2003 sampling year indicate that all Patapsco/Back River watersheds were in the Poor to Very Poor categories. In 2005, Liberty Reservoir watershed improved to a mean rating of Fair. Two watersheds (Patapsco River and Gwynns Falls) improved from Very Poor to Poor between 2003 and 2005. As explained above, this may be a result of the extended drought in 2001-2002, followed by the extremely wet year in 2003. The 2005 results may be a recovery from these naturally stressful conditions. Watersheds in the Gunpowder River and Deer Creek basins were stable. The Deer Creek, Prettyboy Reservoir, Loch Raven Reservoir, and Little Gunpowder watersheds had Fair mean BIBI scores in both 2004 and 2006. The Lower Gunpowder and Bird River had Poor and Very Poor mean BIBI scores, respectively.

Table 9-7: Means and Standard Deviations of BIBI Scores by Watershed

Watershed	Mean BIBI Score	N	Standard Deviation of Mean BIBI
Patapsco/Back River Basin – Sampled in 2003			
Liberty Reservior (LI)	2.73	10	0.89
Patapsco River (PA)	1.79	13	0.50
Gwynns Falls (GF)	1.94	30	0.42
Jones Falls (JF)	2.28	32	0.86
Back River (BR)	1.49	15	0.31
Gunpowder River Basin/Deer Creek – Sampled in 2004			
Deer Creek (DC)	3.33	3	0.33
Prettyboy Reservoir (PB)	3.62	7	0.73
Loch Raven Reservoir (LR)	3.49	67	0.73
Lower Gunpowder (GU)	2.24	7	0.63
Little Gunpowder (LG)	3.39	6	0.27
Bird River (BI)	1.67	2	0.94
Patapsco/Back River Basin – Sampled in 2005			
Liberty Reservior (LI)	3.11	22	0.69
Patapsco River (PA)	2.48	21	0.75
Gwynns Falls (GF)	2.20	22	0.49
Jones Falls (JF)	2.65	23	0.71
Back River (BR)	1.83	12	0.30
Gunpowder River Basin/Deer Creek – Sampled in 2006			
Deer Creek (DC)	3.51	13	0.81
Prettyboy Reservoir (PB)	3.39	17	0.71
Loch Raven Reservoir (LR)	3.24	44	0.76
Lower Gunpowder (GU)	2.33	17	0.87
Little Gunpowder (LG)	3.42	4	0.96
Bird River (BI)	1.47	5	0.30

The methodology developed by Maryland Department of the Environment and Maryland Department of Natural Resources to determine biological impairment of fresh water streams was used to determine the watershed condition for all three sampling years. The methodology is detailed in Appendix G at the following web site:
http://www.mde.state.md.us/assets/document/2006DRAFTList_Appendices(1).pdf

This methodology is applied to watersheds that have a minimum of 10 sampling locations. Less than 10 sampling locations in a watershed are indicated as having insufficient data to make a determination. The determination is based on the mean BIBI and the 90% confidence intervals. The results of the analysis are presented in Table 9-8.

Table 9-8: Watershed Biological Condition

Watershed	BIBI Mean	N	CL_{Lower}	CL_{Upper}	Condition
2003 Sampling Year					
Liberty	2.73	10	2.22	3.25	Inconclusive
Patapsco River	1.79	13	1.55	2.04	Impaired
Gwynns Falls	1.94	30	1.81	2.07	Impaired
Jones Falls	2.28	32	2.02	2.54	Impaired
Back River	1.49	15	1.35	1.63	Impaired
2004 Sampling Year					
Deer Creek	3.33	3	2.77	3.90	Insufficient Data
Prettyboy	3.62	7	3.08	4.16	Insufficient Data
Loch Raven	3.49	67	3.34	3.64	Meets Criteria
Lower Gunpowder	2.24	7	1.78	2.70	Insufficient Data
Little Gunpowder	3.89	6	3.66	4.11	Insufficient Data
Bird River	1.67	2	-2.54	5.88	Insufficient Data
2005 Sampling Year					
Liberty	3.11	22	2.85	3.36	Inconclusive
Patapsco River	2.48	21	2.20	2.76	Impaired
Gwynns Falls	2.20	22	2.02	2.37	Impaired
Jones Falls	2.65	23	2.40	2.91	Impaired
Back River	1.83	12	1.68	1.99	Impaired
2006 Sampling Year					
Deer Creek	3.51	13	3.11	3.91	Meets Criteria
Prettyboy	3.39	17	3.09	3.69	Meets Criteria
Loch Raven	3.24	44	3.05	3.43	Meets Criteria
Lower Gunpowder	2.33	17	1.34	3.32	Inconclusive
Little Gunpowder	3.42	4	1.84	5.00	Insufficient Data
Bird River	1.47	5	0.98	1.96	Insufficient Data

The current results indicate that four watersheds (Patapsco River, Gwynns Falls, Jones Falls, and Back River) are impaired. The Liberty Reservoir watershed data was inconclusive for both sampling years. Combining the data for Liberty Reservoir for the two sampling years also indicated that data was inconclusive in determining whether the watershed meets criteria or is impaired. Loch Raven Reservoir watershed met the criteria in both 2004 and 2006. Deer Creek and Prettyboy watersheds met the criteria in 2006. The balance of the watersheds had either insufficient data to make a determination or the data were inconclusive. Three watersheds are not assessed using the Biological Probabilistic Monitoring Program (Baltimore Harbor, Middle River, and Gunpowder River) due to the limited miles of free flowing streams in the watersheds.

There are 18 sentinel sites in the Patapsco/Back River drainage and 13 sentinel sites in the Gunpowder River/Deer Creek drainage. Benthic data was collected in 2003, 2004, and 2006. Figure 9-12 shows the sentinel site locations and biological condition by year. As with the probabilistic monitoring, the biological condition of sentinel sites in the Gunpowder River/Deer Creek drainage was generally better than the biological condition of sentinel sites in the Patapsco/Back River drainage. The Gunpowder River/Deer Creek had 31% and 23% of sites rated Good in 2004 and 2006, respectively, whereas the Patapsco/Back River had only 6% of sites rated Good in 2003. A more dramatic difference existed between the two drainages when comparing the percentage of sites rated Poor or Very Poor. The Patapsco/Back River had 83% of sites rated Poor or Very Poor in 2003. The Gunpowder River/Deer Creek had 31% and 46%

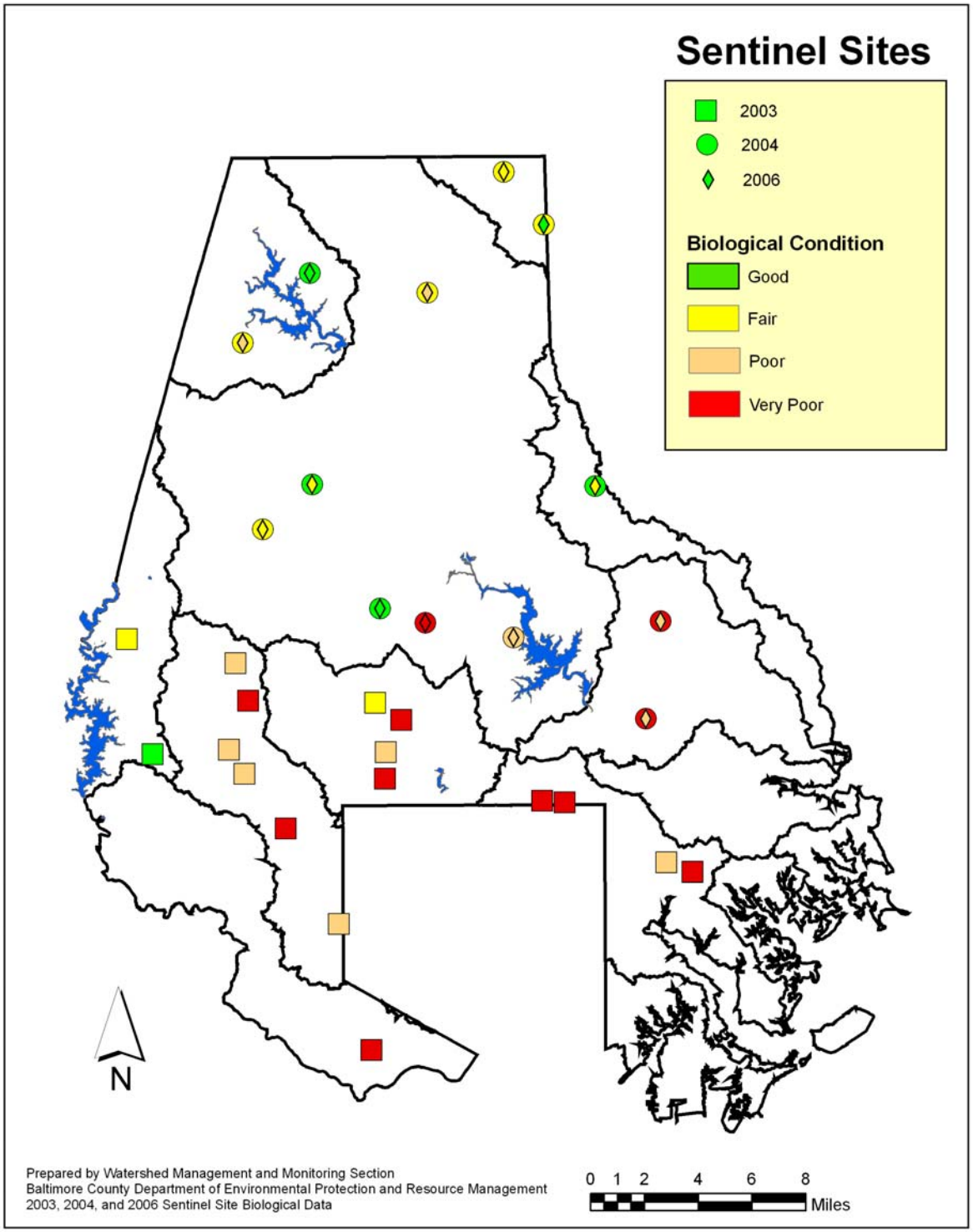

Figure 9-12: Sentinel Site Locations and Biological Condition for 2003, 2004, and 2006.

of sites rated Poor or Very Poor in 2004 and 2006, respectively. Not surprisingly, sites rated Poor or Very Poor were located in urbanized and agricultural areas. Good sites were in less populated, more forested subwatersheds. Four of the 13 Gunpowder River/Deer Creek sites (31%) decreased in biological condition between 2004 and 2006, while three sites (23%) increased in biological condition between the two years.

9.4.2 Capital Improvement Projects Monitoring

Baltimore County monitors benthic macroinvertebrate and fish assemblages in conjunction with several capital improvement stream restoration projects. Monitoring is performed in the stream segments where the restoration will take place or has taken place. The segments are monitored pre- and post-construction to document any change in the biological community. As with the Probablistic Monitoring Program, MBSS methods are followed. Stream physical habitat data are also collected during macroinvertebrate and fish surveys. Habitat assessments are based on visual ratings of instream and riparian zone characteristics that are important to stream biological communities. The Minebank Run and Woodvalley projects are currently being monitored under the Capital Improvement Projects Monitoring Program. Their ADC map locations are displayed in Table 9-9.

