Rutgers
New Jersey Agricultural
Experiment Station

The Assiscunk Creek Watershed Restoration and Protection Plan

Data Report

Developed by the Rutgers Cooperative Extension Water Resources Program

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and the
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Watershed Overview

The project area for this planning initiative consists of the headwaters of the Assiscunk Creek, a 14.6 square mile drainage area including the Annaricken Brook and the 4.8 square mile North Branch of Barkers Brook (Henceforth, "The Assiscunk Creek Watershed", Figure 1). The primary streams within the planning watershed are Assiscunk Creek (headwaters), the North Branch of Barkers Brook, and the Annaricken Brook (entire reach), with main stem lengths of 7.3 miles long, 4.8 miles long, and 3.9 miles long, respectively. Within this planning area, there are approximately 40 miles of mapped streams designated Category One, with the exception of Barkers Brook. While there are no major lakes in the sub-watersheds, there are three small impoundments that make up a total lake area of 2.8 acres within the planning area. The project area is completely within Burlington County and contains portions of Mansfield Township and Springfield Township (Figure 1).

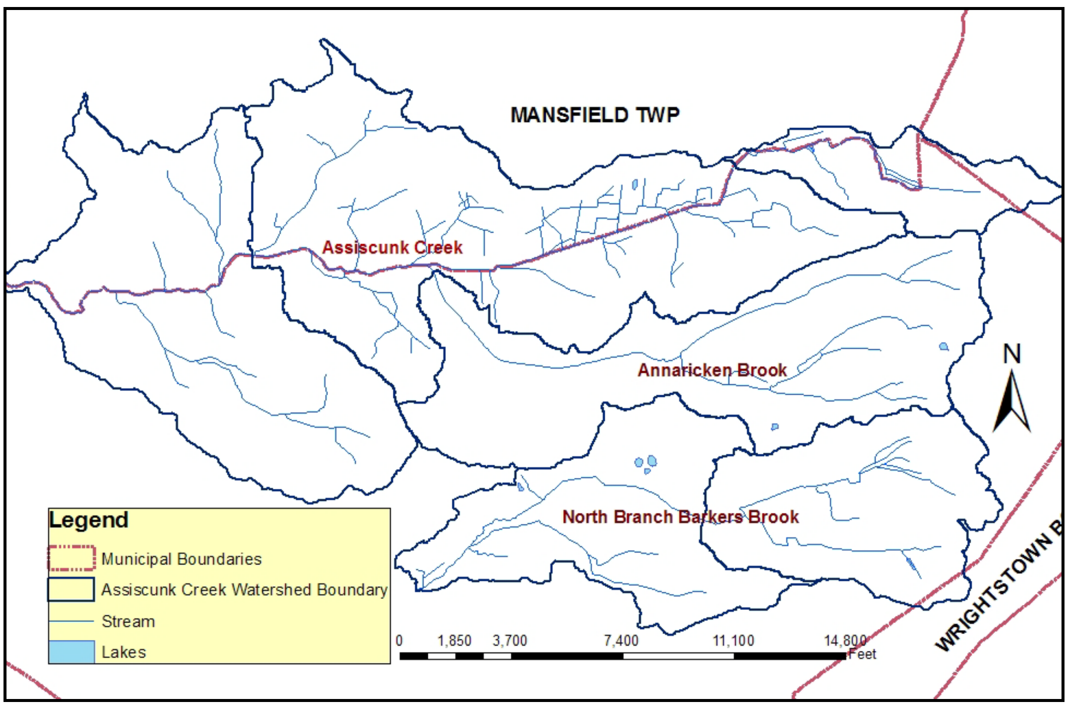

Figure 1: Municipalities and Stream Network of the Assiscunk Creek Watershed (NJDEP GIS)

Of the land uses within the subject watershed, approximately 70 percent is designated as agricultural (including row crops, field nurseries, container nurseries, and animal farming) and agricultural wetlands. Other land uses include forested areas and some suburban and typical small village development (*NJDEP 2002 Land use/Land cover Update, Assiscunk, Crosswicks and Doctors Watershed Management Area, WMA-20).* (Figure 2, 3 and 4)

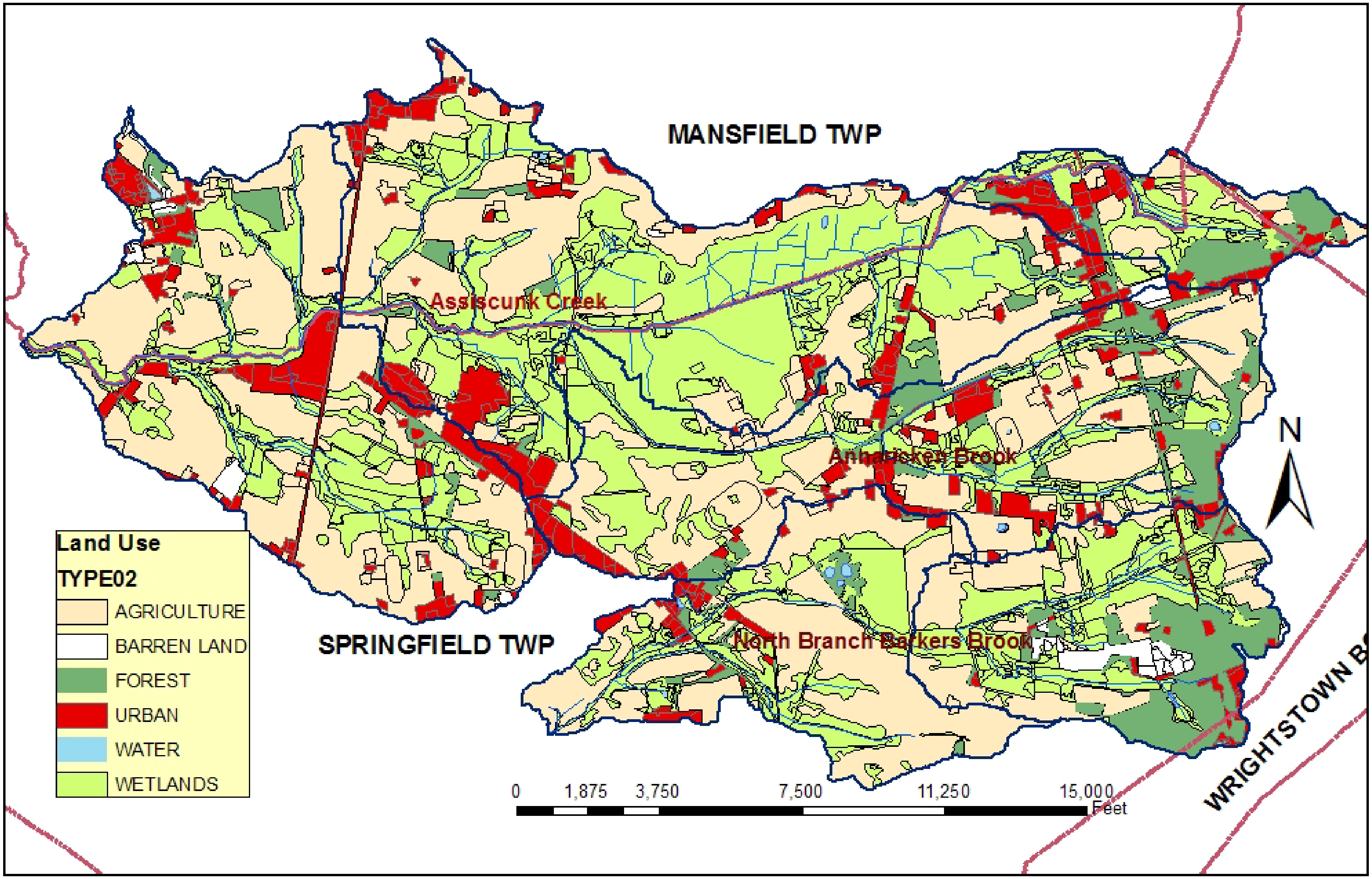

Figure 2: NJDEP 2002 Land Use of the Assiscunk Watershed

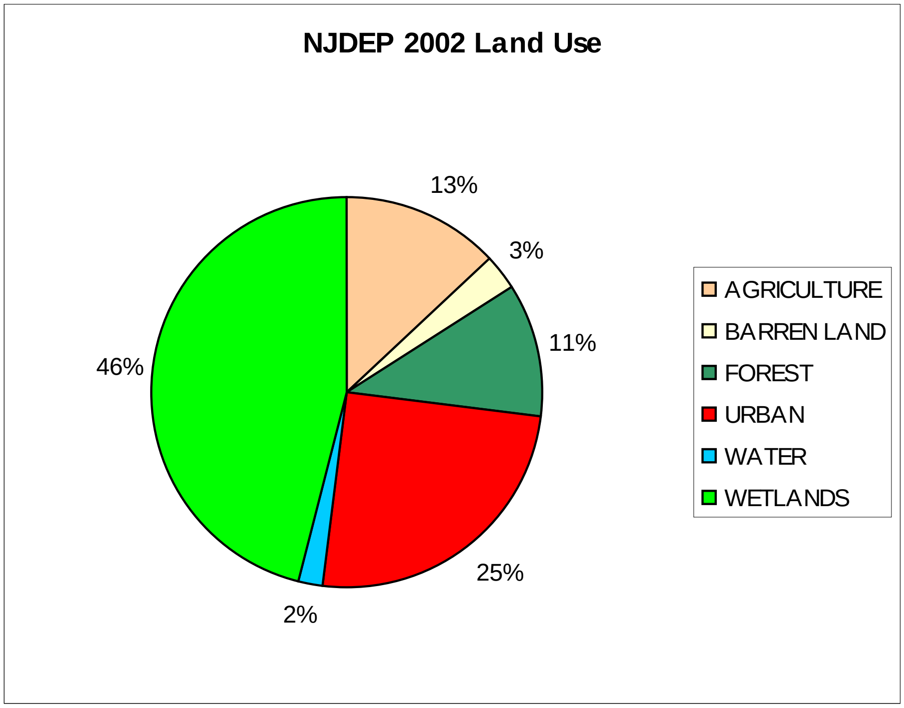

Figure 3: Assiscunk Creek Watershed Land Use (NJDEP, 2002)

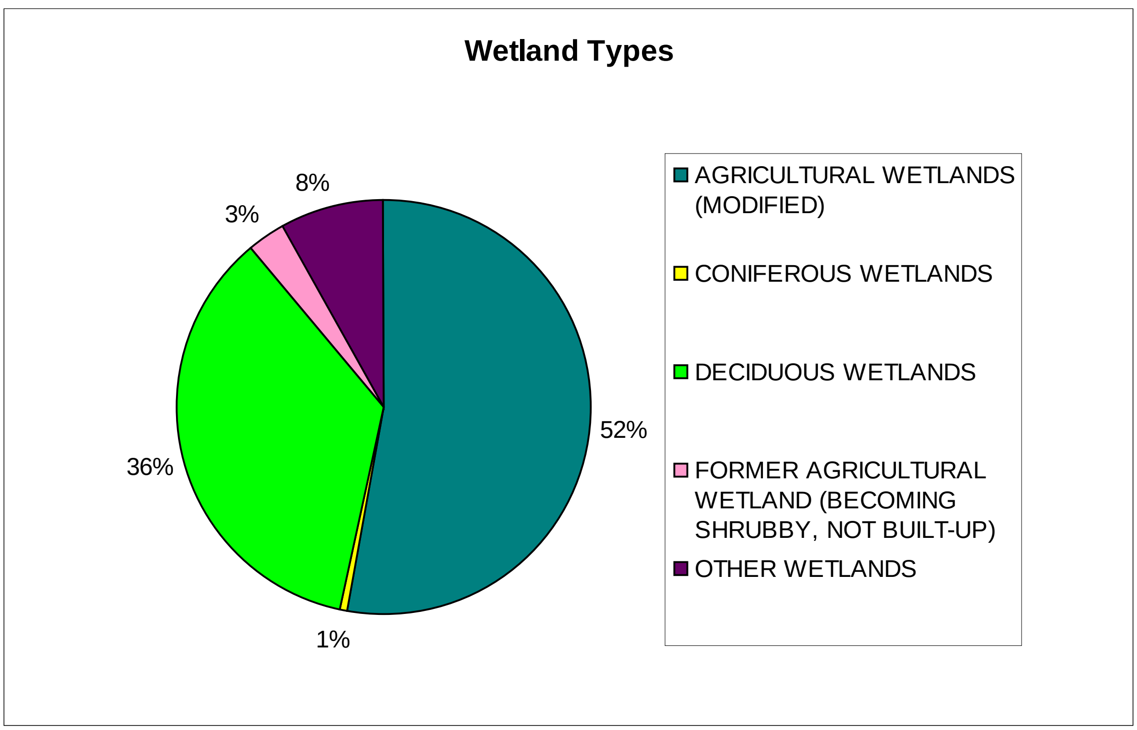

Figure 4: Assiscunk Creek Watershed Wetland Types (NJDEP, 2002)

The Delineation of the Assiscunk Creek Watershed

The total planning area for the Assiscunk Creek Watershed Restoration and Protection Plan is approximately 14.6 square miles, containing one full HUC14 watershed and the upper portions of two other HUC14 watersheds. One full HUC 14 watershed (02040201100010) is included in this planning area, along with the upper subbasins of two HUC 14 watersheds (02040201100040 and 02040201100020-01), which includes the eastern section of the Assiscunk Creek (Route 206 to drainage divide west of Petticoat Bridge Road) and the North Branch of Barkers Brook. (See Figure 5)

The six subbasins of the Assiscunk Creek Watershed were delineated within the boundaries of three HUC14 watersheds. This was performed to allow for analysis of the greatest areas of concern. The boundaries of the Assiscunk Creek Watershed and its subbasins can be viewed within the boundaries of the HUC 14's in Figure 5.

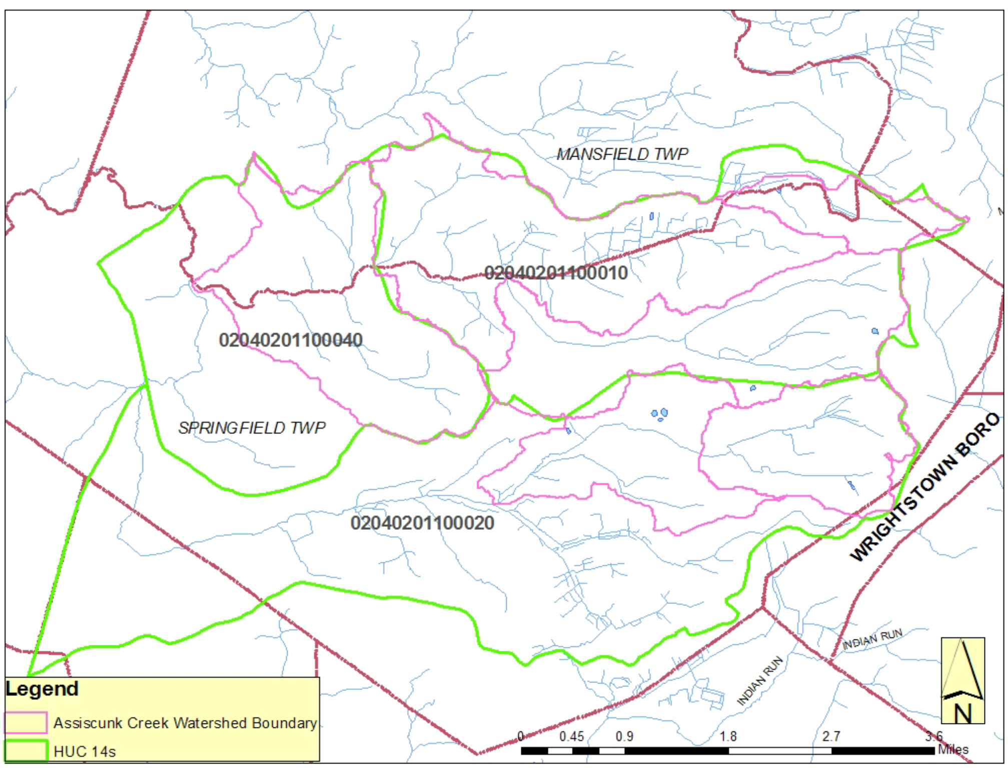

Figure 5: Limits of Assiscunk Creek Watershed Boundary within HUC14 Boundaries

The HUC14 name and number can be identified as to its related Assiscunk Creek Watershed subbasin in Table 1.

Table 1: HUC14 and Corresponding Assiscunk Creek Watershed Boundaries

HUC14	Name	Sub-watersheds from Assiscunk Creek Watershed Contained in HUC14
2040201100010	Assiscunk Creek (above Route 206)	ASK2, ASK1, ANR
2040201100020	Barkers Brook (above 40d02m30s)	BB1, BB2
2040201100040	Assiscunk Creek (Jacksonville Road to Route 206)	ASK3

TMDL Development Process and Project Background

Section 303(d) of the Federal Clean Water Act (CWA) requires New Jersey to prepare and submit to the United States Environmental Protection Agency (USEPA) a report that identifies waters that do not meet or are not expected to meet state surface water quality standards. This report is commonly referred to as the 303(d) list. Those waterbodies, which are listed on the 303(d) list, are water quality limited waterbodies and therefore a total maximum daily load (TMDL) must be developed for each individual pollutant in these water bodies based on an agreed-upon schedule between the state and USEPA.

A TMDL is a calculation of the maximum amount of a single pollutant that a waterbody can receive and still meet state water quality standards. It quantitatively assesses water quality problems, contributing sources, and load reductions or control actions needed to restore and protect individual water bodies. The ultimate goal of the TMDL process is to meet the water quality standards and ultimately improve the water resources within a watershed.

A TMDL establishes waste load allocations and load allocations for point and nonpoint sources (NPS), respectively. These allocations together, with a margin of safety (MOS), are used to calculate the TMDL value. Point source pollution can come from the wastewater of various industries; federal, state, county, and municipal facilities; private companies; private residential developments; hospitals and schools. These point sources are all regulated. NPS pollution, on the other hand, comes from many diffuse sources that enter waterways from stormwater runoff. Some sources of NPS pollution are excess fertilizers, sediment from streets or land that is not stable, and bacteria from pet wastes or faulty septic systems.

Within the Integrated List of Waterbodies (NJDEP, 2008) for New Jersey are lists that indicate the presence and level of impairment for each waterbody monitored. The lists are defined as follows:

- **Sublist 1** suggests that the waterbody is meeting water quality standards.
- **Sublist 2** states that a waterbody is attaining some of the designated uses, and no use is threatened. Furthermore, Sublist 2 suggests that data are insufficient to declare if other uses are being met.
- **Sublist 3** maintains a list of waterbodies where no data or information are available to support an attainment determination.
- **Sublist 4** lists waterbodies where use attainment is threatened and/or a waterbody is impaired; however, a TMDL will not be required to restore the waterbody to meet its use designation.
    - **Sublist 4a** includes waterbodies that have a TMDL developed and approved by the USEPA, that when implemented, will result in the waterbody reaching its designated use.
    - **Sublist 4b** establishes that the impaired reach will require pollutant control measurements taken by local, state, or federal authorities that will result in full attainment of designated use.
    - **Sublist 4c** states that the impairment is not caused by a pollutant, but is due to factors such as instream channel condition and so forth. It is recommended by the USEPA that this list be a guideline for water quality management actions that will address the cause of impairment.
- **Sublist 5** clearly states that the water quality standard is not being attained and requires a TMDL.

Assiscunk Creek Project Background

Based on water quality testing and subsequent data analysis performed under the Integrated Water Quality Monitoring and Assessment Methods Document (NJDEP, 2006c), several sections of the Assiscunk Creek Watershed have been categorized as being impaired for various parameters and uses (NJDEP, 2006b; NJDEP, 2008). In the 2006 and 2008 reports, all areas within the boundaries of the delineated Assiscunk Creek Watershed were listed on Sublist 5 for the impairment of aquatic life (general), thereby requiring a TMDL.

The Assiscunk Creek Watershed is affected by the creation of two TMDLs. A TMDL to address the fecal coliform contamination levels in the Annaricken Brook and Barkers Brook was approved in September of 2003 and requires a reduction in load allocation of 95% for the Annaricken and 96% for Barkers Brook (Table 2). A second TMDL addressing phosphorus levels was approved in October of 2007 and requires a load allocation reduction of 54.6% for the Annaricken and 66% for Barkers Brook (Table 2).

Table 2: Integrated Listing and TMDLs in the Assiscunk Creek Watershed

	Station Name	Use Impairment	Parameter	PerCent Reduction (with MOS)
Approved (by EPA Region 2) 9/29/03	Annaricken Brook near Jobstown	Primary Contact	Fecal Coliform	95%
	North Branch Barkers Brook near Jobstown	Primary Contact	Fecal Coliform	96%
Approved (by EPA Region 2) 10/1/07	Annaricken Brook near Jobstown	Aquatic Life (Gen)	Phosphorus	54.60%
	Barkers Brook near Jobstown	Aquatic Life (Gen)	Phosphorus	66%

Biological Monitoring Data

Biological monitoring data is available for the watershed as part of the Ambient Biological Monitoring Network (AMNET), which is administered by the New Jersey Department of Environmental Protection (NJDEP). The NJDEP has been monitoring the biological communities of the State's waterways since the early 1970's, specifically the benthic macroinvertebrate communities. Benthic macroinvertebrates are primarily bottom-dwelling (benthic) organisms that are generally ubiquitous in freshwater and are macroscopic. Due to their important role in the food web, macroinvertebrate communities reflect current perturbations in the environment. There are several advantages to using macroinvertebrates to gauge the health of a stream. First, macroinvertebrates have limited mobility, and thus, are good indicators of site-specific water conditions. Also, macroinvertebrates are sensitive to pollution, both point and nonpoint sources. Macroinvertebrates can be impacted by short-term environmental impacts such as intermittent discharges and contaminated spills. In addition to indicating chemical impacts to stream quality, macroinvertebrates can gauge non-chemical issues of a stream such as turbidity, siltation, eutrophication, and thermal stresses. Finally, macroinvertebrate communities are a holistic overall indicator of water quality health, which is consistent with the goals of the Clean Water Act (NJDEP, 2004). These organisms are normally abundant in New Jersey freshwaters and are relatively inexpensive to sample.

The AMNET program began in 1992 and is currently comprised of more than 800 stream sites with approximately 200 monitoring locations in each of the five major drainage basins of New Jersey (i.e., Upper and Lower Delaware, Northeast, Raritan, and Atlantic). These sites are sampled once every five years using a modified version of the USEPA Rapid Bioassessment Protocol (RBP) II. To evaluate the biological condition of the sampling locations, several community measures are calculated by the NJDEP from the data collected and include the following:

1. Taxa Richness: Taxa richness is a measure of the total number of benthic macroinvertebrate families identified. A reduction in taxa richness typically indicates the presence of organic enrichment, toxics, sedimentation, or other factors.

2. EPT (Ephemeroptera, Plecoptera, Trichoptera) Index: The EPT Index is a measure of the total number of Ephemeroptera, Plecoptera, and Trichoptera

families (i.e., mayflies, stoneflies, and caddisflies) in a sample. These organisms typically require clear moving water habitats.

3. %EPT: Percent EPT measures the numeric abundance of the mayflies, stoneflies, and caddisflies within a sample. A high percentage of EPT taxa is associated with good water quality.

4. %CDF (percent contribution of the dominant family): Percent CDF measures the relative balance within the benthic macroinvertebrate community. A healthy community is characterized by a diverse number of taxa that have abundances somewhat proportional to each other.

5. Family Biotic Index: The Family Biotic Index measures the relative tolerances of benthic macroinvertebrates to organic enrichment based on tolerance scores assigned to families ranging from 0 (intolerant) to 10 (tolerant).

This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey Impairment Score (NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired. A non-impaired site has a benthic community comparable to other high quality "reference" streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and a good representation of intolerant individuals. A moderately impaired site is characterized by reduced macroinvertebrate taxa richness, in particular the EPT taxa. Changes in taxa composition result in reduced community balance and intolerant taxa become absent. A severely impaired site is one in which the benthic community is significantly different from that of the reference streams. The macroinvertebrates are dominated by a few taxa which are often very abundant. Tolerant taxa are typically the only taxa present.

The scoring criteria currently used by the NJDEP are as follows:

- Non-impaired sites have total scores ranging from 24 to 30,
- Moderately impaired sites have total scores ranging from 9 to 21, and
- Severely impaired sites have total scores ranging from 0 to 6.

It is important to note that the entire scoring system is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams. While a low score indicates "impairment," the score may actually be a consequence of habitat or other natural differences between the subject stream and the reference stream.

Starting with the second round of sampling under the AMNET program held between 2000 and 2001 for the Lower Delaware River region, habitat assessments were conducted in conjunction with the biological assessments. The first round of sampling under the AMNET program did not include habitat assessments. The habitat assessment, which was designed to provide a measure of habitat quality, involves a visually based technique for assessing stream habitat structure. The habitat assessment is designed to provide an estimate of habitat quality based upon qualitative estimates of selected habitat attributes. The assessment involves the numerical scoring of ten habitat parameters to evaluate instream substrate, channel morphology, bank structural features, and riparian vegetation. Each parameter is scored and summed to produce a total score which is assigned a habitat quality category of optimal, sub-optimal, marginal, or poor. Sites with optimal/excellent habitat conditions have total scores ranging from 160 to 200; sites with suboptimal/good habitat conditions have total scores ranging from 110 to 159; sites with marginal/fair habitat conditions have total scores ranging from 60 to 109, and sites with poor habitat conditions have total scores less than 60. The findings from the habitat assessment are used to interpret survey results and identify obvious constraints on the attainable biological potential within the study area.

AMNET and the Assiscunk Creek Watershed

The NJDEP Bureau of Biological & Freshwater Monitoring maintains three AMNET stations within the delineation of the Assiscunk Creek Watershed (Stations AN0138, AN0139 and AN0140) (See Figure 6).

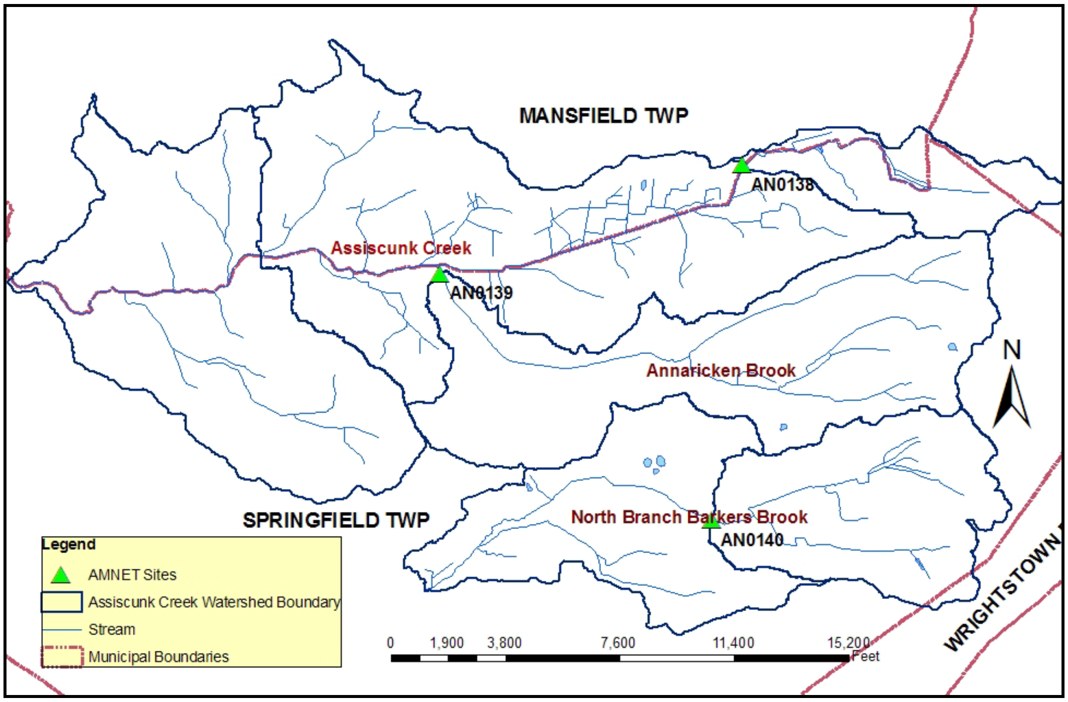

Figure 6: Location of AMNET Stations within the Assiscunk Creek Watershed

All three stations were sampled by NJDEP in 1993, 1998, 2001, and 2006 under the AMNET program. Findings from the AMNET program for the stations located within the project area are summarized in Table 3. The biological condition over the years has ranged from severely to moderately impaired, and the habitat has ranged from marginal to sub-optimal conditions within the Assiscunk Creek Watershed.

Table 3: Summary of NJDEP Ambient Biological Monitoring Network (AMNET) results (NJDEP, 1994; NJDEP, 1999; NJDEP, 2003; NJDEP, 2010)

AMNET Station (RCE Location)	Location	1993 - Round 1		1998 - Supplemental Sampling			2001 - Round 2			2006 - Round 3		
		Date Sampled	Impairment Status	Date Sampled	Impairment Status	Habitat Analysis Result	Date Sampled	Impairment Status	Habitat Analysis Result	Date Sampled	Impairment Status	Habitat Analysis Result
AN0138 (ASK1)	Assiscunk Ck., Columbus-Georgetown Rd., Mansfield Twp.	1/25/93	severe (NJIS)	1/8/98	moderate (NJIS)	sub-optimal	1/16/01	moderate (NJIS) fair (PMI)	marginal	6/6/06	moderate (NJIS) fair (PMI)	sub-optimal
AN0139 (ANR)	Annaricken Bk., Island Rd., Springfield Twp.	1/25/93	moderate (NJIS)	1/8/98	moderate (NJIS)	sub-optimal	1/16/01	moderate (NJIS) fair (CPMI)	sub-optimal	6/15/06	moderate (NJIS) good (CPMI)	sub-optimal
AN0140 (BB1)	North Br. Barkers Bk., Georgetown-Juliustown Rd., Springfield Twp.	1/25/93	severe (NJIS)	1/13/98	moderate (NJIS)	sub-optimal	1/17/01	severe (NJIS) poor (PMI)	marginal	6/15/06	severe (NJIS) poor (PMI)	sub-optimal

NJIS = New Jersey Impairment Score, PMI = Pinelands Macroinvertebrate Index, CPMI = Coastal Plain Macroinvertebrate Index

Given these aquatic life impairments, an additional biological assessment was proposed as part of the development of the Watershed Restoration and Protection Plan for the Assiscunk Creek Watershed. A biological assessment was conducted by the Rutgers Cooperative Extension Water Resources Program in July 2008 at Station BB1 (i.e., AN0140), Station ANR (i.e., AN0139), Station ASK1 (i.e., AN0138), and Station ASK3. Station ASK3 is approximately 1.5 miles upstream from AMNET Station AN0141 on the Assiscunk Creek, which is just outside of the study area but within the Assiscunk Creek Watershed. The NJDEP under the AMNET program has assessed AN0141 as being moderately impaired and having sub-optimal habitat conditions. The 2008 biological assessment conducted by the Water Resources Program is summarized in Data Report Appendix A.

The 2008 assessment by the Water Resources Program at Station BB1 demonstrates that the biological condition improved to a moderately impaired status since 2006, but with a score of 9, the biological condition at BB1 borders on being severely impaired. The habitat condition in 2008 was downgraded to marginal. The 2008 assessment at Station ANR and ASK1 demonstrates that the biological condition remained at a moderately impaired status, and the habitat condition remained as sub-optimal. Furthermore, the 2008 assessment at Station ASK3 demonstrates that the biological condition in the vicinity of AMNET Station AN0141 remained as moderately impaired, and the habitat conditions remained as sub-optimal.

Coastal Plain Macroinvertebrate Index (CPMI)

New Jersey's benthic macroinvertebrate communities can be grouped into three distinct groupings based on geographical regions: high gradient (above the Fall Line), low gradient (Coastal Plain excluding the Pinelands), and Pinelands. A multimetric index has been developed, using genus level taxonomic identifications, for each distinct region. The NJIS described and presented above is a single index used statewide that is based on family level taxonomic identifications. The NJDEP, in 2009, began using the multimetric indices for each distinct region. The index appropriate to use within the Assiscunk Creek Watershed is the Coastal Plain Macroinvertebrate Index (CPMI). The CPMI is comprised of the following metrics: total number of genera, total number of EPT genera, percent Ephemeroptera genera, Hilsenhoff Biotic Index, and percent clinger genera ("Clinger" describes a habitat and behavior designation for how the organism functions in the stream. Clingers are able to remain stationery on the bottom substrates in flowing waters.).

The scoring criteria used by the NJDEP Bureau of Freshwater & Biological Monitoring for the CPMI are outlined in Table 4. Excellent sites have total scores ranging from 22-30 and are characterized as having minimal changes in the structure of biological community and having minimal changes in ecosystem function. Good sites have total scores ranging from 12-20 and are characterized as having some evident changes in the structure of the biological community and having minimal changes in ecosystem function. Fair sites have total scores ranging from 10-6 and are characterized as having moderate to major changes in the structure of the biological community and having moderate changes in ecosystem function. Poor sites have total scores of < 6 and are characterized by extreme changes in the structure of the biological community and a major loss of ecosystem function. CPMI scores for Stations BB1, ANR, ASK3, and ASK1 are provided in Tables 6-9, respectively. All the stations were assessed as being fair. A fair assessment under the CPMI falls below the acceptable regulatory range and would be considered impaired from a Federal Clean Water Act perspective and not attaining the aquatic life use.

Table 4: Scoring Criteria for Coastal Plain Macroinvertebrate Index (CPMI)

Score:	***Excellent***	***Good***	***Fair***	***Poor***
	6	***4***	***2***	***0***
Index Metrics:				
1. Number of genera	>25	17-25	9-16	<9
2. Number of EPT genera	>9	7-9	4-6	<4
3. % of Ephemeroptera	>29	20-29	10-19	<10
4. Hilsenhoff Biotic Index	<4.9	4.9-6.0	6.1-7.3	>7.3
5. % Clinger genera	>51	34-51	17-33	<17
Assessment Rating:	Total Score			
Excellent	22-30			
Good	12-20			
Fair	10-6			
Poor	<6			

Table 5: Calculation of Coastal Plain Macroinvertebrate Index for Station BB1

Taxa	***Tolerance Value***	***Station BB1 Number of Individuals***
Gammarus sp.	6	85
Calopteryx sp.	6	2
Enallagma sp.	8	3
Ischnura sp.	9	1
Belostoma sp.	5	2
Trichocorixa sp.	5	3
Stenelmis sp.	5	2
Sialis sp.	4	4
Tanypodinae	7	2
Total Number of Genera		9
Number of EPT Genera		0
% of Ephemeroptera		0%
Hilsenhoff Biotic Index		5.96 (Fair - fairly significant organic pollution)
% Clinger Genera		2%
Coastal Plain Macroinvertebrate Index (CPMI)		6
Assessment Rating		***Fair***

Table 6: Calculation of Coastal Plain Macroinvertebrate Index for Station ANR

Taxa	***Tolerance Value***	***Station ANR Number of Individuals***
Physa sp.	8	2
Orconectes sp.	6	2
Gammarus sp.	6	5
Baetis sp.	6	4
Gomphus sp.	5	2
Microvelia sp.	5	9
Rhagovelia sp.	5	1
Stenelmis sp.	5	18
Sialis sp.	4	1
Hydropsyche sp.	4	15
Cheumatopsyche sp.	5	28
Dicranota sp.	3	2
Tipula sp.	6	1
Simulium sp.	5	10
Chironominae	6	1
Tanypodinae	7	3
Total Number of Genera		16
Number of EPT Genera		3
% of Ephemeroptera		4%
Hilsenhoff Biotic Index		5.05 (Good - some organic pollution)
% Clinger Genera		51%
Coastal Plain Macroinvertebrate Index (CPMI)		10
Assessment Rating		***Fair***

Table 7: Calculation of Coastal Plain Macroinvertebrate Index for Station ASK3

Taxa	***Tolerance Value***	***Station ASK3 Number of Individuals***
Physa sp.	8	3
Pisidium sp.	6	2
Gammarus sp.	6	3
Orconectes sp.	6	4
Isotomurus sp.	5	1
Argia sp.	6	1
Enallagma sp.	8	1
Sigara sp.	3	49
Pelocoris sp.	5	1
Notonecta sp.	5	3
Chauliodes sp.	4	1
Sialis sp.	4	7
Polycentropus sp.	6	5
Chironominae	6	7
Tanypodinae	7	10
Bittacomorpha sp.	9	2
Total Number of Genera		16
Number of EPT Genera		1
% of Ephemeroptera		0%
Hilsenhoff Biotic Index		4.56 (Good - some organic pollution)
% Clinger Genera		7%
Coastal Plain Macroinvertebrate Index (CPMI)		8
Assessment Rating		***Fair***

Table 8: Calculation of Coastal Plain Macroinvertebrate Index for Station ASK1

Taxa	***Tolerance Value***	***Station ASK1 Number of Individuals***
Dina sp.	8	2
Erpobdella sp.	8	1
Placobdella sp.	8	1
Physa sp.	8	6
Caecidotea sp.	8	4
Gammarus sp.	6	24
Cordulegaster sp.	3	5
Sigara sp.	3	7
Microvelia sp.	6	6
Promoresia sp.	2	2
Stenelmis sp.	5	2
Cheumatopsyche sp.	5	19
Hydropsyche sp.	4	7
Chironominae	6	4
Tanypodinae	7	13
Diacranota sp.	3	1
Total Number of Genera		16
Number of EPT Genera		2
% of Ephemeroptera		0%
Hilsenhoff Biotic Index		5.61 (Fair - fairly significant organic pollution)
% Clinger Genera		29%
Coastal Plain Macroinvertebrate Index (CPMI)		8
Assessment Rating		***Fair***

Stressor Identification

Biological assessments have become an important tool for managing water quality to meet the goal of the Clean Water Act (i.e., to maintain the chemical, physical, and biological integrity of the nation's water). However, although biological assessments are a critical tool for detecting impairment, they do not identify the cause or causes of the impairment. The U.S. Environmental Protection Agency (USEPA) developed a process, known as the Stressor Identification (SI) process, to accurately identify any type of stressor or combination of stressors that might cause biological impairment (USEPA, 2000). The SI process involves the critical review of available information, the formation of possible stressor scenarios that may explain the observed impairment, the analysis of these possible scenarios, and the formation of conclusions about which stressor or combination of stressors are causing the impairment. The SI process is iterative, and in some cases additional data may be needed to identify the stressor(s). In addition, the SI process provides a structure or a method for assembling the scientific evidence needed to support any conclusions made about the stressor(s). When the cause of a biological impairment is identified, stakeholders are then in a better position to locate the source(s) of the stressor(s) and are better prepared to implement the appropriate management actions to improve the biological condition of the impaired waterway.

The benthic macroinvertebrate community occurring within the Assiscunk Creek Watershed is apparently under some type of stress as evidenced by sensitive taxa (i.e., EPT taxa) being markedly diminished and by a conspicuously unbalanced distribution of major groups (i.e, relatively high percent dominance). Based on the calculated family level and generic level Hilsenhoff Biotic Index, the types of organisms found within the study area are indicative of some organic pollution to fairly substantial levels of organic pollution (Hilsenhoff, 1988). In addition, the habitat assessment revealed sub-optimal habitat to marginal conditions which may also account for the impaired condition of the community within the study area.

Candidate causes of impairment within the Assiscunk Creek Watershed include:

1. Elevated nutrient levels (i.e., total phosphorus)
2. Elevated bacteria levels (i.e., fecal coliform and *E. coli*)
3. Degraded instream habitat
4. Altered hydrology
5. Toxicants.

Analysis/Evaluation of Candidate Causes:

<u>Elevated nutrient levels and elevated bacteria levels</u>: The role of elevated nutrients and elevated bacteria levels in impairing the biological community was indicated by continual and persistent exceedances of the surface water quality criteria for phosphorus and bacteria throughout the watershed during the surface water quality monitoring portion of this study. Surface water quality samples were collected from stations within the Assiscunk Creek Watershed over a six-month sampling time frame from April 2008 to September 2008, demonstrating a co-occurrence of these candidate causes within the watershed. Approximately 70% of the designated land use within the watershed is agricultural/agricultural wetlands. Stormwater runoff from these agricultural land uses is a likely source of elevated nutrients. In addition, visual assessments (i.e., SVAP) were conducted in the Assiscunk Creek Watershed as part of this study. Manure was observed at several locations which may be a likely source of the elevated bacteria levels observed within the watershed.

<u>Degraded habitat</u>: The role of degraded habitat in impairing the biological community within the watershed was indicated by the assessed sub-optimal to marginal habitat conditions within the watershed. A likely source observed within the watershed for degraded habitat conditions includes channelization, which reduces channel diversity, promotes a uniform flow regime, and ultimately reduces habitat diversity. Another likely source is stormwater outfalls which can increase erosion and scour leading to reduced channel diversity, homogenous flow regime and unstable habitat. An additional source observed within the watershed is a decreased riparian vegetative zone (i.e., riparian buffer) which leads to increased stream temperatures, depressed dissolved oxygen levels, unstable banks, and an overall reduction in habitat complexity.

<u>Altered hydrology</u>: The role of altered hydrology in impairing the biological community within the watershed was indicated by reduced channel and habitat diversity, a slow and homogenous flow regime, and a potential reduction in baseflow. Stations BB1, ANR, and ASK1 all appeared to be drying up during the summer of 2008 during the biological assessment portion of the study, especially Station ASK1. A likely source for altered

hydrology observed within the watershed includes channelization, which reduces channel diversity and therefore promotes a uniform flow regime. Another likely source for altered hydrology observed within the watershed would include stormwater outfalls. Stormwater outfalls can increase erosion and scour leading to reduced channel diversity and homogenous flow regime. Finally, a source for the altered hydrology may be the low gradient condition of the stream, which is characterized by a slow flow regime. The low gradient condition of the stream is naturally occurring and characteristic of small coastal plain streams such as Annaricken Brook, Barkers Brook, and the Assiscunk Creek.

<u>Toxicants</u>: The role of toxicants in impairing the biological community was indicated by the observation of water odors and surface oils at ASK3 and BB1, as well as the observation of sediment odors and oils at BB1. Additional monitoring for toxics, especially petroleum hydrocarbons, is warranted at these locations and within the watershed. Monitoring for pesticides and herbicides as possible toxicants is warranted given the agricultural nature of the watershed, as well.

Stream Visual Assessment Protocol (SVAP) Data Collected in the Assiscunk Creek Watershed

Introduction to SVAP

To characterize watershed health, the USDA Natural Resources Conservation Service (NRCS) developed the Stream Visual Assessment Protocol (SVAP). The SVAP was originally developed for use by landowners (USDA, 1998), but it has also proved to be useful for those familiar with local river systems and flooding occurrences. The protocol provides an outline on how to quantitatively score in-stream and riparian qualities that include water appearance, channel condition, and riparian health. There are ten (10) primary SVAP elements:

- channel condition,
- hydrologic alternation,
- riparian zone,
- bank stability,
- water appearance,
- nutrient enrichment,
- barriers to fish movement,
- instream fish cover,
- presence of pools, and
- invertebrate habitat.

There are five (5) additional elements that should only be scored if applicable. These are canopy cover, manure presence, salinity, riffle embeddedness, and observed macroinvertebrates. Elements are scored from 1 to 10 (poor to excellent) with the exception of observed macroinvertebrates, which uses a scale ranging from 1 to 15 (poor to excellent). Once all the individual elements are scored, their average is calculated and the range of mean scores is used to qualitatively describe overall watershed health as follows:

- < 6.0 is Poor;
- 6.1-7.4 is Fair;
- 7.5-8.9 is Good;
- > 9.0 is Excellent.

The SVAP data sheet was modified by the RCE Water Resources Program to include other reach features to aid in pollution source track down in the Assiscunk Creek Watershed. These reach features include the identification of pipes and ditches, details on erosion or impairment caused by identified pipes or ditches, and access to stream reach for possible restoration. Additionally, all assessed reaches were photo-documented, and a site sketch was made denoting important reach characteristics.

SVAP in the Assiscunk Creek Watershed

Stream Visual Assessment Protocol (SVAP) was conducted in the Assiscunk Creek Watershed beginning in June of 2009. In June of 2009, staff members from the RCE Water Resources Program and an intern from the Burlington County Department of Resource Conservation were trained in SVAP procedures. The training workshop consisted of a full day of SVAP introduction and use, and included presentations in a classroom setting and group and paired exercises in the field. Later training included instructions on how to use the RCE online database entry system for SVAP data. The project watershed was divided into a gridded map, and individual maps of each grid were assigned to participating project partners to facilitate completion of the Assiscunk Creek Watershed SVAP assessments.

Access to the river system was the major obstacle in completing visual assessments in the Assiscunk Creek Watershed. Due to the agricultural land use dominating the watershed, it was necessary to alert landowners of this upcoming effort. Therefore, announcements were made in local newspapers, and letters were mailed to the landowners. This was advantageous to the project, as feedback from these landowners improved the assessments and additional information about the stream conditions were gained that might otherwise have been unavailable.

At the onset of the assessment effort, it was decided that macroinvertebrates observed were not to be scored as part of this SVAP process since macroinvertebrate data were collected as part of the NJDEP-approved sampling plan for this project (Data Report Appendix C).

SVAP Data

Fifty-two stream reaches were evaluated in the Assiscunk Creek Watershed (Figure ; Data Report Appendix B) The overall SVAP score for all 52 reaches was 6.0, a resulting watershed quality of “fair” (Table 9). There were five areas where the presence of manure was observed and assessed. Pastures were noted along the banks of eleven of the fifty-two sites evaluated, but no access to stream was noted. Observations were made regarding the rust colored water and rust colored algae or floc at distributed sites throughout the watershed, attributed to sulfur and iron containing substrates. Riffles were present at sixteen locations and received an average score of poor, which means that riffles were on average 30-40% embedded. The average for canopy cover was also rated as poor.

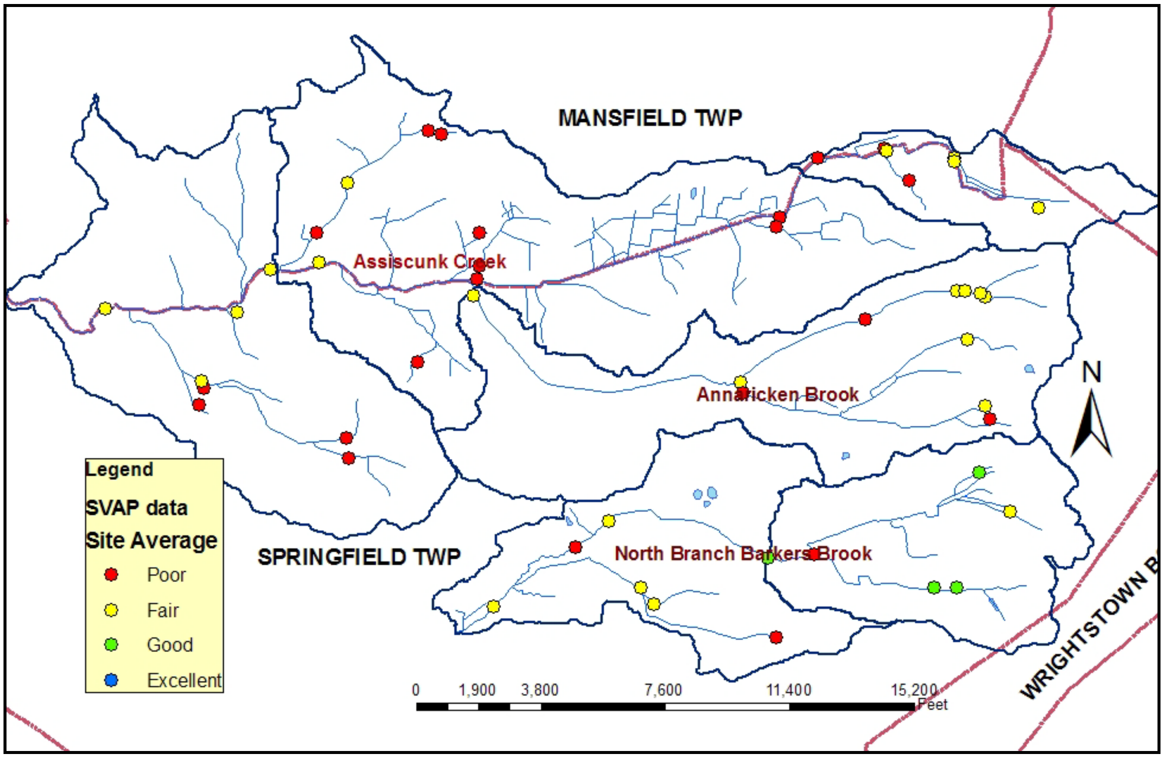

Figure 7: Stream visual assessment reaches with scores in the Assiscunk Creek Watershed

Table 9: SVAP Assessment Elements and Data

	Hydrologic Alteration	Channel Condition	Riparian Zone - left bank	Riparian Zone - right bank	Bank Stability - left bank	Bank Stability - right bank	Water Appearance	Nutrient Enrichment	Barriers to Fish Movement
# of scores	52	52	52	52	52	52	52	52	52
minimum value	1	2	1	1	2	1	1	1	1
maximum value	10	10	10	10	9	9	10	10	10
average	6.23	6.44	6.31	6.46	5.85	5.73	5.60	6.48	6.29

	Instream Fish Cover	Pools	Invertebrate Habitat	Canopy Cover	Manure Presence	Riffle Embeddedness	Water Appearance & Nutrient Enrichment Averages	Tiered Assessment Averages*
# of scores	52	52	52	52	5	16	52	52
minimum value	1	1	2	0	5	1	1	1
maximum value	9	10	10	10	7	10	10	10
average	5.38	4.29	7.31	5.88	6.20	5.44	6.04	6.14

	Overall Average - left bank	Overall Average - right bank	Overall Site Average			
# of scores	52	52	52			
minimum value	3.82	3.55	3.68			
maximum value	7.92	7.92	7.92			
average	6.00	6	6.00			

Using the SVAP Data

SVAP scores will be evaluated as individual assessment elements and combined with other data collected as part of this restoration planning effort. The SVAP results will be compared to land use, soil characteristics, slope and stream gradient, and water quality monitoring results to determine the quality of waters within the Assiscunk Creek Watershed. The SVAP scores, information on pipes, ditches, photos, and remediation notes will be used to identify sources of pollution and potential opportunities for improved management.

Water Quality Sampling Overview

Surface water quality samples were collected from six (6) water quality monitoring stations (Figure 8) over the fifteen (15) month sampling time frame. Three stations are located on the mainstem Assiscunk Creek, one station is located on the Annaricken, a tributary to the Assiscunk Creek, and two stations are on the North Branch of the Barkers Brook. The stations were placed in accessible sites located at the outlet of the hydrologically delineated subbasins of the Assiscunk Creek Watershed. Stations are identified in Table 10 and Figure . All water quality data are presented in Appendices D and E.

Table 10: Water Quality Monitoring Location IDs and Descriptions

Site ID	Site Description	HUC14	Coordinates
ASK3	Assiscunk Creek at Petticoat Bridge Road	2040201100040	40˚03′13.91″N, -74˚44′35.70″W
ASK2	Assiscunk Creek at United States Highway 206	2040201100010	40˚03′24.91″N, -74˚43′25.96″W
ANR	Annaricken Brook at Island Road (also AN0139)	2040201100010	40˚03′18.91″N, -74˚42′08.19″W
ASK1	Assiscunk Creek at Columbus-Georgetown Road (also AN0138)	2040201100010	40˚03′55.35″N, -74˚40′01.00″W
BB2	Barkers Brook North at Juliustown Road (also AN0140)	2040201100020	40˚01′38.85″N, -74˚42′05.52″W
BB1	Barkers Brook North southeast of Monmouth Road	2040201100020	40˚01′57.83″N, -74˚40′12.48″W

To identify the cause(s) of impairment observed through both of the SVAP results and biological sampling, project partners, including the RCE Water Resources Program and the Burlington County Department of Resource Conservation began water quality monitoring on April 9, 2008. As per the NJDEP-approved Quality Assurance Project Plan (QAPP), *in situ* measurements of pH, dissolved oxygen (DO), and temperature were collected (Data Report Appendix C). Stream velocity and depth were measured across stream transects at each sampling station. Using this information, flow (Q) was calculated for each event where access to the stream was deemed safe. Water samples were collected and analyzed by New Jersey Analytical Laboratories (NJDEP Certified Laboratory #PA 11005) for *Fecal coliform* (FC), *Escherichia coli* (*E.coli*), ammonia-nitrogen (NH_3-N), Nitrate-nitrogen (NO_3^--N), Nitrite-nitrogen (NO_2^--N), total phosphorus (TP), dissolved orthophosphate phosphorus (PO_4^{3-}-P), total Kjeldahl nitrogen (TKN), and total suspended solids (TSS).

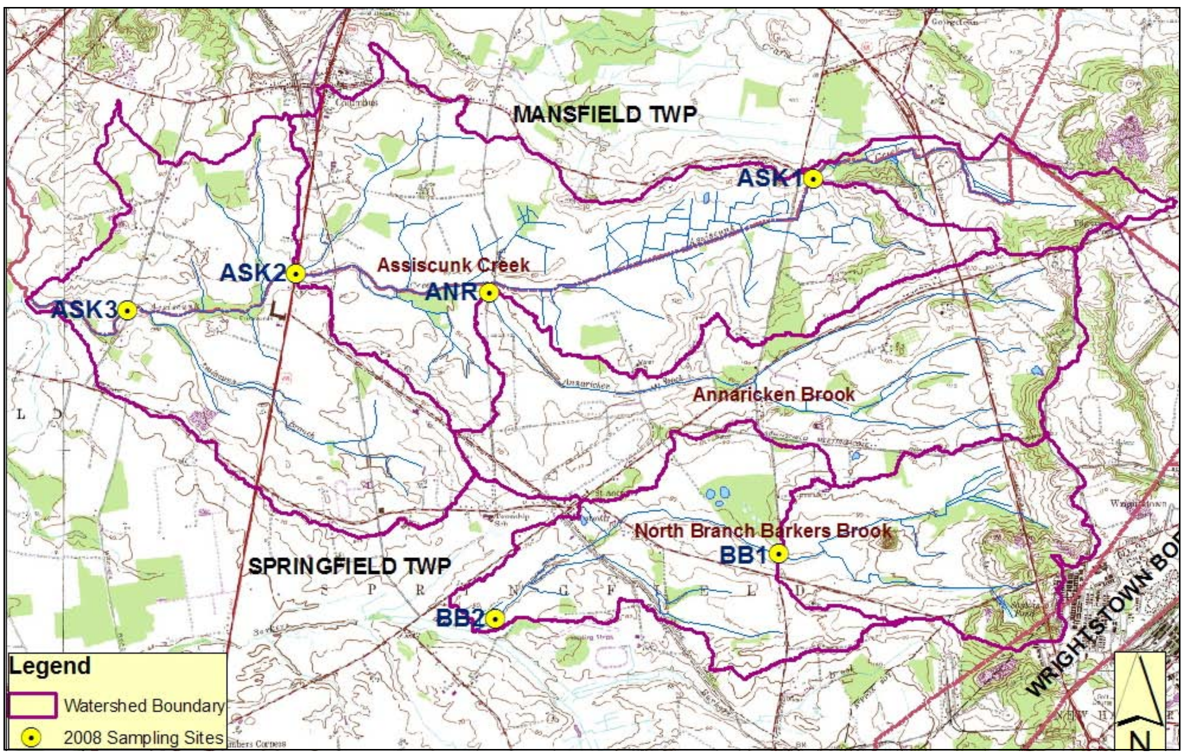

Figure 8: Assiscunk Creek Watershed Water Quality Sampling Site Locations

The monitoring of the water quality included three different types of sampling events as presented in Table 11. Regular monitoring, which included analysis of all original parameters, occurred from April 9, 2008 to September 23, 2008. These events were monitored for all *in situ* parameters, velocity and depth, and FC, *E. coli*, NH_3-N, NO_3^--N, NO_2^--N, TP, PO_4^{3-}-P, TKN, TSS. Bacteria only monitoring was conducted in the summer months of June through August of 2008. This entailed collecting three additional samples in each of those months for Fecal coliform and *E. coli* analyses, as well as *in situ* parameters, velocity and depth. In addition, surface water quality samples from three storm events were collected between July of 2008 and July of 2009. Three samples were collected over the course of each storm event and samples were analyzed for all parameter at all six (6) monitoring sites.

Table 11: Assiscunk Creek Watershed Water Quality Monitoring Events

Date	Regular Monitoring for all Parameters	Bacteria Only Monitoring	Storm Event Monitoring
04/09/08	X		
04/24/08	X		
05/20/08	X		
05/22/08	X		
06/04/08	X		
06/10/08		X	
06/12/08		X	
06/18/08	X		
06/24/08		X	
7/2/2008	X		
07/08/08		X	
07/10/08		X	
07/15/08	X		
07/22/08		X	
07/23/08			X
07/24/08			X
07/24/08			X
08/05/08		X	
08/07/08	X		
08/13/08		X	
08/19/08	X		
08/21/08		X	
09/09/08	X		
09/23/08	X		
09/26/08			X

09/26/08			X
09/29/08			X
07/21/09			X
07/21/09			X
07/22/09			X

Data Results and Comparison to Water Quality Standards

To evaluate the health of the streams of the Assiscunk Creek Watershed at all six (6) stations, the monitoring results were compared to the designated water quality standards. Water quality standards are developed according to the waterbody's designated uses (NJDEP, 2009). The streams within the Upper Barkers Brook subwatershed are classified as FW2-NT, or freshwater (FW) non-trout (NT). The Assiscunk Creek and the Annaricken Brook are classified as FW2-NTC1, C1 being Category 1, a higher level of anti-degradation protection for the stream. "FW2" refers to those waterbodies that are used for primary and secondary contact recreation; industrial and agricultural water supply; maintenance, migration, and propagation of natural and established biota; public potable water supply after conventional filtration treatment and disinfection; and any other reasonable uses. "NT" means those freshwaters that have not been designated as trout production or trout maintenance. NT waters are not suitable for trout due to physical, chemical, or biological characteristics, but can support other fish species. Category One designated waters are protected from any measurable change in water quality because of their exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources (NJDEP, 2009). The applicable water quality standards for this project are detailed in Table 12.

Table 12: Water Quality Standards according to N.J.A.C. 7:9B (NJDEP, 2009)

Substance	Surface Water Classification	Criteria
pH (S.U.)	FW2 (listed at 1.15 (e) in SWQS)	4.5-7.5
TP (mg/L)	FW2 Streams	Except as necessary to satisfy the more stringent criteria in accordance with "Lakes" or where watershed or site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3, phosphorus as total P shall not exceed 0.1 in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses.
TSS (mg/L)	FW2-NT	Non-filterable residue/suspended solids shall not exceed 40.
Bacterial counts (col/100ml):	FW2	*E. coli*: Shall not exceed a geometric mean of 126/100 ml or a single sample maximum of 235/100 ml.
		Fecal Coliform*: Shall not exceed geometric average of 200/100ml, nor should more than 10% of the total samples taken during any 30-day period exceed 400/100ml
Temperature	FW2-NT	Temperatures shall not exceed a daily maximum of 31 degrees Celsius or rolling seven-day average of the daily maximum of 28 degrees Celsius, unless due to natural conditions.
Dissolved Oxygen		24 hour average not less than 5.0, but not less than 4.0 at any time

**Fecal coliform was the indicator organism used during the compilation of TMDL. This standard has since been replaced by E. coli.*

A numeric criterion for total nitrogen in FW2-NT waters does not currently exist in New Jersey. Nitrate-nitrogen has a human health surface water quality criterion of 10 mg/L. A key comment added to the New Jersey Nutrient Criteria Enhancement Plan is that a nutrient criterion is needed for freshwater systems, with the NJDEP noting in the future schedule that NJDEP will evaluate the need (NJDEP, 2009b). Other input information regarding nitrogen levels are that reference conditions in Nutrient Ecoregion VIII are reported as 0.38 mg/L (USEPA, 2001) and New Jersey Pinelands waters have a nitrate-nitrogen surface water quality criteria of 2 mg/L (NJDEP, 2009).

The NJDEP's Integrated Water Quality Monitoring and Assessment Methods advises that if the frequency of water quality results exceed the water quality criteria twice within a five-year period, then the waterway's quality may be compromised (NJDEP, 2009b). NJDEP has further stated that a minimum of eight samples collected quarterly over a two-year period are required to confirm the quality of waters (NJDEP, 2005). Therefore, if a waterbody has a minimum of eight samples collected quarterly over a two-year period and samples exceed the water quality criteria for a certain parameter twice, the waterbody is considered "impaired" for that parameter. By applying this rule to the Assiscunk Creek Watershed water quality data, it is possible to identify which stations are impaired for each parameter that has been identified as a concern for this project (i.e., pH, TP, TSS, and bacteria). The number of samples exceeding these standards is given in Table 13.

Table 13: Percentage of samples that exceeded surface water quality standards (SWQS)

Station	SWQS	Count	Minimum	Maximum	Mean	# of exceedances	% not satisfying SWQS
pH (SU)							
ASK3	min 4.5 max 7.5	30	5.2	7.5	6.0	0	0.0
ASK2		29	4.7	6.3	5.4	0	0.0
ANR		29	5.4	7.5	5.9	0	0.0
ASK1		30	5.3	7.0	5.9	0	0.0
BB2		27	5.3	7.0	6.1	0	0.0
BB1		29	4.1	6.7	6.0	1	3.4
Dissolved Oxygen (mg/L)							
ASK3	4.0	30	3.5	9.3	5.9	2	6.7
ASK2		30	4.1	9.4	5.7	0	0.0
ANR		29	3.6	10.9	7.4	1	3.4
ASK1		30	2.2	10.7	7.1	1	3.3
BB2		27	3.9	11.0	7.3	1	3.7
BB1		29	4.2	11.3	7.5	0	0.0
E.Coli (org./100ml)							
ASK3	235.0	30	4	2700	415.0	10	33.3
ASK2		30	2	3300	504.3	10	33.3
ANR		30	4	3500	735.0	17	56.7

ASK1		30	2	15000	1178.6	17	56.7
BB2		30	10	3000	640.0	17	56.7
BB1		29	18	1500	326.6	12	41.4
Fecal Coliform (org./100ml)							
ASK3	400.0	30	1	22000	2201.0	17	56.7
ASK2		30	10	27000	2516.5	12	40.0
ANR		30	2	25000	2376.0	19	63.3
ASK1		30	4	39000	3281.9	21	70.0
BB2		60	4	20000	1824.0	19	63.3
BB1		29	4	9400	935.9	14	48.3
Total Phosphorus (mg/L)							
ASK3	0.1	21	0.0	0.5	0.1	11	52.4
ASK2		21	0.0	0.2	0.1	7	33.3
ANR		21	0.0	0.4	0.1	13	61.9
ASK1		21	0.0	0.4	0.1	14	66.7
BB2		21	0.0	0.4	0.2	14	66.7
BB1		20	0.0	0.4	0.2	11	55.0
Total Suspended Solids (mg/L)							
ASK3	40.0	21	2.0	72.0	13.0	1	4.8
ASK2		21	2.5	94.0	16.0	2	9.5
ANR		21	1.3	42.0	14.4	1	4.8
ASK1		21	1.0	43.0	11.2	1	4.8
BB2		21	2.5	180.0	19.4	3	14.3
BB1		20	125.0	38.0	8.3	0	0.0

Note: SWQS=Surface Water Quality Standards

At the time of this project's initiation and during the time of data collection, fecal coliform was the accepted measure indicating pathogen pollution for New Jersey freshwaters. Standards in place at that time were that fecal coliform should not exceed a (five samples over thirty days) geometric mean of 200 colonies/100ml or a maximum count of 400 colonies/100mL in no more than 10% of samples taken within a 30-day period. Since then, the fecal coliform standard has been replaced by the measure of *Escherichia coli* (*E. coli*). For New Jersey freshwaters, *E. coli* shall not exceed a (five-samples over thirty days) geometric mean of 126 colonies/100mL or a maximum count of 235 col/100mL in a single sample (NJDEP, 2009). At the time of this study, both fecal coliform data and *E. coli* data were collected. This was performed to conform to the TMDL and will also provide analysis of how the watershed may conform to the revised standard.

Tabulated water quality monitoring results are provided in Data Report Appendix D. Water quality monitoring data have also been graphed with surface water quality criteria, and these are available in Data Report Appendix E.

An additional analysis of the components of total suspended solids was undertaken for four sampling dates. This additional data was collected to provide information about the effect that inorganic (non-volatile) or organic (volatile) matter may have on water color. The data are presented in Table 14.

Table 14: Total Solids Quantification

ASK3	**Total Solids** *(mg/L)*	**TSS** *mg/L*	**Total Volatile solids** *(mg/L)*	ASK1	**Total Solids** *(mg/L)*	**TSS** *mg/L*	**Total Volatile solids** *(mg/L)*
08/07/08	100	14.0	4.0	08/07/08	220	2.5	6.8
08/19/08	150	3.5	37.0	08/19/08	280	4.0	77.0
09/09/08	99	6.5	4.0	09/09/08	260	14.0	12.0
09/23/08	140	4.0	4.2	09/23/08	310	6.5	10.0
ASK2				BB2			
08/07/08	84	10.0	3.7	08/07/08	150	3.0	8.9
08/19/08	150	8.0	30.0	08/19/08	130	2.5	45.0
09/09/08	100	12.0	4.2	09/09/08	250	180.0	3.7
09/23/08	140	4.0	6.3	09/23/08	130	3.5	5.7
ANR				BB1			
08/07/08	120	31.0	4.4	08/07/08	81	nd	3.3
08/19/08	160	5.0	46.0	08/19/08	140	3.5	51.0
09/09/08	110	16.0	4.5	09/09/08			
09/23/08	150	nd	42.0	09/23/08	150	6.5	5.8

nd=non-detect

Data Summary

The data show a variety of water quality concerns in the Assiscunk Creek Watershed. The AMNET macroinvertebrate results show varying impairments, from moderate impairment on the Annaricken, severe to moderate on the Assiscunk Creek and severe impairment on Barkers Brook (Table 3).

While the biological monitoring and SVAP assessments shed light on watershed quality, water monitoring provides possible reasons for this quality. Results indicate that total phosphorus and bacteria concentrations are in violation of surface water quality criteria established by the NJDEP (Table 12; Data Report Appendix D). All locations were in violation of both TP and bacteria (Fecal coliform and *E. coli)* water quality standards in greater than 10% of the samples (Table 13; Data Report Appendix D). At no time was the water quality criteria for temperature exceeded (Data Report Appendix D). Dissolved oxygen concentrations generally met criteria, with only a single sample (July 2008) at one site (ASK3) falling below the criteria. Measurements for pH also determined that general levels were within the boundaries of the water quality criteria, with only a single reading (9/26/2008) at one site (BB1) falling below the criteria.

No site within the Assiscunk Creek Watershed exceeded the human health criterion for nitrate-N of 10 mg/L. The concentration of nitrate-N across all sites ranged from 0.3 mg/L to 0.81 mg/L. Total nitrogen concentration across all sites ranged from 0.81 mg/L to 3.9 mg/L, with subbasin ASK2 having the greatest number of sample concentrations above the 2 mg/L Pinelands surface water quality standard, which this watershed does not currently need to obtain.

The data collected quantifying the total suspended solids concentration showed few surface water quality criteria exceedences (Table 13). The additional analysis of the components of these solids was predicted to provide greater insight into the cloudy, orange-brown color found in the streams of the Assiscunk Creek Watershed. These data (Table 14) included total solids and total volatile solids (organic). This also allowed for the computation of total dissolved solids (inorganic, including ions). The proportion of total volatile solids to total solids was determined. The ratio of the proportion of total volatile solids to total solids to the proportion of total suspended solids to total solids was also determined. Although these data were not conclusive, high volatile solids were determined to be present on one day, August 18, 2008, after one-half inch of rain fell over a five day period, presenting the potential of these organic materials coming from soil interflow contribution to baseflow. The higher values were not correlated to bacteria concentrations. An additional high volatile solid value was found at a single site, ANR, on September 23, 2008. Volatile solids could be anthropogenic (e.g., PAH's, pesticides, herbicides) or natural (e.g., humus).

Water quality data will be combined with land use data analysis to determine sources of pollutants. A full analysis of data will be conducted and presented in the *Assiscunk Creek Watershed Restoration and Protection Plan*.

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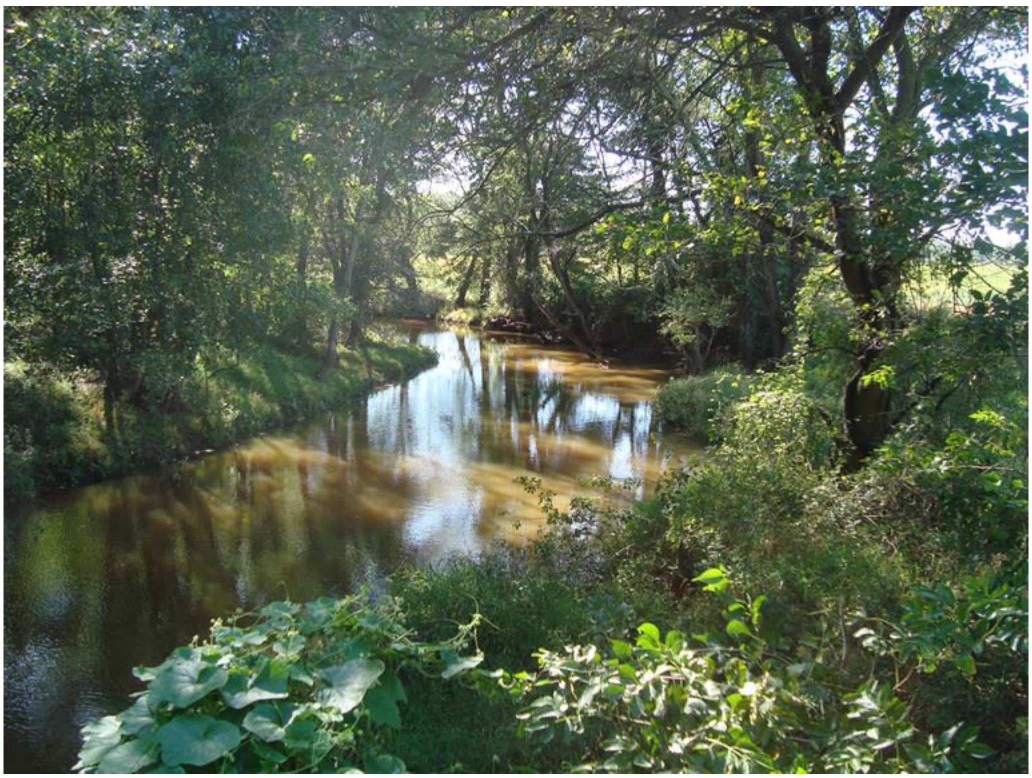
Data Report Appendix A:

Assiscunk Creek Watershed Restoration and Protection Plan, Data Summary- Biological Assessment

ASSISCUNK CREEK HEADWATER WATERSHED RESTORATION PLAN
DATA SUMMARY – JULY 2008 BIOLOGICAL ASSESSMENT



Rutgers Cooperative Extension Water Resources Program

Introduction

The total planning area for the Assiscunk Creek Headwater Watershed Restoration Plan is 14.6 square miles. The primary streams within the planning watershed are the Assiscunk Creek (headwaters), the North Branch of Upper Barkers Brook, and the Annaricken Brook (entire reach), with main stem lengths of 7.3 miles long, 4.8 miles long, and 3.9 miles long, respectively. Within this planning area, there are approximately 40 miles of mapped streams designated as Category One, with the exception of the North Branch of Upper Barkers Brook. While there are no major lakes in the sub-watersheds, there are three small impoundments that make up a total lake area of 2.8 acres within the planning area. The project area is entirely within Burlington County and contains portions of Mansfield Township and Springfield Township. Of the land use within the subject watershed, approximately 70 percent is designated as agricultural and agricultural wetlands with some suburban residential land use (*NJDEP 1995/97 Land use/Land cover Update, Assiscunk, Crosswicks and Doctors Watershed Management Area, WMA-20)*. According to the *New Jersey 2004 and 2006 Integrated Water Quality Monitoring and Assessment Report*, segments of the Assiscunk Creek do not meet the criteria for the aquatic life designated use and are documented as impaired for pH, total phosphorus, benthic macroinvertebrates, and fecal coliform (FC). Two total maximum daily loads (TMDLs) have been developed to address these water quality impairments. A TMDL to address the fecal coliform contamination levels in the Annaricken Brook and Barkers Brook was approved in September 2003 and requires a reduction in load allocation of 95% for the Annaricken and 96% for Barkers Brook. A second TMDL addressing phosphorus levels was approved in October 2007 and requires a load allocation reduction of 54.6% for the Annaricken and 66% for Barkers Brook.