Table 9-9: Stream Restoration Biological Monitoring Site Locations

Station	Stream and Location	ADC Map, Grid
Minebank Run II Stream Restoration		
MNBK-1	Minebank Run upstream of Gunpowder River	28 C2
MNBK-2	Minebank Run upstream of USGS gage	28 B3
MNBK-3	Minebank Run downstream of bridge @ park	28 A4
MNBK-4	Minebank Run upstream of bridge @ park	28 A4
MNBK-5	Minebank Run behind Loch Raven High School	27 K5
MNBK-6	Minebank Run upstream of Cowpens Road	27 J5
MNBK-7	Minebank Run upstream of Glen Eagles Court	27 H6
MNBK-8	Minebank Run upstream of MNBK-7	27 H6
MNBK-9	Minebank Run downstream of Cromwell ES	27 G6
JB-1	Jennifer Branch upstream of Gunpowder River	28 J2
JB-2	Jennifer Branch near archery range	28 J3
Wood Valley Stream Restoration		
WDVL-1	Unnamed Trib to Jones Falls at Michelle Way	25 F7
WDVL-2	Unnamed Trib to Jones Falls at Gardenview Way	25 G6
WDVL-3	Unnamed Trib to Jones Falls at Evan Way	25 F6

The staff of the Watershed Management and Monitoring Section of DEPRM has conducted yearly biological assessments of the Minebank Run stream restoration project since April, 2004, at eleven sampling stations (Figure 9-13). The stream restoration was completed in 2002 (Phase I) on the reach where MNBK-6, MNBK-7, MNBK-8, and MNBK-9 are located. The stream restoration was completed in 2005 (Phase II) where MNBK-2, MNBK-3, MNBK-4, and MNBK-5 are located. Stations MNBK-1, JB-1, and JB-2 are controls. Therefore, DEPRM has collected three years of post-restoration data at the Phase I stations, and one year of pre-restoration and two years of post-restoration data at the Phase II stations.

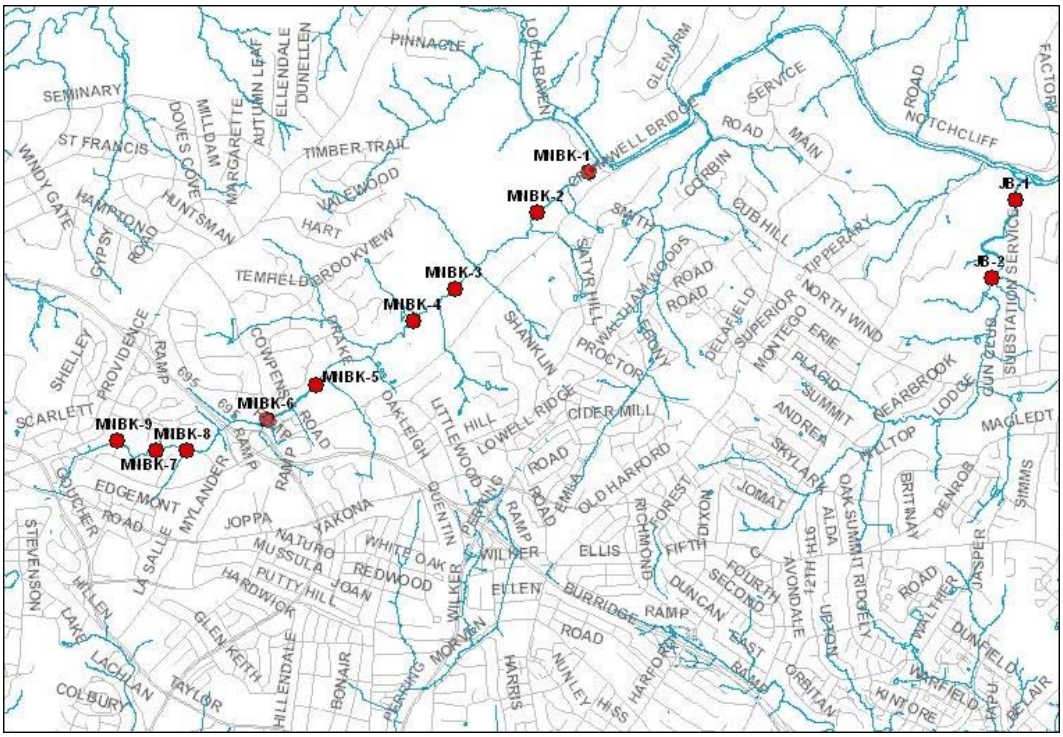

Figure 9-13. Minebank Run biological monitoring stations.

All eleven stations were sampled yearly for macroinvertebrates. Fish surveys were completed for a sub-set of the stations: MNBK-1, MNBK-2, MNBK-7, and JB-1 in 2004; MNBK-1, MNBK-7, and JB-1 in 2005; MNBK-1, MNBK-2, MNBK-4, MNBK-7, and JB-1 in 2006.

The BIBI scores were in the Poor and Very Poor condition categories (Figure 9-14). There was little apparent difference among Phase I, Phase II, and control stations, although the highest biological scores occurred in 2005 at Phase II stations. All stations support macroinvertebrate communities dominated by pollution tolerant Chironomidae. The average percentage of Chironomidae represented at all stations was 75% (range 23%-100%). Mayflies, stoneflies, and caddisflies were a very small part of all samples in all years. The average number of taxa in these orders was 2, with a range of 0-6. The fish community spanned the range of biological condition from Very Poor to Good (Figure 9-15). Several wild brown trout have been collected at MNBK-1 in all three years, and at MNBK-4 in 2006. The inflow of cold-water springs upstream of MNBK-4 maintains water temperatures suitable for trout.

The biological community is probably limited by the flow regime of Minebank Run. Field observations suggest that high storm flows scour the stream bottom cobble, which presents a harsh physical environment for organisms so reliant upon stable substrates. The flows appear to be reflected in the physical habitat scores (Appendix 9-5). Parameters that characterize habitat stability, such as instream habitat and epifaunal substrate, were generally rated marginal or sub-optimal. The high flows also make it nearly impossible for stream-bank tree plantings to become established. Riparian trees stabilize stream-banks, shade and cool the water, and provide a seasonal food source (leaves) for certain macroinvertebrates. This link between the terrestrial and aquatic environments is vital for the natural function of stream ecosystems. This biological data set represents a small time frame, and the results suggest that the Minebank Run stream system may require more time to stabilize and show improvement in biological condition.

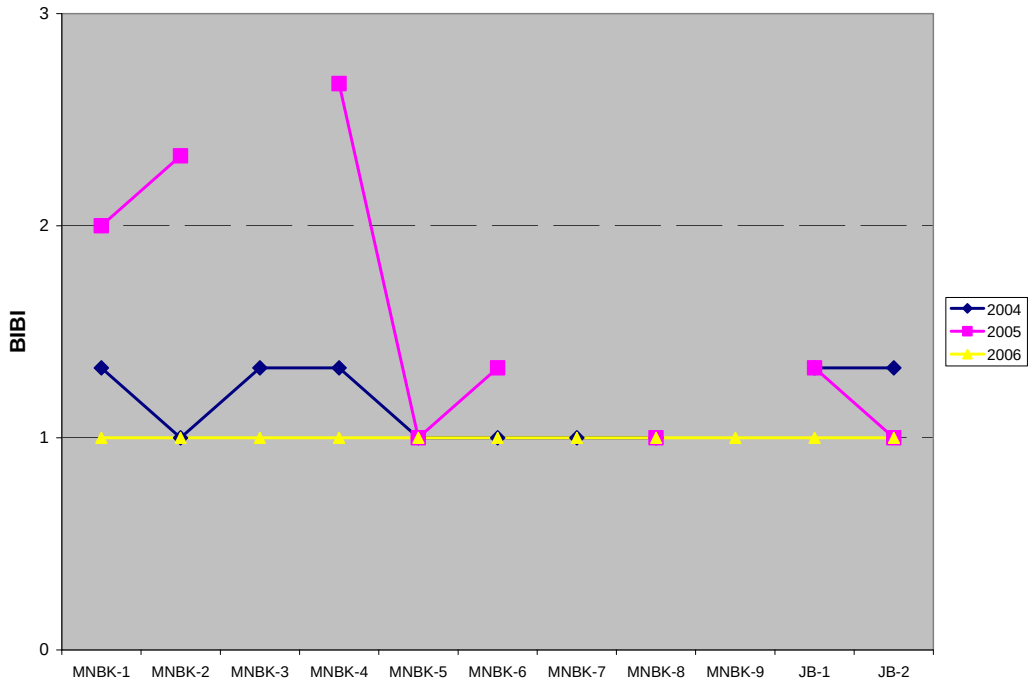

Figure 9-14. BIBI scores by year.

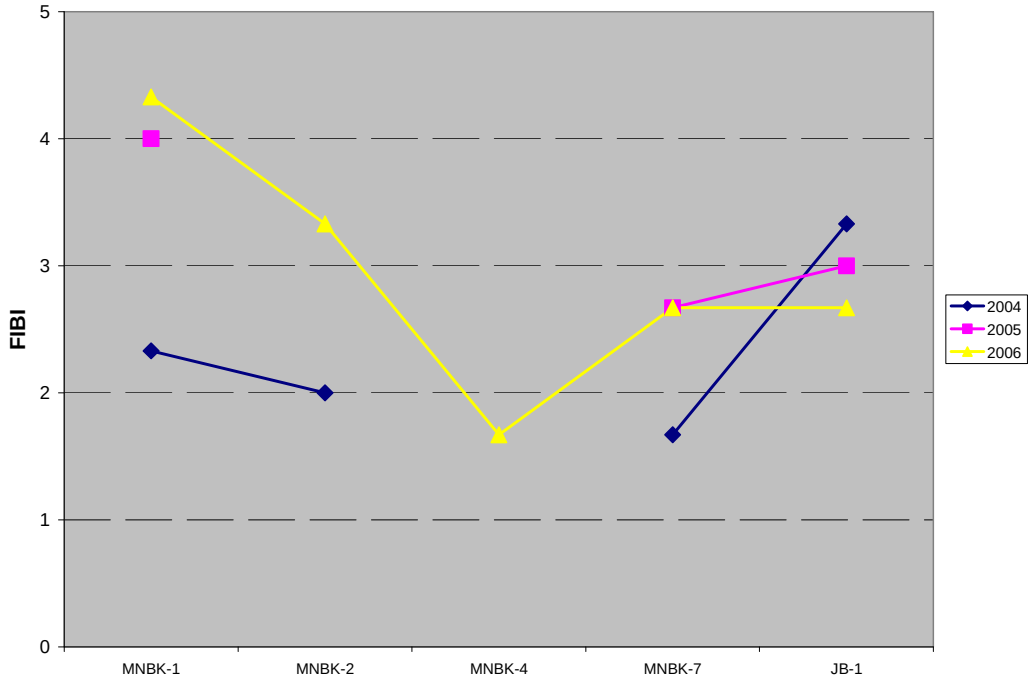

Figure 9-15. FIBI scores by year.

The WoodValley stream restoration project was completed in 2005. Pre-restoration data were collected in 2004 at two stations: (1) WDVL-1, unnamed tributary to Jones Falls at Michelle Way (within the restored reach), and (2) WDVL-2, unnamed tributary to Jones Falls at Gardenview Way. WDVL-2 served as a control for the restored reach. Post-restoration data were collected beginning in 2005. A third station, WDVL-3, unnamed tributary to Jones Falls at

Evan Way and Park Heights Avenue, was added as a control in 2005 because no fish were collected at WDVL-2 in 2004. Due to time and staffing constraints, WDVL-2 was not sampled in 2005. Presently, macroinvertebrates are collected at all stations, while fish are collected only at WDVL-1 and WDVL-3.

The BIBI scores all rated Very Poor and FIBI scores were either Poor or Very Poor (Table 9-10). The restored segment (WDVL-1) supports a macroinvertebrate community dominated by pollution tolerant Chironomidae. Fishes are primarily represented by black-nosed dace and creek chubs, which are also pollution tolerant. At present, it appears that stream habitat is

Table 9-10: BIBI and FIBI Scores for WoodValley Stations

Station	Year	BIBI	BIBI Condition	FIBI	FIBI Condition
WDVL-1	2004	1.33	Very Poor	2.33	Poor
WDVL-2	2004	1.00	Very Poor	N/A	N/A
WDVL-1	2005	1.00	Very Poor	N/A	N/A
WDVL-2	2005	1.33	Very Poor	N/A	N/A
WDVL-3	2005	1.00	Very Poor	1.67	Very Poor
WDVL-1	2006	1.00	Very Poor	2.33	Poor
WDVL-2	2006	1.33	Very Poor	N/A	N/A
WDVL-3	2006	1.00	Very Poor	2.00	Poor

limiting the biological community within WDVL-1 (Appendix 9-6). Stable, diverse stream-bottom substrates capable of supporting healthy macroinvertebrate and fish communities are mostly absent. At present, the riparian buffer that was planted as part of the restoration project has not had time to mature and achieve its full function. Tree cover is necessary for both macroinvertebrates and fish. Leaf litter is an important food source for some macroinvertebrates, while shading maintains cold water needed by trout and other cold-water fish species. The control station, WDVL-3, generally scored higher than WDVL-1 for all habitat parameters. Although it was not reflected in the FIBI scores, one wild brown trout was collected from WDVL-1 in 2004, and three wild brown trout were collected from WDVL-3 in 2006.

9.4.3 Reference Site Monitoring

Baltimore County has been monitoring eight reference sites in the County since spring of 2001. GIS was used to identify watersheds within the County that contained greater than 50% forested land use and less than 20% urban land use. Based on the GIS data, chemical data and habitat data, the initial twenty-one (21) sites were reduced to eight (8) sites for future monitoring. The ADC map site locations, along with the stream name are displayed in Table 9-11.

Table 9-11: Reference Site Locations

Station	Stream Name and Location	ADC Map, Grid
REF-001	Baisman Run upstream of Ivy Hill Road	18 C5
REF-004	Poplar Run upstream of Gunpowder Road	1 H11
REF-009	Springhouse Run upstream of Gunpowder Rd	1 H8
REF-012	Panther Branch upstream of Gunpowder Falls	7 H8
REF-013	Mingo Branch upstream of Gunpowder Falls	7 C7
REF-015	Charles Run upstream of Gerting Road	8 F11
REF-017	Sunnyking Run near Sunnyking Drive	24 A3
REF-019	Fourth Mine Branch upstream of Stablers Church Road	3 H12

The eight sites are sampled annually for benthic macroinvertebrates in the spring index period using MBSS sampling protocols. The samples are sorted and identified in the laboratory to

genus or the lowest practical taxonomic level. The metrics in Table 9-6 are used to calculate the BIBIs for the eight sites. The data will be included in next years report.

Data generated from reference site monitoring will be used to show temporal variability in stream community data. The biological community can vary year to year due to drought, periods of excessive precipitation, fluctuations in average temperature and other natural environmental factors. These fluctuations would also show up in the reference sites. This would allow for better analysis of the biological community without underestimation or overestimation due to temporal variability.

9.4.4 Submerged Aquatic Vegetation Monitoring Program

Baltimore County has conducted Submerged Aquatic Vegetation monitoring since 1989 on certain waterways. With the advent of water quality standards for submerged aquatic vegetation, reporting on the monitoring results will commence this year. During the last Water Quality Standards Triennial Review Maryland Department of the Environment adopted standards for tidal water submerged aquatic vegetation and water clarity, among other standards also adopted. The standards are based on water quality segments that are derived from the Chesapeake Bay Program model. There are a total of seven segments in Baltimore County tidal waters. Three of the segments (MIDOH, GUNOH1, and BACOH) are entirely within Baltimore County tidal waters. Four other segments have tidal waters that extend to other jurisdictions. Two of these segments (CB2OH and CB#MH) are Chesapeake Bay mainstem segments and extend to the eastern shore of Maryland. The Chesapeake Bay Program draft document *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a for the Chesapeake Bay and Its Tidal Tributaries 2006 Addendum* provides guidance on assessing the attainment of the SAV acreage criteria. The document states "the shallow-water bay grass designated use is considered in attainment if there are sufficient acres of SAV observed within the segment or there are enough acres of shallow-water habitat meeting the applicable water clarity criteria to support restoration of the desired acres of SAV for that segment." The recommended procedure is to use the **single best year SAV acreage** based on the most recent three-year period of available data. The criteria may also be met by attaining water clarity acres for the most recent three-year period of available data. Water clarity data is currently not collected in Baltimore County, so only the SAV acreage will be used.

Baltimore County monitors SAV distributions in the spring and summer of each year in accordance with the US Fish and Wildlife methodologies. There are currently 29 waterways in the County that are monitored. In order to assess the total acres of yearly coverage for the creeks surveyed, the data for the spring and summer were analyzed for overlap in SAV distribution between the two seasons. The total SAV coverage for each year is calculated by the following formula:

$$\textbf{Total SAV}_{\textbf{acres}} = (\textbf{Spring SAV}_{\textbf{acres}} - \textbf{Overlap}_{\textbf{acres}}) + (\textbf{Summer}_{\textbf{acres}}\ \textbf{SAV} - \textbf{Overlap}_{\textbf{acres}}) + \textbf{Overlap}_{\textbf{acres}}$$

To estimate the progress in meeting the SAV goal for each tidal segment the Total SAV_{acres} are divided by the SAV goal for that segment. Since only three of the seven segments are totally within Baltimore County jurisdiction and therefore can be assessed for SAV criteria attainment. The other four segments provide a conservative estimate of the SAV criteria attainment.

Table 9-12 presents the SAV water quality standard for each segment and the results of the last three years of SAV monitoring. The yellow highlighted water quality segments lie entirely

within Baltimore County. The red highlighted cells are the highest percent attainment for each water quality segment based on the last three years of data.

Table 9-12: SAV Standards and Baltimore County SAV Monitoring Results (2004-2006)

Water Quality Segment	SAV Goal (Acres)	2004		2005		2006	
		Acres	% of Goal	Acres	% of Goal	Acres	% of Goal
MIDOH	879	**483**	**54.9**	432	49.1	234	26.7
GUNOH1	1,860	**	**	**	**	**	**
GUNOH2	572	21	3.6	13	9.2	**84**	**14.7**
BACOH	0	1	100	**13**	**100**	5	100
PATMH	389	21	5.4	**53**	**13.5**	5	1.3
CB2OH	705	158	22.4	**202**	**28.6**	152	21.6
CB3MH	1,370	41	3.0	10	0.7	**55**	**4.0**
Total SAV Acres		**242**		**291**		**301**	

* Acres of SAV area surveyed
** No monitoring conducted by Baltimore County in this segment.

The Middle River segment (MIDOH) has consistently the highest acreage of SAV coverage each year. In 2004 Middle River attained 54.9% of the SAV criteria, but has subsequently declined to 26.7%. Back River has no SAV criteria, and generally has the least amount of SAV coverage. The Gunpowder segment (GUNOH1) is not monitored by Baltimore County. Of all the County's waterways surveyed, Middle River has the largest area of monitoring and Back River has the least amount of area monitored.

Appendix 9-1: Baseflow Monitoring Sites by Watershed

Site ID	Subwatershed	Site ID	Subwatershed
Liberty Reservoir – 8 Sites			
LI-01	Cliffs Branch	LI-05	Timber Run
LI-02	Glen Falls Run	LI-06	Cooks Branch
LI-03	Keysers Run	LI-07	Chimney Branch
LI-04	Norris Run	LI-08	Locust Run
Patapsco River – 10 Sites			
PA-01	Mardella Run	PA-06	Cooper Branch
PA-02	Brice Run	PA-07	Patapsco River
PA-03	Granite Branch	PA-09	Soapstone Branch
PA-04	Ben's Run	PA-10	West Branch Herbert Run
PA-05	Patapsco River	PA-11	East Branch Herbert Run
Gwynns Falls – 10 Sites			
GW-01	Gwynns Falls – Glyndon	GW-06	Scotts Level Branch
GW-02	Gwynns Falls – Unnamed Trib.	GW-07	Gwynn's Falls Trib.
GW-03	Holly Branch	GW-08	Dead Run – North Branch
GW-04	Red Run	GW-09	Dead Run – South Branch
GW-05	Horsehead Branch	GW-10	Dead Run – Mainstem
Jones Falls – 10 Sites			
JF-01	Western Run	JF-06	Roland Run
JF-02	Jones Falls – Upper Mainstem	JF-07	Roland Run
JF-03	North Branch	JF-08	Shaughterhouse Run
JF-04	Dipping Pond Run	JF-09	Moores Run
JF-05	Deep Run	JF-10	Towson Run
Back River – 10 Sites			
HR-01	West Branch – Herring Run	BR-02	Brians Run
HR-02	West Branch – Herring Run	BR-03	Redhouse Run
HR-03	East Branch – Herring Run	BR-04	Redhouse Run
HR-04	East Branch – Herring Run	BR-05A	Stemmers Run
BR-01	Bread and Cheese Creek	BR-06	Stemmers Run
Baltimore Harbor – 5 Sites			
BH-005	Bear Creek – Headwaters	BH-009	Bullneck Run
BH-006	Lynch Cove	BH-011	Tabasco Cove
BH-007	Charlesmont Cove		
Deer Creek – 4 Sites			
DC-01	Harris Mill	DC-03	Deer Creek – mainstem
DC-02	Ebaughs Creek	DC-04	Plumtree Branch
Prettyboy Reservoir – 8 Sites			
PB-26	Gunpowder Falls South Branch	PB-44	Graves Run
PB-28	Gunpowder Falls South Branch	PB-52	Murphy's Run
PB-33	Gunpowder Falls- Unnamed Trib.	PB-54	Georges Run
PB-43	Indian Run	PB-66	Compass Run
Loch Raven Reservoir – 36 Sites			
LR-02	Fitzhugh Run	LR-23	Charles Run
LR-03	Dulaney Valley Branch	LR-24	Little Falls
LR-04	Loch Raven Res. Unnamed Trib.	LR-25	First Mine Branch
LR-10 (LQ3)	Long Quarter Branch	LR-26	Second Mine Branch
LR-11 (SB-3)	Spring Branch	LR-27	Third Mine Branch
LR-12	Merryman Branch	LR-28	Owl Branch
LR-13 (BR1)	Beaver Dam Run – York Road	LR-29	Little Falls
LR-14	Baisman Run	LR-30	Beetree Run
LR-15	Beaver Dam Run – Rises Court	LR-31	Mingo Branch
LR-16	Oregon Branch	LR-32	Black Rock Run – Western Run