Due to the recognized impairments and value of this ecological resource**,** a Watershed Restoration Plan for this project area will be developed that, when implemented, will achieve the load reductions required by the New Jersey Department of Environmental Protection (NJDEP) TMDLs, therefore bringing the waterway into compliance with surface water quality standards. Furthermore, the Watershed Restoration Plan will aim to restore and protect the physical, biological, and chemical integrity of these waterways, in particular the Category One segments, by fulfilling the nine minimum components of watershed planning and guiding the implementation of nonpoint source (NPS) pollution management measures. The following is a data summary of the biological assessment conducted by the Rutgers Cooperative Extension (RCE) Water Resources Program in July 2008 to collect water quality data needed to support the development of the watershed protection plan.

Biological Data Collection

A survey of the benthic macroinvertebrate community within the Assiscunk Creek watershed was conducted by the RCE Water Resources Program on July 17-18, 2008 in accordance with a Quality Assurance Project Plan (QAPP) (Submitted January 2007, Approved June 2007). The sampling and data analysis procedures were conducted in accordance with the Rapid Bioassessment Protocol (RBP) procedure used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (Barbour et al., 1999). Benthic macroinvertebrates were collected at four locations, ASK3, ANR, ASK1, and BB1, within the Assiscunk Creek watershed as described and identified in Figure 1.

A multi-habitat sampling approach, concentrating on the most productive habitat of the stream plus coarse particulate organic matter (CPOM) or leaf litter, was used. Given the nature of the substrate and the flow conditions at Stations FN1, SN1, TN3, and N1, a Surber Square Foot Bottom Sampler was used to collect three grab type samples from the most productive habitat of the stream (i.e., riffle/run areas). Samples were sorted and processed in the field using a U.S. Standard No. 30 sieve, composited (i.e., the contents from the grab samples from each location were combined into a single container), and preserved in 80% ethanol for later subsampling, identification, and enumeration.

A composite collection of a variety of CPOM forms (e.g., leaves, needles, twigs, bark, or fragments of these) was gathered. It is difficult to quantify the amount of CPOM collected in terms of weight or volume given the variability of its composition. Collection of several handfuls of material is usually adequate, and the material is typically found in depositional areas, such as in pools and along snags and undercut banks. The CPOM sample was processed using a U.S. Standard No. 30 sieve and was added to the composite of the grab samples for each location.

A 100-organism subsample of the benthic macroinvertebrate composite sample from each sampling location was taken in the laboratory according to the methods outlined in the Rapid

Bioassessment Protocol used by the NJDEP Bureau of Freshwater & Biological Monitoring (Barbour et al., 1999). With the exception of any chironomids and oligochaetes, benthic macroinvertebrates were identified to genus. Chironomids were identified to subfamily as a minimum, and oligochaetes were identified to family as a minimum. Standard taxonomic references were used and included Merritt and Cummins, 1988; Pennak, 1989; Peckarsky, *et al*., 1990; and Thorp and Covich, 1991.

A habitat assessment was conducted in accordance with the methods used by the NJDEP Bureau of Freshwater & Biological Monitoring for low gradient streams (NJDEP, 2007). The habitat assessment, which has been designed to provide a measure of habitat quality, involves a visual technique for assessing stream habitat structure. The findings from the habitat assessment are used to interpret survey results and identify obvious constraints on the attainable biological potential within the study area.

Results

Physicochemical Characteristics:

The stream width at Station ASK3 was approximately 20 feet. The stream depth ranged from 0.4 feet to 1.1 feet in the run areas and was greater than 2.5 feet in some pool areas. The stream velocity ranged from 0 ft/sec to 0.1 ft/sec. The canopy was mostly closed at this location. The inorganic substrate at Station ASK3 consisted mostly of cobbles, gravel, and coarse sand. The organic substrate was comprised mainly of detritus in the form of decomposing leaves, muck-mud, and sparse stands of rooted emergent and submergent aquatic vegetation. Water odors and surface oils were present. Sediment odors and oils were absent. The water was very turbid. The water temperature was 22.2˚C; the pH was 5.97 SU; the dissolved oxygen was 5.27 mg/L, and the concentration of total dissolved solids was 130 mg/L. The predominant surrounding land uses at Station ASK3 were forest, field/pasture, and some rural residential. Erosion was moderate to heavy at this location, and obvious sources of local nonpoint sources of pollution were noted from the surrounding land use (e.g., road runoff, stormwater outfalls).

The stream width at Station ANR was approximately 13 feet. The stream depth ranged from 0.6 feet to 1.2 feet in the riffle/run areas and was approximately 1.0 foot to 1.5 feet in the pool areas. The stream velocity ranged from 0 ft/sec to 0.03 ft/sec. The canopy was mostly closed at this location. The inorganic substrate at Station ANR consisted mostly of small cobbles, gravel, and coarse sand. The organic substrate was minimal and was comprised mainly of detritus in the form of sticks, decomposing leaves, and new fall. Sediment odors and oils were absent. The water was clear, and water odors and surface oils were absent. The water temperature was 21.0˚C; the pH was 6.00 SU; the dissolved oxygen was 6.81 mg/L, and the concentration of total dissolved solids was 150 mg/L. The predominant surrounding land uses at Station ANR were forest and field/pasture. Local watershed erosion was noted as being moderate to heavy, and a potential source of nonpoint source pollution included road runoff.

The stream width at Station ASK1 was approximately 6 feet. The stream depth ranged from 0.1 feet to 0.75 feet in the riffle/run areas and was approximately 1.0 feet in the pool areas. The stream velocity ranged from 0 ft/sec to 0.01 ft/sec. There was little to no flow, and it appeared as if this site was drying up. The canopy was mostly closed at this location. The inorganic substrate at Station ASK1 consisted mostly of cobbles and coarse sand. The organic substrate was minimal and was comprised mainly of detritus in the form of sticks, decomposing leaves, and new fall, as well as moss on the rocks. Sediment odors and oils were absent. The water was slightly turbid, and water odors and surface oils were absent. The water temperature was 21.5˚C; the pH was 6.14 SU; the dissolved oxygen was 5.00 mg/L, and the concentration of total dissolved solids was 300 mg/L. The predominant surrounding land use for Station ASK1 included forest along the immediate stream corridor, pasture/agricultural fields (soybean), and some rural residential. Moderate erosion was noted, and obvious nonpoint sources of pollution included runoff from the agricultural field and the road.

The stream width at Station BB1 was approximately 17 feet. The stream depth ranged from 0.4 feet to 1.0 feet in the run areas and was approximately 1.5 feet in the pool areas. The stream velocity ranged from 0 ft/sec to 0.05 ft/sec. The canopy was open on the upstream side of the road crossing and mostly closed on the downstream side of the road crossing. The inorganic substrate at Station BB1 consisted mostly of small cobbles, gravel, and green clay. The organic substrate was comprised mainly of emergent and submergent aquatic vegetation, muck/mud, and some detritus in the form of coarse plant material. Sediment odors and oils were present. The water was slightly turbid, and water odors and surface oils were present. The water temperature was 25.7˚C; the pH was 5.69 SU; the dissolved oxygen was 7.31 mg/L, and the concentration of total dissolved solids was 140 mg/L. The predominant surrounding land use for Station BB1 included fallow fields/pasture and agriculture (soybean and corn). Moderate erosion was observed, and obvious nonpoint sources of pollution included runoff from the surrounding roadway and agricultural fields.

Habitat Assessment:

The habitat assessment is designed to provide an estimate of habitat quality based upon qualitative estimates of selected habitat attributes. The assessment involves the numerical scoring of ten habitat parameters to evaluate instream substrate, channel morphology, bank structural features, and riparian vegetation. Each parameter is scored and summed to produce a total score which is assigned a habitat quality category of optimal (excellent), sub-optimal (good), marginal (fair), or poor. Table 1 outlines the habitat scoring criteria for low gradient streams by the NJDEP Bureau of Freshwater & Biological Monitoring. Sites with optimal habitat conditions have total scores ranging from 160 to 200; sites with suboptimal habitat conditions have total scores ranging from 110 to 159; sites with marginal habitat conditions have total scores ranging from 60 to 109, and sites with poor habitat conditions have total scores less than 60. The scores for Stations ASK3, ANR, ASK1, and BB1 are summarized in Table 2. Station BB1 was found to have marginal habitat conditions, and Stations ASK3, ANR, and ASK1 were found to have sub-optimal habitat conditions.

Benthic Macroinvertebrates:

The results of the benthic macroinvertebrate survey are presented in Table 3. These results are organized by the order, the family, and then by the generic taxonomic levels. The number of taxa and individuals collected from each sampling location is also summarized in Table 3. A total of 36 different taxa of benthic macroinvertebrates was collected within the study area, representing three phyla (i.e., annelids, mollusks, and arthropods). The arthropods, in particular the insects, were the most strongly represented in terms of the number of different taxa present. A total of 20 insect families was represented.

To evaluate the biological condition of the sampling locations, several community measures were calculated from the data presented in Table 3 and included the following:

1. Taxa Richness: Taxa richness is a measure of the total number of benthic macroinvertebrate families identified. A reduction in taxa richness typically indicates the presence of organic enrichment, toxics, sedimentation, or other factors.

2. EPT (Ephemeroptera, Plecoptera, Trichoptera) Index: The EPT Index is a measure of the total number of Ephemeroptera, Plecoptera, and Trichoptera families (i.e., mayflies, stoneflies, and caddisflies). These organisms typically require clear moving water habitats.

3. %EPT: Percent EPT measures the numeric abundance of the mayflies, stoneflies, and caddisflies within a sample. A high percentage of EPT taxa are associated with good water quality.

4. % CDF (percent contribution of the dominant family): Percent CDF measures the relative balance within the benthic macroinvertebrate community. A healthy community is characterized by a diverse number of taxa that have abundances somewhat proportional to each other.

5. Family Biotic Index: The Family Biotic Index measures the relative tolerances of benthic macroinvertebrates to organic enrichment based on tolerance scores assigned to families ranging from 0 (intolerant) to 10 (tolerant) (Hilsenhoff, 1988).

This analysis integrates several community parameters into an evaluation of biological integrity referred to as the New Jersey Impairment Score (NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired. A non-impaired site has a benthic community comparable to other high quality "reference" streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and a good representation of intolerant individuals. A moderately impaired site is characterized by reduced macroinvertebrate taxa richness, in particular the EPT taxa. Changes in taxa composition result in reduced community balance and intolerant taxa become absent. A severely impaired site is one in which the benthic community is significantly different from that of the reference streams. The macroinvertebrates are dominated by a few taxa which are often very abundant. Tolerant taxa are typically the only taxa present.

The scoring criteria used by the NJDEP Bureau of Freshwater & Biological Monitoring are outlined in Table 4. This scoring system is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams. While a low score indicates "impairment," the score may actually be a consequence of habitat or other natural differences between the subject stream and the reference stream. Non-impaired sites have total scores ranging from 24-30, moderately impaired sites have total scores ranging from 9 to 21, and severely impaired sites have total scores ranging from

0 to 6. Impairment scores for Stations ASK3, ANR, ASK1, and BB1 are provided in Tables 5A, 5B, 5C, and 5D, respectively. All four Stations were assessed as being moderately impaired. Station ANR had the highest score of 21, and Station BB1 had the lowest score of 9, bordering on being assessed as severely impaired.

Discussion

The NJDEP Bureau of Biological & Freshwater Monitoring maintains three Ambient Biomonitoring Network (AMNET) stations within the study area (i.e., Stations AN0140, AN0139, and AN0138). Station BB1 corresponds to AN0140; ANR corresponds to AN0139; and ASK1 corresponds to AN0138. ASK3 is approximately 1.5 miles upstream from AN0141, which is just outside of the study area but within the Assiscunk Creek Watershed. Data collected from these AMNET stations are summarized in Table 6 (NJDEP, 1994; NJDEP, 1999; NJDEP, 2003; NJDEP, 2009).

In 1993, 2001, and 2006, Station AN0141 was assessed as being moderately impaired by NJDEP. This station was not sampled in 1998 due to bridge construction. Habitat conditions were found to be sub-optimal in 2001 and 2006. The 2008 assessment by the RCE Water Resources Program at Station ASK3 demonstrates that the biological condition in the vicinity of this AMNET station remained as moderately impaired, and the habitat conditions remained as sub-optimal.

In 1993, 1998, 2001, and 2006, Station AN0139 was assessed as being moderately impaired, and in 1998, 2001, and 2006, habitat conditions were found to be sub-optimal. The 2008 assessment by the RCE Water Resources Program at Station ANR demonstrates that the biological condition remained at a moderately impaired status, and the habitat condition remained as sub-optimal.

In 1993, the biological condition at AN0138 was assessed as being severely impaired. Subsequent assessments in 1998, 2001, and 2006 revealed an improvement to a moderately impaired status. Habitat conditions at AN0138 in 1998 were found to be sub-optimal. In 2001, habitat conditions degraded to marginal, and in 2006, habitat conditions improved to sub-optimal. The 2008 assessment by the RCE Water Resources Program at Station ASK1 demonstrates that the biological condition remained at a moderately impaired status, and the habitat condition remained as sub-optimal.

Similar to Station AN0138, the habitat condition at AN0140 was sub-optimal in 1998, marginal in 2001, and sub-optimal in 2006. However, the biological condition at AN0140 was found to be severely impaired in 1993, 2001, and 2006. An improvement to a moderately impaired status was noted in 1998. The 2008 assessment by the RCE Water Resources Program at Station BB1 demonstrates that the biological condition improved to a moderately impaired status, but with a score of 9, the biological condition at BB1 borders on being severely impaired. The habitat condition in 2008 was downgraded to marginal.

The benthic macroinvertebrate community occurring within the Assiscunk Creek Watershed, in particular in the vicinity of ASK3, ANR, ASK1, and BB1, is apparently under some type of stress as evidenced by the overall poor representation of EPT taxa and the relatively high percent dominance of taxa within the community. Based on the calculated Family Biotic Index, the types of organisms found within the study area are indicative of some organic pollution to fairly substantial levels of pollution (Hilsenhoff, 1988). In addition, the habitat assessment revealed sub-optimal habitat to marginal conditions, which may also account for the impaired condition of the benthic macroinvertebrate community within the study area.

Recommendations

Biological assessments have become an important tool for managing water quality to meet the goal of the Clean Water Act (i.e., to maintain the chemical, physical, and biological integrity of the nation's water). However, although biological assessments are a critical tool for detecting impairment, they do not identify the cause or causes of the impairment. The U.S. Environmental Protection Agency (USEPA) developed a process, known as the Stressor Identification (SI) process, to accurately identify any type of stressor or combination of stressors that might cause biological impairment (USEPA, 2000). The SI process involves the critical review of available information, the formation of possible stressor scenarios that may explain the observed impairment, the analysis of these possible scenarios, and the formation of conclusions about which stressor or combination of stressors are causing the impairment. The SI process is iterative, and in some cases additional data may be needed to identify the stressor(s). In addition, the SI process provides a structure or a method for assembling the scientific evidence needed to support any conclusions made about the stressor(s). When the cause of a biological impairment is identified, stakeholders are then in a better position to locate the source(s) of the stressor(s) and are better prepared to implement the appropriate management actions to improve the biological condition of the impaired waterway. The SI process is recommended as the next step toward improving the biological condition within the Assiscunk Creek Watershed, particularly in the vicinity of Station BB1, which was found to be bordering on being severely impaired with marginal habitat conditions.

Figures and Tables

Station	Description	Coordinates
ASK3	Assiscunk Creek, Petticoat Bridge Road, Springfield Township, Burlington County, NJ Approximately 1.5 miles upstream from AMNET Station AN0141 HUC 02040201100040	40˚03′11.52″N 74˚44′33.51″W
ANR	Annaricken Brook, Island Road, Springfield Township, Burlington County, NJ AMNET Station AN0139, USGS Station #01464578 HUC 02040201100010	40˚03′18.91″N 74˚42′08.19″W
ASK1	Assiscunk Creek, Columbus Georgetown Road, Mansfield Township, Burlington County, NJ AMNET #AN0138 HUC 02040201100010	40˚03′54.76″N 74˚39′59.58″W
BB1	North Branch of the Upper Barker's Brook, Georgetown- Juliustown Road, Springfield Township, Burlington County, NJ AMNET Station AN0140, USGS Station #01464583 HUC 02040201100020-01	40˚01′57.83″N 74˚40′12.48″W

FIGURE 1. Biological Assessment Sampling Locations

TABLE 1. Scoring Criteria for Habitat Assessment

Table 4 (cont.) — **HABITAT ASSESSMENT FOR *LOW* GRADIENT STREAMS**

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Bank Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, under story shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

HABITAT SCORES	VALUE
OPTIMAL	160 • 200
SUB-OPTIMAL	110 • 159
MARGINAL	60 • 109
POOR	< 60

TABLE 2. Habitat Assessment Results

Habitat Parameter	**Scores**			
	ASK3	**ANR**	**ASK1**	**BB1**
1. Epifaunal Substrate/Available Cover	8	13	13	8
2. Pool Substrate Characterization	13	8	8	13
3. Pool Variability	13	8	8	3
4. Sediment Deposition	8	8	13	8
5. Channel Flow Status	13	13	8	13
6. Channel Alteration	13	13	13	13
7. Channel Sinuosity	8	13	13	3
8a. Bank Stability (Left Bank)	7	7	7	4
8b. Bank Stability (Right Bank)	7	7	7	4
9a. Bank Vegetative Protection (Left Bank)	1	7	9	4
9b. Bank Vegetative Protection (Right Bank)	7	7	9	4
10a. Riparian Vegetative Zone Width (Left Bank)	9	7	4	1
10b. Riparian Vegetative Zone Width (Right Bank)	4	7	4	1
Total Score	*111*	*118*	*116*	*79*
Condition Category	*sub-optimal*	*sub-optimal*	*sub-optimal*	*marginal*

TABLE 3. Results of the Benthic Macroinvertebrate Sampling

Taxa:	*Station ASK3*	*Station ANR*	*Station ASK1*	*Station BB1*
Arhynchobdellida				
Erpobdellidae				
Dina sp.			2	
Erpobdella sp.			1	
Rhynchobdellida				
Glossiphoniidae				
Placobdella sp.			1	
Limnophila (snails)				
Physidae				
Physa sp.	3	2	6	
Sphaeracea (fingernail clams)				
Sphaeriidae				
Pisidium sp.	2			
Isopoda				
Asellidae				
Caecidotea sp.			4	
Amphipoda (scuds or side swimmers)				
Gammaridae				
Gammarus sp.	3	5	24	85
Decapoda (crayfish)				
Cambaridae				
Orconectes sp.	4	2		
Collembola (springtails)				
Isotomidae				
Isotomurus sp.	1			
Ephemeroptera (mayflies)				
Baetidae				
Baetis sp.		4		
Hemiptera (true bugs)				
Belostomatidae				
Belostoma sp.				2

TABLE 3. Results of the Benthic Macroinvertebrate Sampling (continued)

Taxa:	***Station ASK3***	***Station ANR***	***Station ASK1***	***Station BB1***
Corixidae				
Trichocorixa sp.				3
Sigara sp.	49		7	
Naucoridae				
Pelocoris sp.	1			
Notonectidae				
Notonecta sp.	3			
Veliidae				
Microvelia sp.		9	6	
Rhagovelia sp.		1		
Odonata (damselflies/dragonflies)				
Calopterygidae				
Calopteryx sp.				2
Coenagrionidae				
Argia sp.	1			
Enallagma sp.	1			3
Ischnura sp.				1
Cordulegastridae				
Cordulegaster sp.			5	
Gomphidae				
Gomphus sp.		2		
Megaloptera (fishflies/dobsonflies)				
Corydalidae				
Chauliodes sp.	1			
Sialidae				
Sialis sp.	7	1		4
Trichoptera (caddisflies)				
Hydropsychidae				
Cheumatopsyche sp.		28	19	
Hydropsyche sp.		15	7	
Polycentropodidae				
Polycentropus sp.	5			
Coleoptera (beetles)				
Elmidae				
Stenelmis sp.		18	2	2
Promoresia sp.			2	

TABLE 3. Results of the Benthic Macroinvertebrate Sampling (continued)

Taxa:	***Station ASK3***	***Station ANR***	***Station ASK1***	***Station BB1***
Diptera (true flies)				
Chironomidae				
Chironominae	7	1	4	
Tanypodinae	10	3	13	2
Ptychopteridae				
Bittacomorpha sp.	2			
Simuliidae				
Simulium sp.		10		
Tipulidae				
Dicranota sp.		2		
Tipula sp.		1		
Total # taxa:	***16***	***16***	***16***	***9***
Total # individuals:	***100***	***104***	***104***	***104***

TABLE 4. Scoring Criteria for Rapid Bioassessments in New Jersey Streams

	Non-impaired	***Moderately Impaired***	***Severely Impaired***
Biological Condition Score:	***6***	***3***	***0***
Biometrics:			
1. Taxa Richness	>10	10-5	4-0
2. EPT Index	>5	5-3	2-0
3. %CDF	<40	40-60	>60
4. %EPT	>35	35-10	<10
5. Family Biotic Index	<5	5-7	>7
Biological Condition:	Total Score		
Non-impaired	24-30		
Moderately Impaired	9-21		
Severely Impaired	0-6		

TABLE 5A. Calculation of Biological Condition for Station ASK3

Taxa	***Tolerance Value***	***Station ASK3 Number of Individuals***
Physidae	8	3
Sphaeriidae	8	2
Gammaridae	4	3
Cambaridae	6	4
Isotomidae	10	1
Coenagrionidae	9	2
Corixidae	5	49
Naucoridae	5	1
Notonectidae	5	3
Corydalidae	0	1
Sialidae	4	7
Polycentropodidae	6	5
Chrionomidae	6	17
Ptychopteridae	9	2
Taxa Richness		14
EPT Index		1
%CDF		49% Corixidae
%EPT		5%
Family Biotic Index		5.57 Fair - Fairly substantial pollution likely
NJIS Rating		12
Biological Condition		***Moderately Impaired***

TABLE 5B. Calculation of Biological Condition for Station ANR

Taxa	***Tolerance Value***	***Station ANR Number of Individuals***
Physidae	8	2
Cambaridae	6	2
Gammaridae	4	5
Baetidae	4	4
Gomphidae	1	2
Veliidae	5	10
Elmidae	4	18
Sialidae	4	1
Hydropsychidae	4	43
Tipulidae	3	3
Simuliidae	6	10
Chironomidae	6	4
Taxa Richness		12
EPT Index		2
%CDF		41% Hydropsychidae
%EPT		45%
Family Biotic Index		4.42 Good - some organic pollution probable
NJIS Rating		21
Biological Condition		***Moderately Impaired***

TABLE 5C. Calculation of Biological Condition for Station ASK1

Taxa	***Tolerance Value***	***Station ASK1 Number of Individuals***
Erpobdellidae	8	3
Glossiphoniidae	8	1
Physidae	8	6
Asellidae	8	4
Gammaridae	4	24
Cordulegastridae	3	5
Corixidae	5	7
Veliidae	6	6
Elmidae	4	4
Hydropsychidae	4	26
Chironomidae	6	17
Tipulidae	3	1
Taxa Richness		12
EPT Index		1
%CDF		25% Hydropsychidae
%EPT		25%
Family Biotic Index		5.12 Fair - Fairly substantial pollution likely
NJIS Rating		18
Biological Condition		***Moderately Impaired***

TABLE 5D. Calculation of Biological Condition for Station BB1

Taxa	***Tolerance Value***	***Station BB1 Number of Individuals***
Gammaridae	4	85
Calopterygidae	5	2
Coenagrionidae	9	4
Belostomatidae	5	2
Corixidae	5	3
Elmidae	4	2
Sialidae	4	4
Chironomidae	7	2
Taxa Richness		8
EPT Index		0
%CDF		82% Gammaridae
%EPT		0%
Family Biotic Index		4.32 Good - some organic pollution probable
NJIS Rating		9
Biological Condition		***Moderately Impaired***

TABLE 6. Summary of NJDEP Ambient Biological Monitoring Network (AMNET) results (NJDEP, 1994; NJDEP, 1999; NJDEP, 2003; NJDEP, 2009)

AMNET Station (RCE Location)	Location	1993 - Round 1		1998 - Supplemental Sampling			2001 - Round 2			2006 - Round 3		
		Date Sampled	Impairment Status	Date Sampled	Impairment Status	Habitat Analysis Result	Date Sampled	Impairment Status	Habitat Analysis Result	Date Sampled	Impairment Status	Habitat Analysis Result
AN0141 (1.5 miles downstream from ASK3)	Assiscunk Ck., Jacksonville Rd., Springfield Twp.	1/26/93	moderately impaired	Not sampled due to bridge construction			1/17/01	moderately impaired	sub-optimal	6/6/06	moderately impaired	sub-optimal
AN0139 (ANR)	Annaricken Bk., Island Rd., Springfield Twp.	1/25/93	moderately impaired	1/8/98	moderately impaired	sub-optimal	1/16/01	moderately impaired	sub-optimal	6/15/06	moderately Impaired	sub-optimal
AN0138 (ASK1)	Assiscunk Ck., Columbus-Georgetown Rd., Mansfield Twp.	1/25/93	severely impaired	1/8/98	moderately impaired	sub-optimal	1/16/01	moderately impaired	marginal	6/6/06	moderately impaired	sub-optimal
AN0140 (BB1)	North Br. Barkers Bk., Georgetown-Juliustown Rd., Springfield Twp.	1/25/93	severely impaired	1/13/98	moderately impaired	sub-optimal	1/17/01	severely impaired	marginal	6/15/06	severely impaired	sub-optimal

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Data Report Appendix B:

Tabulated Stream Visual Assessment Protocol (SVAP) Data

ID	Sub-watershed	DateTime	Reference Location	Active Channel Width (feet)	Dominant Substrate	Hydrologic Alteration	Channel Condition	Riparian Zone Left Bank	Riparian Zone Right Bank	Bank Stability Left Bank	Bank Stability Right Bank	Water Appearance
31	ANR	6/30/2009	Off Monmouth Road	5	mud	4	6	8	8	6	4	3
32	ANR	6/30/2009	Route 68	6	mud	7	4	8	8	8	8	7
33	BB2	7/1/2009	Off Saylors Farm Rd.	10	mud	5	8	7	7	6	7	7
34	BB2	7/1/2009	Off Jobston/Juliustown Rd	5	mud	3	5	5	3	4	5	4
36	ASK2	7/2/2009	Off Juliustown bridge	7	mud	5	6	8	7	5	6	7
39	BB1	7/2/2009	Next to ranch	9	mud	5	6	1	1	4	4	8
40	ANR	7/1/2009	Off Rt. 68	12	mud	7	7	6	4	7	5	8
45	ANR	7/14/2009	Route 68	4	mud	10	3	10	10	7	8	1
51	ASK2	7/20/2009	High Ridge Farm	5	mud	5	7	5	6	8	7	9
52	ASK2	7/20/2009	High Ridge Farms	8	mud	6	7	6	8	7	6	8
54	ASK2	7/20/2009	Pinelands Nursery	10	mud	2	3	3	1	3	2	3
60	BB2	8/3/2009	Off Georgetown Rd	5	mud	3	4	5	5	4	3	7
64	ASK3	8/3/2009	Behind farmer's market on Rt. 206	8	sand	6	9	8	6	7	6	7
70	ASK3	8/7/2009	Off Folwell Rd	8	mud	8	7	5	6	7	7	1
71	ASK3	8/7/2009	Off Folwell Rd.	6	mud	5	8	6	8	5	6	8
72	ANR	8/7/2009	Off Route 68	5	mud	4	3	5	6	6	6	6
77	ASK2	8/13/2009	Off Island Rd, near sampling site	5	mud	4	5	3	6	5	5	5
18	ASK1	6/23/2009	None	12	mud	4	7	4	2	4	3	4
19	ASK1	6/23/2009	None	4	mud	8	5	6	5	8	8	7
20	ASK1	6/23/2009	Over bridge on Mt. Pleasant	15	mud	7	8	8	8	7	6	8
26	ASK1	6/23/2009	Mt. Pleasant Rd.	15	mud	7	8	9	6	2	2	7
27	ANR	6/30/2009	None	20	mud	6	6	7	8	3	5	7
28	ASK1	6/23/2009	None.	12	mud	7	8	8	8	3	3	6
29	BB1	6/30/2009	Sampling Site	12	mud	6	8	9	9	7	3	8
35	ASK2	7/2/2009	None	6	silt	5	6	2	5	8	5	5

ID	Sub-watershed	DateTime	Reference Location	Active Channel Width (feet)	Dominant Substrate	Hydrologic Alteration	Channel Condition	Riparian Zone Left Bank	Riparian Zone Right Bank	Bank Stability Left Bank	Bank Stability Right Bank	Water Appearance
37	BB1	7/2/2009	None.	4	mud	7	9	7	9	6	6	4
38	BB1	7/2/2009	None	4	mud	2	5	6	8	8	7	1
41	ASK1	6/26/2009	None	5	mud	3	8	4	8	2	4	3
42	ASK1	6/26/2009	None.	20	mud	9	9	7	7	9	9	2
43	BB1	7/14/2009	Saylor Pond Road	5	silt	10	9	10	8	3	5	8
44	BB1	7/14/2009	Saylor Pond Road	4	silt	10	9	7	9	7	8	10
46	BB1	7/14/2009	Route 68 entry	4	mud	10	10	9	9	9	9	8
47	ANR	7/14/2009	Route 68	6	silt	9	8	5	7	9	8	8
48	ANR	7/14/2009	Route 68	5	gravel	9	8	9	9	8	7	8
49	ANR	7/14/2009	Route 68	5	gravel	7	8	7	7	7	7	6
50	ASK2	7/20/2009	High Ridge Farms	30	mud	6	6	7	7	5	7	4
53	ASK2	7/20/2009	Pinelands	5	mud	2	2	6	4	3	5	7
55	ASK2	7/20/2009	High Ridge Farms	8	mud	6	7	8	7	7	5	9
56	BB2	7/27/2009	White Road	5	silt	7	5	10	9	9	9	2
57	BB2	7/27/2009	White Road	7	silt	10	3	10	9	2	1	3
59	BB2	8/3/2009	Sampling site off Monmouth Road	20	mud	6	8	6	7	4	5	4
61	BB1	8/3/2009	Off Route 68	7	mud	8	6	5	4	6	6	7
62	ASK3	8/3/2009	On Route 206	30	mud	7	7	7	6	8	8	3
63	ASK3	8/3/2009	Petticoat Bridge	30	mud	6	7	4	8	7	7	3
65	ASK3	8/5/2009	Behind asphalt plant	5	mud	8	2	4	4	6	6	3
66	ASK3	8/5/2009	Behind asphalt plant	5	mud	8	2	4	4	6	6	3
67	ASK3	8/5/2009	Behind asphalt plant	8	mud	8	7	5	7	7	7	8
68	ANR	8/5/2009	On Island Road	8	mud	4	7	4	5	3	5	8
69	ASK2	8/5/2009	Near Paddock Road	40	mud	8	7	6	7	8	9	6
75	ASK2	8/10/2009	Off Island Rodd	12	mud	9	9	6	5	7	7	6
76	ASK2	8/10/2009	On Island Road	20	mud	5	6	6	6	4	4	3
78	ANR	8/13/2009	Off Juliustown Georgetown Road	10	mud	1	7	7	5	3	1	3

ID	Subwatershed	DateTime	Reference Location	Nutrient Enrichment	Barriers to Fish Movement	Instream Fish Cover	Pools	Invertebrate Habitat	Canopy Cover	Manure Presence	Riffle Embeddedness
31	ANR	6/30/2009	Off Monmouth Road	6	5	4	5	7	8	na	na
32	ANR	6/30/2009	Route 68	7	4	6	7	8	4	na	na
33	BB2	7/1/2009	Off Saylors Farm Rd.	7	6	9	8	8	7	na	9
34	BB2	7/1/2009	Off Jobston/Juliustown Rd	5	7	7	7	8	4	5	4
36	ASK2	7/2/2009	Off Juliustown bridge	4	6	7	5	8	5	na	4
39	BB1	7/2/2009	Next to ranch	9	8	5	2	8	4	5	na
40	ANR	7/1/2009	Off Rt. 68	8	9	4	1	9	6	na	na
45	ANR	7/14/2009	Route 68	7	5	6	1	10	8	na	na
51	ASK2	7/20/2009	High Ridge Farm	4	8	7	3	2	1	na	na
52	ASK2	7/20/2009	High Ridge Farms	8	7	6	6	8	3	na	na
54	ASK2	7/20/2009	Pinelands Nursery	7	7	6	2	5	1	na	na
60	BB2	8/3/2009	Off Georgetown Rd	3	1	8	1	5	1	na	na
64	ASK3	8/3/2009	Behind farmer's market on Rt. 206	10	4	8	7	8	6	na	8
70	ASK3	8/7/2009	Off Folwell Rd	2	5	9	9	6	0	na	na
71	ASK3	8/7/2009	Off Folwell Rd.	3	7	5	1	6	7	na	7
72	ANR	8/7/2009	Off Route 68	8	7	3	1	2	3	na	na
77	ASK2	8/13/2009	Off Island Rd, near sampling site	7	5	7	2	9	4	na	na
18	ASK1	6/23/2009	None	4	3	7	5	8	10	na	7
19	ASK1	6/23/2009	None	8	3	3	1	4	9	na	na
20	ASK1	6/23/2009	Over bridge on Mt. Pleasant	6	8	5	6	7	8	na	na
26	ASK1	6/23/2009	Mt. Pleasant Rd.	9	9	4	6	6	8	na	2
27	ANR	6/30/2009	None	9	7	5	4	10	8	na	na
28	ASK1	6/23/2009	None.	8	8	2	2	6	9	na	na
29	BB1	6/30/2009	Sampling Site	8	9	8	5	10	8	na	7
35	ASK2	7/2/2009	None	8	9	5	3	7	3	7	1

ID	Subwatershed	DateTime	Reference Location	Nutrient Enrichment	Barriers to Fish Movement	Instream Fish Cover	Pools	Invertebrate Habitat	Canopy Cover	Manure Presence	Riffle Embeddedness
37	BB1	7/2/2009	None.	6	6	9	7	9	4	na	na
38	BB1	7/2/2009	None	1	10	3	3	9	1	7	1
41	ASK1	6/26/2009	None	5	9	4	4	9	5	na	8
42	ASK1	6/26/2009	None.	2	1	7	3	10	9	na	na
43	BB1	7/14/2009	Saylor Pond Road	10	7	8	3	10	8	7	10
44	BB1	7/14/2009	Saylor Pond Road	10	8	5	3	10	9	na	1
46	BB1	7/14/2009	Route 68 entry	8	8	3	2	10	9	na	na
47	ANR	7/14/2009	Route 68	8	8	3	5	10	9	na	5
48	ANR	7/14/2009	Route 68	6	8	6	3	10	8	na	5
49	ANR	7/14/2009	Route 68	8	6	5	3	10	7	na	na
50	ASK2	7/20/2009	High Ridge Farms	4	1	6	8	6	7	na	na
53	ASK2	7/20/2009	Pinelands	8	7	8	2	5	1	na	na
55	ASK2	7/20/2009	High Ridge Farms	8	4	5	6	7	7	na	na
56	BB2	7/27/2009	White Road	7	8	7	3	10	1	na	8
57	BB2	7/27/2009	White Road	7	8	3	6	10	7	na	na
59	BB2	8/3/2009	Sampling site off Monmouth Road	8	8	6	8	9	7	na	na
61	BB1	8/3/2009	Off Route 68	8	6	5	3	4	9	na	na
62	ASK3	8/3/2009	On Route 206	7	10	5	8	3	4	na	na
63	ASK3	8/3/2009	Petticoat Bridge	7	9	4	8	9	6	na	na
65	ASK3	8/5/2009	Behind asphalt plant	6	3	1	1	3	7	na	na
66	ASK3	8/5/2009	Behind asphalt plant	6	3	1	1	3	6	na	na
67	ASK3	8/5/2009	Behind asphalt plant	7	5	9	10	6	2	na	na
68	ANR	8/5/2009	On Island Road	6	8	5	8	5	7	na	na
69	ASK2	8/5/2009	Near Paddock Road	7	1	1	4	4	9	na	na
75	ASK2	8/10/2009	Off Island Rodd	4	2	5	1	8	7	na	na
76	ASK2	8/10/2009	On Island Road	6	8	4	6	8	6	na	na
78	ANR	8/13/2009	Off Juliustown Georgetown Road	2	8	6	4	8	9	na	na

Data Report Appendix C:

Quality Assurance Project Plan for the Assiscunk Creek Watershed Restoration and Protection Plan (November 7, 2007)

Plus Revisions (November 2008)

QUALITY ASSURANCE PROJECT PLAN

ASSISCUNK CREEK HEADWATER WATERSHED RESTORATION PLAN

Rutgers Cooperative Extension Water Resources Program

May 25, 2007

QUALITY ASSURANCE PROJECT PLAN

ASSISCUNK CREEK HEADWATER WATERSHED RESTORATION PLAN

Rutgers Cooperative Extension Water Resources Program

Applicant/
Project Officer:

Christopher C. Obropta, Ph.D., P.E.
Rutgers Cooperative Extension Water Resources Program
14 College Farm Road – 2nd Floor
New Brunswick, NJ 08901-8551
732-932-9800 x 6209 (phone); 732-932-8644 (fax)
obropta@envsci.rutgers.edu

______________________________________5/25/07
Signature Date

QA Officers:

Lisa Galloway Evrard
Rutgers Cooperative Extension Water Resources Program
14 College Farm Road – 2nd Floor
New Brunswick, NJ 08901-8551
732-932-9800 x 6142 (phone); 732-932-8644 (fax)
evrard@rci.rutgers.edu

______________________________________5/25/07
Signature Date

MAR 05 2008 08:58 FR NJDEP WATERSHED 609 777 1282 TO 917329328644 P.03/03

NJDEP Main Point of Contact:

Mike Haberland
Watershed Management Area 20 Manager
Division of Watershed Management
New Jersey Department of Environmental Protection
401 East State Street
P.O. Box 418
Trenton, NJ 08625-0418
609-633-7714 (phone); 609-633-0750 (fax)
Mike.Haberland@dep.state.nj.us (email)

Mike Haberland 2/29/08
Signature Date

NJDEP Office of Quality Assurance:

Marc Ferko
Research Scientist
Office of Quality Assurance
New Jersey Department of Environmental Protection
9 Ewing Street
P.O. Box 424
Trenton, NJ 08625-0418
609-292-3950 (phone); 609-777-1774 (fax)
Marc.Ferko@dep.state.nj.us

Signature

Marc Ferko 2/29/08
Date

1. Project Name: Assiscunk Creek Headwater Watershed Restoration Plan

   Requested By: Mike Haberland
   New Jersey Department of Environmental Protection

2. This project has been initiated by the New Jersey Department of Environmental Protection to collect data needed to prepare a comprehensive watershed restoration plan for the Assiscunk Creek Headwater watershed.