LR-17 (WR1)	Western Run	LR-34	McGill Run
LR-18	Green Branch	LR-35	Piney Run
LR-19 (OR1)	Overshot Run	LR-38	Delaware Run
LR-20	Carroll Branch	LR-39	Slade Run
LR-21	Piney Creek	LR-132	Black Rock Rn. (LR-32 Relocated)
LR-22 (GF1)	Gunpowder Falls - Glencoe	LR-133	Indian Run (LR-33 Relocated)
Lower Gunpowder Falls – 7 Sites			
GU-01	Bean Run	GU-06	Cowen Run
GU-03	Haystack Branch	GU-07	Jennifer Branch
GU-04	Long Green Creek – Hydes Rd.	GU-08	Minebank Run
GU-05	Long Green Creek – Hartley Mill		
Little Gunpowder Falls – 7 Sites			
LG-01	Nelson Branch	LG-05	Little Gunpowder Falls
LG-02	Parker Branch	LG-07	Little Gunpowder Falls
LG-03	Sawmill Branch	LG-09	Frannklinville Channel.
LG-04	Little Gunpowder Falls		
Bird River – 5 Sites			
BI-01	Windlass Run	BI-04	North Fork
BI-02	Honeygo Run	BI-05	Whitemarsh Run – Mainstem
BI-03	Whitemarsh Run - Headwaters		

Appendix 9-2: Baseflow Water Quality Data by Site

Site	Pollutant Parameter					
	pH			TSS		
	Mean	N	Std.Dev	Mean	N	Std.Dev
Deer Creek						
DC-01	7.45	1	0.0	0.5	2	0.0
DC-02	7.56	1	0.0	3.3	2	3.9
DC-03	7.76	1	0.0	0.5	2	0.0
DC-04	7.39	1	0.0	0.5	2	0.0
Prettyboy Reservoir						
PB-26				0.5	1	0.0
PB-28				0.5	1	0.0
PB-33				0.5	1	0.0
PB-43				0.5	1	0.0
PB-44				2.3	2	2.5
PB-52	6.00	1	0.0	0.5	2	0.0
PB-54				0.5	1	0.0
PB-66	6.50	1	0.0	0.5	1	0.0
Loch Raven Reservoir						
LR-02	6.50	1	0.0	1.3	2	1.1
LR-03	6.00	1	0.0	3.5	3	2.8
LR-04	7.00	1	0.0	0.5	2	0.0
LR-10	7.25	2	0.35	0.5	2	0.0
LR-11	7.00	1	0.0	0.5	1	0.0
LR-12	6.50	1	0.0	0.5	1	0.0
LR-13	6.75	2	0.35	4.0	2	0.0
LR-14	6.25	2	0.35	0.5	2	0.0
LR-15	6.25	2	0.35	0.5	2	0.0
LR-16	6.50	2	0.00	0.5	2	0.0
LR-17	6.25	2	0.35	0.5	2	0.0
LR-18	6.25	2	0.35	0.5	2	0.0
LR-19	6.00	1	0.0	0.5	1	0.0
LR-20	6.00	1	0.0	0.5	1	0.0
LR-21	6.00	2	0.71	0.5	2	0.0
LR-22	6.25	2	0.35	0.5	2	0.0
LR-23				0.5	1	0.0
LR-24	7.09	2	1.53	0.5	2	0.0
LR-25	6.00	1	0.0	8.0	1	0.0
LR-26	6.92	2	1.29	0.5	2	0.0
LR-27	6.95	2	1.34	0.5	2	0.0
LR-28	6.91	2	1.29	2.0	2	0.0
LR-29				0.5	1	0.0
LR-30	8.12	1	0.0	0.5	2	0.0
LR-31	6.00	2	0.71	0.5	2	0.0
LR-32	6.00	1	0.0	0.5	1	0.0
LR-34	7.18	2	0.96	1.3	2	1.1
LR-35	6.73	3	1.26	1.7	3	0.0
LR-38	6.85	2	1.20	5.3	2	6.7
LR-39	6.85	2	1.20	0.5	2	0.0
LR-132	7.90	1	0.0	0.5	1	0.0
LR-133	8.12	1	0.0	0.5	1	0.0

Site	Pollutant Parameter

	pH			TSS		
	Mean	N	Std.Dev	Mean	N	Std.Dev
Lower Gunpowder Falls						
GU-01	6.00	1	0.0	14.0	1	0.0
GU-03	6.00	1	0.0	0.5	1	0.0
GU-04	6.00	1	0.0	0.5	1	0.0
GU-05	6.00	1	0.0	0.5	1	0.0
GU-06	6.00	1	0.0	0.5	1	0.0
GU-07	6.00	1	0.0	8.0	1	0.0
GU-08	7.00	1	0.0	6.0	1	0.0
Little Gunpowder Falls						
LG-01	6.00	1	0.0	0.5	1	0.0
LG-02	6.00	1	0.0	0.5	1	0.0
LG-03	6.00	1	0.0	0.5	1	0.0
LG-04	6.00	1	0.0	0.5	1	0.0
LG-05	5.00	1	0.0	0.5	1	0.0
LG-07	5.50	1	0.0	0.5	1	0.0
LG-09	6.00	1	0.0	0.5	1	0.0
Bird River						
BI-01	6.47	3	0.05	5.7	3	1.9
BI-02	6.55	2	0.78	0.5	2	0.0
BI-03	6.5	1	0.0	0.5	1	0.0
BI-04	7.01	2	0.71	0.5	2	0.0
BI-05	7.18	2	0.95	0.5	2	0.0
Site	**Pollutant Parameter**					
	TS			**TKN**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	126	2	39.6	0.10	2	0.0
DC-02	105	2	12.7	0.25	2	0.2
DC-03	125	2	60.8	0.17	2	0.1
DC-04	105	2	63.6	0.31	2	0.0
Prettyboy Reservoir						
PB-26	65	1	0.0	0.10	1	0.0
PB-28	100	1	0.0	0.26	1	0.0
PB-33	79	1	0.0	0.21	1	0.0
PB-43	57	1	0.0	0.10	1	0.0
PB-44	58.5	2	12.0	0.28	2	0.3
PB-52	98.5	2	44.5	0.27	2	0.1
PB-54	113	1	0.0	0.24	1	0.0
PB-66	90	1	0.0	0.49	1	0.0
Loch Raven Reservoir						
LR-02	47	2	66.1	0.10	2	0.0
LR-03	139	3	38.8	0.10	3	0.0
LR-04	407	2	12.7	0.22	2	0.2
LR-10	455	2	26.9	0.25	2	0.2
LR-11	208	1	0.0	0.10	1	0.0
LR-12	142	1	0.0	0.10	1	0.0
LR-13	275	2	18.4	0.10	2	0.0
LR-14	47	2	58.0	0.20	2	0.1
LR-15	142	2	22.6	0.25	2	0.2
LR-16	198	2	67.9	0.21	2	0.1
LR-17	123	2	26.9	0.24	2	0.2

LR-18	172	2	5.7	0.23	2	0.2
LR-19	0.5	1	0.0	0.10	1	0.0
LR-20	80	1	0.0	0.10	1	0.0
LR-21	201	2	12.7	0.16	2	0.1
LR-22	108	2	50.9	0.21	2	0.2
LR-23	104	1	0.0	0.10	1	0.0
LR-24	81	2	41.0	0.21	2	0.1
LR-25	108	1	0.0	0.21	1	0.0
LR-26	65	2	7.1	0.10	0	0.0
LR-27	53.25	2	74.6	0.18	2	0.1
LR-28	87	2	41.0	0.15	2	0.1
LR-29	78	1	0.0	0.10	1	0.0
LR-30	78	2	19.8	0.20	2	0.1
LR-31	140	2	39.6	0.10	2	0.0
LR-32	8	1	0.0	0.10	1	0.0
LR-34	142	2	17.0	0.23	2	0.2
LR-35	132	3	73.2	0.24	3	0.2
LR-38	190	2	2.8	0.18	2	0.1
LR-39	3112	2	4234.2	0.17	2	0.1
LR-132	112	1	0.0	0.10	1	0.0
LR-133	148	1	0.0	0.10	1	0.0
Lower Gunpowder Falls						
GU-01	204	1	0.0	0.73	1	0.0
GU-03	104	1	0.0	0.20	1	0.0
GU-04	68	1	0.0	0.21	1	0.0
GU-05	190	1	0.0	0.29	1	0.0
GU-06	216	1	0.0	0.10	1	0.0
GU-07	276	1	0.0	0.24	1	0.0
GU-08	360	1	0.0	0.10	1	0.0
Little Gunpowder Falls						
LG-01	113	1	0.0	0.10	1	0.0
LG-02	81	1	0.0	0.10	1	0.0
LG-03	104	1	0.0	0.10	1	0.0
LG-04	107	1	0.0	0.10	1	0.0
LG-05	113	1	0.0	0.10	1	0.0
LG-07	116	1	0.0	0.10	1	0.0
LG-09	147	1	0.0	0.10	1	0.0
Bird River						
BI-01	108	3	24.2	0.59	3	0.2
BI-02	192	2	39.6	0.34	2	0.0
BI-03	328	1	0.0	0.31	1	0.0
BI-04	215	2	100.4	0.42	2	0.0
BI-05	326	2	0.0	0.31	2	0.1
Site	**Pollutant Parameter**					
	NO_2-NO_3			**TP**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	3.28	2	0.8	0.01	2	0.0
DC-02	4.13	2	0.4	0.04	2	0.0
DC-03	3.65	2	0.8	0.02	2	0.0
DC-04	2.82	2	0.5	0.01	2	0.0
Prettyboy Reservoir						
PB-26	3.01	1	0.0	0.01	1	0.0

PB-28	2.66	1	0.0	0.01	1	0.0
PB-33	2.60	1	0.0	0.01	1	0.0
PB-43	3.03	1	0.0	0.01	1	0.0
PB-44	4.27	2	1.1	0.01	2	0.0
PB-52	5.02	2	1.0	0.01	2	0.0
PB-54	5.63	1	0.0	0.01	1	0.0
PB-66	3.16	1	0.0	0.01	1	0.0
Loch Raven Reservoir						
LR-02	1.79	2	0.8	0.02	2	0.0
LR-03	1.89	3	0.5	0.03	3	0.0
LR-04	1.84	2	0.4	0.01	2	0.0
LR-10	1.00	2	0.3	0.02	2	0.0
LR-11	1.85	1	0.0	0.01	1	0.0
LR-12	1.04	1	0.0	0.02	1	0.0
LR-13	1.34	2	0.3	0.01	2	0.0
LR-14	1.20	2	0.2	0.01	2	0.0
LR-15	2.78	2	0.3	0.01	2	0.0
LR-16	1.71	2	0.0	0.01	2	0.0
LR-17	2.52	2	0.2	0.01	2	0.0
LR-18	1.77	2	0.3	0.01	2	0.0
LR-19	2.41	1	0.0	0.01	1	0.0
LR-20	2.06	1	0.0	0.02	1	0.0
LR-21	2.53	2	0.1	0.01	2	0.0
LR-22	1.87	2	0.0	0.02	2	0.0
LR-23	1.27	1	0.0	0.01	1	0.0
LR-24	2.79	2	0.8	0.01	2	0.0
LR-25	3.64	1	0.0	0.02	1	0.0
LR-26	3.24	2	0.7	0.01	2	0.0
LR-27	2.82	2	0.7	0.01	2	0.0
LR-28	1.85	2	0.4	0.01	2	0.0
LR-29	3.64	1	0.0	0.01	1	0.0
LR-30	1.99	2	1.4	0.01	2	0.0
LR-31	1.31	2	0.2	0.01	2	0.0
LR-32	2.80	1	0.0	0.01	1	0.0
LR-34	3.30	2	1.4	0.02	2	0.0
LR-35	3.63	3	0.7	0.01	3	0.0
LR-38	2.46	2	0.7	0.04	2	0.0
LR-39	1.07	2	0.4	0.02	2	0.0
LR-132	1.96	1	0.0	0.01	1	0.0
LR-133	1.70	1	0.0	0.01	1	0.0
Lower Gunpowder Falls						
GU-01	1.05	1	0.0	0.05	1	0.0
GU-03	3.19	1	0.0	0.01	1	0.0
GU-04	3.95	1	0.0	0.01	1	0.0
GU-05	3.55	1	0.0	0.03	1	0.0
GU-06	2.17	1	0.0	0.05	1	0.0
GU-07	1.23	1	0.0	0.01	1	0.0
GU-08	1.12	1	0.0	0.01	1	0.0
Little Gunpowder Falls						
LG-01	1.45	1	0.0	0.01	1	0.0
LG-02	1.82	1	0.0	0.01	1	0.0
LG-03	2.66	1	0.0	0.01	1	0.0
LG-04	3.57	1	0.0	0.01	1	0.0

LG-05	2.74	1	0.0	0.01	1	0.0
LG-07	3.74	1	0.0	0.01	1	0.0
LG-09	1.78	1	0.0	0.01	1	0.0
Bird River						
BI-01	0.58	3	0.2	0.05	3	0.0
BI-02	1.15	2	0.0	0.02	2	0.0
BI-03	0.93	1	0.0	0.01	1	0.0
BI-04	0.67	2	0.3	0.01	2	0.0
BI-05	0.94	2	0.0	0.01	2	0.0
Site	**Pollutant Parameter**					
	Cd			**Cd-dissolved**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	0.001	2	0.0	0.001	2	0.0
DC-02	0.001	2	0.0	0.001	2	0.0
DC-03	0.001	2	0.0	0.001	2	0.0
DC-04	0.001	2	0.0	0.001	2	0.0
Prettyboy Reservoir						
PB-26	0.001	1	0.0	0.001	1	0.0
PB-28	0.001	1	0.0	0.001	1	0.0
PB-33	0.001	1	0.0	0.001	1	0.0
PB-43	0.001	1	0.0	0.001	1	0.0
PB-44	0.001	2	0.0	0.001	2	0.0
PB-52	0.001	2	0.0	0.001	2	0.0
PB-54	0.001	1	0.0	0.001	1	0.0
PB-66	0.001	1	0.0	0.001	1	0.0
Loch Raven Reservoir						
LR-02	0.001	2	0.0	0.001	2	0.0
LR-03	0.001	3	0.0	0.001	3	0.0
LR-04	0.001	2	0.0	0.001	2	0.0
LR-10	0.001	2	0.0	0.001	2	0.0
LR-11	0.001	1	0.0	0.001	1	0.0
LR-12	0.001	1	0.0	0.001	1	0.0
LR-13	0.001	2	0.0	0.001	2	0.0
LR-14	0.001	2	0.0	0.001	2	0.0
LR-15	0.001	2	0.0	0.001	2	0.0
LR-16	0.001	2	0.0	0.001	2	0.0
LR-17	0.001	2	0.0	0.001	2	0.0
LR-18	0.001	2	0.0	0.001	2	0.0
LR-19	0.001	1	0.0	0.001	1	0.0
LR-20	0.001	1	0.0	0.001	1	0.0
LR-21	0.001	2	0.0	0.001	2	0.0
LR-22	0.001	2	0.0	0.001	2	0.0
LR-23	0.001	1	0.0	0.001	1	0.0
LR-24	0.001	2	0.0	0.001	2	0.0
LR-25	0.001	1	0.0	0.001	1	0.0
LR-26	0.001	2	0.0	0.001	2	0.0
LR-27	0.001	2	0.0	0.001	2	0.0
LR-28	0.001	2	0.0	0.001	2	0.0
LR-29	0.001	2	0.0	0.001	2	0.0
LR-30	0.001	2	0.0	0.001	2	0.0
LR-31	0.001	2	0.0	0.001	2	0.0
LR-32	0.001	1	0.0	0.001	1	0.0

LR-34	0.001	2	0.0	0.001	2	0.0
LR-35	0.001	3	0.0	0.001	3	0.0
LR-38	0.001	2	0.0	0.001	2	0.0
LR-39	0.001	2	0.0	0.001	2	0.0
LR-132	0.001	1	0.0	0.001	1	0.0
LR-133	0.001	1	0.0	0.001	1	0.0
Lower Gunpowder Falls						
GU-01	0.0001	1	0.0	0.0001	1	0.0
GU-03	0.0001	1	0.0	0.0001	1	0.0
GU-04	0.0001	1	0.0	0.0001	1	0.0
GU-05	0.0001	1	0.0	0.0001	1	0.0
GU-06	0.0001	1	0.0	0.0001	1	0.0
GU-07	0.0001	1	0.0	0.0001	1	0.0
GU-08	0.0001	1	0.0	0.0001	1	0.0
Little Gunpowder Falls						
LG-01	0.0001	1	0.0	0.0001	1	0.0
LG-02	0.0001	1	0.0	0.0001	1	0.0
LG-03	0.0001	1	0.0	0.0001	1	0.0
LG-04	0.0001	1	0.0	0.0001	1	0.0
LG-05	0.0001	1	0.0	0.0001	1	0.0
LG-07	0.0001	1	0.0	0.0001	1	0.0
LG-09	0.0001	1	0.0	0.0001	1	0.0
Bird River						
BI-01	0.001	3	0.0	0.001	3	0.0
BI-02	0.001	2	0.0	0.001	2	0.0
BI-03	0.001	1	0.0	0.001	1	0.0
BI-04	0.001	2	0.0	0.001	2	0.0
BI-05	0.001	2	0.0	0.001	2	0.0
Site	**Pollutant Parameter**					
	Cu			**Cu-dissolved**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	0.001	2	0.0	0.001	2	0.0
DC-02	0.002	2	0.0	0.001	2	0.0
DC-03	0.001	2	0.0	0.001	2	0.0
DC-04	0.001	2	0.0	0.001	2	0.0
Prettyboy Reservoir						
PB-26	0.002	1	0.0	0.001	1	0.0
PB-28	0.017	1	0.0	0.004	1	0.0
PB-33	0.007	1	0.0	0.002	1	0.0
PB-43	0.007	1	0.0	0.002	1	0.0
PB-44	0.002	2	0.0	0.001	2	0.0
PB-52	0.004	2	0.0	0.001	2	0.0
PB-54	0.006	1	0.0	0.002	1	0.0
PB-66	0.001	1	0	0.001	1	0.0
Loch Raven Reservoir						
LR-02	0.002	2	0.0	0.001	2	0.0
LR-03	0.003	3	0.0	0.002	3	0.0
LR-04	0.001	2	0.0	0.001	2	0.0
LR-10	0.002	2	0.0	0.001	2	0.0
LR-11	0.005	1	0.0	0.001	1	0.0
LR-12	0.001	1	0.0	0.001	1	0.0
LR-13	0.001	2	0.0	0.001	2	0.0

LR-14	0.005	2	0.0	0.002	2	0.0
LR-15	0.010	2	0.0	0.004	2	0.0
LR-16	0.009	2	0.0	0.004	2	0.0
LR-17	0.012	2	0.0	0.005	2	0.0
LR-18	0.013	2	0.0	0.005	2	0.0
LR-19	0.002	1	0.0	0.001	1	0.0
LR-20	0.001	1	0.0	0.001	1	0.0
LR-21	0.021	2	0.0	0.007	2	0.0
LR-22	0.007	2	0.0	0.002	2	0.0
LR-23	0.003	1	0.0	0.001	1	0.0
LR-24	0.003	2	0.0	0.001	2	0.0
LR-25	0.001	1	0.0	0.001	1	0.0
LR-26	0.002	2	0.0	0.001	2	0.0
LR-27	0.002	2	0.0	0.001	2	0.0
LR-28	0.002	2	0.0	0.001	2	0.0
LR-29	0.001	1	0.0	0.001	1	0.0
LR-30	0.003	2	0.0	0.001	2	0.0
LR-31	0.009	2	0.0	0.005	2	0.0
LR-32	0.01	1	0.0	.003	1	0.0
LR-34	0.003	2	0.0	0.001	2	0.0
LR-35	0.004	3	0.0	0.001	3	0.0
LR-38	0.021	2	0.0	0.009	2	0.0
LR-39	0.003	2	0.0	0.001	2	0.0
LR-132	0.001	1	0.0	0.001	1	0.0
LR-133	0.001	1	0.0	0.001	1	0.0
Lower Gunpowder Falls						
GU-01	0.02	1	0.0	0.006	1	0.0
GU-03	0.017	1	0.0	0.004	1	0.0
GU-04	0.016	1	0.0	0.004	1	0.0
GU-05	0.018	1	0.0	0.004	1	0.0
GU-06	0.017	1	0.0	0.004	1	0.0
GU-07	0.017	1	0.0	0.005	1	0.0
GU-08	0.019	1	0.0	0.005	1	0.0
Little Gunpowder Falls						
LG-01	0.007	1	0.0	0.002	1	0.0
LG-02	0.005	1	0.0	0.002	1	0.0
LG-03	0.012	1	0.0	0.003	1	0.0
LG-04	0.014	1	0.0	0.003	1	0.0
LG-05	0.014	1	0.0	0.003	1	0.0
LG-07	0.015	1	0.0	0.003	1	0.0
LG-09	0.013	1	0.0	0.003	1	0.0
Bird River						
BI-01	0.003	3	0.0	0.001	3	0.0
BI-02	0.002	2	0.0	0.001	2	0.0
BI-03	0.006	1	0.0	0.002	1	0.0
BI-04	0.006	2	0.0	0.002	2	0.0
BI-05	0.005	2	0.0	0.002	2	0.0
Site	**Pollutant Parameter**					
	Pb			**Pb-dissolved**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	0.001	2	0.0	0.001	2	0.0
DC-02	0.001	2	0.0	0.001	2	0.0

DC-03	0.001	2	0.0	0.001	2	0.0
DC-04	0.001	2	0.0	0.001	2	0.0
Prettyboy Reservoir						
PB-26	0.001	1	0.0	0.001	1	0.0
PB-28	0.001	1	0.0	0.001	1	0.0
PB-33	0.001	1	0.0	0.001	1	0.0
PB-43	0.001	1	0.0	0.001	1	0.0
PB-44	0.001	2	0.0	0.001	2	0.0
PB-52	0.001	2	0.0	0.001	2	0.0
PB-54	0.001	1	0.0	0.001	1	0.0
PB-66	0.001	1	0.0	0.001	1	0.0
Loch Raven Reservoir						
LR-02	0.001	2	0.0	0.001	2	0.0
LR-03	0.001	3	0.0	0.001	3	0.0
LR-04	0.001	2	0.0	0.001	2	0.0
LR-10	0.001	2	0.0	0.001	2	0.0
LR-11	0.001	1	0.0	0.001	1	0.0
LR-12	0.001	1	0.0	0.001	1	0.0
LR-13	0.001	2	0.0	0.001	2	0.0
LR-14	0.001	2	0.0	0.001	2	0.0
LR-15	0.001	2	0.0	0.001	2	0.0
LR-16	0.001	2	0.0	0.001	2	0.0
LR-17	0.001	2	0.0	0.001	2	0.0
LR-18	0.001	2	0.0	0.001	2	0.0
LR-19	0.001	1	0.0	0.001	1	0.0
LR-20	0.001	1	0.0	0.001	1	0.0
LR-21	0.001	2	0.0	0.001	2	0.0
LR-22	0.001	2	0.0	0.001	2	0.0
LR-23	0.001	1	0.0	0.001	1	0.0
LR-24	0.001	2	0.0	0.001	2	0.0
LR-25	0.001	1	0.0	0.001	1	0.0
LR-26	0.001	2	0.0	0.001	2	0.0
LR-27	0.001	2	0.0	0.001	2	0.0
LR-28	0.001	2	0.0	0.001	2	0.0
LR-29	0.001	1	0.0	0.001	1	0.0
LR-30	0.001	2	0.0	0.001	2	0.0
LR-31	0.001	2	0.0	0.001	2	0.0
LR-32	0.001	1	0.0	0.001	1	0.0
LR-34	0.001	2	0.0	0.001	2	0.0
LR-35	0.001	3	0.0	0.001	3	0.0
LR-38	0.001	2	0.0	0.001	2	0.0
LR-39	0.001	2	0.0	0.001	2	0.0
LR-132	0.001	1	0.0	0.001	1	0.0
LR-133	0.001	1	0.0	0.001	1	0.0
Lower Gunpowder Falls						
GU-01	0.003	1	0.0	0.001	1	0.0
GU-03	0.002	1	0.0	0.001	1	0.0
GU-04	0.002	1	0.0	0.001	1	0.0
GU-05	0.003	1	0.0	0.001	1	0.0
GU-06	0.002	1	0.0	0.001	1	0.0
GU-07	0.002	1	0.0	0.001	1	0.0
GU-08	0.002	1	0.0	0.001	1	0.0