3. Date Project Requested: May 2007

4. Date Project Initiated: June 2007

5. Project Officer: Christopher C. Obropta
   Rutgers Cooperative Extension Water Resources Program

6. QA Officers: Lisa Galloway Evrard
   Rutgers Cooperative Extension Water Resources Program

7. Project Description:

A. Objective and Scope

The total planning area for the Assiscunk Creek Headwater WRPP is approximately 16 square miles. The primary streams within the planning watershed are Assiscunk Creek (headwaters), the North Branch of Upper Barkers Brook, and the Annaricken Brook (entire reach), with main stem lengths of 7.3 miles long, 4.8 miles long, and 3.9 miles long, respectively. Within this planning area, there are approximately 40 miles of mapped streams designated as Category One, with the exception of the North Branch of Upper Barkers Brook. While there are no major lakes in the sub-watersheds, there are three small impoundments that make up a total lake area of 2.8 acres within the planning area. Two HUC 14 watersheds (02040201100040 and 02040201100010) are included in this planning area, along with a subbasin of one HUC 14 (02040201100020-01), which includes only the North Branch of Upper Barkers Brook. This division is based on the area segments that are listed as impaired. The project area is entirely within Burlington County and contains portions of Mansfield Township and Springfield Township. Of the land uses within the subject watershed, approximately 70 percent is designated as agricultural and agricultural wetlands with some suburban residential land use (*NJDEP 1995/97 Land use/Land cover Update, Assiscunk, Crosswicks and Doctors Watershed Management Area, WMA-20)*. According to the *New Jersey 2004 and 2006 Integrated Water Quality Monitoring and Assessment Report*, segments of the Assiscunk Creek do not meet the criteria for the aquatic life designated use and are documented as impaired for pH, total phosphorus, benthic macroinvertebrates, and fecal coliform (FC). Several total maximum daily loads (TMDLs) have been developed to address these water quality impairments. These are as follows:

- Ninety-five percent (95%) reduction in fecal coliform for the Assiscunk Creek;

- Sixty-six percent (66%) reduction in total phosphorus for the Annaricken Creek (8.2 river miles);
- Fifty-four percent (54.6%) reduction in total phosphorus for the North Branch of Upper Barkers Brook (3.9 river miles).

Due to the recognized impairments and value of this ecological resource**,** a Watershed Restoration Plan for this project area will be developed that, when implemented, will achieve the load reductions required by the New Jersey Department of Environmental Protection (NJDEP) TMDLs, therefore bringing the waterway into compliance with surface water quality standards. Furthermore, the Watershed Restoration Plan will aim to restore and protect the physical, biological and chemical integrity of these waterways, in particular the Category One segments, by fulfilling the nine minimum components of watershed planning and guiding the implementation of nonpoint source (NPS) pollution management measures.

B. <u>Data Usage</u>

The data collected in accordance with this Quality Assurance Project Plan (QAPP) will help describe both dry weather and wet weather water quality conditions. These data will provide the information needed to identify and quantify sources of pollution so that appropriate management practices can be implemented to minimize these sources.

C. <u>Monitoring Network Design and Rationale</u>

Sampling Locations:

The sampling locations are shown in Attachment A. The six sampling stations throughout the watershed are as follows:

ASK3: Assiscunk Creek, Jacksonville Road, Springfield Township, Burlington County, NJ
- AMNET Station AN0141
- HUC 02040201100040
- 40˚03′50.00″N, 74˚45′25.88″W

ASK2: Assiscunk Creek, Route 206, Columbus, Burlington County, NJ
- HUC 02040201100010
- 40˚03′24.91″N, 74˚43′25.96″W

ANR: Annaricken Brook, Island Road, Springfield Township, Burlington County, NJ
- AMNET Station AN0139, USGS Station #01464578
- HUC 02040201100010
- 40˚03′18.91″N, 74˚42′08.19″W

ASK1: Assiscunk Creek, Columbus-Georgetown Road, Mansfield Township, Burlington County, NJ
- AMNET Station AN0138
- HUC 02040201100010
- 40˚03′54.76″N, 74˚39′59.58″W

BB2: North Branch of the Upper Barker's Brook, Jobstown-Juliustown Road, Springfield Township, Burlington County, NJ
- HUC 02040201100020-01

- 40˚01′58.17″N, 74˚41′24.12″W

BB1: North Branch of the Upper Barker's Brook, Georgetown- Juliustown Road, Springfield Township, Burlington County, NJ
- AMNET Station AN0140, USGS Station #01464583
- HUC 02040201100020-01
- 40˚01′57.83″N, 74˚40′12.48″W.

A WAAS-enable Garmin Rino 120 GPS (global positioning system) unit will be used to locate and identify the sampling locations. Sampling locations will be marked with stakes and surveying tape or flags. Field personnel will take GPS readings in the field to aid in verifying the correct sampling locations during the first sampling event.

Basis for Sampling Locations:
Surface water quality sampling will be conducted to assess the loading inputs of nutrients, total suspended solids and bacteria to the Assiscunk Creek Headwaters, as well as the movement of nutrients, total suspended solids and bacteria from basin to basin to identify and quantify the sources of pollution under dry weather and wet weather conditions. Biological sampling will be conducted so that the benthic macroinvertebrate community can be better characterized, compared, and evaluated for biological integrity within the study area.

Location ASK3 was selected to characterize the outlet of HUC 02040201100040. Locations ASK1 was selected to characterize the inlet of HUC 02040201100010, and ASK2 was selected to characterize the outlet of HUC 02040201100010 as the Assiscunk flows into HUC 02040201100040. Location ANR was selected to characterize Annaricken Brook, a major tributary to the Assiscunk Creek within HUC 02040201100010. Locations BB1 and BB2 were selected to characterize the North Branch of the Upper Barkers Brook as it flows through HUC 02040201100020-01.

Temporal and Spatial Aspects:
Biweekly Surface Water Sampling
Surface water quality samples will be collected from all sampling locations in a downstream to upstream order to avoid disturbances to downstream water column samples twice a month, independent of weather, from June through November 2007 (12 events). Three additional surface water quality samples will be collected from all sampling locations in June, July, and August 2007 for fecal coliform and Eschericia coli (*E. coli*) analyses (nine additional sampling events). These nine additional sampling events will be independent of precipitation and will allow for a total of five fecal coliform, as well as five *E. coli* analyses at all sampling locations within a 30 day period during the warmer summer months. NJDEP considers the warm weather sampling months to fall between Memorial Day (i.e., May 28, 2007) and Labor Day (i.e., September 3, 2007).

All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions). In accordance with the Field Sampling Procedures Manual (See Section 6.8.1.1, Chapter 6D – page 59 of 188), field personnel will not wade into flowing water when the product of depth (in feet) and velocity (in feet per second) equals ten or greater to ensure the health and safety of all field personnel. If the stream flow conditions preclude entry into the stream, samples will be collected from the closest bridge crossing to that location or from the stream bank.

Bacteriology samples will be collected directly into a bacteriological sample container in accordance with the methods outlined in section 6.8.2.2.7 of the Field Sampling Procedures Manual (See Chapter 6D - page 67 of 188). Composite samples will not be collected for bacteriology samples.

For the most part, the Assiscunk Creek and its tributaries are uniformly mixed which warrants grab sampling (See Section 6.8.2.2.3, Chapter 6D-Page 66 of 188 of the Field Sampling Procedures Manual). A single grab sample will be collected at all locations where the stream width is six feet or less. At stream locations with a width greater than six feet, a minimum of three subsurface grab samples (i.e., quarter points) will be collected at equidistant points across the stream. The number of individual samples in a composite varies with the width of the stream being sampled. Horizontal intervals will be at least one foot wide (See Section 6.8.2.2.2, Chapter 6D – Page 64 of 188 of the Field Sampling Procedures Manual). These grab samples then will be composited in a larger volume container from which the desired volume will be transferred to the sample bottles. A dedicated large volume container will be assigned to each sample location.

Field equipment used for surface water quality sample collection (i.e., bottles and buckets) will be decontaminated/cleaned in the laboratory prior to each sampling event. A dedicated large volume container will be assigned to each sample location. Prior to each sampling event, the large volume containers will be decontaminated in the laboratory using the following procedures in accordance with the Field Sampling Procedures Manual (See Chapter 2A – Page 10 of 61): 1) laboratory grade glassware detergent plus tap water wash, 2) generous tap water rinse, 3) distilled/deionized water rinse, 4) 10% nitric acid rinse, 5) distilled/deionized water rinse. Note that the samples collected will not be analyzed for metals or organics. Also, field equipment decontamination water will be disposed of in accordance with the laboratory's Standard Operating Procedures and Quality Assurance Manual.

Wet Weather Surface Water Sampling

Three wet weather sampling events, at a minimum, will be conducted between June and November 2007 at each station. The wet weather samples for this plan will be in addition to the 12 biweekly surface water sampling events described above. Collection of stormwater samples will begin at the onset of the storm (i.e., a storm predicted to produce a minimum of ½ inch of precipitation), and an attempt will be made to span the course of the event. By using this method of sampling, the samples should accurately reflect loading for the entire event. A priority will be to acquire first flush samples. Flow will be measured along with concentrations to quantify loading for selected parameters. A total of three samples will be obtained between the onset of the storm and the time when the flow reaches the pre-storm level, unless impractical, at each station during each storm event. At each station, the samples obtained for the entire event will be flow-weight composited to provide one sample from each station, with the exception of fecal coliform and *E. coli*, which will require analysis of each individual grab sample. Rainfall data will be collected from a rain gauge that will be installed in the watershed.

If three samples can not be collected between the onset of the storm and the time when the flow reaches the pre-storm level, then the sampling event will not count as a wet weather surface water sampling event. If three ½ inch storm events are not captured between June - November 2007, the Water Resources Program, after consultation with the Department, may have to defer the Wet Weather Surface Water Sampling portions of the study to June – November 2008. Attempts will be made to conduct this portion of the study as early on in the study period as possible. Regarding time for collection of the first flush samples, the Water Resources Program will attempt to capture the first flush using the expected or anticipated rising limb of the hydrograph. The actual point on the hydrograph will have to be confirmed after sample completion.

Biological Sampling

Samples of the benthic macroinvertebrate community will be collected in accordance with the Rapid Bioassessment Protocol (RBP) procedure used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-002 Nov. 1999). A multihabitat sampling approach, concentrating on the most productive habitat of the stream plus coarse particulate organic matter (CPOM) or leaf litter, will be used. Benthic macroinvertebrates will be collected from four locations (i.e., ASK3, ANR, ASK1, and BB1) in either early summer or late summer (i.e., early/mid June or late August/early September) as described in Attachment B. The biological sampling locations were selected to correspond with existing AMNET sampling locations within the study area.

Summary of Monitoring Network Design and Rational –
Temporal and Spatial Aspects

Type:	Biweekly Surface Water Sampling	Additional Bacteriology Sampling	Wet Weather Surface Water Sampling	Biological Sampling
Frequency:	Two (2) times a month from June - November 2007 (12 events)	Three (3) times, in addition to biweekly samples, in June, July, & August 2007 (9 events)	Three (3) times between June - November 2007 (3 events)	Once in either early summer or late summer (1 event)
Parameters:	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, total suspended solids, fecal coliform, *E. coli*	Stream width, stream depth, stream velocity, fecal coliform, *E. coli*	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, total suspended solids, fecal coliform, *E. coli*	pH, temperature, dissolved oxygen, stream width, stream depth, stream velocity, total dissolved solids, benthic macroinvertebrate survey, habitat assessment
Sampling Locations:				
ASK3	X	X	X	X
*ASK2	X	X	X	
ANR	X	X	X	X
ASK1	X	X	X	X
BB2	X	X	X	
BB1	X	X	X	X

** Stream width, stream depth, and stream velocity will not be measured at sampling location ASK2.*

D. Monitoring Parameters

Surface water quality sample collection will be conducted by the Rutgers Cooperative Extension Water Resources Program (RCE WRP). Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment C by the RCE WRP. Stream width, stream depth, and stream velocity will not be measured at sampling location ASK2. *In situ* measurements of pH, temperature, and dissolved oxygen will be conducted by the Rutgers EcoComplex Laboratory (NJDEP Certified Laboratory #03019). Collected samples will be analyzed for fecal coliform, ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, and total suspended solids by New Jersey Analytical Laboratories (NJDEP Certified Laboratory #11005). In addition, collected samples will be analyzed for *E. coli* by Garden State Laboratories (NJDEP Certified Laboratory #20044).

Biological sampling will include benthic macroinvertebrate grab/jab type sampling, along with the collection of CPOM. Physicochemical measurements will include total dissolved solids and *in situ* pH, temperature, dissolved oxygen, stream width, stream depth, and stream velocity. Benthic macroinvertebrate sampling and identification will be conducted by the RCE WRP in accordance with the Rapid Bioassessment Protocol (RBP) procedure used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-002 Nov. 1999). The RCE WRP will make stream width, stream depth, and stream velocity determinations in accordance with the procedures specified in Attachment C. *In situ* measurements of pH, temperature, and dissolved oxygen will be conducted by the Rutgers EcoComplex Laboratory (NJDEP Certified Laboratory #03019). Total dissolved solids will be measured by New Jersey Analytical Laboratories (NJDEP Certified Laboratory #11005).

E. Parameter Table

Measurements of the sampled parameters will be performed in accordance with Table 1A – List of Approved Biological Methods and Table 1B – List of Approved Inorganic Test Procedures (40 CFR Part 136.3) of Attachment D. Sample containers, preservation techniques, and holding times will be in accordance with Table II (40 CFR Part 136.3) of Attachment E. New Jersey Analytical Laboratories and Garden State Laboratories will provide appropriate containers for all analyses. The circled methods and test procedures noted in Attachments D and E are the actual tests/methods that will be used as part of this project. These are the methods and procedures that the laboratories referenced in this QAPP are certified for. Any deviations from the test procedures and/or preservation methods and holding times will be reported to the NJDEP Office of Quality Assurance and will be noted in the final report from the laboratory.

8. Schedule:*

Task	Date
Submit QAPP	May 2007
Conduct biweekly surface water sampling	June – November 2007
Conduct additional bacteriology sampling	June, July, August 2007
Conduct wet weather surface water sampling	June - November 2007
Conduct biological sampling	Early Summer or Late Summer 2007
Submit data and summary report to NJDEP	February 2008

* All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions).

9. Project Organization and Responsibility:

Laboratory Operations:	(NJ Analytical)	Allen Thomas
	(Garden State L.)	Harvey Klein
	(Rutgers EcoComplex)	Lisa Galloway Evrard
	(NJDEP Representative)	Marc Ferko
Sampling Operations:	(RCE WRP)	Sandra Goodrow
	(NJDEP Representative)	Marc Ferko
Data Processing/	(RCE WRP)	Sandra Goodrow
Data Quality Review:	(NJDEP Representative)	Beth Torpey
		Mike Haberland
Overall QA:	(QA Officer)	Lisa Galloway Evrard
Overall Coordination:	(Project Officer)	Christopher C. Obropta

10. Organizational Chart:

Overall Coordination: Christopher C. Obropta (RCE WRP) Overall QA: Lisa Galloway Evrard (RCE WRP)
Data Quality Review/Data Processing: Sandra Goodrow (RCE WRP) Beth Torpey (NJDEP) Mike Haberland (NJDEP)
Sampling QC/Sampling Operations: Sandra Goodrow (RCE WRP) Marc Ferko (NJDEP)
Laboratory Operations: Allen Thomas (NJ Analytical) Harvey Klein (Garden State Laboratories) Lisa Galloway Evrard (Rutgers EcoComplex) Marc Ferko (NJDEP)

11. Sampling Procedures:

All sampling procedures will be in conformance with the NJDEP 2005 Field Sampling Procedures Manual, any applicable USEPA guidance, or with prior written approval.

- Bacteriology samples will be collected in accordance with the methods outlined in section 6.8.2.2.7 of the Field Sampling Procedures Manual (See Chapter 6D - page 67 of 188).
- Manual composite sampling for wider portions of the streams will be conducted in accordance with the methods outlined in section 6.8.2.2.2 of the Field Sampling Procedures Manual (See Chapter 6D – page 64 of 188).
- Grab sampling where the natural stream conditions make compositing unnecessary will be conducted in accordance with the methods outlined in section 6.8.2.2.3 of the Field Sampling Procedures Manual (See Chapter 6D – page 66 of 188).

In addition, instrumentation used for the collection of field data will be properly calibrated, in conformance with the manufacturer's instructions, laboratory SOPs and QA Manuals, and the NJDEP Field Sampling Procedures Manual.

12. Chain of Custody Procedures:

    Chain of Custody procedures will be followed for all samples collected for this monitoring program. A sample chain of custody form is provided in Attachment F. A sample is in someone's "custody" if 1) it is in one's actual physical possession, 2) it is in one's view, after being in one's physical possession, 3) it is in one's physical possession and then locked up so that no one can tamper with it, and 4) it is kept in a secured area, restricted to authorized personnel only.

13. Calibration Procedures and Preventative Maintenance:

    Calibration and preventative maintenance of laboratory and field equipment will be in accordance with the manufacturer's instructions, NJDEP Field Sampling Procedures Manual, NJAC 7:18 and 40 CFR Part 136.

14. Documentation, Data Reduction, and Reporting:

    The QA Officer, for a minimum of five years, will keep all data on file, and all applicable data will be included in the summary report to NJDEP. An electronic version of all reports and data will be provided on a CD for the Department’s use.

15. Quality Assurance and Quality Control:

    NJAC 7:18 and 40 CFR Part 136 will be followed for all quality assurance and quality control (QA/QC) practices, including detection limits, quantitation limits, precision, and accuracy. Tables of parameter detection limits, quantitation limits, accuracy, and precision applicable to this study are provided in Attachment G. New Jersey Analytical Laboratories, Garden State Laboratories, and Rutgers Cooperative Extension will perform data validation.

    Marion McClary, Jr., Ph.D. (Associate Professor of Biological Sciences and Associate Director of Biological Sciences at Fairleigh Dickinson University) will verify the reference/voucher collections prepared by Lisa Galloway Evrard of the Rutgers Cooperative Extension Water Resources Program.

16. Performance and Systems Audits:

    All NJDEP certified laboratories participate annually in a NJDEP mandated Performance Testing Program. The NJDEP Office of Quality Assurance conducts a performance audit of each laboratory that is certified. The NJDEP Office of Quality Assurance also periodically conducts on-site technical systems audits of each certified laboratory. The findings of these audits, together with the NJDEP mandated Performance Testing Program, are used to update each laboratory's certification status.

    The NJDEP Office of Quality Assurance periodically conducts field audits of project sampling operations. The Office of Quality Assurance will be contacted during the project to schedule a possible field audit.

17. Corrective Action:

    All NJDEP certified laboratories must have a written corrective action procedure which they adhere to in the event that calibration standards, performance evaluation results, blanks, duplicates, spikes, etc. are out of the acceptable range or control limits. If the acceptable results cannot be obtained for the above-mentioned QA/QC samples during any given day, sample analysis must be repeated for that day with the acceptable QA/QC results. NJDEP will be notified if there are any deviations from the approved work plan.

    All signatories of this QAPP will be notified when deviations to the QAPP are made prior to their implementation.

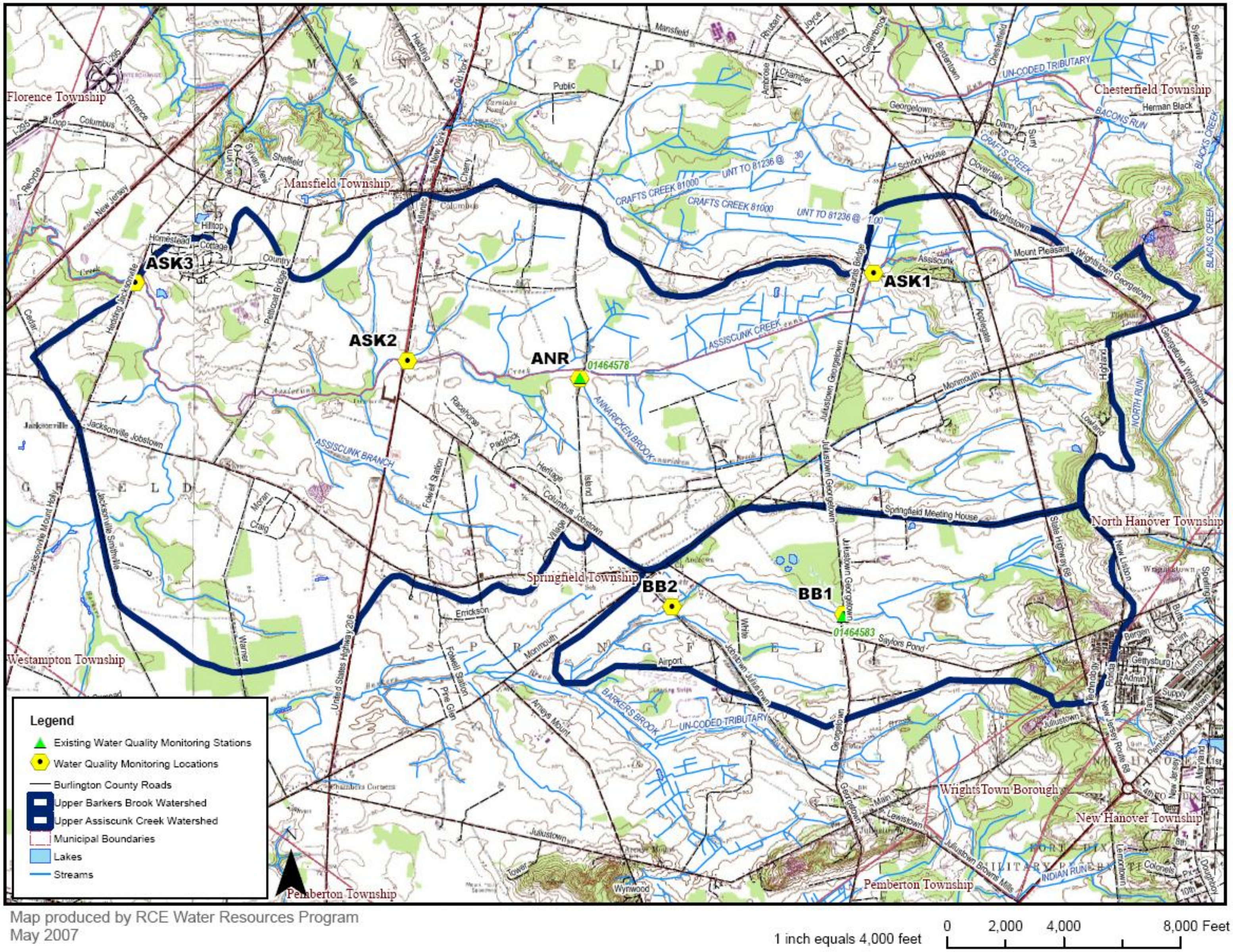
18. Reports:

    The summary report will include at a minimum an Introduction, Purpose and Scope, Results and Discussion, Conclusions and Recommendations, and an appendix with data tables. An electronic version of all reports and data will be provided on a CD for the Department's use.

ATTACHMENT A

Sampling Locations
Assiscunk Creek Headwaters

FIGURE 1: Water Quality Monitoring Stations
Headwaters of the Assiscunk Creek Watershed and Barkers Brook Watershed



Map produced by RCE Water Resources Program
May 2007

ATTACHMENT B

Biological Sampling Procedures and Analysis

Biological Sampling Procedures and Analysis

These sampling and data analysis procedures are in accordance with the Rapid Bioassessment Protocol procedures used by the NJDEP Bureau of Freshwater and Biological Monitoring, which is based on USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers* (EPA 841-B-99-02 Nov. 1999).

Sampling Procedures:

Samples will be collected using a multi-habitat sampling approach, concentrating on the most productive habitat of the stream (i.e., the riffle/run areas), plus coarse particulate organic matter (CPOM) or leaf litter. This sampling method minimizes habitat or substrate variation between sampling sites, and includes all likely functional feeding groups of macroinvertebrates in the stream. Three grab type samples will be collected at each sampling site. These samples will be sorted in the field, composited (i.e., the contents from the three grab samples from each site will be combined into a single container), and preserved in 80% ethanol for later subsampling, identification and enumeration.

A composite collection of a variety of CPOM forms (e.g., leaves, needles, twigs, bark, or fragments of these) will be collected. It is difficult to quantify the amount of CPOM to be collected in terms of weight or volume, given the variability of its composition. Collection of several handfuls of material is usually adequate, and the material is typically found in depositional areas, such as in pools and along snags and undercut banks. The CPOM sample will be processed using a U.S. Standard No. 30 sieve, and added to the composite of the grab samples for each site.

A 100-organism subsample of the benthic macroinvertebrate composite sample from each sampling site will be taken in the laboratory according to the methods outlined in the Rapid Bioassessment Protocol used by the NJDEP Bureau of Freshwater and Biological Monitoring. With the exception of chironomids and oligochaetes, benthic macroinvertebrates will be identified to genus. Chironomids will be identified to subfamily as a minimum, and oligochaetes will be identified to family as a minimum.

A habitat assessment will be conducted concurrent with the benthic macroinvertebrate sampling in accordance with the methods used by the NJDEP Bureau of Freshwater and Biological Monitoring. The measurement of physicochemical parameters will also be conducted concurrent with the benthic macroinvertebrate sampling. Surface water sampling for the measurement of pH, temperature, and dissolved oxygen will be conducted on a representative cross section of the steam. At least four subsurface grab samples will be collected across an established transect. These grab samples will be composited, and an appropriate volume will be transferred to sample bottles for *in situ* measurements of pH, temperature, and dissolved oxygen. Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment C. Total dissolved solids (TDS) will also be measured as part of the biological sampling.

Biological Sampling Procedures and Analysis (continued)

Data Analysis:
The NJDEP Bureau of Freshwater and Biological Monitoring uses several community measures of biometrics adapted from the Rapid Bioassessment Protocols to evaluate the biological condition of sampling sites within the Ambient Biomonitoring Network in New Jersey. These community measures include taxa richness, EPT index, %EPT, %CDF, and Modified Family Biotic Index. This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey Impairment Score (NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired, and is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams.

If the above metrics are not utilized, or if different metrics or indices are used, these changes will be discussed with NJDEP for approval. For example, to determine the similarity among the sampling sites with respect to species composition, the Percentage Similarity Index may be calculated for all pair wise comparisons of the sampling sites. Also, the benthic macroinvertebrates may be separated into the four broad functional feeding groups to evaluate community structure. In addition, the Shannon diversity index may be calculated to evaluate community structure. In addition, the findings from the habitat assessment will be used to interpret survey results and identify obvious constraints on the attainable biological potential of the site.

The final report will include a characterization of the aquatic biota, in particular the benthic macroinvertebrate community.

ATTACHMENT C

Stream Flow Measurement Procedure

Stream Flow Measurement Procedure

Stream width, depth, velocity, and flow determinations will be made in conformance with the following procedures:

1. A measuring tape is extended across the stream, from bank to bank, perpendicular to flow. Meter calibration is checked.

2. Using a Marsh-McBirney, Inc. Model 2000 Flo-Mate Portable Water Flow meter, velocity and depth measurements are made at points along the tape. Normally depth is measured using a rod calibrated in tenths of a foot. In shallow streams, a yardstick may be used to measure depth. Velocities are measured at approximately 0.6 depth (from the surface) where depths are less than 2.5 feet and at 0.2 and 0.8 depth (from the surface) in areas where the depth exceeds 2.5 feet.

3. The stream cross section is divided into segments with depth and velocity measurements made at equal intervals along the cross section. The number of measurements will vary with site conditions and uniformity of stream cross section. Each cross section is divided into equal parts depending upon the total width and uniformity of the section. At a minimum, velocities are taken at quarter points for very narrow sections. In general, velocity and depth measurements are taken every one to five feet. A minimum of ten velocity locations is used whenever possible. The velocity is determined by direct readout from the Marsh-McBirney meter set for 5 second velocity averaging.

4. Using the field data collected, total flow, average velocity, and average depth can be computed. Individual partial cross-sectional areas are computed for each depth and velocity measurement. The mean velocity of flow in each partial area is computed and multiplied by the partial cross-sectional area to produce an incremental flow. Incremental flows are summed to calculate the total flow. The average velocity for the stream can be computed by dividing the total flow by the sum of the partial cross-sectional areas. The average depth for the stream can be computed by dividing the sum of the partial cross-sectional areas by the total width of the stream. The accuracy of this method depends upon a number of factors, which include the uniformity of the steam bottom, total width, and the uniformity of the velocity profile.

   - Flow measurements will be collected for all sampling events. However, in accordance with the Field Sampling Procedures Manual (See Section 6.8.1.1, Chapter 6D – page 59 of 188), field personnel will not wade into flowing water when the product of depth (in feet) and velocity (in feet per second) equals ten or greater. All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions) to ensure the health and safety of all field personnel. If the stream flow conditions preclude entry into the stream, flow will have to be estimated or calculated based on the recorded flow at the closest USGS gaging station and the drainage area.

ATTACHMENT D

Table 1A – List of Approved Biological Methods
&
Table 1B – List of Approved Inorganic Test Procedures
40 CFR Part 136.3
July 1, 2005

TABLE IA—LIST OF APPROVED BIOLOGICAL METHODS

Parameter and units	Method[1]	EPA	Standard methods 18th, 19th, 20th Ed.	ASTM	AOAC	USGS	Other
Bacteria:							
1. Coliform (fecal), number per 100 mL.	Most Probable Number (MPN), 5 tube, 3 dilution, or	p. 132[3]	9221C E[4]				
	Membrane filter (MF)[2], single step.	p. 124[3]	9222D[4]			B–0050–85[5]	
2. Coliform (fecal) in presence of chlorine, number per 100 mL.	MPN, 5 tube, 3 dilution, or	p. 132[3]	9221C E[4]				
	MF, single step[6]	p. 124[3]	9222D[4]				
3. Coliform (total), number per 100 mL.	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2], single step or two step	p. 108[3]	9222B[4]			B–0025–85[5]	
4. Coliform (total), in presence of chlorine, number per 100 mL.	MPN, 5 tube, 3 dilution, or	p. 114[3]	9221B[4]				
	MF[2] with enrichment	p. 111[3]	9222(B+B.5c)[4]				
5. *E. coli*, number per 100 mL[28].	MPN[7,9,15], multiple tube,		9221B.1/9221F[4,12,14]				
	multiple tube/multiple well,		9223B[4,13]		991.15[11]		Colilert®[13,17] Colilert-18®[13,16,17]
	MF[2,6,7,8,9] two step, or	1103.1[20]	9222B/9222G[4,19] 9213D[4]	D5392–93[10]			
	single step	1603[21] 1604[22]					mColiBue 24[18]
6. Fecal streptococci, number per 100 mL.	MPN, 5 tube, 3 dilution,	p. 139[3]	9230B[4], 9230C[4]				
	MF[2], or	p. 136[3]			B–0055–85[5]		
	Plate count	p. 143[4]					
7. Enterococci, number per 100 mL.	MPN[7,9] multiple tube		9230B[4]				
	multiple tube/multiple well			D6503–99[10]			Enterolert®[13,23]
	MF[2,6,7,8,9] two step	1106.1[24]	9230C[4]	D5259–92[10]			
	single step, or	1600[25]					
	Plate count	p. 143[3]					
Protozoa:							
8. *Cryptosporidium*[28]	Filtration/IMS/FA	1622[26] 1623[27]					
9. *Giardia*[28]	Filtration/IMS/FA	1623[27]					
Aquatic Toxicity:							
10. Toxicity, acute, fresh water organisms, LC50, percent effluent.	*Ceriodaphnia dubia* acute	2002.0[29]					

	Sea urchin, *Arbacia punctulata*, fertilization.	1008.0[31]					

Notes to Table IA:

[1] The method must be specified when results are reported.

[2] A 0.45 µm membrane filter (MF) or other pore size certified by the manufacturer to fully retain organisms to be cultivated and to be free of extractables which could interfere with their growth.

[3] USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water, and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. EPA/600/8–78/017.

[4] APHA. 1998, 1995, 1992. Standard Methods for the Examination of Water and Wastewater. American Public Health Association. 20th, 19th, and 18th Editions. Amer. Publ. Hlth. Assoc., Washington, D.C.

[5] USGS. 1989. U.S. Geological Survey Techniques of Water-Resource Investigations, Book 5, Laboratory Analysis, Chapter A4, Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples, U.S. Geological Survey, U.S. Department of Interior, Reston, Virginia.

[6] Because the MF technique usually yields low and variable recovery from chlorinated wastewaters, the Most Probable Number method will be required to resolve any controversies.

[7] Tests must be conducted to provide organism enumeration (density). Select the appropriate configuration of tubes/filtrations and dilutions/volumes to account for the quality, character, consistency, and anticipated organism density of the water sample.

[8] When the MF method has not been used previously to test ambient waters with high turbidity, large number of noncoliform bacteria, or samples that may contain organisms stressed by chlorine, a parallel test should be conducted with a multiple-tube technique to demonstrate applicability and comparability of results.

[9] To assess the comparability of results obtained with individual methods, it is suggested that side-by-side tests be conducted across seasons of the year with the water samples routinely tested in accordance with the most current Standard Methods for the Examination of Water and Wastewater or EPA alternate test procedure (ATP) guidelines.

[10] ASTM. 2000, 1999, 1996. Annual Book of ASTM Standards—Water and Environmental Technology. Section 11.02. American Society for Testing and Materials. 100 Barr Harbor Drive, West Conshohocken, PA 19428.

[11] AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. Association of Official Analytical Chemists International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417.

[12] The multiple-tube fermentation test is used in 9221B.1. Lactose broth may be used in lieu of lauryl tryptose broth (LTB), if at least 25 parallel tests are conducted between this broth and LTB using the water samples normally tested, and this comparison demonstrates that the false-positive rate and false-negative rate for total coliform using lactose broth is less than 10 percent. No requirement exists to run the completed phase on 10 percent of all total coliform-positive tubes on a seasonal basis.

[13] These tests are collectively known as defined enzyme substrate tests, where, for example, a substrate is used to detect the enzyme β–glucuronidase produced by *E. coli*.

[14] After prior enrichment in a presumptive medium for total coliform using 9221B.1, all presumptive tubes or bottles showing any amount of gas, growth or acidity within 48 h ± 3 h of incubation shall be submitted to 9221F. Commercially available EC-MUG media or EC media supplemented in the laboratory with 50 µg/mL of MUG may be used.

[15] Samples shall be enumerated by the multiple-tube or multiple-well procedure. Using multiple-tube procedures, employ an appropriate tube and dilution configuration of the sample as needed and report the Most Probable Number (MPN). Samples tested with Colilert® may be enumerated with the multiple-well procedures, Quanti-Tray® or Quanti-Tray® 2000, and the MPN calculated from the table provided by the manufacturer.

[16] Colilert-18® is an optimized formulation of the Colilert® for the determination of total coliforms and *E. coli* that provides results within 18 h of incubation at 35 °C rather than the 24 h required for the Colilert® test and is recommended for marine water samples.

[17] Descriptions of the Colilert®, Colilert-18®, Quanti-Tray®, and Quanti-Tray®/2000 may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.

[18] A description of the mColiBlue24'' test, Total Coliforms and *E. coli*, is available from Hach Company, 100 Dayton Ave., Ames, IA 50010.

[19] Subject total coliform positive samples determined by 9222B or other membrane filter procedure to 9222G using NA-MUG media.

[20] USEPA. 2002. Method 1103.1: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using membrane-Thermotolerant *Escherichia coli* Agar (mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–020.

[21] USEPA. 2002. Method 1603: *Escherichia coli* (*E. coli*) In Water By Membrane Filtration Using Modified membrane-Thermotolerant *Escherichia coli* Agar (modified mTEC). U.S. Environmental Protection Agency, Office of Water, Washington D.C. EPA–821–R–02–023.

[22] Preparation and use of MI agar with a standard membrane filter procedure is set forth in the article, Brenner *et al.* 1993. "New Medium for the Simultaneous Detection of Total Coliform and *Escherichia coli* in Water.'' Appl. Environ. Microbiol. 59:3534–3544 and in USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli* (*E. coli*) in Water by Membrane Filtration by Using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA 821–R–02–024.

[23] A description of the Enterolert® test may be obtained from IDEXX Laboratories, Inc., One IDEXX Drive, Westbrook, Maine 04092.

[24] USEPA. 2002. Method 1106.1: Enterococci In Water By Membrane Filtration Using membrane-Enterococcus-Esculin Iron Agar (mE-EIA). U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–02–021.

[25] USEPA. 2002. Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA–821–R–02–022.

[26] Method 1622 uses filtration, concentration, immunomagnetic separation of oocysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the detection of *Cryptosporidium*. USEPA. 2001. Method 1622: Cryptosporidium in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–026.

[27] Method 1623 uses filtration, concentration, immunomagnetic separation of oocysts and cysts from captured material, immunofluorescence assay to determine concentrations, and confirmation through vital dye staining and differential interference contrast microscopy for the simultaneous detection of *Cryptosporidium* and *Giardia* oocysts and cysts. USEPA. 2001. Method 1623. Cryptosporidium and Giardia in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA–821–R–01–025.

[28] Recommended for enumeration of target organism in ambient water only.

[29] USEPA. October 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/012.
[30] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/013.
[31] USEPA. October 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. Third Edition. U.S. Environmental Protection Agency, Office of Water, Washington DC. EPA/821/R–02/014.

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES

Parameter, units and method	Reference (method number or page)				
	EPA[1,35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
1. Acidity, as $CaCO_3$, mg/L:					
Electrometric endpoint or phenolphthalein endpoint.	305.1	2310 B(4a) [18th, 19th, 20th].	D1067–92	I–1020–85	
				I–2030–85	
2. Alkalinity, as $CaCO_3$, mg/L:					
Electrometric of Colorimetric titration to pH 4.5, manual	310.1	2320 B [18th, 19th, 20th]	D1067–92	I–1030–85	973.43[3]
or automatic.	310.2.			I–2030–85	
3. Aluminium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	202.1	3111 D [18th, 19th]		I–3051–85	
AA furnace	202.2	3113 B [18th, 19th].			
Inductively Coupled Plasma/Atomic Emission Spectrometry (ICP/AES)[36].	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
Direct Current Plasma (DCP)[36].			D4190–94		Note 34.
Colorimetric (Eriochrome cyanine R).		3500–Al B [20th] and 3500–Al D [18th, 19th].			
4. Ammonia (as N), mg/L:					
Manual, distillation (at pH 9.5)[6] followed by.	350.2	4500–NH_3 B [18th, 19th, 20th].			973.49[3]
Nesslerization	350.2	4500–NH_3 C [18th]	D1426–98(A)	I–3520–85	973.49[3]
Titration	350.2	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th].			
Electrode	350.3	4500–NH_3 D or E [19th, 20th] and 4500–NH_3 F or G [18th].	D1426–98(B).		
Automated phenate, or	350.1	4500–NH_3 G [19th, 20th] and 4500–NH_3 H [18th].		I–4523–85	
Automated electrode					Note 7.
5. Antimony-Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	204.1	3111 B [18th, 19th]			
AA furnace	204.2	3113 B [18th, 19th]			
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]			
6. Arsenic-Total[4] mg/L:					

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1, 35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration (See Parameters 13 and 33)	130.2	2340 B or C [18th, 19th, 20th].	D1126–86(92)	I–1338–85	973.52B[3]
28. Hydrogen ion (pH), pH units:					
Electrometric measurement, or:	150.1	4500–H^+ B [18th, 19th, 20th].	D1293–84 (90)(A or B)	I–1586–85	973.41[3]
Automated electrode				I–2587–85	Note 21.
29. Iridium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration or	235.1	3111 B [18th, 19th]			
AA furnace	235.2				
30. Iron—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	236.1	3111 B or C [18th, 19th]	D1068–96(A or B)	I–3381–85	974.27[3]
AA furnace	236.2	3113 B [18th, 19th]	D1068–96(C)		
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36] or			D4190–94		Note 34.
Colorimetric (Phenanthroline).		3500–Fe B [20th] and 3500–Fe D [18th, 19th].	D1068–96(D)		Note 22.
31. Kjeldahl Nitrogen—Total, (as N), mg/L:					
Digestion and distillation followed by:	351.3	4500–N_{org} B or C and 4500–NH_3 B [18th, 19th, 20th].	D3590–89(A)		
Titration	351.3		D3590–89(A)		973.48[3]
Nesslerization	351.3	4500–NH_3 C [18th]	D3590–89(A)		
Electrode	351.3	4500–NH_3 C [19th, 20th] and 4500–NH_3 E [18th].			
Automated phenate colorimetric	351.1			I–4551–78[8]	
Semi-automated block digestor colorimetric.	351.2		D3590–89(B)	I–4515–91[45].	
Manual or block digestor potentiometric.	351.4		D3590–89(A)		
Block digester, followed by Auto distillation and Titration, or.					Note 39.
Nesslerization, or					Note 40.
Flow injection gas diffusion					Note 41.
32. Lead—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	239.1	3111 B or C [18th, 19th]	D3559–96(A or B)	I–3399–85	974.27[3]

AA furnace	239.2	3113 B [18th, 19th]	D3559–96(D)	I–4403–89[51]	
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36]			D4190–94		Note 34.
Voltammetry[11] or			D3559–96(C)		
Colorimetric (Dithizone)		3500–Pb B [20th] and 3500–Pb D [18th, 19th].			
33. Magnesium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	242.1	3111 B [18th, 19th]	D511–93(B)	I–3447–85	974.27[3]
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP or					Note 34.
Gravimetric		3500–Mg D [18th, 19th]			
34. Manganese-Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	243.1	3111 B [18th, 19th]	D858–95(A or B)	I–3454–85	974.27[3]
AA furnace	243.2	3113 B [18th, 19th]	D858–95(C)		
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP[36], or			D4190–94		Note 34
Colorimetric (Persulfate), or		3500–Mn B [20th] and 3500–Mn D [18th, 19th].			920.203[3]
(Periodate)					Note 23.
35. Mercury—Total,[4] mg/L:					
Cold vapor, manual or	245.1	3112 B [18th, 19th]	D3223–91	I–3462–85	977.22[3]
Automated	245.2				
Oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry (ng/L).	1631E[43]				
36. Molybdenum—Total[4], mg/L; Digestion[4] followed by:					
AA direct aspiration	246.1	3111 D [18th, 19th]		I–3490–85	
AA furnace	246.2	3113 B [18th, 19th]		I–3492–96[47]	
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50]	
DCP					Note 34.
37. Nickel—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	249.1	3111 B or C [18th, 19th]	D1886–90(A or B)	I–3499–85.	
AA furnace	249.2	3113 B [18th, 19th]	D1886–90(C)	I–4503–89[51].	
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50].	
DCP[36], or			D4190–94		Note 34.
Colorimetric (heptoxime)		3500–Ni D [17th].			
38. Nitrate (as N), mg/L:					
Colorimetric (Brucine sulfate), or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40).	352.1				973.50,[3] 419D,[17] p. 28[9]
39. Nitrate-nitrite (as N), mg/L:					
Cadmium reduction, Manual or.	353.3	4500–NO_3^-E [18th, 19th, 20th].	D3867–99(B).		

Nitrate: EPA 300.0;
Ion Chromatography

TABLE IB—LIST OF APPROVED INORGANIC TEST PROCEDURES—Continued

Parameter, units and method	Reference (method number or page)				
	EPA[1,35]	*Standard Methods* [Edition(s)]	ASTM	USGS[2]	Other
Automated, or	353.2	4500–NO_3^-F [18th, 19th, 20th].	D3867–99(A)	I–4545–85.	
Automated hydrazine	353.1	4500–NO_3^-H [18th, 19th, 20th].			
40. Nitrite (as N), mg/L: Spectrophotometric:					
Manual or	354.1	4500–NO_2^-B [18th, 19th, 20th].			Note 25.
Automated (Diazotization)				I–4540–85.	
41. Oil and grease—Total recoverable, mg/L:					
Gravimetric (extraction)	413.1	5520B [18th, 19th, 20th][38].			
Oil and grease and non-polar material, mg/L: Hexane extractable material (HEM): n-Hexane extraction and gravimetry.	1664A[42]	5520B [18th, 19th, 20th][38].			
Silica gel treated HEM (SGT-HEM): Silica gel treatment and gravimetry.	1664A[42].				
42. Organic carbon—Total (TOC), mg/L:					
Combustion or oxidation	415.1	5310 B, C, or D [18th, 19th, 20th].	D2579–93 (A or B)		973.47,[3] p. 14[24]
43. Organic nitrogen (as N), mg/L:					
Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4)					
44. Orthophosphate (as P), mg/L: Ascorbic acid method:					
Automated, or	365.1	4500–P F [18th, 19th, 20th]		I–4601–85	973.56[3]
Manual single reagent	365.2	4500–P E [18th, 19th, 20th]	D515–88(A)		973.55[3]
Manual two reagent	365.3.				
45. Osmium—Total[4], mg/L; Digestion[4] followed by:					
AA direct aspiration, or	252.1	3111 D [18th, 19th].			
AA furnace	252.2.				
46. Oxygen, dissolved, mg/L:					
Winkler (Azide modification), or	360.2	4500–O C [18th, 19th, 20th]	D888–92(A)	I–1575–78[8]	973.45B[3]
Electrode	360.1	4500–O G [18th, 19th, 20th].	D888–92(B)	I–1576–78[8].	

Nitrite: EPA 300.0,
Ion Chromatography

47. Palladium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration, or	253.1	3111 B [18th, 19th]			p. S27[10]
AA furnace	253.2				p. S28[10]
DCP					Note 34.
48. Phenols, mg/L:					
Manual distillation[26]	420.1				Note 27.
Followed by:					
Colorimetric (4AAP) manual, or	420.1				Note 27.
Automated[19]	420.2.				
49. Phosphorus (elemental), mg/L:					
Gas-liquid chromatography					Note 28.
50. Phosphorus—Total, mg/L:					
Persulfate digestion followed by.	365.2	4500–P B, 5 [18th, 19th, 20th].			973.55[3]
Manual or	365.2 or 365.3	4500–P E [18th, 19th, 20th]	D515–88(A)		
Automated ascorbic acid reduction.	365.1	4500–P F [18th, 19th, 20th]		I–4600–85	973.56[3]
Semi-automated block digestor.	365.4		D515–88(B)	I–4610–91[48].	
51. Platinum—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration	255.1	3111 B [18th, 19th].			
AA furnace	255.2.				
DCP					Note 34
52. Potassium—Total,[4] mg/L: Digestion[4] followed by:					
AA direct aspiration	258.1	3111 B [18th, 19th]		I–3630–85	973.53[3]
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th].			
Flame photometric, or		3500–K B [20th] and 3500–K D [18th, 19th].			
Colorimetric					317 B[17]
53. Residue—Total, mg/L:					
Gravimetric, 103–105°	160.3	2540 B [18th, 19th, 20th]		I–3750–85.	
54. Residue—filterable, mg/L:					
Gravimetric, 180°	160.1	2540 C [18th, 19th, 20th]		I–1750–85.	
55. Residue—nonfilterable (TSS), mg/L:					
Gravimetric, 103–105° post washing of residue.	160.2	2540 D [18th, 19th, 20th]		I–3765–85.	
56. Residue—settleable, mg/L:					
Volumetric, (Imhoff cone), or gravimetric.	160.5	2540 F [18th, 19th, 20th].			
57. Residue—Volatile, mg/L:					
Gravimetric, 550°	160.4			I–3753–85.	
58. Rhodium-Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration, or	265.1	3111 B [18th, 19th].			

Colorimetric (methylene blue).	376.2	4500–S^{-2}D [18th, 19th, 20th].			
67. Sulfite (as SO_3), mg/L:					
Titrimetric (iodine-iodate)	377.1	4500–SO_3^{-2}B [18th, 19th, 20th].			
68. Surfactants, mg/L:					
Colorimetric (methylene blue).	425.1	5540 C [18th, 19th, 20th]	D2330–88.		
69. Temperature, °C:					
Thermometric	170.1	2550 B [18th, 19th, 20th]			Note 32.
70. Thallium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	279.1	3111 B [18th, 19th].			
AA furnace	279.2.				
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th].			
71. Tin—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	282.1	3111 B [18th, 19th]		I–3850–78[8].	
AA furnace, or	282.2	3113 B [18th, 19th].			
ICP/AES	200.7[5].				
72. Titanium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	283.1	3111 D [18th, 19th].			
AA furnace	283.2.				
DCP					Note 34.
73. Turbidity, NTU:					
Nephelometric	180.1	2130 B [18th, 19th, 20th]	D1889–94(A)	I–3860–85.	
74. Vanadium—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration	286.1	3111 D [18th, 19th].			
AA furnace	286.2		D3373–93.		
ICP/AES	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50].	
DCP, or			D4190–94		Note 34.
Colorimetric (Gallic Acid)		3500–V B [20th] and 3500–V D [18th, 19th].			
75. Zinc—Total,[4] mg/L; Digestion[4] followed by:					
AA direct aspiration[36]	289.1	3111 B or C [18th, 19th]	D1691–95(A or B)	I–3900–85	974.27,[3] p. 37[9]
AA furnace	289.2.				
ICP/AES[36]	200.7[5]	3120 B [18th, 19th, 20th]		I–4471–97[50].	
DCP,[36] or			D4190–94		Note 34.
Colorimetric (Dithizone) or		3500–Zn E [18th, 19th].			
(Zincon)		3500–Zn B [20th] and 3500–Zn F [18th, 19th].			Note 33.

Table 1B Notes:

[1] "Methods for Chemical Analysis of Water and Wastes," Environmental Protection Agency, Environmental Monitoring Systems Laboratory—Cincinnati (EMSL-CI), EPA–600/4–79–020, Revised March 1983 and 1979 where applicable.

[2] Fishman, M.J., *et al.* "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments, "U.S. Department of the Interior, Techniques of Water-Resource Investigations of the U.S. Geological Survey, Denver, CO, Revised 1989, unless otherwise stated.

[3] "Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 15th ed. (1990).

[4] For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979 and 1983". One (Section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (Section 4.1.4) is preferred; however, the analyst should be cautioned that this mild digestion may not suffice for all samples types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organo-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials may also benefit by this vigorous digestion, however, vigorous digestion with concentrated nitric acid will convert antimony and tin to insoluble oxides and render them unavailable for analysis. Use of ICP/AES as well as determinations for certain elements such as antimony, arsenic, the noble metals, mercury, selenium, silver, tin, and titanium require a modified sample digestion procedure and in all cases the method write-up should be consulted for specific instructions and/or cautions.

NOTE TO TABLE 1B NOTE 4: If the digestion procedure for direct aspiration AA included in one of the other approved references is different than the above, the EPA procedure must be used. Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion of the filtrate for dissolved metals (or digestion of the original sample solution for total metals) may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses, provided the sample solution to be analyzed meets the following criteria:

a. has a low COD (<20)
b. is visibly transparent with a turbidity measurement of 1 NTU or less
c. is colorless with no perceptible odor, and
d. is of one liquid phase and free of particulate or suspended matter following acidification.

[5] The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.

[6] Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary: however, manual distillation will be required to resolve any controversies.

[7] Ammonia, Automated Electrode Method, Industrial Method Number 379–75 WE, dated February 19, 1976, Bran & Luebbe (Technicon) Auto Analyzer II, Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[8] The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments", USGS TWRI, Book 5, Chapter A1 (1979).

[9] American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 25 West 43rd Street, New York, NY 10036.

[10] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency", Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater (1981).

[11] The use of normal and differential pulse voltage ramps to increase sensitivity and resolution is acceptable.

[12] Carbonaceous biochemical oxygen demand ($CBOD_5$) must not be confused with the traditional BOD_5 test method which measures "total BOD". The addition of the nitrification inhibitor is not a procedural option, but must be included to report the $CBOD_5$ parameter. A discharger whose permit requires reporting the traditional BOD_5 may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states $CBOD_5$ is required can the permittee report data using a nitrification inhibitor.

[13] OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 1978, 512 West Loop, PO Box 2980, College Station, TX 77840.

[14] Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[15] The back titration method will be used to resolve controversy.

[16] Orion Research Instruction Manual, Residual Chlorine Electrode Model 97–70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138. The calibration graph for the Orion residual chlorine method must be derived using a reagent blank and three standard solutions, containing 0.2, 1.0, and 5.0 mL 0.00281 N potassium iodate/100 mL solution, respectively.

[17] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1976.

[18] National Council of the Paper Industry for Air and Stream Improvement, Inc. Technical Bulletin 253, December 1971.

[19] Copper, Biocinchoinate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[20] After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the re-sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.

[21] Hydrogen ion (pH) Automated Electrode Method, Industrial Method Number 378–75WA, October 1976, Bran & Luebbe (Technicon) Autoanalyzer II. Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[22] Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[23] Manganese, Periodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2–113 and 2–117, Hach Chemical Company, Loveland, CO 80537.

[24] Wershaw, R.L., *et al*, "Methods for Analysis of Organic Substances in Water," Techniques of Water-Resources Investigation of the U.S. Geological Survey, Book 5, Chapter A3, (1972 Revised 1987) p. 14.

[25] Nitrogen, Nitrite, Method 8507, Hach Chemical Company, PO Box 389, Loveland, CO 80537.

[26] Just prior to distillation, adjust the sulfuric-acid-preserved sample to pH 4 with 1 + 9 NaOH.

[27] The approved method is cited in Standard Methods for the Examination of Water and Wastewater, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0±0.2. The approved methods are given on pp 576–81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrometric procedure.

[28] R.F. Addison and R.G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," Journal of Chromatography, Vol. 47, No. 3, pp. 421–426, 1970.

[29] Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to pH of 12. Therefore, for levels of silver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M $Na_2S_2O_3$ and NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.

[30] The approved method is that cited in Standard Methods for the Examination of Water and Wastewater, 15th Edition.

[31] EPA Methods 335.2 and 335.3 require the NaOH absorber solution final concentration to be adjusted to 0.25 N before colorimetric determination of total cyanide.

[32] Stevens, H.H., Ficke, J.F., and Smoot, G.F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation," Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 1, Chapter D1, 1975.

[33] Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2–231 and 2–333, Hach Chemical Company, Loveland, CO 80537.

[34] "Direct Current Plasma (DCP) Optical Emission Spectrometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029," 1986—Revised 1991, Thermo Jarrell Ash Corporation, 27 Forge Parkway, Franklin, MA 02038.

[35] Precision and recovery statements for the atomic absorption direct aspiration and graphite furnace methods, and for the spectrophotometric SDDC method for arsenic are provided in Appendix D of this part titled, "Precision and Recovery Statements for Methods for Measuring Metals".

[36] "Closed Vessel Microwave Digestion of Wastewater Samples for Determination of Metals", CEM Corporation, PO Box 200, Matthews, NC 28106–0200, April 16, 1992. Available from the CEM Corporation.

[37] When determining boron and silica, only plastic, PTFE, or quartz laboratory ware may be used from start until completion of analysis.

[38] Only use Trichlorotrifluorethane (1,1,2-trichloro-1,2,2-trifluoroethane; CFC–113) extraction solvent when determining Total Recoverable Oil and Grease (analogous to EPA Method 413.1). Only use *n*-hexane extraction solvent when determining Hexane Extractable Material (analogous to EPA Method 1664A). Use of other extraction solvents is strictly prohibited.

[39] Nitrogen, Total Kjeldahl, Method PAI-DK01 (Block Digestion, Steam Distillation, Titrimetric Detection), revised 12/22/94, OI Analytical/ALPKEM, PO Box 9010, College Station, TX 77842.

[40] Nitrogen, Total Kjeldahl, Method PAI-DK02 (Block Digestion, Steam Distillation, Colorimetric Detection), revised 12/22/94, OI Analytical/ALPKEM, PO Box 9010, College Station, TX 77842.

[41] Nitrogen, Total Kjeldahl, Method PAI-DK03 (Block Digestion, Automated FIA Gas Diffusion), revised 12/22/94, OI Analytical/ALPKEM, PO Box 9010, College Station, TX 77842.

[42] Method 1664, Revision A "n-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated n-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry" EPA–821–R–98–002, February 1999. Available at NTIS, PB–121949, U.S. Department of Commerce, 5285 Port Royal, Springfield, Virginia 22161.

[43] USEPA. 2002. Method 1631, Revision E, "Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry." September 2002. Office of Water, U.S. Environmental Protection Agency (EPA–821–R–02–019). The application of clean techniques described in EPA's draft Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (EPA–821–R–96–011) are recommended to preclude contamination at low-level, trace metal determinations.

[44] Available Cyanide, Method OIA–1677 (Available Cyanide by Flow Injection, Ligand Exchange, and Amperometry), ALPKEM, A Division of OI Analytical, PO Box 9010, College Station, TX 77842–9010.

[45] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Ammonia Plus Organic Nitrogen by a Kjeldahl Digestion Method", Open File Report (OFR) 00–170.

[46] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Chromium in Water by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 93–449.

[47] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Molybdenum by Graphite Furnace Atomic Absorption Spectrophotometry", Open File Report (OFR) 97–198.

[48] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Total Phosphorus by Kjeldahl Digestion Method and an Automated Colorimetric Finish That Includes Dialysis" Open File Report (OFR) 92–146.

[49] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Arsenic and Selenium in Water and Sediment by Graphite Furnace-Atomic Absorption Spectrometry" Open File Report (OFR) 98–639.

[50] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Elements in Whole-water Digests Using Inductively Coupled Plasma-Optical Emission Spectrometry and Inductively Coupled Plasma-Mass Spectrometry", Open File Report (OFR) 98–165.

[51] "Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of Inorganic and Organic Constituents in Water and Fluvial Sediment", Open File Report (OFR) 93–125.

TABLE IC—LIST OF APPROVED TEST PROCEDURES FOR NON-PESTICIDE ORGANIC COMPOUNDS

Parameter [1]	EPA method number [2,7]			Other approved methods		
	GC	GC/MS	HPLC	*Standard Methods* [Edition(s)]	ASTM	Other
1. Acenaphthene	610	625, 1625B	610	6440 B [18th, 19th, 20th].	D4657–92	Note 9, p.27.
2. Acenaphthylene	610	625, 1625B	610	6440 B, 6410 B [18th, 19th, 20th].	D4657–92	Note 9, p.27.
3. Acrolein	603	624[4], 1624B				
4. Acrylonitrile	603	624[4], 1624B				
5. Anthracene	610	625, 1625B	610	6410 B, 6440 B [18th, 19th, 20th].	D4657–92	Note 9, p. 27.

ATTACHMENT E

Table II - Required Containers, Preservation Techniques, and Holding Times
40 CFR Part 136.3
July 1, 2005

3544. Available from the American Society for Microbiology, 1752 N Street NW., Washington, DC 20036. Table IA, Note 22.

(58) USEPA. 2002. Method 1604: Total Coliforms and *Escherichia coli (E. coli)* in Water by Membrane Filtration using a Simultaneous Detection Technique (MI Medium). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA 821–R–02–024. Available from NTIS, PB2003–100129. Table IA, Note 22.

(59) USEPA. 2002. Method 1600: Enterococci in Water by Membrane Filtration using membrane-Enterococcus Indoxyl-β-D-Glucoside Agar (mEI). U.S. Environmental Protection Agency, Office of Water, Washington D.C. September 2002, EPA–821–R–02–022. Available from NTIS, PB2003–100127. Table IA, Note 25.

(60) USEPA. 2001. Method 1622: *Cryptosporidium* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–026.

Available from NTIS, PB2002–108709. Table IA, Note 26.

(61) USEPA. 2001. Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water, Washington, DC April 2001, EPA–821–R–01–025. Available from NTIS, PB2002–108710. Table IA, Note 27.

(62) AOAC. 1995. Official Methods of Analysis of AOAC International, 16th Edition, Volume I, Chapter 17. AOAC International. 481 North Frederick Avenue, Suite 500, Gaithersburg, Maryland 20877–2417. Table IA, Note 11.

(c) Under certain circumstances the Regional Administrator or the Director in the Region or State where the discharge will occur may determine for a particular discharge that additional parameters or pollutants must be reported. Under such circumstances, additional test procedures for analysis of pollutants may be specified by the Regional Administrator, or the Director upon the recommendation of the Director of the Environmental Monitoring Systems Laboratory—Cincinnati.

(d) Under certain circumstances, the Administrator may approve, upon recommendation by the Director, Environmental Monitoring Systems Laboratory—Cincinnati, additional alternate test procedures for nationwide use.

(e) Sample preservation procedures, container materials, and maximum allowable holding times for parameters cited in Tables IA, IB, IC, ID, and IE are prescribed in Table II. Any person may apply for a variance from the prescribed preservation techniques, container materials, and maximum holding times applicable to samples taken from a specific discharge. Applications for variances may be made by letters to the Regional Administrator in the Region in which the discharge will occur. Sufficient data should be provided to assure such variance does not adversely affect the integrity of the sample. Such data will be forwarded, by the Regional Administrator, to the Director of the Environmental Monitoring Systems Laboratory—Cincinnati, Ohio for technical review and recommendations for action on the variance application. Upon receipt of the recommendations from the Director of the Environmental Monitoring Systems Laboratory, the Regional Administrator may grant a variance applicable to the specific charge to the applicant. A decision to approve or deny a variance will be made within 90 days of receipt of the application by the Regional Administrator.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter No./name	Container [1]	Preservation [2,3]	Maximum holding time [4]
Table IA—Bacteria Tests:			
1–5 Coliform, total, fecal, and *E. coli*	PP, G	Cool, <10 °C, 0.0008% $Na_2S_2O_3$ [5].	6 hours.
6 Fecal *streptococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$ [5]	6 hours.
7 *Enterococci*	PP, G	Cool, <10° 0.0008% $Na_2S_2O_3$ [5]	6 hours.
Table IA—Protozoa Tests:			
8 *Cryptosporidium*	LDPE	0–8 °C	96 hours. [17]
9 *Giardia*	LDPE	0–8 °C	96 hours. [17]
Table IA—Aquatic Toxicity Tests:			
6–10 Toxicity, acute and chronic	P,G	Cool, 4 °C [16]	36 hours.

TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
Table IB—Inorganic Tests:			
1. Acidity	P, G	Cool, 4°C	14 days.
2. Alkalinity	P, G	......do	Do.
4. Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
9. Biochemical oxygen demand	P, G	Cool, 4°C	48 hours.
10. Boron	P, PFTE, or Quartz.	HNO_3 TO pH<2	6 months.
11. Bromide	P, G	None required	28 days.
14. Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours.
15. Chemical oxygen demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
16. Chloride	P, G	None required	Do.
17. Chlorine, total residual	P, G	......do	Analyze immediately.
21. Color	P, G	Cool, 4°C	48 hours.
23–24. Cyanide, total and amenable to chlorination.	P, G	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid[5].	14 days.[6]
25. Fluoride	P	None required	28 days.
27. Hardness	P, G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months.
28. Hydrogen ion (pH)	P, G	None required	Analyze immediately.
31, 43. Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
Metals:[7]			
18. Chromium VI[7]	P, G	Cool, 4 °C	24 hours.
35. Mercury[17]	P, G	HNO_3 to pH<2	28 days.
3, 5–8, 12,13, 19, 20, 22, 26, 29, 30, 32–34, 36, 37, 45, 47, 51, 52, 58–60, 62, 63, 70–72, 74, 75. Metals except boron, chromium VI and mercury[7].	P, G	do	6 months.
38. Nitrate	P, G	Cool, 4°C	48 hours.
39. Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
40. Nitrite	P, G	Cool, 4°C	48 hours.
41. Oil and grease	G	Cool to 4°C, HCl or H_2SO_4 to pH<2.	28 days.
42. Organic Carbon	P, G	Cool to 4 °C HC1 or H2SO4 or H3PO4, to pH<2.	28 days.
44. Orthophosphate	P, G	Filter immediately, Cool, 4°C	48 hours.
46. Oxygen, Dissolved Probe	G Bottle and top.	None required	Analyze immediately.
47. Winkler	......do	Fix on site and store in dark	8 hours.
48. Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days.
49. Phosphorus (elemental)	G	Cool, 4°C	48 hours.
50. Phosphorus, total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days.
53. Residue, total	P, G	Cool, 4°C	7 days.
54. Residue, Filterable	P, G	......do	7 days.
55. Residue, Nonfilterable (TSS)	P, G	......do	7 days.
56. Residue, Settleable	P, G	......do	48 hours.
57. Residue, volatile	P, G	......do	7 days.
61. Silica	P, PFTE, or Quartz.	Cool, 4 °C	28 days.
64. Specific conductance	P, G	......do	Do.
65. Sulfate	P, G	......do	Do.
66. Sulfide	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH>9.	7 days.
67. Sulfite	P, G	None required	Analyze immediately.
68. Surfactants	P ,G	Cool, 4°C	48 hours.
69. Temperature	P, G	None required	Analyze.
73. Turbidity	P, G	Cool, 4°C	48 hours.
Table IC—Organic Tests[8]			
13, 18–20, 22, 24–28, 34–37, 39–43, 45–47, 56, 76, 104, 105, 108–111, 113. Purgeable Halocarbons.	G, Teflon-lined septum.	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5].	14 days.
6, 57, 106. Purgeable aromatic hydrocarbons	......do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] HCl to pH2[9].	Do.
3, 4. Acrolein and acrylonitrile	......do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] adjust pH to 4–5[10].	Do.
23, 30, 44, 49, 53, 77, 80, 81, 98, 100, 112. Phenols[11].	G, Teflon-lined cap..	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction.
7, 38. Benzidines[11]	......do	......do	7 days until extraction.[13]
14, 17, 48, 50–52. Phthalate esters[11]	......do	Cool, 4 °C	7 days until extraction; 40 days after extraction.

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TABLE II—REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES—Continued

Parameter No./name	Container[1]	Preservation[2,3]	Maximum holding time[4]
82–84. Nitrosamines[11,14]	......do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
88–94. PCBs[11]	......do	Cool, 4 °C	Do.
54, 55, 75, 79. Nitroaromatics and isophorone[11].	......do	Cool, 4 °C, 0.008% $Na_2S_2O_3$,[5] store in dark.	Do.
1, 2, 5, 8–12, 32, 33, 58, 59, 74, 78, 99, 101. Polynuclear aromatic hydrocarbons[11].	......do	......do	Do.
15, 16, 21, 31, 87. Haloethers[11]	......do	Cool, 4 °C, 0.008% $Na_2S_2O_3$[5]	Do.
29, 35–37, 63–65, 73, 107. Chlorinated hydrocarbons[11].	......do	Cool, 4 °C	Do.
60–62, 66–72, 85, 86, 95–97, 102, 103. CDDs/CDFs[11].			
aqueous: field and lab preservation.	G	Cool, 0–4 °C, pH<9, 0.008% $Na_2S_2O_3$[5].	1 year.
Solids, mixed phase, and tissue: field preservation..	......do	Cool, <4 °C	7 days.
Solids, mixed phase, and tissue: lab preservation.	......do	Freeze, < 10 °C	1 year.
Table ID—Pesticides Tests:			
1–70. Pesticides[11]	......do	Cool, 4°C, pH 5–9[15]	Do.
Table IE—Radiological Tests:			
1–5. Alpha, beta and radium	P, G	HNO_3 to pH<2	6 months.