Little Gunpowder Falls						
LG-01	0.001	1	0.0	0.001	1	0.0
LG-02	0.001	1	0.0	0.001	1	0.0
LG-03	0.001	1	0.0	0.001	1	0.0
LG-04	0.001	1	0.0	0.001	1	0.0
LG-05	0.001	1	0.0	0.001	1	0.0
LG-07	0.001	1	0.0	0.001	1	0.0
LG-09	0.001	1	0.0	0.001	1	0.0
Bird River						
BI-01	0.001	3	0.0	0.001	3	0.0
BI-02	0.001	2	0.0	0.001	2	0.0
BI-03	0.001	1	0.0	0.001	1	0.0
BI-04	0.001	2	0.0	0.001	2	0.0
BI-05	0.001	2	0.0	0.001	2	0.0
Site	**Pollutant Parameter**					
	Zn			**Zn-dissolved**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	0.019	2	0.0	0.006	2	0.0
DC-02	0.015	2	0.0	0.004	2	0.0
DC-03	0.005	2	0.0	0.002	2	0.0
DC-04	0.013	2	0.0	0.004	2	0.0
Prettyboy Reservoir						
PB-26	0.001	1	0.0	0.001	1	0.0
PB-28	0.001	1	0.0	0.001	1	0.0
PB-33	0.001	1	0.0	0.001	1	0.0
PB-43	0.001	1	0.0	0.001	1	0.0
PB-44	0.002	2	0.0	0.001	2	0.0
PB-52	0.005	2	0.0	0.002	2	0.0
PB-54	0.001	1	0.0	0.001	1	0.0
PB-66	0.006	1	0.0	0.001	1	0.0
Loch Raven Reservoir						
LR-02	0.011	2	0.0	0.004	2	0.0
LR-03	0.008	3	0.0	0.002	3	0.0
LR-04	0.013	2	0.0	0.004	2	0.0
LR-10	0.016	2	0.0	0.006	2	0.0
LR-11	0.003	1	0.0	0.001	1	0.0
LR-12	0.004	1	0.0	0.001	1	0.0
LR-13	0.014	2	0.0	0.005	2	0.0
LR-14	0.008	2	0.0	0.003	2	0.0
LR-15	0.014	2	0.0	0.006	2	0.0
LR-16	0.003	2	0.0	0.001	2	0.0
LR-17	0.003	2	0.0	0.001	2	0.0
LR-18	0.006	2	0.0	0.003	2	0.0
LR-19	0.002	1	0.0	0.001	1	0.0
LR-20	0.004	1	0.0	0.001	1	0.0
LR-21	0.007	2	0.0	0.002	2	0.0
LR-22	0.003	2	0.0	0.001	2	0.0
LR-23	0.001	1	0.0	0.001	2	0.0
LR-24	0.005	2	0.0	0.002	2	0.0
LR-25	0.012	1	0.0	0.004	1	0.0
LR-26	0.002	2	0.0	0.001	2	0.0
LR-27	0.002	2	0.0	0.001	2	0.0

LR-28	0.003	2	0.0	0.001	2	0.0
LR-29	0.001	1	0.0	0.001	1	0.0
LR-30	0.002	2	0.0	0.001	2	0.0
LR-31	0.003	2	0.0	0.001	2	0.0
LR-32	0.001	1	0.0	0.001	1	0.0
LR-34	0.015	2	0.0	0.006	2	0.0
LR-35	0.009	3	0.0	0.003	3	0.0
LR-38	0.014	2	0.0	0.006	2	0.0
LR-39	0.006	2	0.0	0.003	2	0.0
LR-132	0.020	1	0.0	0.008	1	0.0
LR-133	0.018	1	0.0	0.005	1	0.0
Lower Gunpowder Falls						
GU-01	0.01	1	0.0	0.002	1	0.0
GU-03	0.01	1	0.0	0.002	1	0.0
GU-04	0.009	1	0.0	0.002	1	0.0
GU-05	0.008	1	0.0	0.002	1	0.0
GU-06	0.011	1	0.0	0.003	1	0.0
GU-07	0.009	1	0.0	0.003	1	0.0
GU-08	0.009	1	0.0	0.002	1	0.0
Little Gunpowder Falls						
LG-01	0.001	1	0.0	0.001	1	0.0
LG-02	0.001	1	0.0	0.001	1	0.0
LG-03	0.001	1	0.0	0.001	1	0.0
LG-04	0.001	1	0.0	0.001	1	0.0
LG-05	0.001	1	0.0	0.001	1	0.0
LG-07	0.001	1	0.0	0.001	1	0.0
LG-09	0.001	1	0.0	0.001	1	0.0
Bird River						
BI-01	0.025	3	0.0	0.007	3	0.0
BI-02	0.017	2	0.0	0.006	2	0.0
BI-03	0.015	1	0.0	0.006	1	0.0
BI-04	0.017	2	0.0	0.006	2	0.0
BI-05	0.024	2	0.0	0.009	2	0.0
Site	**Pollutant Parameter**					
	BOD			**COD**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	1	2	0.0	5	2	3.9
DC-02	1	2	0.0	3	2	0.0
DC-03	1	2	0.0	4	2	1.8
DC-04	1	2	0.0	4	2	1.8
Prettyboy Reservoir						
PB-26	1	1	0.0	3	1	0.0
PB-28	1	1	0.0	3	1	0.0
PB-33	1	1	0.0	3	1	0.0
PB-43	1	1	0.0	3	1	0.0
PB-44	1	2	0.0	3	2	0.0
PB-52	1	2	0.0	3	2	0.0
PB-54	1	1	0.0	5	1	0.0
PB-66	1	1	0.0	3	1	0.0
Loch Raven Reservoir						
LR-02	1	2	0.0	3	2	0.0
LR-03	1	3	0.0	3	3	0.0

LR-04	1	2	0.0	3	2	0.0
LR-10	1	2	0.0	4	2	2.5
LR-11	1	1	0.0	5	1	0.0
LR-12	1	1	0.0	3	1	0.0
LR-13	1	2	0.0	3	2	0.0
LR-14	1	2	0.0	8	2	8.1
LR-15	1	2	0.0	8	2	8.1
LR-16	1	2	0.0	10	2	6.4
LR-17	1	2	0.0	6	2	5.3
LR-18	1	2	0.0	10	2	6.4
LR-19	1	1	0.0	3	1	0.0
LR-20	1	1	0.0	3	1	0.0
LR-21	1	2	0.0	6	2	5.3
LR-22	1	2	0.0	10	2	5.7
LR-23	1	1	0.0	9	1	0.0
LR-24	1	2	0.0	4	2	2.5
LR-25	1	1	0.0	3	1	0.0
LR-26	1	2	0.0	4	2	1.8
LR-27	1	2	0.0	5	2	3.2
LR-28	1	2	0.0	4	2	2.5
LR-29	1	1	0.0	5	1	0.0
LR-30	1	2	0.0	4	2	1.8
LR-31	1	2	0.0	3	2	0.0
LR-32	1	1	0.0	3	1	0.0
LR-34	1	2	0.0	3	2	0.0
LR-35	1	3	0.0	6	3	3.3
LR-38	1	2	0.0	21	2	25.8
LR-39	1	2	0.0	4	2	1.8
LR-132	1	1	0.0	3	1	0.0
LR-133	1	1	0.0	3	1	0.0
Lower Gunpowder Falls						
GU-01	3	1	0.0	7	1	0.0
GU-03	1	1	0.0	3	1	0.0
GU-04	1	1	0.0	5	1	0.0
GU-05	1	1	0.0	3	1	0.0
GU-06	1	1	0.0	3	1	0.0
GU-07	1	1	0.0	6	1	0.0
GU-08	1	1	0.0	3	1	0.0
Little Gunpowder Falls						
LG-01	1	1	0.0	3	1	0.0
LG-02	1	1	0.0	3	1	0.0
LG-03	1	1	0.0	3	1	0.0
LG-04	1	1	0.0	3	1	0.0
LG-05	1	1	0.0	3	1	0.0
LG-07	1	1	0.0	3	1	0.0
LG-09	1	1	0.0	3	1	0.0
Bird River						
BI-01	1	3	0.0	18	3	10.7
BI-02	1	2	0.0	8	2	0.7
BI-03	1	1	0.0	3	1	0.0
BI-04	1	2	0.0	12	2	5.7
BI-05	1	2	0.0	7	2	6.0
Site	**Pollutant Parameter**					

	Cl			TN		
	Mean	N	Std.Dev	Mean	N	Std.Dev
Deer Creek						
DC-01	43.10	2	0.5	3.38	2	0.0
DC-02	21.63	2	1.7	4.38	2	0.0
DC-03	25.12	2	0.9	3.81	2	0.0
DC-04	31.33	2	1.7	3.13	2	0.0
Prettyboy Reservoir						
PB-26	15.04	1	0.0	3.11	1	0.0
PB-28	27.52	1	0.0	2.92	1	0.0
PB-33	16.42	1	0.0	2.81	1	0.0
PB-43	12.38	1	0.0	3.13	1	0.0
PB-44	22.09	2	5.0	4.55	2	1.32
PB-52	46.68	2	10.8	5.29	2	1.08
PB-54	45.55	1	0.0	5.87	1	0.0
PB-66	48.59	1	0.0	3.65	1	0.0
Loch Raven Reservoir						
LR-02	27.73	2	3.3	1.89	2	0.8
LR-03	34.40	3	2.0	1.99	3	0.5
LR-04	65.52	2	6.2	2.06	2	0.5
LR-10	110.36	1	0.0	1.25	2	0.5
LR-11	104.52	1	0.0	1.95	1	0.0
LR-12				1.14	1	0.0
LR-13	108.89	2	13.5	1.44	2	0.3
LR-14	29.42	2	1.5	1.41	1	0.0
LR-15	64.87	2	1.2	3.10	1	0.0
LR-16	38.80	2	2.9	1.83	1	0.0
LR-17	26.32	2	3.7	2.74	1	0.0
LR-18	51.33	2	4.2	2.06	1	0.0
LR-19	49.93	1	0.0	2.51	1	0.0
LR-20	15.93	1	0.0	2.16	1	0
LR-21	62.37	2	15.5	2.71	1	0.0
LR-22	26.97	2	3.0	1.98	1	0.0
LR-23	19.29	1	0.0	1.37	1	0.0
LR-24	31.75	2	5.8	3.48	1	0.0
LR-25	23.21	1	0.0	3.85	1	0.0
LR-26	23.47	2	3.1	3.85	1	0.0
LR-27	23.89	2	4.0	3.44	1	0.0
LR-28	46.16	2	3.0	2.25	1	0.0
LR-29	23.36	1	0.0	3.74	1	0.0
LR-30	30.53	2	2.7	3.05	1	0.0
LR-31	107.05	2	1.6	1.41	2	0.2
LR-32	30.22	1	0.0	2.90	1	0.0
LR-34	27.64	2	20.6	3.52	2	1.5
LR-35	33.95	3	5.3	3.87	3	0.8
LR-38	23.47	2	6.7	2.64	2	0.8
LR-39	14.56	2	4.3	1.24	2	0.5
LR-132	22.76	1	0.0	2.06	1	0.0
LR-133	20.21	1	0.0	1.80	1	0.0
Lower Gunpowder Falls						
GU-01	55.07	1	0.0	1.78	1	0.0
GU-03	32.35	1	0.0	3.39	1	0.0
GU-04	38.67	1	0.0	4.16	1	0.0