Table II Notes

[1] Polyethylene (P) or glass (G). For microbiology, plastic sample containers must be made of sterilizable materials (polypropylene or other autoclavable plastic).

[2] Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

[3] When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details. The term ''analyze immediately'' usually means within 15 minutes or less of sample collection.

[5] Should only be used in the presence of residual chlorine.

[6] Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[7] Samples should be filtered immediately on-site before adding preservative for dissolved metals.

[8] Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[9] Sample receiving no pH adjustment must be analyzed within seven days of sampling.

[10] The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

[11] When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6–9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).

[12] If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

[13] Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

[14] For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7–10 with NaOH within 24 hours of sampling.

[15] The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[16] Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the 4C temperature maximum has not been exceeded. In the isolated cases where it can be documented that this holding temperature can not be met, the permittee can be given the option of on-site testing or can request a variance. The request for a variance should include supportive data which show that the toxicity of the effluent samples is not reduced because of the increased holding temperature.

[17] Samples collected for the determination of trace level mercury (100 ng/L) using EPA Method 1631 must be collected in tightly-capped fluoropolymer or glass bottles and preserved with BrCl or HCl solution within 48 hours of sample collection. The time to preservation may be extended to 28 days if a sample is oxidized in the sample bottle. Samples collected for dissolved trace level mercury should be filtered in the laboratory. However, if circumstances prevent overnight shipment, samples should be filtered in a designated clean area in the field in accordance with procedures given in Method 1669. Samples that have been collected for determination of total or dissolved trace level mercury must be analyzed within 90 days of sample collection.

ATTACHMENT F

Sample Chain of Custody Form

New Jersey Analytical Laboratories

Chain Of Custody
Commercial

Client Information

Client Name & Address:

page ______ of ______

Phone: Fax:

Sampled by: (Print/Sign)

Lab ID No.	Sample ID/Location	Date Sampled	Time Sampled	Total No. Containers	Bottle Volume	Matrix	HCl	Sterile	H2SO4	HNO_3	Unpreserved	Other	Analysis					Notes

Relinquished by Sampler 1	Date: Time:	Received by: 1	Date: Time:
Relinquished by: 2	Date: Time:	Received by: 2	Date: Time:
Relinquished by: 3	Date: Time:	Received by: 3	Date: Time:
New Jersey Analytical Laboratories, LLC 1590 Reed Road, Suite 101B Tel: 609-737-3477 Pennington, NJ 08534 Fax: 609-737-3052	Cooler Temp	Received for Laboratory by:	

ATTACHMENT G

Tables of Parameter Detection Limits, Accuracy, and Precision

Parameter Detection Limits, Accuracy, and Precision

Parameter:	Dissolved Ortho-Phosphate (as P)	Total Phosphorus (as P)	Ammonia-Nitrogen	Nitrate-Nitrogen	Nitrite-Nitrogen	Total Kjeldahl Nitrogen	Total Suspended Solids
Referenced Methodology – (NJDEP Certified Methodology)	EPA 365.3	EPA 365.2	EPA 350.2 +.3	EPA 300.0	EPA 300.0	EPA 351.3	EPA 160.2
Technique Description	Ascorbic Acid, Manual Two Reagents	Persulfate Digestion + Manual	Distillation, Electrode	Ion Chro-mato-graphy	Ion Chro-mato-graphy	Digestion, Distillation, Titration	Gra-vimetric, 103-105˚C
Method Detection Limit (ppm)-Calculated	0.0029	0.0060	0.004	0.034	0.031	0.048	NA
Instrument Detection Limit (ppm)	NA	NA	NA	0.034	0.031	NA	NA
Project Detection Limit (ppm)	0.01	0.02	0.05	0.04	0.04	0.05	0.5
Quantitation Limit (ppm)	0.01	0.02	0.05	0.04	0.04	0.05	0.5
Accuracy (mean % recovery)	106.9	108.6	94.9	97.5	98.2	96.9	NA
Precision-% (mean – RPD)	2.18	2.80	4.31	3.01	3.46	5.98	8.61
Accuracy Protocol (% recovery for LCL/UCL)	83.8/ 130.0	91.3/ 126.0	62.6/ 127.2	92.2/ 102.8	80.1/ 116.3	67.1/ 126.7	NA
Precision Protocol-% (maximum RPD)	8.10	10.13	10.63	5.03	6.74	9.28	28.03

RPD – Relative % Difference; NA – Not Applicable

Laboratory: New Jersey Analytical (NJDEP #11005)

Parameter Detection Limits, Accuracy, and Precision

Parameter:	**pH (SU)**	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**†Total Dissolved Solids (mg/L)**	**†Fecal Coliform**	**‡*Eschericia coli* (*E. coli*)**
Referenced Methodology – (NJDEP Certified Methodology)	Standard Methods 4500-H^+ B	Standard Methods 2550 B	Standard Methods 4500-O G	EPA 160.1	Standard Methods 9222D	EPA 1603
Technique Description	Electrometric	Thermometric	Electrode	Gravi-metric, 180˚C	Membrane Filter (MF), Single Step	Membrane Filter (modified mTEC)
Method Detection Limit (ppm)	NA	NA	NA	5.35	<10 (col/ 100 ml)	<10 organisms per 100 ml
Instrument Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 – 20 mg/L	NA	NA	NA
Project Detection Limit (ppm)	0.00-14.00 S.U.	0.0 to 100.0 °C	0 - 20 mg/L	10.0	<10 (col/ 100 ml)	<10 organisms per 100 ml
Quantitation Limit (ppm)	NA	NA	NA	10.0	NA	60,000 organisms per 100 ml
Accuracy (mean % recovery)	NA	NA	NA	103.65	NA	NA
Precision (mean – RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	3.50	17.34	NA
Accuracy Protocol (% recovery for LCL/UCL)	NA	NA	NA	72.4/135.0	NA	Detect – 144%
Precision Protocol (maximum RPD)	± 0.01 S.U.	± 0.3 °C	± 0.3 mg/l	6.47	24.82	61%

RPD – Relative % Difference; NA – Not Applicable

Laboratory: Rutgers EcoComplex Laboratory (NJDEP #03019), †Laboratory: New Jersey Analytical (NJDEP #11005), ‡Laboratory: Garden State Laboratories, Inc. (NJDEP #20044

RUTGERS
New Jersey Agricultural Experiment Station

Sandra Goodrow
Program Associate

Water Resources Program
Rutgers Cooperative Extension
New Jersey Agricultural Experiment Station
Rutgers, The State University of New Jersey
14 College Farm Road • Room 241
New Brunswick • New Jersey 08901

http://www.water.rutgers.edu
sgoodrow@envsci.rutgers.edu

P: 732-932-9800, ext. 6125
F: 732-932-8644

November 13, 2008

Ms. Gina Berg
Water Resources Coordinator
Burlington County
P.O. Box 6000
Mt. Holly, NJ 08060

Re: Assiscunk Watershed Restoration and Protection Plan Sampling Site Revisions

Dear Gina,

Water quality sampling for the Assiscunk/Anniricken/Barkers Brook Watershed Restoration and Protection Plan has been completed for 2008. We have had a good season and have begun to process the analyzed data.

Early in the field sampling process, it was determined that two of the chosen sampling sites had problems that needed to be addressed. One site (ASK 1) appeared to be a misprint in the QAPP and I would like to clarify the location at this time. The second (ASK 3) had several problems. The problems with ASK 3 were discussed and generally agreed upon, but it should be noted in writing at this time.

The location for ASK 1 in the original 2007 QAPP was too high in the subbasin to properly characterize the pollutant load of that drainage area. This location was also determined to be inappropriate due to the fact that it was so far up in the headwaters and was often dry. The site that was sampled is approximately 3400 feet southwest at: 40° 03′ 13.91″ N and -74° 44′ 35.70″ W. Please refer to the enclosed map.

The location for ASK 3 as originally determined was found to actually be a small division of the outlet of the stream. After the main branch of the Assiscunk Creek flows under the Petticoat Bridge, it begins to divide, braid and form several channels through a wetland area. It was one of these channels that were originally identified as the sampling site. This original site was also determined to be difficult and dangerous to access due to a heavy sediment load and deep mud. As was discussed early on, the site needed to move upstream and was relocated at the Petticoat Bridge. The site that was sampled is approximately 3,000 feet east from the original site at: 40° 03′ 55.35″ N and -74° 40′ 01.00″ W.

RUTGERS

Section C of the November 2007 Assiscunk Creek Headwater Watershed Restoration Plan should be amended to read as follows:

Sampling Locations:
The sampling locations are shown in Attachment A. The six sampling stations throughout the watershed are as follows:

ASK3: Assiscunk Creek, off of Petticoat Bridge, Petticoat Bridge Road, Springfield, Burlington County, NJ
- HUC 02040201100010
- 40°03'13.91"N, -74°44'35.70"W

ASK2: Assiscunk Creek, Route 206, Columbus, Burlington County, NJ
- HUC 02040201100010
- 40°03'24.91"N, -74°43'25.96"W

ANR: Annaricken Brook, Island Road, Springfield Township, Burlington County, NJ
- AMNET Station AN0139, USGS Station #01464578
- HUC 02040201100010
- 40°03'18.91"N, -74°42'08.19"W

ASK1: Assiscunk Creek, Mount Pleasant Road, Mansfield Township, Burlington County, NJ
- HUC 02040201100010
- 40°03'55.35"N, -74°40'01.00"W

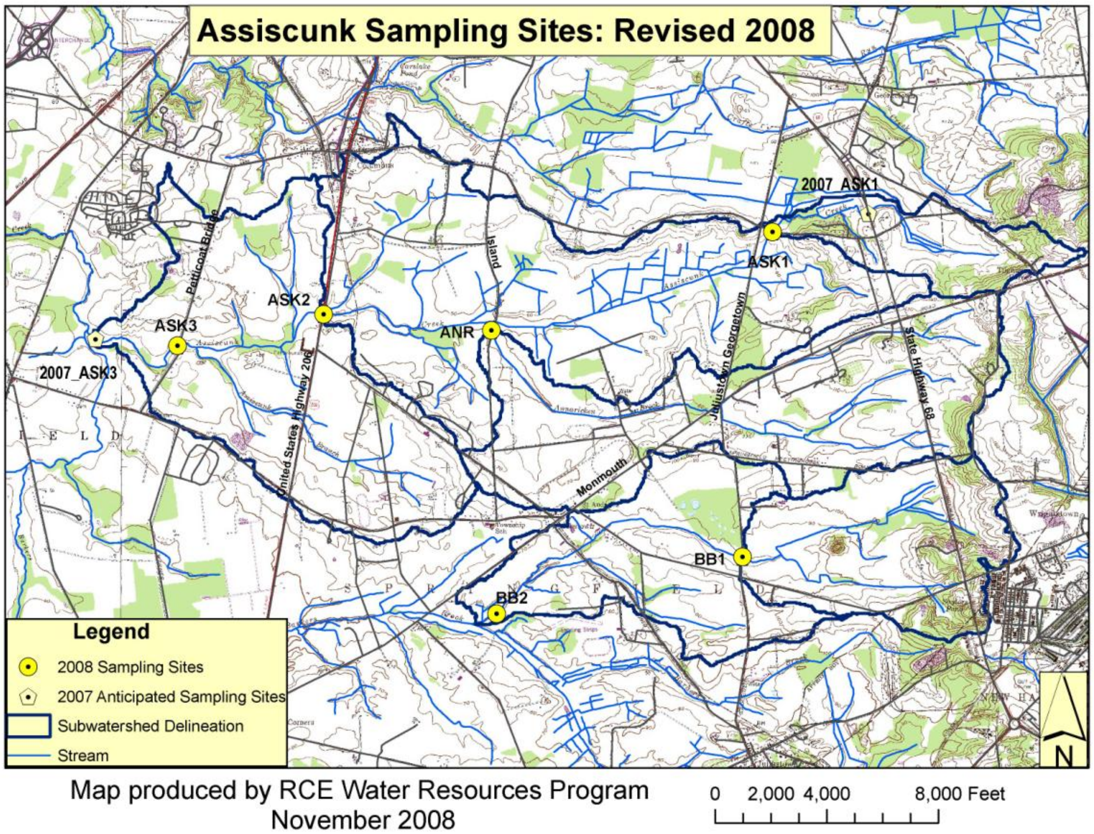
BB2: North Branch of the Upper Barker's Brook, in front of property located at 2410 Monmouth Road, Springfield Township (mailing address Jobstown), Burlington County, NJ
- HUC 02040201100020
- 40°01'38.85"N, -74°42'05.52"W

BB1: North Branch of the Upper Barker's Brook, Georgetown- Juliustown Road, Springfield Township, Burlington County, NJ
- AMNET Station AN0140, USGS Station #01464583
- HUC 02040201100020-01
- 40°01'57.83"N, -74°40'12.48"W.

I hope this letter and the enclosed map provide all the information that you require. Please contact me if you have any questions or if you require additional information.

Thank you,

Sandra M. Goodrow
Program Associate


Assiscunk Sampling Sites: Revised 2008
2007_ASK1
ASK1
ASK2
ASK3
ANR
2007_ASK3
BB1
BB2
Petticoat Bridge
United States Highway 206
Island
Jacksonville Georgetown
State Highway 68
Monmouth
Legend
2008 Sampling Sites
2007 Anticipated Sampling Sites
Subwatershed Delineation
Stream
N
Map produced by RCE Water Resources Program
November 2008
0 2,000 4,000 8,000 Feet

Data Report Appendix D:

Tabulated Water Quality Monitoring Results

Table 1: ASK 3

Date	Station ID	Flow Rate cfs	pH S.U.	Dissolved Oxygen mg/L	Temperature deg C	Fecal Coliform col/100 ml	*E. coli* col/100ml	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen as N (mg/L)	Nitrite-N (mg/L)	Nitrate-N (mg/L)	TN (calculated) (mg/L)	Ortho Phosphate Dissolved (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)
4/9/2008	ASK3	7.126	5.2	9.27	11.6	8	4	0.49	0.12	nd	0.92	1.53	nd	nd	2
4/24/2008	ASK3	5.18	7.46	8.10	16.8	8	10	0.43	0.1	nd	0.54	1.07	nd	0.05	3.00
5/20/2008	ASK3	8.74	5.76	8.47	11.7	1	32	0.97	0.28	nd	1.29	2.54	0.04	0.02	8.50
5/22/2008	ASK3	12.80	5.77	8.08	13.6	360	6	0.9	0.38	nd	1.52	2.8	nd	0.04	8.00
6/4/2008	ASK3	13.13	5.97	5.81	18.4	1000	160	1.67	0.3	nd	0.72	2.69	0.02	0.15	23.00
6/10/2008	ASK3	3.33	6.09	5.01	24	220	140	Bacteria Only							
6/12/2008	ASK3	3.33	6.06	5.74	21.4	120	16								
6/18/2008	ASK3	2.73	6.57	5.81	18.1	50	60	0.51	0.43	nd	0.78	1.72	0.01	0.04	7.5
6/24/2008	ASK3	1.81	6.23	5.81	19.8	1	50	Bacteria Only							
7/2/2008	ASK3	0.98	6.07	4.84	21.1	1300	70	1.06	0.38	nd	0.65	2.09	0.01	0.1	5.5
7/8/2008	ASK3	3.24	6.74	5.64	22	300	240	Bacteria Only							
7/10/2008	ASK3	3.1	5.88	4.57	22	20	260								
7/15/2008	ASK3	1.166	6.27	5.05	20.9	580	30	0.61	0.27	nd	0.66	1.54	0.02	0.11	7.5
7/22/2008	ASK3	0.7	5.75	3.89	23.4	640	180	Bacteria Only							
*7/23/2008	ASK3	2.1825	5.43	4.22	23.8	22000	1700	1.52	0.21	nd	0.89	2.62	0.04	0.2	16
*7/24/2008	ASK3	26.504	5.23	5.0	21.9	6100	2700	1.3	0.35	nd	1.19	2.84	0.03	0.07	20
*7/24/2008	ASK3	22.302	5.40	5.31	22.9	12000	1900	1.63	0.33	nd	0.89	2.85	0.04	0.46	72
8/5/2008	ASK3	2.04	6.11	5.99	20.8	1400	150	Bacteria Only							
8/7/2008	ASK3	1.43	6.17	5.85	21.2	800	170	0.88	0.18	nd	0.66	1.72	0.03	0.02	14
8/13/2008	ASK3	0.292	5.75	6.5	18.2	440	80	Bacteria Only							
8/19/2008	ASK3	1.3	6.28	5.73	20.2	540	120	0.29	0.2	nd	0.66	1.15	0.01	0.12	3.5
8/21/2008	ASK3	0.856	6.25	6.58	17.4	130	110	Bacteria Only							
9/9/2008	ASK3	1.811	6.15	5.84	20.4	200	800	0.8	0.14	nd	0.65	1.59	-	0.03	6.5
9/23/2008	ASK3	0.1469	6.07	7.01	20.9	200	220	0.74	0.13	nd	0.62	1.49	0.02	0.1	4
*9/26/2008	ASK3	-0.172	6.15	5.31	15.8	4800	450	0.79	0.32	nd	0.7	1.81	0.02	0.15	6
*9/26/2008	ASK3	1.18	5.46	3.49	16.7	2600	100	0.85	0.21	nd	0.64	1.7	0.02	0.04	6
*9/29/2008	ASK3	-3.26	6.48	4.86	18.4	4200	850	0.52	0.17	nd	0.53	1.22	0.02	0.1	6.5
5/14/2009	ASK3	7.38	-	-	-	-	-	-	-	-	-	-	-	-	-
*7/21/2009	ASK3	5.05	5.67	6.76	19.6	1000	420	1.11	0.23	nd	0.83	2.17	0.01	0.14	23
*7/21/2009	ASK3	6.51	5.4	5.85	20.1	3900	1200	1.18	0.26	nd	0.78	2.22	0.02	0.06	19
*7/22/2009	ASK3	4.19	6.04	5.75	19.3	1100	210	1.17	0.29	nd	0.75	2.21	0.02	0.1	12
‡ n		31	30	30	30	30	30	21	21	nd	21	21	21	21	21
‡ min		-3.3	5.2	3.5	11.6	1	4	0.3	0.1	nd	0.5	1.1	0.0	0.0	2.0
‡ mean**		4.7	6.0	5.9	19.4	359	141	0.9	0.3	nd	0.8	2.0	0.0	0.1	13.0
June 2008 Mean**		-	-	-	-	70	54	-	-	-	-	-	-	-	-
July 2008 Mean**		-	-	-	-	547	225	-	-	-	-	-	-	-	-
August 2008 Mean**		-	-	-	-	346	170	-	-	-	-	-	-	-	-
‡ max		26.5	7.5	9.3	24.0	22000	2700	1.7	0.4	nd	1.5	2.9	0.0	0.5	72.0
‡ std. dev.		6.4	0.5	1.3	3.2	4517	649	0.4	0.1	nd	0.3	0.6	0.0	0.1	15.0

* Storm Event

** A geometric mean is used for average fecal coliform and *E. coli* levels

‡ statistics involving a "nd" used (0.5*analysis detection limit)

Table 2: ASK2

		Flow Rate	pH	Dissolved Oxygen	Temperature	Fecal Coliform	*E. coli*	Total Kjeldahl Nitrogen	Ammonia Nitrogen as N	Nitrite-N	Nitrate-N	TN (calculated)	Ortho Phosphate Dissolved	Total Phosphorus	TSS
Date	*Station ID*	*cfs*	*S.U.*	*mg/L*	*deg C*	*col/100 ml*	*col/100ml*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
4/9/2008	ASK2	na	4.7	9.4	9.9	16	4	0.4	0.1	nd	0.98	1.48	nd	nd	4
4/24/2008	ASK2	na	5.42	6.83	15.9	16	16	1.37	0.11	nd	0.58	2.06	nd	nd	14
5/20/2008	ASK2	na	5.43	8.17	11.4	44	4	0.94	0.29	nd	1.43	2.66	nd	0	8.6
5/22/2008	ASK2	na	5.3	7.85	13.2	120	2	0.79	0.33	nd	1.68	2.8	0.02	0.03	9.5
6/4/2008	ASK2	na	5.36	7.97	17.9	820	8	1.6	0.64	nd	1.23	3.47	0.01	0.03	25
6/10/2008	ASK2	na	5.85	4.91	23	270	88	Bacteria Only							
6/12/2008	ASK2	na	5.35	4.65	21.2	250	66								
6/18/2008	ASK2	na	5.5	5.31	17.4	210	30	0.53	0.4	nd	1.03	1.96	nd	0.140	14
6/24/2008	ASK2	na	5.06	4.33	19.5	10	80	Bacteria Only							
7/2/2008	ASK2	na	5.37	4.92	22	80	50	1.37	0.34	nd	0.8	2.51	nd	0.07	10.5
7/8/2008	ASK2	na	6.27	4.76	21.4	490	160	Bacteria Only							
7/10/2008	ASK2	na	5.54	4.13	22	20	540								
7/15/2008	ASK2	na	5.61	4.22	21.4	60	40	1.39	0.26	nd	1.01	2.66	nd	nd	12
7/22/2008	ASK2	na	5.18	5.69	23.6	160	150	Bacteria Only							
*7/23/2008	ASK2	na	5.12	5.63	23.6	15000	1100	0.83	0.28	nd	0.88	1.99	0.02	0.11	5.5
*7/24/2008	ASK2	na	5.18	6.06	21.7	22000	2000	1.02	0.43	nd	1.37	2.82	0.03	0.21	94
*7/24/2008	ASK2	na	5.68	5.96	22.6	27000	3300	1.04	0.43	nd	1.32	2.79	0.03	0.04	48
8/5/2008	ASK2	na	5.58	4.9	20.7	460	100	Bacteria Only							
8/7/2008	ASK2	na	5.7	4.57	21.7	630	290	0.44	0.13	nd	0.67	1.24	0.02	0.18	10
8/13/2008	ASK2	na	5.5	5.86	18.4	100	70	Bacteria Only							
8/19/2008	ASK2	na	5.48	4.77	19.6	80	20	1.46	0.23	nd	0.7	2.39	nd	0.11	8
8/21/2008	ASK2	na	5.52	4.84	16.8	40	30	Bacteria Only							
9/9/2008	ASK2	na	5.35	4.92	20	nd	300	0.58	0.13	nd	0.74	1.45	-	0.03	12
9/23/2008	ASK2	na	5.5	5.78	15.9	40	30	0.89	0.19	nd	0.75	1.83	nd	0.030	4
*9/26/2008	ASK2	na	na	5.99	15.70	600	200	0.72	0.25	nd	0.97	1.94	nd	0.100	5.00
*9/26/2008	ASK2	na	5.25	4.8	16.8	550	nd	0.76	0.22	nd	0.95	1.93	nd	0.1	2.5
*9/29/2008	ASK2	na	5.44	6.14	18.6	4600	3100	0.7	0.17	nd	0.58	1.45	0.04	0.030	11
*7/21/2009	ASK2	na	5.29	6.5	19.4	960	1600	1.05	0.27	nd	0.93	2.25	nd	0.060	14
*7/21/2009	ASK2	na	5.02	6.10	19.30	560	1300	0.51	0.23	nd	0.9	1.64	nd	0.020	14.00
*7/22/2009	ASK2	na	5.79	5.45	20	300	440	1.61	0.3	nd	0.86	2.77	0.01	0.070	11
‡n		0	29	30	30	30	30	21	21	nd	21	21	8	18	21
‡min		0.0	4.7	4.1	9.9	10.0	2.0	0.4	0.1	nd	0.6	1.2	0.0	0.0	2.5
‡mean**		0.0	5.4	5.7	19.0	258.9	106.8	1.0	0.3	nd	1.0	2.2	0.0	0.1	16.0
June 2008 Mean**		-	-	-	-	163.3	40.7	-	-	-	-	-	-	-	-
July 2008 Mean**		-	-	-	-	94.5	121.0	-	-	-	-	-	-	-	-
August 2008 Mean**		-	-	-	-	156.1	65.6	-	-	-	-	-	-	-	-
‡max		0.0	6.3	9.4	23.6	27000.0	3300.0	1.6	0.6	nd	1.7	3.5	0.0	0.2	94.0
‡std. dev.		0.0	0.3	1.3	3.4	6725.3	903.7	0.4	0.1	nd	0.3	0.6	0.0	0.1	20.3

* Storm Event

** A geometric mean is used for average fecal coliform and *E. coli* levels

‡ statistics involving a "nd" used (0.5*analysis detection limit)

Table 3: ANR

		Flow Rate	pH	Dissolved Oxygen	Temperature	Fecal Coliform	*E. coli*	Total Kjeldahl Nitrogen	Ammonia Nitrogen as N	Nitrite-N	Nitrate-N	TN (calculated)	Ortho Phosphate Dissolved	Total Phosphorus	TSS
Date	*Station ID*	*cfs*	*S.U.*	*mg/L*	*deg C*	*col/100 ml*	*col/100ml*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
4/9/2008	ANR	1.46	5.35	10.86	9.4	4	12	2.9	0.06	nd	0.85	3.81	nd	0.060	1.5
4/24/2008	ANR	0.95	5.68	9.9	16.2	2	12	0.54	0.05	nd	0.41	1	nd	0.040	1.5
5/20/2008	ANR	1.79	5.59	9.43	11.5	nd	12	0.68	0.18	nd	1.07	1.93	nd	0.06	4
5/22/2008	ANR	1.79	5.48	9.39	13	32	4	0.85	0.16	nd	1.38	2.39	0.08	0.11	9.5
6/4/2008	ANR	1.84	6.06	8.86	17.5	1400	28	1.14	0.29	nd	0.97	2.4	0.02	0.02	20
6/10/2008	ANR	0.80	6.36	3.61	24.1	370	220	Bacteria Only							
6/12/2008	ANR	0.31	5.93	7.38	20.8	400	40								
6/18/2008	ANR	0.34	nd	nd	nd	350	30	1.17	0.28	nd	0.96	2.41	0.07	0.030	8
6/24/2008	ANR	0.30	5.57	6.88	20.1	330	120	Bacteria Only							
7/2/2008	ANR	0.12	5.69	6.44	21.2	460	250	0.55	0.18	nd	0.56	1.29	0.02	0.17	8
7/8/2008	ANR	0.19	6.54	6.71	23.2	770	320	Bacteria Only							
7/10/2008	ANR	0.45	5.98	6.35	22.2	80	400								
7/15/2008	ANR	0.05	5.97	7.15	21.5	1600	180	0.6	0.12	nd	0.6	1.32	0.03	0.17	5.5
7/22/2008	ANR	0.05	5.88	5.1	23.9	1000	230	Bacteria Only							
*7/23/2008	ANR	0.11	5.59	5.71	23.2	5600	3500	0.89	0.15	nd	0.67	1.71	0.04	0.13	15
*7/24/2008	ANR	0.22	5.45	6.95	21.9	25000	2800	1.11	0.23	nd	0.99	2.33	0.04	0.37	42
*7/24/2008	ANR	0.21	5.69	7.2	22.6	14000	1800	1.46	0.3	nd	1.23	2.99	0.04	0.1	38
8/5/2008	ANR	0.41	5.88	7.17	20.7	340	120	Bacteria Only							
8/7/2008	ANR	-0.14	5.96	6.48	21.1	560	180	0.62	0.09	nd	0.59	1.3	0.03	0.04	31
8/13/2008	ANR	-0.02	5.92	8.76	18.4	640	290	Bacteria Only							
8/19/2008	ANR	0.35	5.94	7.74	21.1	650	340	0.36	0.08	nd	0.41	0.85	0.02	0.15	5
8/21/2008	ANR	0.37	5.78	8.65	17.3	870	810	Bacteria Only							
9/9/2008	ANR	nd	5.68	7.41	20.6	nd	700	0.46	nd	nd	0.45	0.91	-	0.24	16
9/23/2008	ANR	nd	5.93	8.92	15.8	390	420	0.73	nd	nd	0.43	1.16	0.02	0.140	nd
*9/26/2008	ANR	0.41	7.49	8.15	15.2	2900	1400	0.42	nd	nd	0.5	0.92	0.040	0.020	28.00
*9/26/2008	ANR	0.09	7.28	7.59	16.2	2400	1200	0.35	nd	nd	0.48	0.83	0.05	0.14	nd
*9/29/2008	ANR	0.72	5.8	6.52	18.4	4100	3400	0.67	0.1	nd	0.71	1.48	0.08	0.050	18
5/14/2009	ANR	0.96	-	-	-	-	-	-	-	-	-	-	-	-	-
*7/21/2009	ANR	1.09	5.93	5.21	19.4	3600	1600	0.75	0.14	nd	0.86	1.75	0.02	0.420	34
*7/21/2009	ANR	0.12	5.68	6.57	20.7	2800	1400	0.34	0.13	nd	0.85	1.32	0.02	0.260	9.50
*7/22/2009	ANR	0.64	5.9	6.64	19.2	600	240	0.33	0.13	nd	0.74	1.2	0.02	0.170	4.5
‡ n		31	30	30	30	30	30	21	21	nd	21	21	21	21	21
‡ min		-0.1	5.4	3.6	9.4	2	4	0.3	0.1	nd	0.4	0.8	0.0	0.0	1.5
‡ mean**		0.6	5.9	7.4	19.2	631	239	0.8	0.2	nd	0.7	1.7	0.0	0.1	15.7
ne 2008 Mean**		-	-	-	-	379	95	-	-	-	-	-	-	-	-
ly 2008 Mean**		-	-	-	-	888	450	-	-	-	-	-	-	-	-
gust 2008 Mean**		-	-	-	-	671	399	-	-	-	-	-	-	-	-
‡ max		1.8	7.5	10.9	24.1	25000	3500	2.9	0.3	nd	1.4	3.8	0.1	0.4	42.0
‡ std. dev.		0.6	0.5	1.6	3.7	5208	995	0.6	0.1	nd	0.3	0.8	0.0	0.1	12.9

* Storm Event

** A geometric mean is used for average fecal coliform and *E. coli* levels

‡ statistics involving a "nd" used (0.5*analysis detection limit)

Table 4: ASK1

		Flow Rate	pH	Dissolve d Oxygen	emperatur	cal Colifor	*E. coli*	Total Kjeldahl Nitrogen	Ammoni a Nitrogen as N	Nitrite-N	Nitrate-N	TN (calculat ed)	Ortho Phosphat e Dissolve d	Total Phosphor us	TSS
Date	*Station ID*	*cfs*	*S.U.*	*mg/L*	*deg C*	*col/100 ml*	*col/100ml*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*	*(mg/L)*
4/9/2008	ASK1	0.79	5.3	10.67	9.2	16	24	0.42	0.13	nd	1.07	1.62	nd	0.030	1.5
4/24/2008	ASK1	0.40	5.63	10.33	16.2	28	57	0.4	0.06	nd	0.83	1.29	nd	0.040	1
5/20/2008	ASK1	0.63	5.85	9.91	10.9	4	20	0.6	0.28	nd	1.32	2.2	0.04	0.11	8
5/22/2008	ASK1	0.94	5.75	9.73	12.9	80	2	0.56	0.2	nd	1.35	2.11	nd	0.06	5.5
6/4/2008	ASK1	0.95	6.58	9.29	17.8	1600	110	1.36	0.27	nd	0.85	2.48	0.04	nd	25
6/10/2008	ASK1	0.30	6.41	4.4	23.9	290	72				Bacteria Only				
6/12/2008	ASK1	0.17	5.89	7.9	20.9	910	42								
6/18/2008	ASK1	0.10	6.46	8.2	18.3	430	70	1.02	0.53	nd	1.75	3.3	0.01	nd	10.5
6/24/2008	ASK1	0.05	5.52	7.34	20.2	100	90				Bacteria Only				
7/2/2008	ASK1	0.07	5.85	6.6	21.9	1600	210	0.96	0.25	nd	0.96	2.17	0.02	0.06	7.5
7/8/2008	ASK1	0.05	6.84	6.82	23.3	610	340				Bacteria Only				
7/10/2008	ASK1	0.08	5.9	6.37	22.2	420	570								
7/15/2008	ASK1	0.00	5.97	6.42	23.4	2500	560	1.15	0.18	nd	0.87	2.2	0.02	0.17	17
7/22/2008	ASK1	nd	6.11	2.15	24.5	1400	150				Bacteria Only				
*7/23/2008	ASK1	0.06	5.66	4.08	23.1	39000	15000	0.61	0.29	nd	0.88	1.78	0.01	0.06	43
*7/24/2008	ASK1	2.32	5.72	7.96	21.4	21000	2200	0.89	0.34	nd	1.05	2.28	0.04	0.15	20
*7/24/2008	ASK1	1.50	5.8	7.91	22.3	9900	2000	1.15	0.31	nd	1.25	2.71	0.03	0.24	8.5
8/5/2008	ASK1	0.10	5.88	6.72	21.3	820	340				Bacteria Only				
8/7/2008	ASK1	-0.05	5.85	6.23	21.7	1100	840	0.56	0.17	nd	0.79	1.52	0.03	0.11	2.5
8/13/2008	ASK1	-0.02	5.63	7.54	19.2	560	280				Bacteria Only				
8/19/2008	ASK1	0.12	5.77	5.75	22.5	620	270	0.45	0.09	nd	0.56	1.1	nd	0.12	4
8/21/2008	ASK1	nd	5.61	5.97	18.7	160	200				Bacteria Only				
9/9/2008	ASK1	0.01	5.59	6.32	21	nd	800	0.83	nd	nd	0.54	1.37	-	0.15	14
9/23/2008	ASK1	nd	5.82	7.23	16.3	60	30	0.5	nd	nd	0.37	0.87	nd	0.140	6.5
*9/26/2008	ASK1	nd	6.13	7.24	15.8	3400	3000	0.84	0.45	nd	0.62	1.91	0.030	0.150	5.50
*9/26/2008	ASK1	nd	6.99	6.4	16.6	2200	950	0.95	0.49	nd	0.65	2.09	0.03	0.12	nd
*9/29/2008	ASK1	nd	5.91	6.25	18.6	1100	3100	0.58	0.12	nd	0.55	1.25	0.06	0.160	7.5
*7/21/2009	ASK1	0.40	5.93	5.21	19.4	4400	1280	2.02	0.26	nd	1.55	3.83	0.02	0.350	33
*7/21/2009	ASK1	0.17	5.56	8.21	19.2	3300	2000	1.33	0.2	nd	2.34	3.87	0.01	0.170	8.50
*7/22/2009	ASK1	0.19	6.29	7.42	19.4	840	750	1.21	0.15	nd	1.57	2.93	0.02	0.160	4.5
‡ n		24	30	30	30	30	30	21	21	21	21	21	21	21	21
‡ min		-0.1	5.3	2.2	9.2	4	2	0.4	0.1	nd	0.4	0.9	0.0	0.0	1.0
‡ mean**		0.4	5.9	7.1	19.4	670	285	0.9	0.3	nd	1.0	2.1	0.0	0.1	11.7
ne 2008 Mean**		-	-	-	-	449	73	-	-	-	-	-	-	-	-
ly 2008 Mean**		-	-	-	-	1075	321	-	-	-	-	-	-	-	-
gust 2008 Mean**		-	-	-	-	550	337	-	-	-	-	-	-	-	-
‡ max		2.3	7.0	10.7	24.5	39000	15000	2.0	0.5	nd	2.3	3.9	0.1	0.4	43.0
‡ std. dev.		0.6	0.4	1.9	3.7	8000	2757	0.4	0.1	nd	0.5	0.8	0.0	0.1	11.0

* Storm Event

** A geometric mean is used for average fecal coliform and *E. coli* levels

‡ statistics involving a "nd" used (0.5*analysis detection limit)

Table 5: BB2

Date	Station ID	Flow Rate cfs	pH S.U.	Dissolved Oxygen mg/L	Temperature deg C	Fecal Coliform col/100 ml	*E. coli* col/100ml	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen as N (mg/L)	Nitrite-N (mg/L)	Nitrate-N (mg/L)	TN (calculated) (mg/L)	Ortho Phosphate Dissolved (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)
4/9/2008	BB2	2.07	5.26	11.04	9.7	4	16	0.36	0.06	nd	0.88	1.3	0.02	0.090	3
4/24/2008	BB2	0.81	6.06	10.93	16.9	130	120	0.43	nd	nd	0.56	0.99	0.03	0.120	3
5/20/2008	BB2	2.53	5.78	9.5	11.3	76	20	0.97	0.12	nd	1.46	2.55	0.08	0.06	5
5/22/2008	BB2	3.74	5.57	9.43	12.7	120	nd	0.81	0.15	nd	1.79	2.75	0.1	0.16	5.5
6/4/2008	BB2	5.43	nd	nd	nd	1500	170	1.29	0.2	nd	0.82	2.31	0.03	0.22	61
6/10/2008	BB2	1.09	6.55	3.92	24.3	1000	150	Bacteria Only							
6/12/2008	BB2	0.71	6.29	7.96	21.6	570	46								
6/18/2008	BB2	-0.14	6.52	7.74	18.5	570	80	0.76	0.22	nd	1.5	2.48	0.04	0.080	6.5
6/24/2008	BB2	0.53	6.09	6.82	20.6	1100	340	Bacteria Only							
7/2/2008	BB2	0.31	6.02	6.24	21.4	760	600	0.57	0.17	nd	0.67	1.41	0.05	0.22	4.5
7/8/2008	BB2	0.79	6.97	6.97	23.4	270	300	Bacteria Only							
7/10/2008	BB2	1.16	6.13	6.88	22.1	410	240								
7/15/2008	BB2	0.49	6.15	7.01	22.9	780	310	0.74	0.1	nd	1.11	1.95	0.06	0.06	10
7/22/2008	BB2	0.44	6.36	6.54	24.6	480	70	Bacteria Only							
*7/23/2008	BB2	0.44	6.21	6.4	24.1	1800	1500	0.39	0.12	nd	0.84	1.35	0.06	0.37	8
*7/24/2008	BB2	10.76	5.73	6.68	21.6	20000	1900	0.89	0.2	nd	1.21	2.3	0.05	0.04	29
*7/24/2008	BB2	10.70	5.87	6.86	22.7	9000	900	0.84	0.23	nd	0.98	2.05	0.05	0.05	7
8/5/2008	BB2	0.49	6.19	6.91	21.4	130	100	Bacteria Only							
8/7/2008	BB2	-0.01	6.26	6.21	21.7	1900	380	0.43	0.06	nd	1.14	1.63	0.07	0.23	3
8/13/2008	BB2	-0.10	6.17	8.4	19.1	170	70	Bacteria Only							
8/19/2008	BB2	0.21	na	na	na	180	170	0.5	0.11	nd	0.78	1.39	0.06	0.22	2.5
8/21/2008	BB2	0.47	6.16	8.06	17	160	170	Bacteria Only							
9/9/2008	BB2	-	-	-	-	200	1400	1.22	nd	nd	0.33	1.55	-	0.09	180
9/23/2008	BB2	0.11	6.11	8.86	15.7	230	270	0.47	0.06	nd	0.71	1.24	0.04	0.180	3.5
*9/26/2008	BB2	0.34	5.42	7.65	15.5	3000	2200	0.26	nd	nd	0.69	0.95	0.050	0.240	4.50
*9/26/2008	BB2	0.17	6.38	7.36	16.5	950	550	0.43	nd	nd	0.71	1.14	0.05	0.23	2.5
*9/29/2008	BB2	1.07	6.22	6.8	18.8	2500	2100	0.68	0.07	nd	0.84	1.59	0.09	0.260	9.5
5/14/2009	BB2	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
*7/21/2009	BB2	0.38	5.85	4.86	22.5	3100	3000	1.42	0.21	nd	0.89	2.52	0.04	0.360	47
*7/21/2009	BB2	0.57	6.23	4.52	19.8	3000	1600	0.37	0.11	nd	0.89	1.37	0.03	0.260	9.00
*7/22/2009	BB2	1.04	6.3	7.42	19.9	640	420	0.75	0.12	nd	0.76	1.63	0.03	0.200	3
‡ n		30	27	27	27	30	29	21	17	0	21	21	20	21	21
‡ min		-0.14	5.26	3.92	9.70	4.00	16.00	0.26	0.06	0.00	0.33	0.95	0.02	0.04	2.50
‡ mean**		1.608167	6.105556	7.332222	19.4925926	574.858	295.4021	0.694286	0.135882	#DIV/0!	0.931429	1.73571429	0.0515	0.178095238	19.38095
une 2008 Mean**		-	-	-	-	882.77	126.12	-	-	-	-	-	-	-	-
luly 2008 Mean**		-	-	-	-	500.7943	247.964	-	-	-	-	-	-	-	-
igust 2008 Mean**		-	-	-	-	260.9202	150.3682	-	-	-	-	-	-	-	-
‡ max		10.76	6.97	11.04	24.6	20000	3000	1.42	0.23	0	1.79	2.75	0.1	0.37	180
‡ std. dev.		2.743263	0.353981	1.662827	3.96590526	3851.454	808.5909	0.326168	0.059167	#DIV/0!	0.339636	0.55695217	0.021095	0.097602205	39.91613

* Storm Event

** A geometric mean is used for average fecal coliform and *E. coli* levels

‡ statistics involving a "nd" used (0.5*analysis detection limit)

Table 6: BB1

Date	Station ID	Flow Rate cfs	pH S.U.	Dissolved Oxygen mg/L	Temperature deg C	Fecal Coliform col/100 ml	*E. coli* col/100ml	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen as N (mg/L)	Nitrite-N (mg/L)	Nitrate-N (mg/L)	TN (calculated) (mg/L)	Ortho Phosphate Dissolved (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)
4/9/2008	BB1	0.77	5.64	11.27	10.6	4	18	0.45	0.18	nd	0.43	1.06	0.03	0.080	1.5
4/24/2008	BB1	-0.55	6.1	11.2	17.7	32	58	1.01	nd	nd	0.3	1.31	0.03	0.110	3
5/20/2008	BB1	0.95	5.58	9.43	11	4	56	1.13	0.1	nd	0.62	1.85	0.07	0.09	2.5
5/22/2008	BB1	1.38	5.48	9.82	14.4	180	28	0.59	0.08	nd	0.74	1.41	0.04	0.09	6.5
6/4/2008	BB1	2.66	6.47	8.38	18.9	1600	260	1.04	0.16	nd	0.62	1.82	0.04	0.02	38
6/10/2008	BB1	0.39	6.48	5.1	30.1	770	120	Bacteria Only							
6/12/2008	BB1	0.15	6.41	7.11	25	220	80								
6/18/2008	BB1	0.02	6.5	8.11	23.4	280	70	0.61	0.14	nd	0.69	1.44	0.03	0.050	8.5
6/24/2008	BB1	0.13	5.96	7.26	25.6	430	170	Bacteria Only							
7/2/2008	BB1	0.31	5.86	6.43	24.7	410	70	0.99	0.1	nd	0.47	1.56	0.03	0.04	14
7/8/2008	BB1	-0.40	6.73	6.56	26.2	240	90	Bacteria Only							
7/10/2008	BB1	0.26	6.09	24.8	6.37	190	150								
7/15/2008	BB1	0.01	6.17	7.54	26.3	200	150	0.37	0.07	nd	0.42	0.86	0.03	0.21	8
7/22/2008	BB1	-0.16	6.41	6.71	26.5	410	210	Bacteria Only							
*7/23/2008	BB1	0.00	6.02	5.92	25.2	480	250	0.38	0.08	nd	0.35	0.81	0.04	0.4	7
*7/24/2008	BB1	9.72	5.8	6.17	21.8	9400	1200	0.39	0.14	nd	0.73	1.26	0.15	0.33	17
*7/24/2008	BB1	6.14	6.13	6.68	23.6	6400	950	0.54	0.15	nd	0.7	1.39	0.1	0.06	7
8/5/2008	BB1	0.21	6.01	6.83	22.8	800	320	Bacteria Only							
8/7/2008	BB1	-0.21	5.41	7.52	24	270	100	0.29	nd	nd	0.37	0.66	0.07	0.07	nd
8/13/2008	BB1	-0.05	6.09	9.4	21.3	240	110	Bacteria Only							
8/19/2008	BB1	0.14	6.07	8.72	23.8	250	300	0.3	0.06	nd	0.33	0.69	0.02	0.18	3.5
8/21/2008	BB1	0.19	6	na	18.9	160	130	Bacteria Only							
9/9/2008	BB1	nd	5.9	6.57	20.8	nd	nd	nd	nd	nd	nd	0	-	nd	nd
9/23/2008	BB1	0.02	6.19	10.61	17.5	120	100	0.43	nd	nd	0.32	0.75	0.05	0.360	6.5
*9/26/2008	BB1	nd	4.1	5.64	15.6	500	550	0.32	nd	nd	0.45	0.77	0.020	0.170	4.50
*9/26/2008	BB1	nd	6.25	8	17.4	500	400	0.36	nd	nd	0.47	0.83	0.04	0.17	3.5
*9/29/2008	BB1	nd	5.99	7.2	19.6	950	1000	0.53	nd	nd	0.74	1.27	0.04	0.110	nd
*7/21/2009	BB1	-0.01	6.15	4.21	na	520	670	0.64	0.11	nd	0.57	1.32	0.02	0.030	12
*7/21/2009	BB1	-0.03	6.06	5.16	20.9	1300	1500	0.65	0.09	nd	0.6	1.34	0.02	0.320	10.00
*7/22/2009	BB1	0.303	6.22	6.36	20.6	280	360	0.58	0.08	nd	0.49	1.15	0.02	0.270	10.5
‡ n		26	30	29	29	29	29	20	14	21	21	21	20	20	18
‡ min		-0.6	4.1	4.2	6.4	4	18	0.3	0.1	nd	0.3	0.0	0.0	0.0	1.5
‡ mean**		0.9	6.0	8.1	20.7	308	184	0.6	0.1	nd	0.5	1.1	0.0	0.2	9.1
June 2008 Mean**		-	-	-	-	504	124	-	-	-	-	-	-	-	-
July 2008 Mean**		-	-	-	-	274	124	-	-	-	-	-	-	-	-
August 2008 Mean**		-	-	-	-	291	169	-	-	-	-	-	-	-	-
‡ max		9.7	6.7	24.8	30.1	9400	1500	1.1	0.2	nd	0.7	1.9	0.2	0.4	38.0
‡ std. dev.		2.2	0.5	3.7	5.4	2004	382	0.3	0.0	nd	0.2	0.4	0.0	0.1	8.3

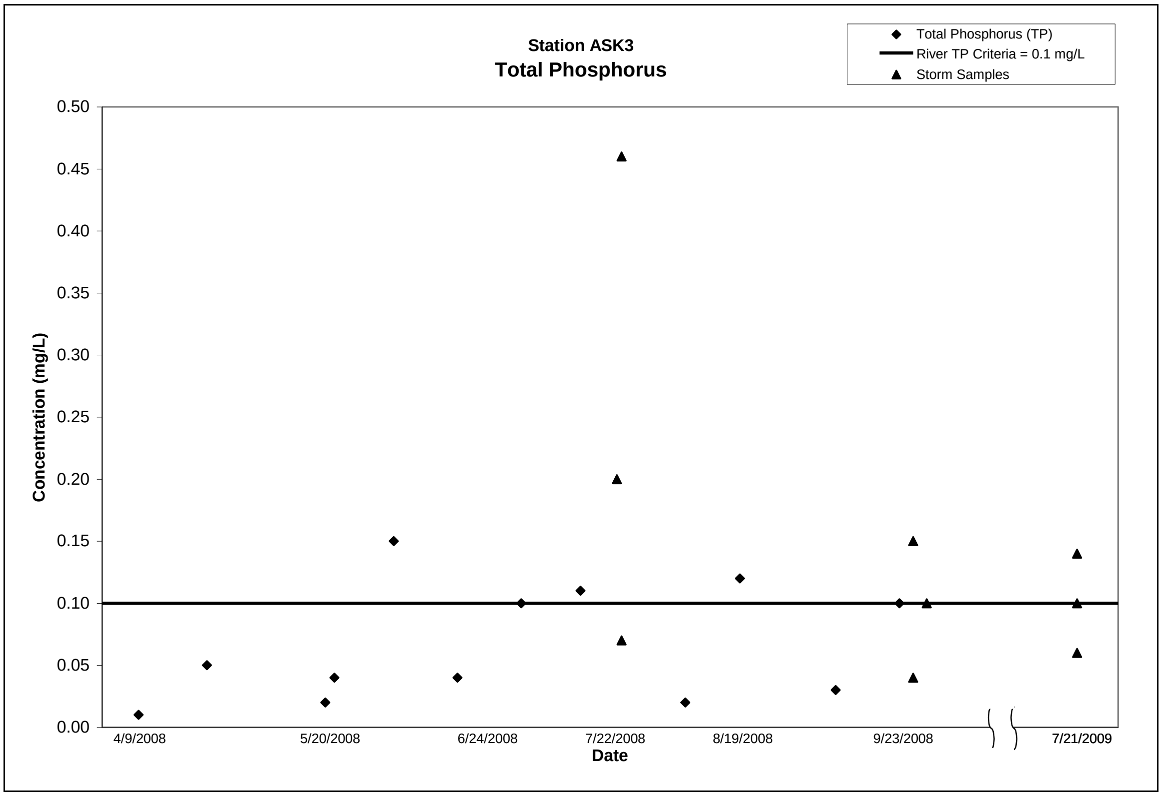
* Storm Event

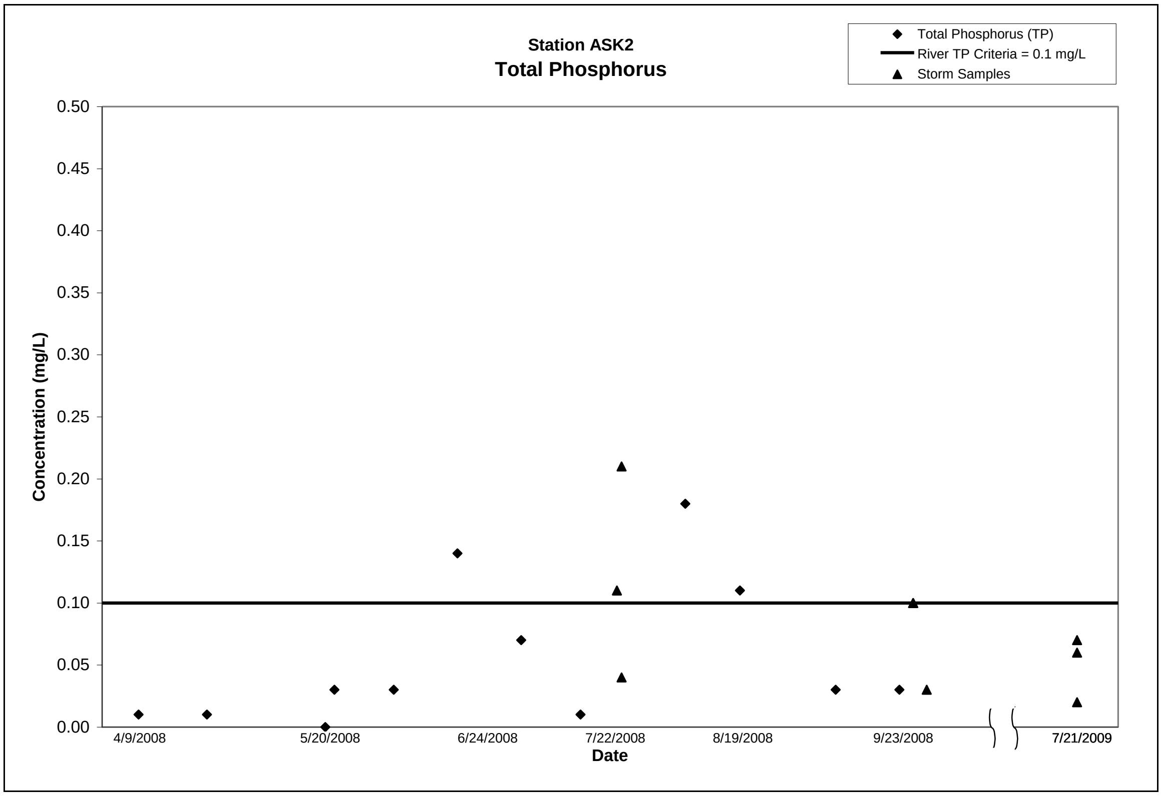
** A geometric mean is used for average fecal coliform and *E. coli* levels

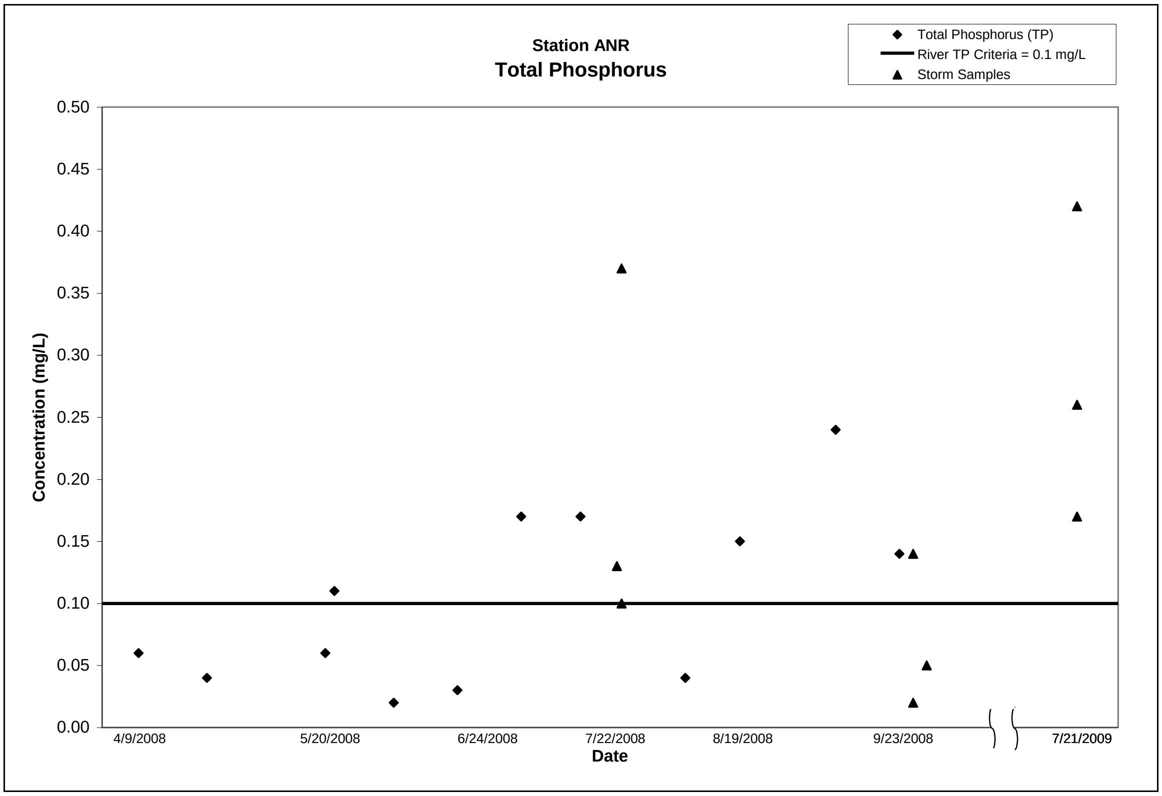
‡ statistics involving a "nd" used (0.5*analysis detection limit)

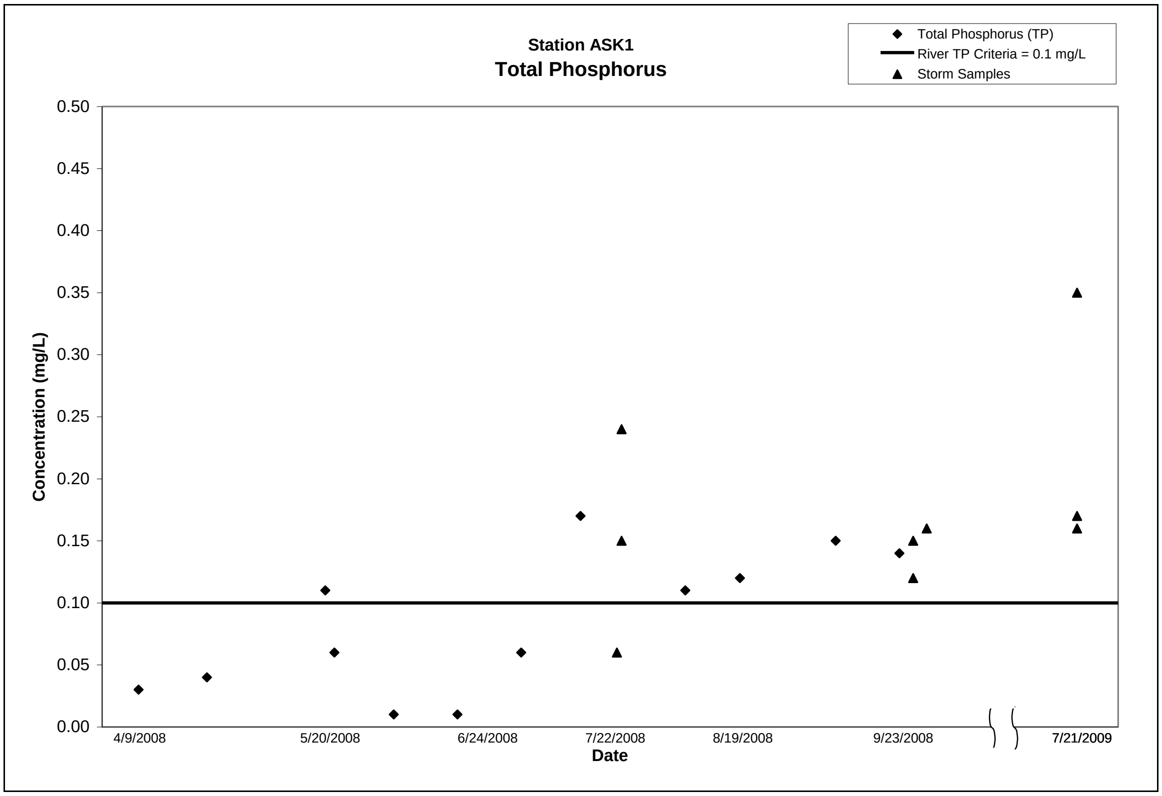
Data Report Appendix E:

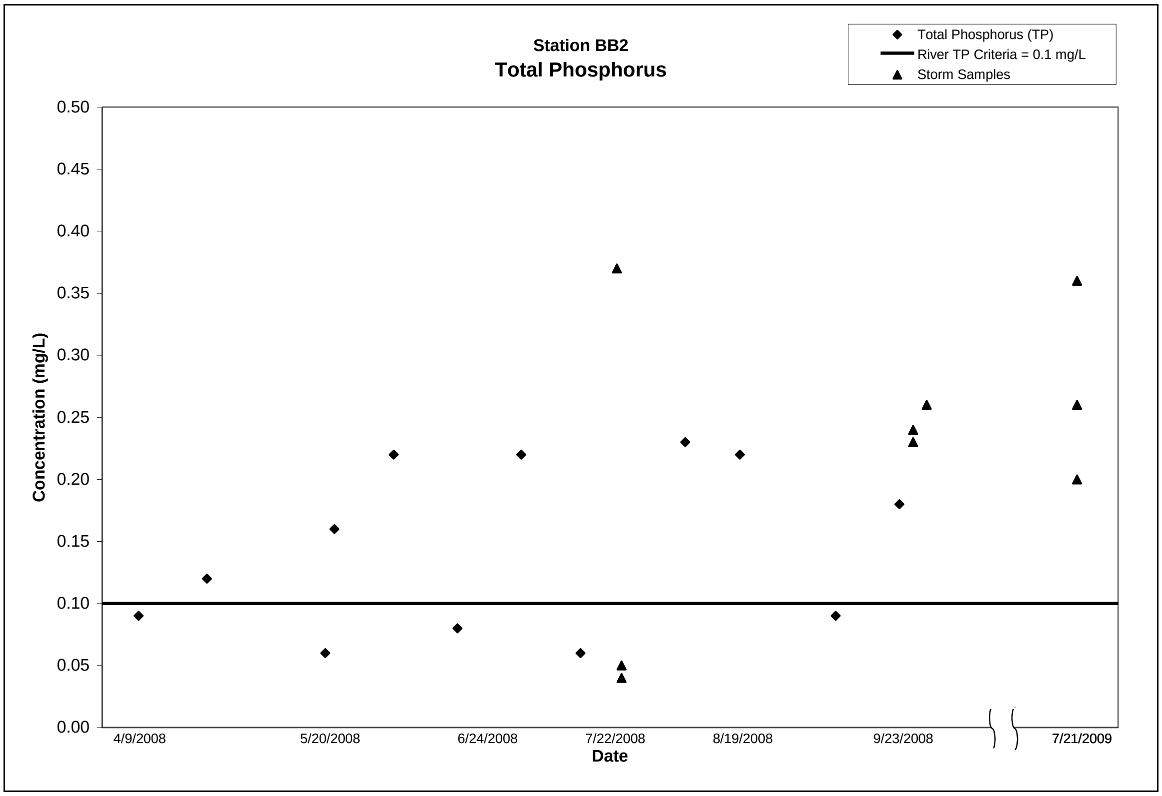
Presentation of Total Phosphorus, pH, Bacteria and Nitrogen In-stream Concentration Graphs