GU-05	33.09	1	0.0	3.84	1	0.0
GU-06	61.13	1	0.0	2.27	1	0.0
GU-07	66.18	1	0.0	1.47	1	0.0
GU-08	116.70	1	0.0	1.22	1	0.0
Little Gunpowder Falls						
LG-01	25.92	1	0.0	1.55	1	0.0
LG-02	17.14	1	0.0	1.92	1	0.0
LG-03	47.20	1	0.0	2.76	1	0.0
LG-04	37.61	1	0.0	3.67	1	0.0
LG-05	22.94	1	0.0	2.84	1	0.0
LG-07	40.40	1	0.0	3.84	1	0.0
LG-09	47.15	1	0.0	1.88	1	0.0
Bird River						
BI-01	16.53	3	4.1	0.93	1	0.0
BI-02	79.30	2	7.4	1.51	1	0.0
BI-03	168.14	1	0.0	1.24	1	0.0
BI-04	104.14	2	26.0	1.27	1	0.0
BI-05	143.52	2	54.5	1.19	1	0.0
Site	**Pollutant Parameter**					
	Na			**Hardness**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
Deer Creek						
DC-01	24.85	1	0.0	63.98	1	0.0
DC-02	15.85	1	0.0	79.53	1	0.0
DC-03	15.45	1	0.0	69.34	1	0.0
DC-04	19.85	1	0.0	81.04	1	0.0
Prettyboy Reservoir						
PB-26	19.05	1	0.0	87.54	1	0.0
PB-28	13.50	1	0.0	38.26	1	0.0
PB-33	20.50	1	0.0	97.91	1	0.0
PB-43	2.40	1	0.0	46.64	1	0.0
PB-44	6.15	1	0.0	47.88	1	0.0
PB-52	7.55	1	0.0	58.17	1	0.0
PB-54	18.55	1	0.0	72.27	1	0.0
PB-66	6.50	1	0.0			
Loch Raven Reservoir						
LR-02	13.88	2	0.7	48.46	2	29.2
LR-03	13.62	3	2.6	133.77	3	19.0
LR-04	21.48	2	8.4	306.53	2	59.5
LR-10	42.68	2	1.5	357.38	2	58.5
LR-11	21.45	1	0.0	140.81	1	0.0
LR-12	39.10	1	0.0	49.23	1	0.0
LR-13	33.08	2	3.8	177.64	2	13.0
LR-14	12.80	2	6.8	39.39	2	12.1
LR-15	31.53	2	3.4	87.23	2	30.1
LR-16	10.88	2	1.5	121.48	2	70.9
LR-17	14.75	2	2.5	150.81	2	7.5
LR-18	20.85	2	3.5	97.49	2	56.9
LR-19	22.55	1	0.0	39.56	1	0.0
LR-20	11.05	1	0.0	68.47	1	0.0
LR-21	44.80	2	35.4	158.34	2	14.5
LR-22	16.18	2	6.2	47.12	2	7.7
LR-23	13.00	1	0.0	21.14	1	0.0

LR-24	11.45	1	0.0	38.73	1	0.0
LR-25						
LR-26	10.55	1	0.0	62.52	1	0.0
LR-27	10.40	1	0.0	48.56	1	0.0
LR-28	20.55	1	0.0	77.32	1	0.0
LR-29				9.44	1	0.0
LR-30	12.45	1	0.0	67.79	2	12.8
LR-31	20.60	1	0.0	31.45	1	0.0
LR-32	11.45	1	0.0	41.77	1	0.0
LR-34	15.83	2	4.1	69.02	2	42.2
LR-35	23.05	3	1.9	65.65	3	24.1
LR-38	16.75	2	5.2	140.54	2	41.2
LR-39	16.68	2	1.9	51.03	2	14.7
LR-132	9.80	1	0.0	70.40	1	0.0
LR-133	15.75	1	0.0	110.32	1	0.0
Lower Gunpowder Falls						
GU-01	17.2	1	0.0	93.45	1	0.0
GU-03	14.6	1	0.0	78.40	1	0.0
GU-04	7	1	0.0	66.86	1	0.0
GU-05	8.85	1	0.0	77.09	1	0.0
GU-06	47.65	1	0.0	141.11	1	0.0
GU-07	38.40	1	0.0	132.66	1	0.0
GU-08	52.85	1	0.0	312.73	1	0.0
Little Gunpowder Falls						
LG-01	7.70	1	0.0	46.72	1	0.0
LG-02	7.30	1	0.0	46.31	1	0.0
LG-03	19.50	1	0.0	68.77	1	0.0
LG-04	13.30	1	0.0	52.33	1	0.0
LG-05	13.70	1	0.0	58.12	1	0.0
LG-07	16.00	1	0.0	52.65	1	0.0
LG-09	13.85	1	0.0	55.60	1	0.0
Bird River						
BI-01	12.23	2	2.3	26.15	2	2.8
BI-02	14.85	1	0.0	122.21	1	0.0
BI-03						
BI-04	27.95	1	0.0	244.30	1	0.0
BI-05	30.75	1	0.0	275.17	1	0.0

Appendix 9-3: Tidal Waters Chemical Monitoring Results

Site	TSS			TS		
	Mean	N	Std.Dev	Mean	N	Std.Dev
GR	25.2	17	12.8	1756.6	17	957.7
MR	23.7	17	13.2	3425.1	17	1216.8
MS	24.5	17	15.1	3399.9	17	1492.9
BR	31.6	17	15.9	3100.6	17	1358.4
BC	48.4	16	27.6	7461.0	16	1720.1
PR	47.3	17	33.7	8066.1	17	2368.9
HM	26.1	17	19.0	3719.5	17	1505.1
BD	38.9	17	46.0	644.1	17	310.7
PS-F	20.9	14	14.4	2906.7	14	1753.1
PS-E	3.5	15	10.2	188.9	15	35.9
Site	**TKN**			**NO_2-NO_3**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.4344	16	0.1853	0.1613	16	0.1994
MR	0.4888	16	0.1660	0.0913	16	0.0855
MS	0.4038	16	0.1701	0.1300	16	0.15475
BR	1.1813	16	0.3848	0.5019	16	1.2197
BC	0.7313	15	0.2996	0.1467	15	0.1942
PR	0.5919	16	0.2632	0.1725	16	0.2068
HM	0.4344	16	0.2253	0.1919	16	0.2088
BD	0.7925	16	0.2893	0.2138	16	0.2493
PS-F	0.6246	13	0.2533	0.5557	14	0.3638
PS-E	0.4650	14	0.1719	1.0233	15	0.3056
Site	**TP**			**Cu**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.0681	16	0.0269	0.0114	16	0.0066
MR	0.0513	16	0.0150	0.0139	16	0.0086
MS	0.0494	16	0.0118	0.0138	16	0.0100
BR	0.1556	16	0.0408	0.0153	16	0.0093
BC	0.0920	15	0.0338	0.0191	16	0.0072
PR	0.0588	16	0.0171	0.0211	17	0.0097
HM	0.0531	16	0.0265	0.0143	16	0.0105
BD	0.1169	16	0.0745	0.0119	16	0.0095
PS-F	0.0546	13	0.0310	0.0124	14	0.0095
PS-E	0.0257	14	0.0174	0.0135	15	0.0085
Site	**Cu-dissolved**			**Pb**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.0039	16	0.0027	0.0008	16	0.0004
MR	0.0044	16	0.0030	0.0008	16	0.0004
MS	0.0043	16	0.0034	0.0010	16	0.0005
BR	0.0050	16	0.0033	0.0013	16	0.0007
BC	0.0064	16	0.0024	0.0015	16	0.0006
PR	0.0066	17	0.0027	0.0014	17	0.0007
HM	0.0047	16	0.0033	0.0011	16	0.0007
BD	0.0038	16	0.0032	0.0010	16	0.0006
PS-F	0.0039	14	0.0029	0.0013	14	0.0012
PS-E	0.0046	15	0.0026	0.0010	15	0.0005
Site	**Pb-dissolved**			**Zn**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.0005	16	0.0000	0.0098	16	0.0114
MR	0.0006	16	0.0000	0.0100	16	0.0096

MS	0.0006	16	0.0001	0.0120	16	0.0113
BR	0.0007	16	0.0001	0.0183	16	0.0130
BC	0.0008	16	0.0001	0.0215	16	0.0118
PR	0.0007	17	0.0001	0.0191	17	0.0147
HM	0.0006	16	0.0001	0.0115	16	0.0135
BD	0.0006	16	0.0000	0.0140	16	0.0160
PS-F	0.0006	14	0.0000	0.0134	14	0.0125
PS-E	0.0006	15	0.0000	0.0085	15	0.0107
Site	**Zn-dissolved**			**BOD**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.0034	16	0.0035	1.4	17	0.6183
MR	0.0033	16	0.0032	1.8	17	1.0744
MS	0.0041	16	0.0034	1.4	17	0.7019
BR	0.0064	16	0.0048	3.8	17	1.3933
BC	0.0075	16	0.0049	3.8	16	1.5586
PR	0.0068	17	0.0057	2.5	17	1.5459
HM	0.0047	16	0.0054	1.6	17	1.3201
BD	0.0045	16	0.0049	2.8	17	1.2367
PS-F	0.0043	14	0.0038	1.5	14	1.0919
PS-E	0.0026	15	0.0033	1.3	15	0.6172
Site	**COD**			**CL**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	11.4	17	9.9	1014.4	17	634.9
MR	20.6	17	16.1	1941.5	17	823.4
MS	16.4	17	16.8	2029.9	17	997.8
BR	21.3	17	11.6	1872.5	17	1060.5
BC	26.2	16	17.0	4507.0	16	1580.0
PR	30.0	17	22.4	7807.2	17	11610.5
HM	17.0	17	14.1	2321.2	17	1173.9
BD	11.0	17	8.8	328.7	17	236.6
PS-F	17.5	14	17.8	1605.9	14	1174.2
PS-E	8.8	15	10.4	39.6	15	10.1
Site	**Fl**			**SO_4**		
	Mean	**N**	**Std.Dev**	**Mean**	**N**	**Std.Dev**
GR	0.3	17	0.0	158.1	17	100.5
MR	0.4	17	0.3	295.3	17	121.9
MS	0.3	17	0.2	308.7	17	148.4
BR	0.4	17	0.3	300.1	17	145.5
BC	0.4	16	0.3	651.9	16	199.2
PR	0.3	17	0.1	703.0	17	235.5
HM	0.4	17	0.4	351.60	17	169.3
BD	0.3	17	0.0	54.30	17	33.2
PS-F	0.3	15	0.0	16.0	15	3.5
PS-E	0.3	14	0.2	250.7	14	157.8

Appendix 9-4: Results of 2006 Probabilistic Monitoring

Station ID	Subwatershed	DNR 12 Digit Subsheds	Benthic Index of Biotic Integrity Score	Rating
Prettyboy Reservoir				
204014	Prettyboy Direct 3	313	4.00	Good
204033	Georges Run	314	2.33	Poor
206001	Georges Run	314	2.33	Poor
206002	Peggy's Run	314	2.67	Poor
206010	Prettyboy Branch	313	3.00	Fair
206016	Prettyboy Branch	313	4.00	Good
206021	Graves Run	315	4.00	Good
206022	Graves Run	315	3.67	Fair
206023	Graves Run	315	4.00	Good
206025	Compass Run	313	3.67	Fair
206027	Compass Run	313	3.67	Fair
206029	Georges Run	314	3.00	Fair
206039	Georges Run	314	2.67	Poor
206040	Poplar Run	313	3.67	Fair
206043	Silver Run	313	4.33	Good
206044	Silver Run	313	4.33	Good
206050	Prettyboy Branch	313	2.33	Poor
Loch Raven Reservoir				
304021	Fourth Mine Branch	309	2.67	Poor
304084	Piney Run	308	3.67	Fair
304121	Blackrock Run	307	3.67	Fair
304197	Baisman Run	302	4.00	Good
304208	Goodwin Run	302	1.67	Very Poor
304214	Merrymans Branch	300	2.33	Poor
306009	Beaver Dam Run	302	3.67	Fair
306015	Beaver Dam Run	302	3.00	Fair
306030	Beetree Run	311	4.00	Good
306043	Blackrock Run	307	1.00	Very Poor
306052	Piney Run	308	2.00	Poor
306058	Western Run	303	3.00	Fair
306069	Little Piney Run	308	3.00	Fair
306073	Piney Run	308	3.00	Fair
306075	Piney Run	308	3.67	Fair
306076	Piney Run	308	3.67	Fair
306079	Little Falls	311	3.33	Fair
306087	Little Falls	312	3.67	Fair
306090	Blackrock Run	307	3.00	Fair
306095	Little Falls	312	4.00	Good
306096	McGill Run	308	4.00	Good
306099	Little Falls	312	4.00	Good
306102	Little Piney Run	308	4.00	Good
306103	Charles Run	306	3.67	Fair
306106	Western Run	303	2.67	Poor
306114	Blackrock Run	307	3.00	Fair
306116	Blackrock Run	307	3.67	Fair
306149	Overshot Run	301	3.67	Fair
306150	Blackrock Run	307	3.00	Fair
306151	Blackrock Run	307	3.67	Fair
306154	Indian Run-Loch Raven	307	3.33	Fair

306155	Oregon Run	302	3.00	Fair
306156	Oregon Run	302	2.33	Poor
306163	Overshot Run	301	4.00	Good
306165	Beetree Run	311	3.67	Fair
306172	Indian Run-Loch Raven	307	3.33	Fair
306174	Little Falls	312	3.67	Fair
306175	Indian Run-Loch Raven	307	3.67	Fair
306181	Indian Run-Loch Raven	307	3.67	Fair
306204	Piney Creek	305	4.00	Good
306221	Dulaney Valley Branch	300	2.67	Poor
306223	Piney Creek	305	2.33	Poor
306234	Beaver Dam Run	302	1.33	Very Poor
306237	Piney Creek	305	4.33	Good
Deer Creek				
404001	Deer Creek	332	3.33	Fair
404006	Plumtree Branch	332	4.00	Good
406001	Deer Creek	332	4.00	Good
406003	Deer Creek	332	4.00	Good
406007	Ebaughs Creek	332	2.67	Poor
406010	Harris Mill	332	3.67	Fair
406011	Harris Mill	332	4.00	Good
406014	Deer Creek	332	4.33	Good
406017	Little Deer Creek	332	4.00	Good
406018	Harris Mill	332	3.33	Fair
406022	Harris Mill	332	3.00	Fair
406024	Deer Creek-A	332	4.00	Good
406025	Harris Mill	332	1.33	Very Poor
Little Gunpowder Falls				
904008	Parker Branch	299	3.67	Fair
906007	Sawmill Branch	299	4.00	Good
906009	Little Gunpowder Falls	299	4.00	Good
906024	Little Gunpowder Falls-A	299	2.00	Poor
Lower Gunpowder Falls				
1004002	Long Green Creek	297	2.33	Poor
1004029	Long Green Creek	297	2.00	Poor
1006001	Lower Gunpowder Falls	296	2.00	Poor
1006002	Lower Gunpowder Falls	297	2.00	Poor
1006009	Lower Gunpowder Falls	296	3.67	Fair
1006010	Lower Gunpowder Falls	296	3.33	Fair
1006012	Lower Gunpowder Falls	296	1.33	Very Poor
1006015	Bean Run	296	1.67	Very Poor
1006019	Cowen Run	297	2.00	Poor
1006020	Minebank Run	297	1.33	Very Poor

1006021	Minebank Run	297	2.00	Poor
1006022	Cowen Run	297	3.00	Fair
1006023	Long Green Creek	297	3.33	Fair
1006024	Cowen Run	297	1.33	Very Poor
1006033	Minebank Run	297	1.33	Very Poor
1006039	Long Green Creek	297	3.67	Fair
1006049	Long Green Creek	297	3.33	Fair
Bird River				
1106001	Honeygo Run	295	2.00	Poor
1106004	Honeygo Run	295	1.33	Very Poor
1106011	Whitemarsh Run	295	1.33	Very Poor
1106017	Whitemarsh Run (South Fork)	295	1.00	Very Poor
1106021	Windlass Run	294	1.86	Very Poor

Appendix 9-5: Minebank Run Stream Physical Habitat Assessment Data

Station	Year	Survey Type	IH	ES	VDD	PGEQ	RRQ	E	S
MNBK-1	2004	Benthos	12	13	11	12	15	45	40
MNBK-2	2004	Benthos	13	14	10	10	11	35	80
MNBK-3	2004	Benthos	7	6	11	8	7	45	65
MNBK-4	2004	Benthos	6	10	10	2	2	25	90
MNBK-5	2004	Benthos	5	4	5	5	5	75	92
MNBK-6	2004	Benthos	5	5	6	8	6	75	95
MNBK-7	2004	Benthos	10	11	11	9	11	55	90
MNBK-8	2004	Benthos	13	10	11	12	12	80	75
MNBK-9	2004	Benthos	10	11	10	8	8	75	35
JB-1	2004	Benthos	8	10	10	10	9	60	95
JB-2	2004	Benthos	11	10	13	11	14	55	70
MNBK-1	2005	Benthos	7	6	8	6	9	80	35
MNBK-2	2005	Benthos	13	12	11	11	13	45	85
MNBK-3	2005	Benthos	6	12	9	9	12	35	20
MNBK-4	2005	Benthos	8	14	9	6	13	60	30
MNBK-5	2005	Benthos	10	11	10	9	12	40	60
MNBK-6	2005	Benthos	8	8	11	7	9	60	45
MNBK-7	2005	Benthos	9	6	11	11	3	55	85
MNBK-8	2005	Benthos	12	6	11	11	5	40	60
MNBK-9	2005	Benthos	6	7	11	7	7	35	40
JB-1	2005	Benthos	15	16	16	14	13	60	90
JB-2	2005	Benthos	12	16	11	12	13	50	90
MNBK-1	2006	Benthos	12	13	11	11	8	45	35
MNBK-2	2006	Benthos	4	8	11	9	8	15	10
MNBK-3	2006	Benthos	9	11	11	11	10	60	30
MNBK-4	2006	Benthos	7	9	10	6	12	30	25
MNBK-5	2006	Benthos	7	11	11	10	11	40	60
MNBK-6	2006	Benthos	6	8	11	7	7	70	65
MNBK-7	2006	Benthos	8	1	11	7	4	85	80
MNBK-8	2006	Benthos	3	7	9	6	6	50	90
MNBK-9	2006	Benthos	3	6	7	7	6	80	75
JB-1	2006	Benthos	15	12	15	10	15	5	50
JB-2	2006	Benthos	16	15	13	13	15	25	75
MNBK-1	2004	Fish	16	12	14	17	13	20	60
MNBK-2	2004	Fish	8	9	10	11	9	35	20
MNBK-7	2004	Fish	8	6	12	11	5	50	85
JB-1	2004	Fish	17	15	13	13	14	40	95
JB-1	2005	Fish	10	8	12	14	7	30	85
MNBK-1	2006	Fish	15	8	12	13	13	60	35
MNBK-4	2006	Fish	13	12	12	16	12	30	60
MNBK-7	2006	Fish	15	11	11	12	13	40	90
JB-1	2006	Fish	16	13	13	14	15	40	90

Definitions: Instream habitat (IH) and epifaunal substrate (ES) describe the quality of stable habitat for fish and macroinvertebrates, respectively. Velocity/Depth Diversity (VDD) documents the presence of slow, fast, shallow, and deep water. Pool/glide/eddy quality (PGEQ) and riffle/run quality (RRQ) describe the extent of slow and fast water, respectively. Each parameter receives a 0-20 score, which equates to four condition categories: Optimal (16-20), Sub-Optimal (11-15), Marginal (6-10), and Poor (0-5). Embeddedness (E) is a percentage estimate of the amount of fine particles covering coarse stream bottom substrates. Shading (S) is a percentage estimate of the amount of shading over the wetted stream channel.

Appendix 9-6: Stream Physical Habitat Assessment Data

Station	Year	Survey Type	IH	ES	VDD	PGEQ	RRQ	E	S
WDVL-1	2004	Benthos	12	13	11	12	15	45	40
WDVL-1	2005	Benthos	5	4	5	5	5	75	92
WDVL-1	2006	Benthos	10	11	10	8	8	75	35
WDVL-2	2004	Benthos	13	14	10	10	11	35	80
WDVL-2	2005	Benthos	5	5	6	8	6	75	95
WDVL-2	2006	Benthos	8	10	10	10	9	60	95
WDVL-3	2005	Benthos	10	11	11	9	11	55	90
WDVL-3	2006	Benthos	11	10	13	11	14	55	70
WDVL-1	2004	Fish	7	6	11	8	7	45	65
WDVL-1	2006	Fish	7	6	8	6	9	80	35
WDVL-2	2004	Fish	6	10	10	2	2	25	90
WDVL-3	2005	Fish	13	10	11	12	12	80	75
WDVL-3	2006	Fish	13	12	11	11	13	45	85

Definitions: Instream habitat (IH) and epifaunal substrate (ES) describe the quality of stable habitat for fish and macroinvertebrates, respectively. Velocity/Depth Diversity (VDD) documents the presence of slow, fast, shallow, and deep water. Pool/glide/eddy quality (PGEQ) and riffle/run quality (RRQ) describe the extent of slow and fast water, respectively. Each parameter receives a 0-20 score, which equates to four condition categories: Optimal (16-20), Sub-Optimal (11-15), Marginal (6-10), and Poor (0-5). Embeddedness (E) is a percentage estimate of the amount of fine particles covering coarse stream bottom substrates. Shading (S) is a percentage estimate of the amount of shading over the wetted stream channel.