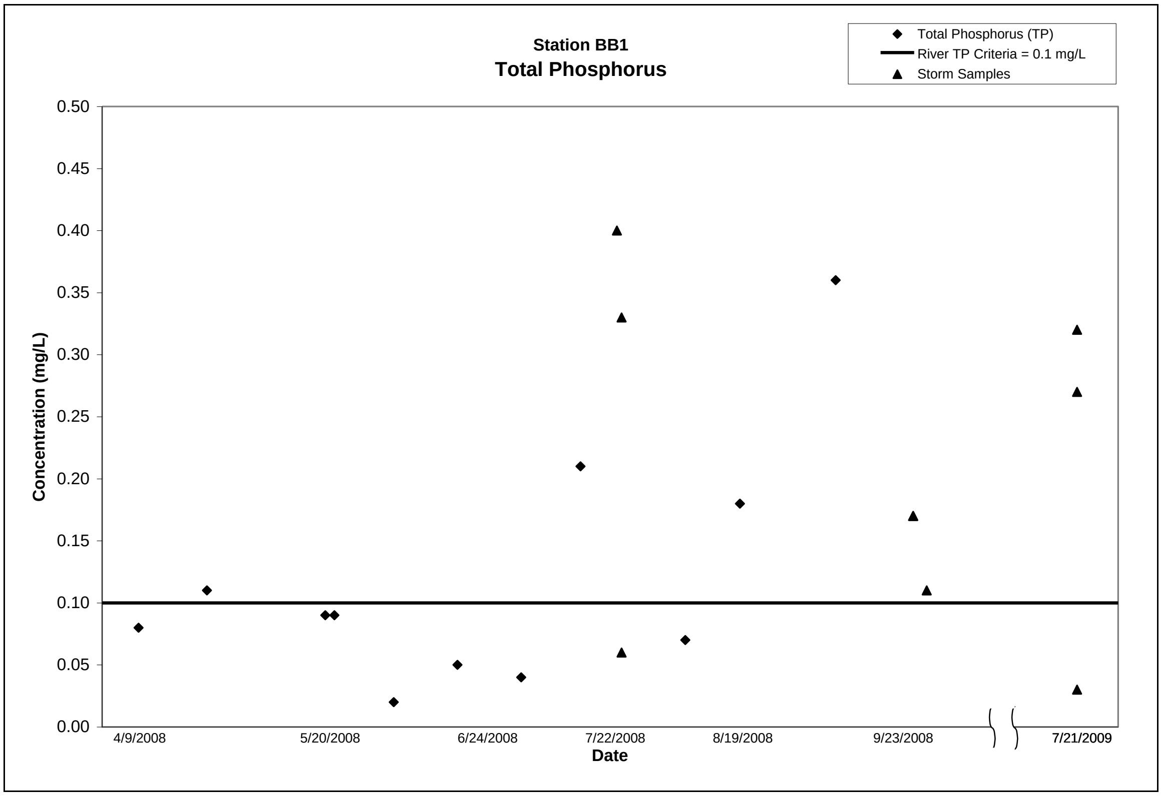

Station ASK3
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

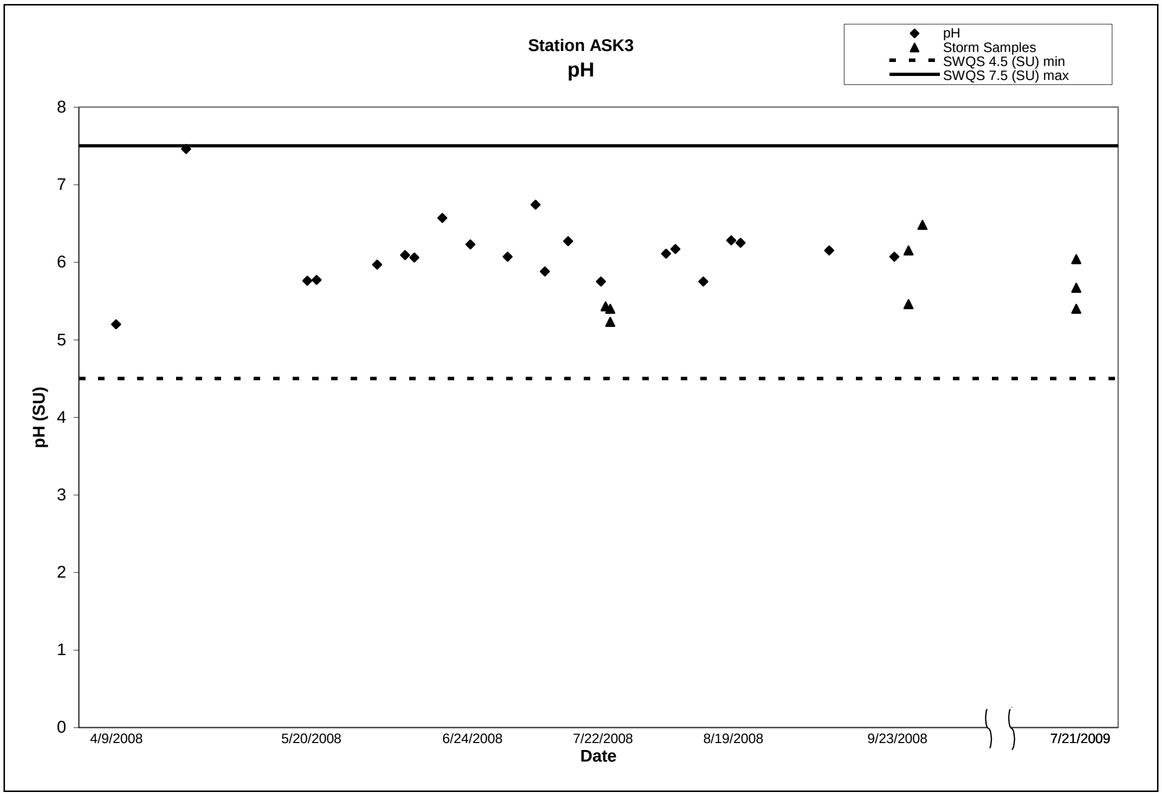

Station ASK2
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

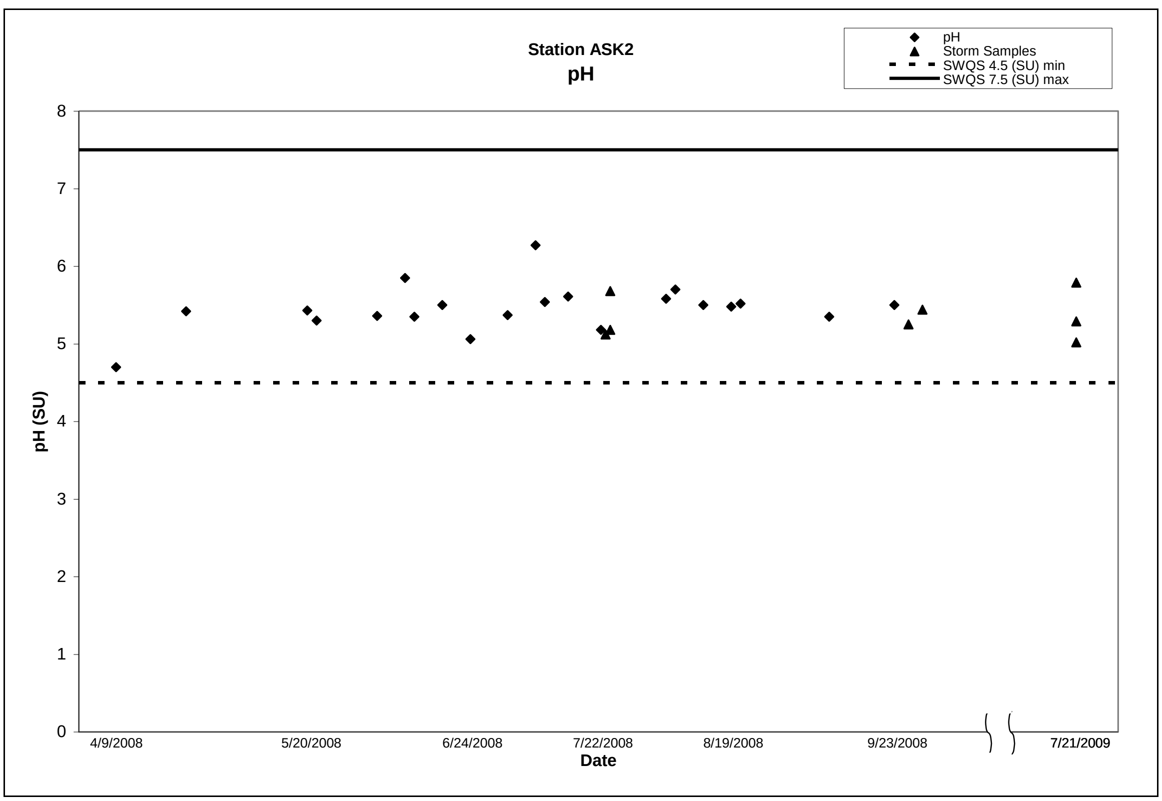

Station ANR
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

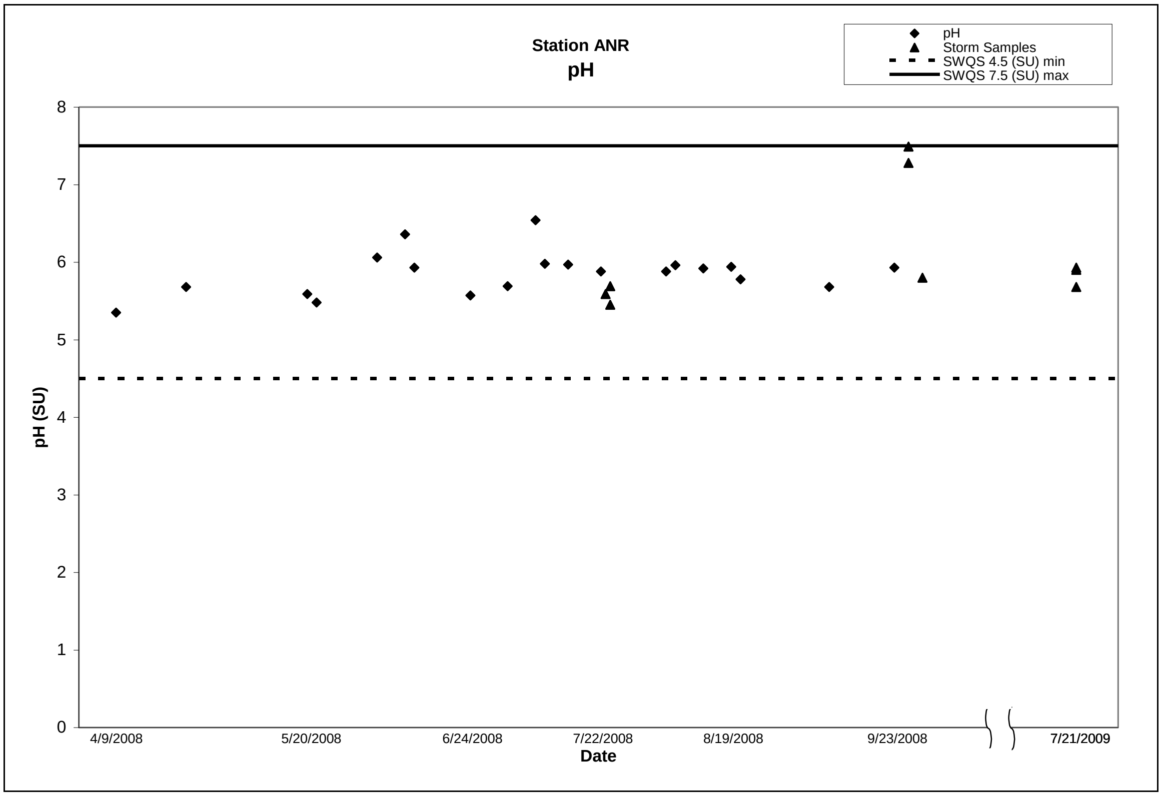

Station ASK1
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

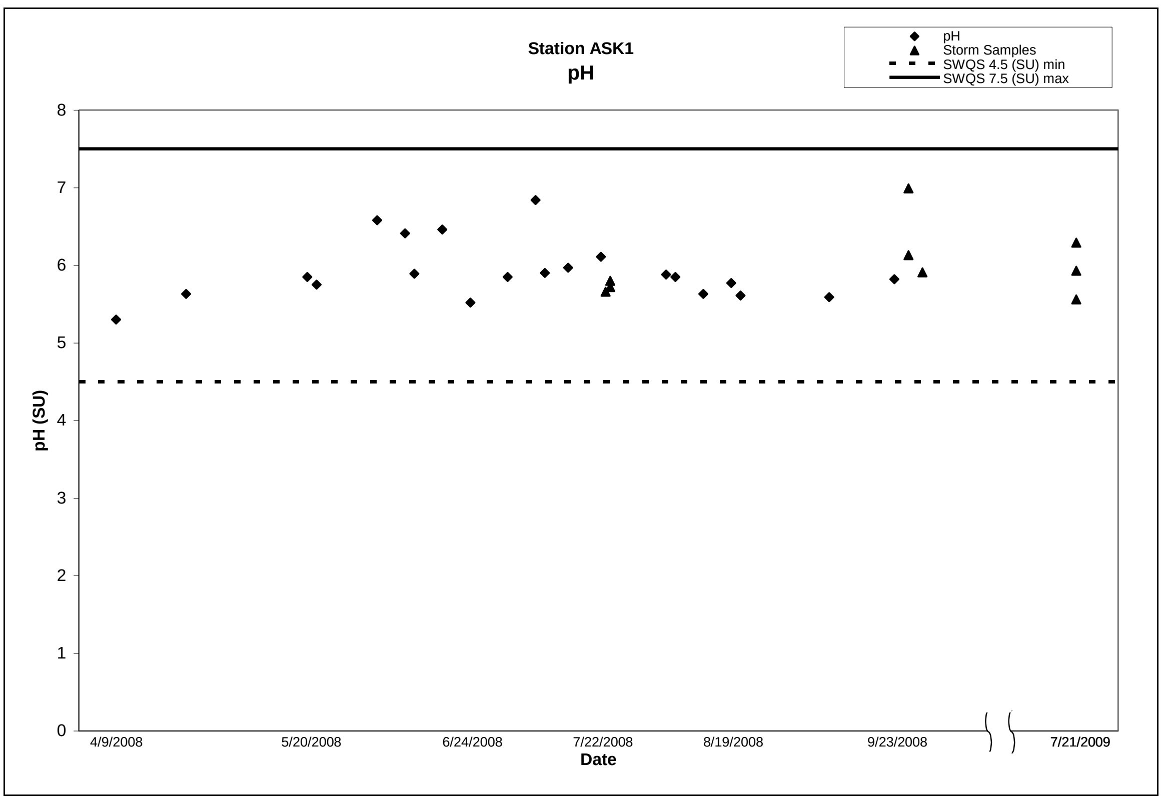

Station BB2
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

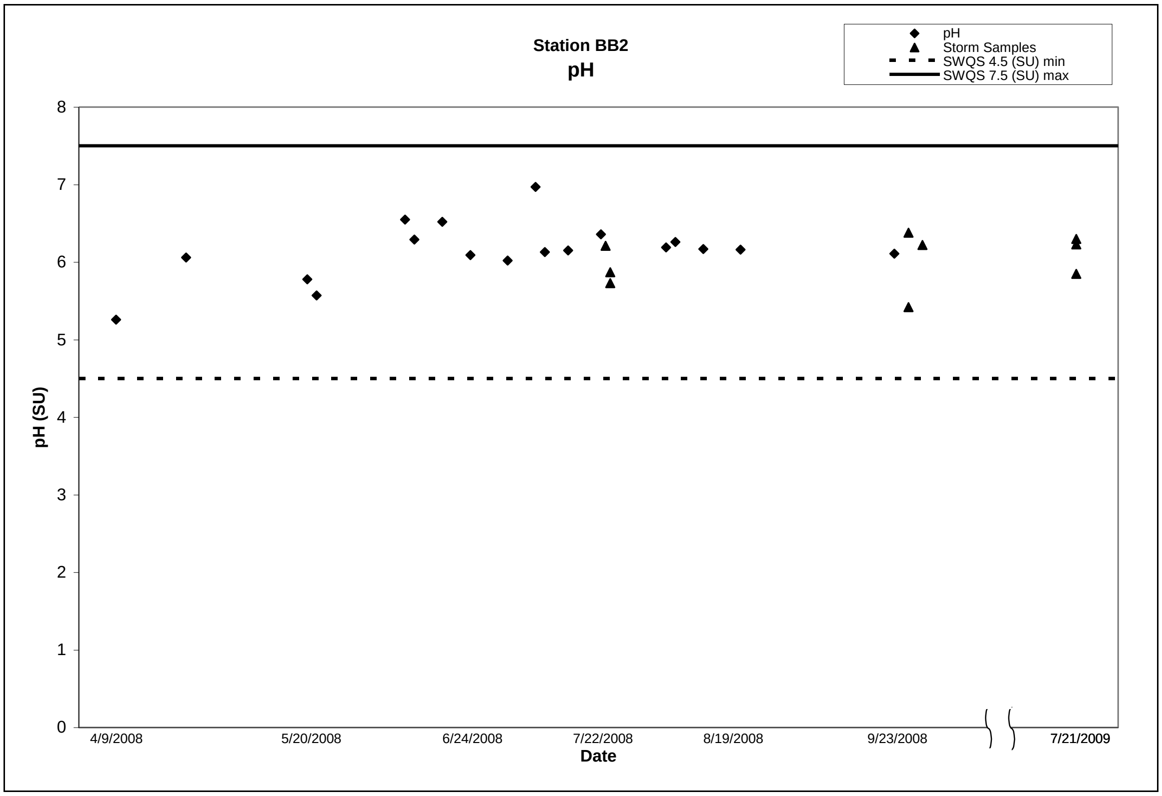

Station BB1
Total Phosphorus
Total Phosphorus (TP)
River TP Criteria = 0.1 mg/L
Storm Samples
Concentration (mg/L)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

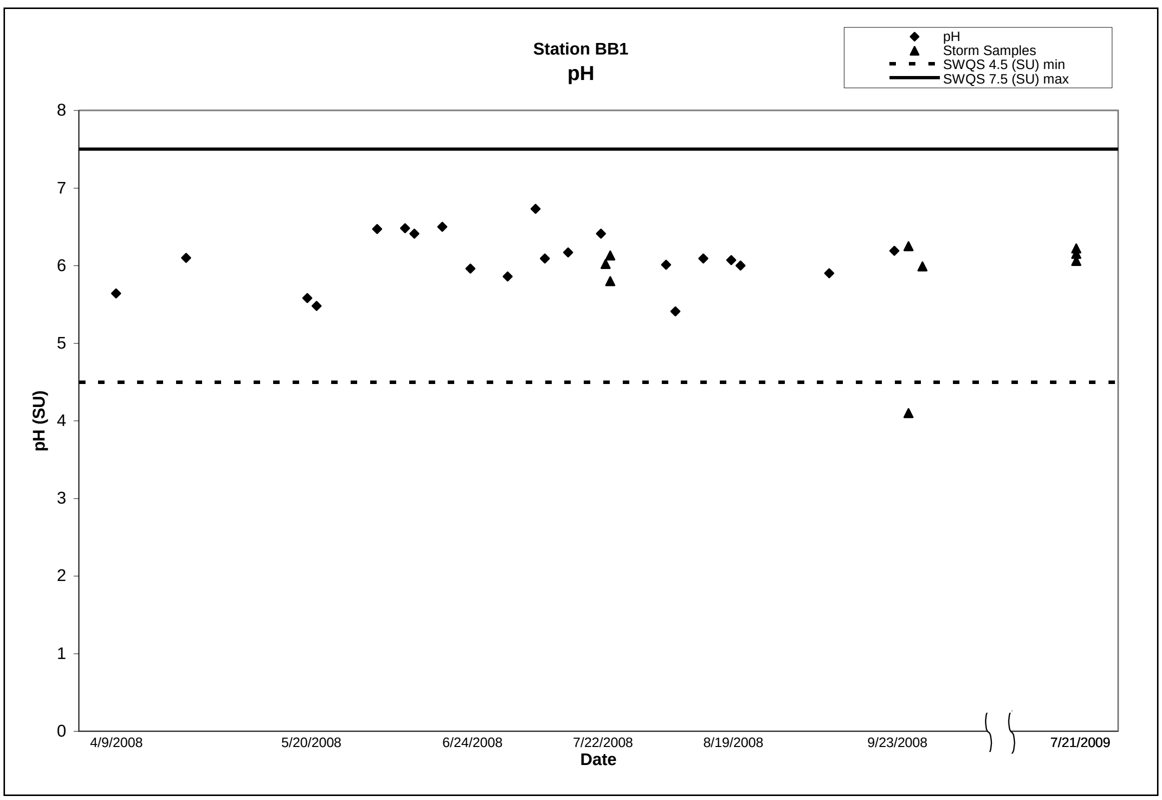

Station ASK3
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
8
7
6
5
4
3
2
1
0
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

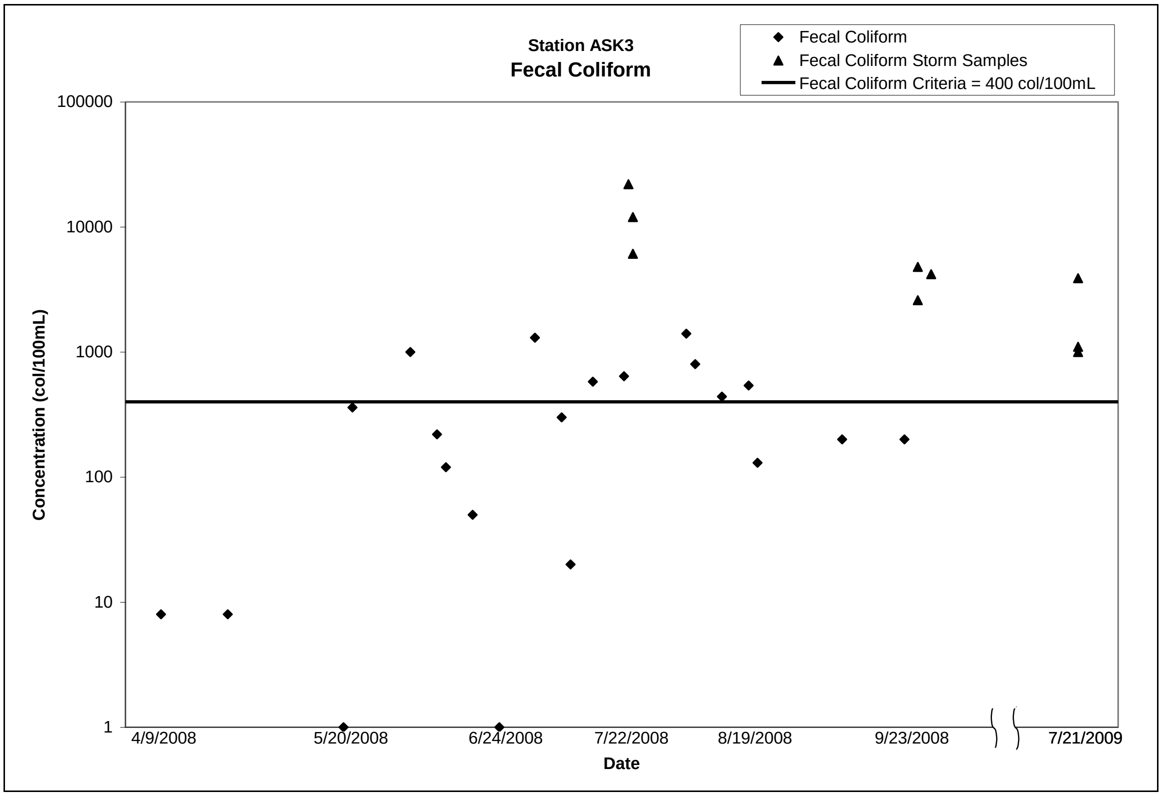

Station ASK2
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
8
7
6
5
4
3
2
1
0
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

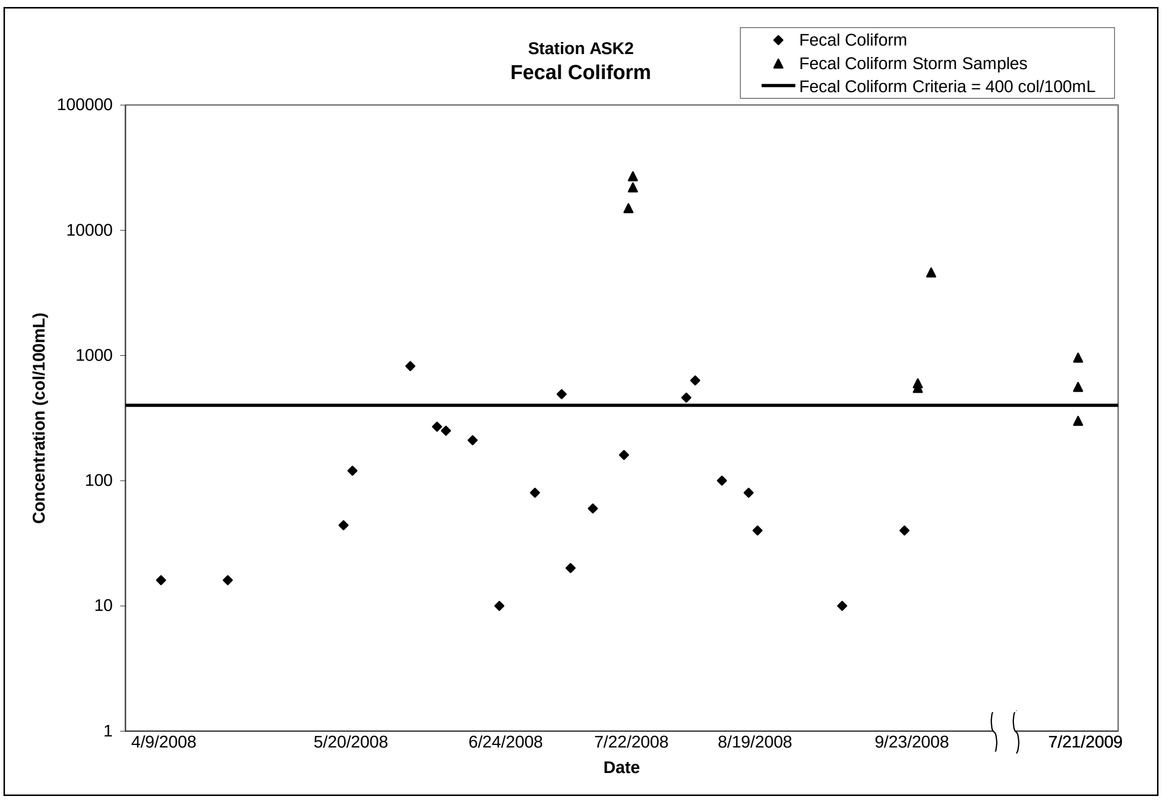

Station ANR
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
0
1
2
3
4
5
6
7
8
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

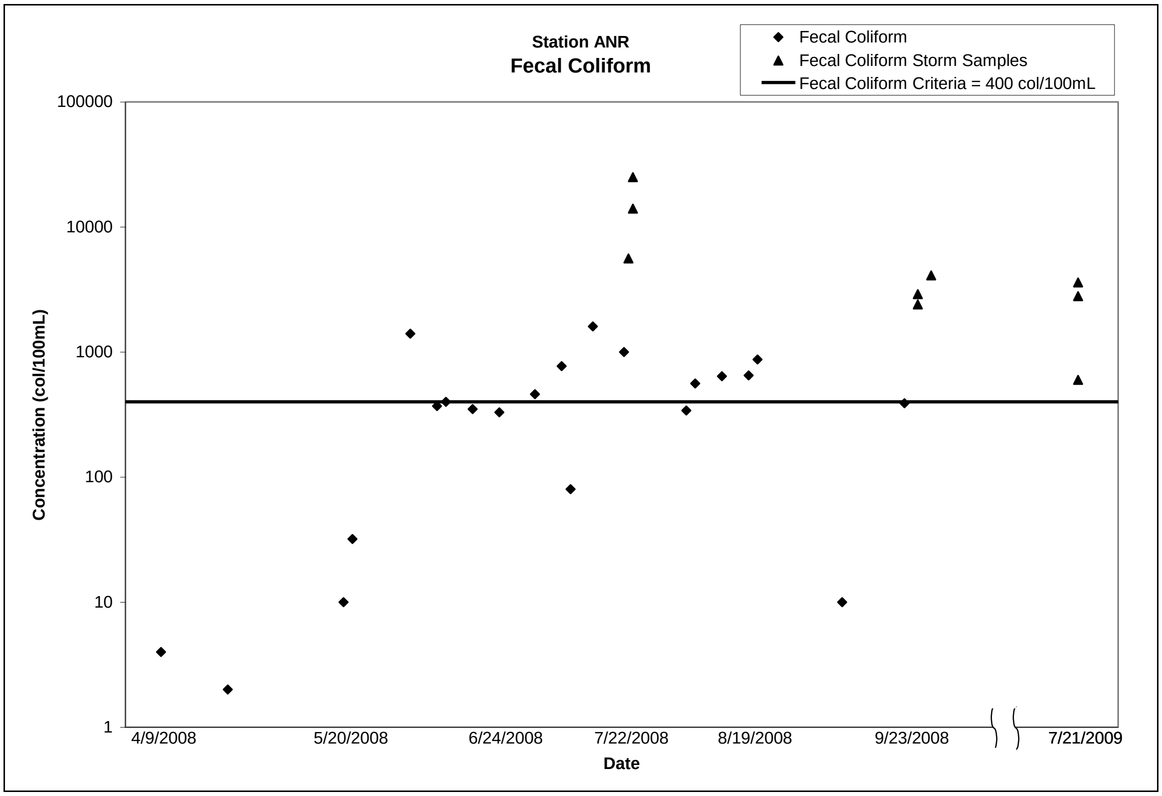

Station ASK1
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
0
1
2
3
4
5
6
7
8
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

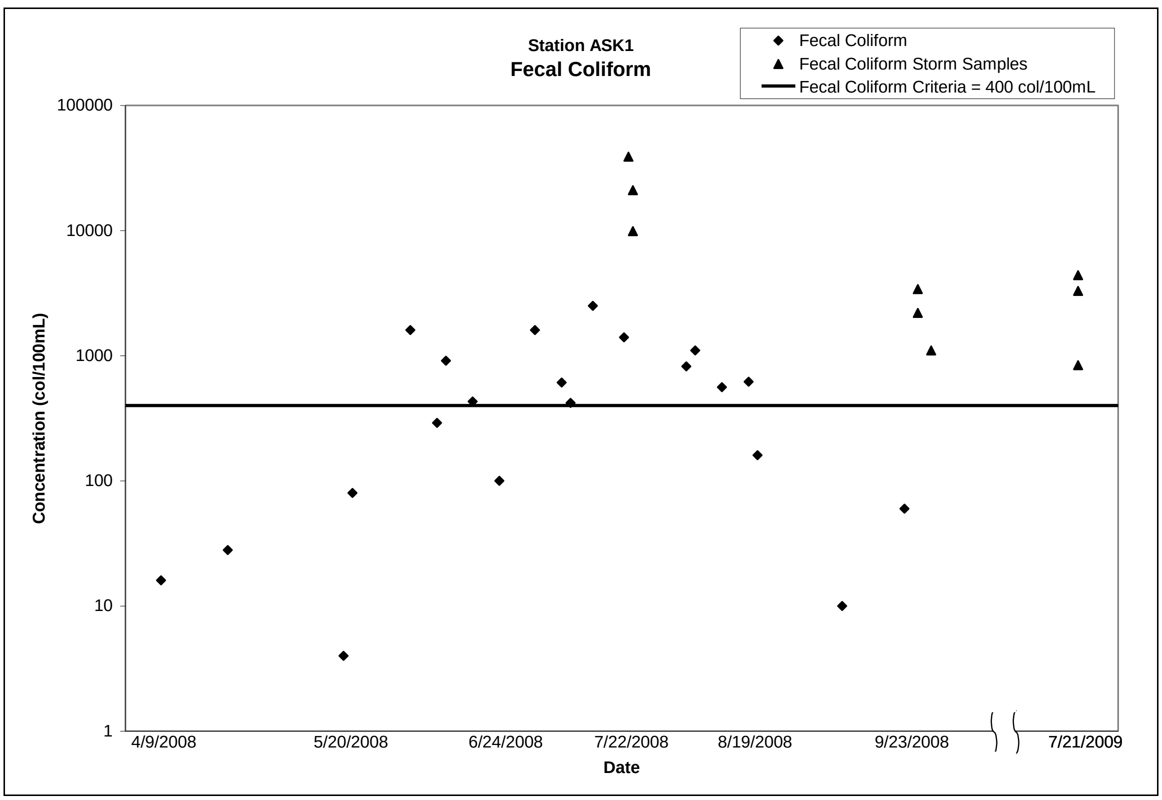

Station BB2
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
8
7
6
5
4
3
2
1
0
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

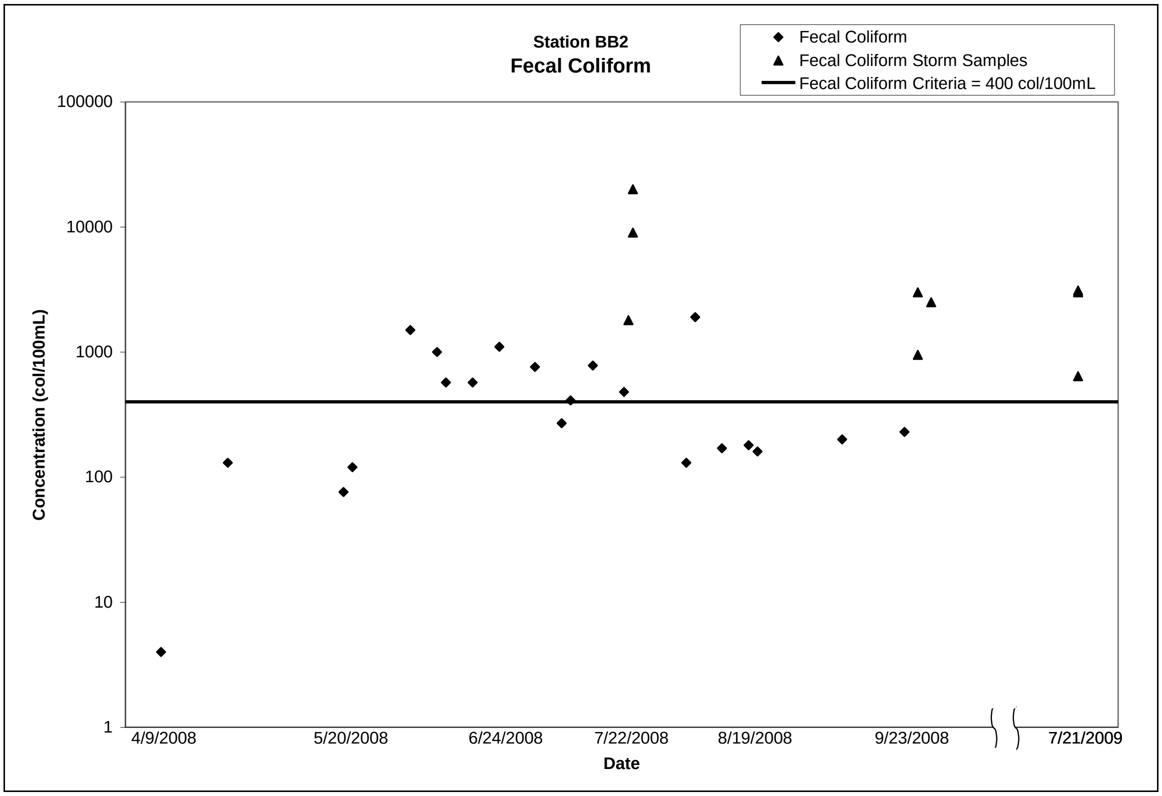

Station BB1
pH
pH
Storm Samples
SWQS 4.5 (SU) min
SWQS 7.5 (SU) max
pH (SU)
8
7
6
5
4
3
2
1
0
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

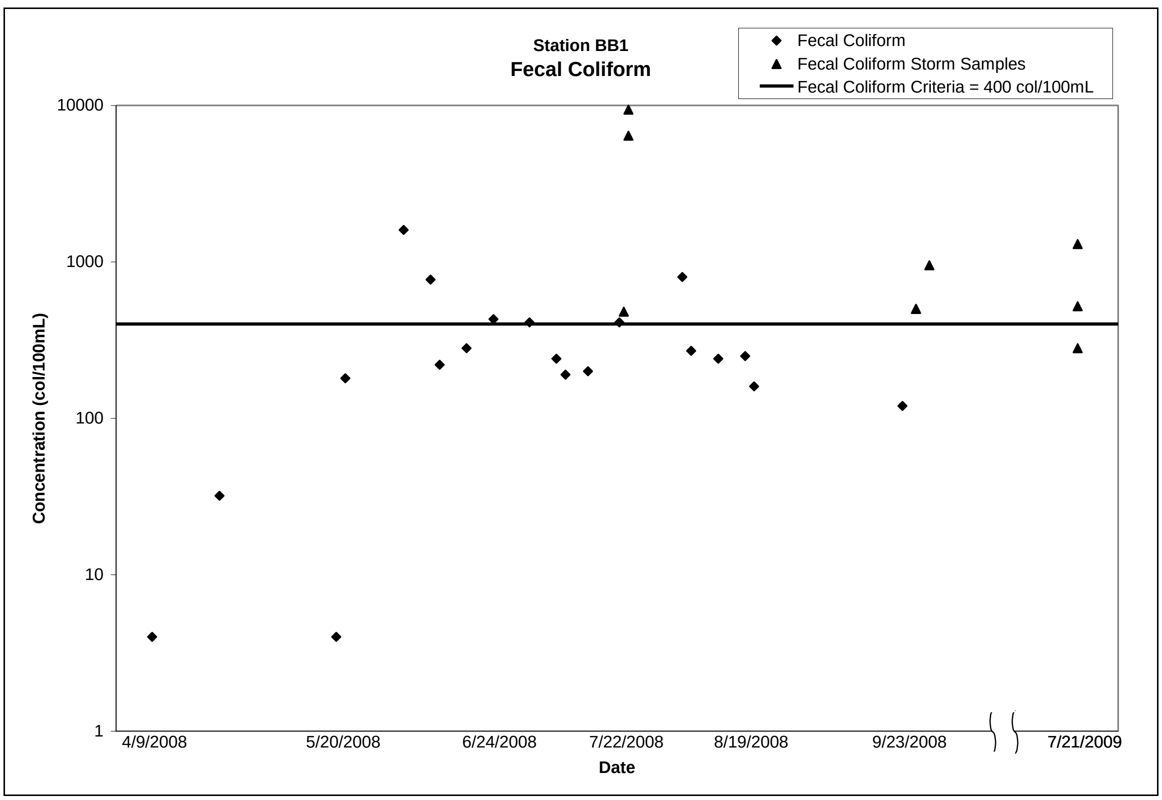

Station ASK3
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
100000
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

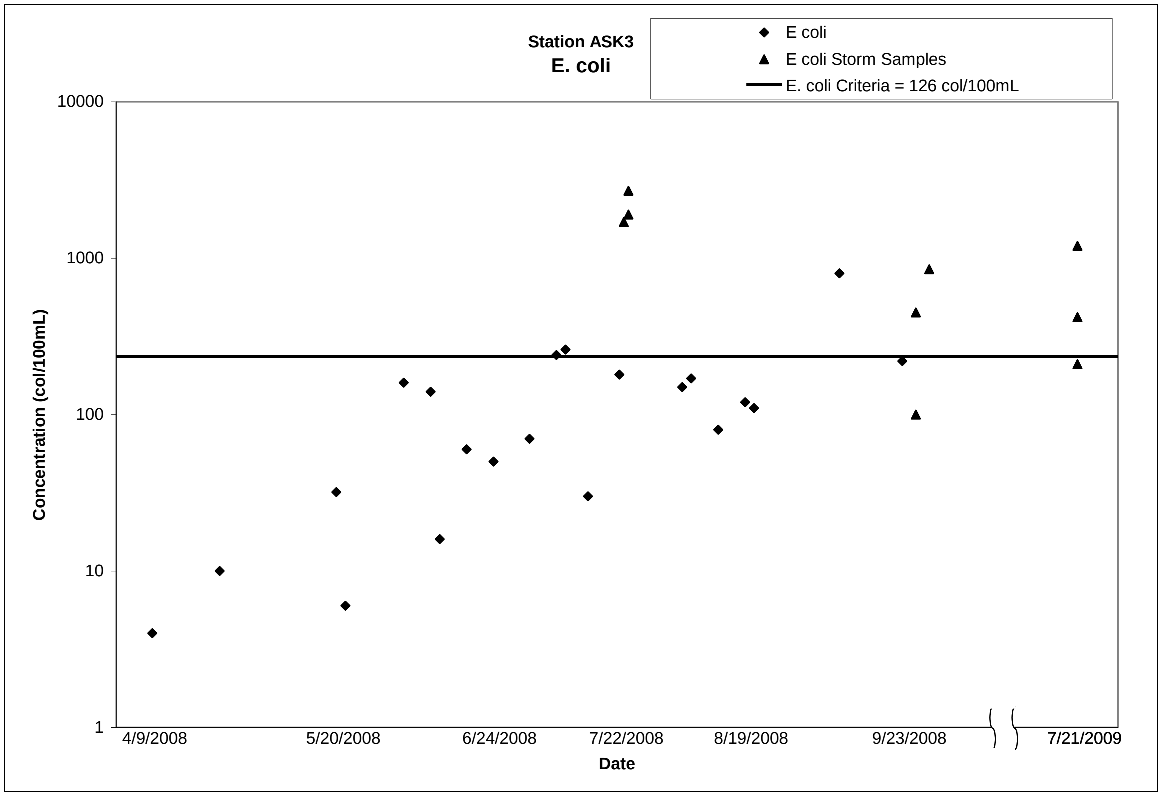

Station ASK2
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
100000
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

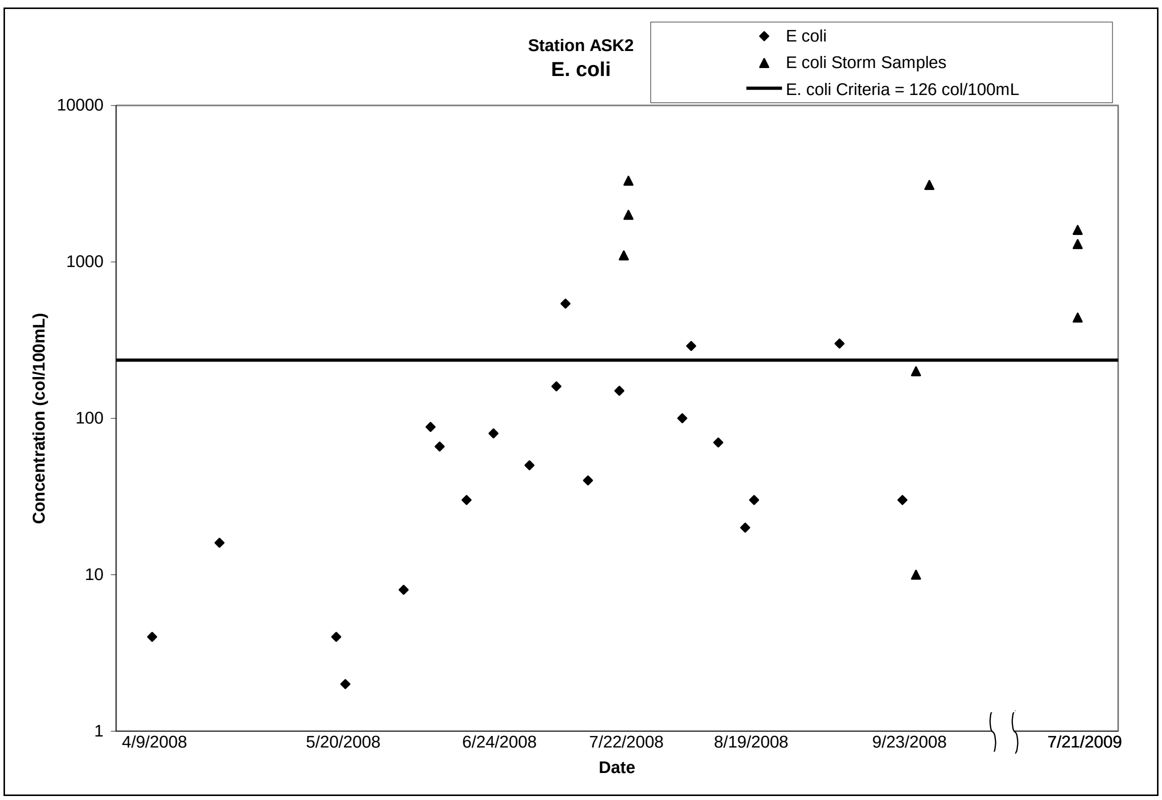

Station ANR
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
100000
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

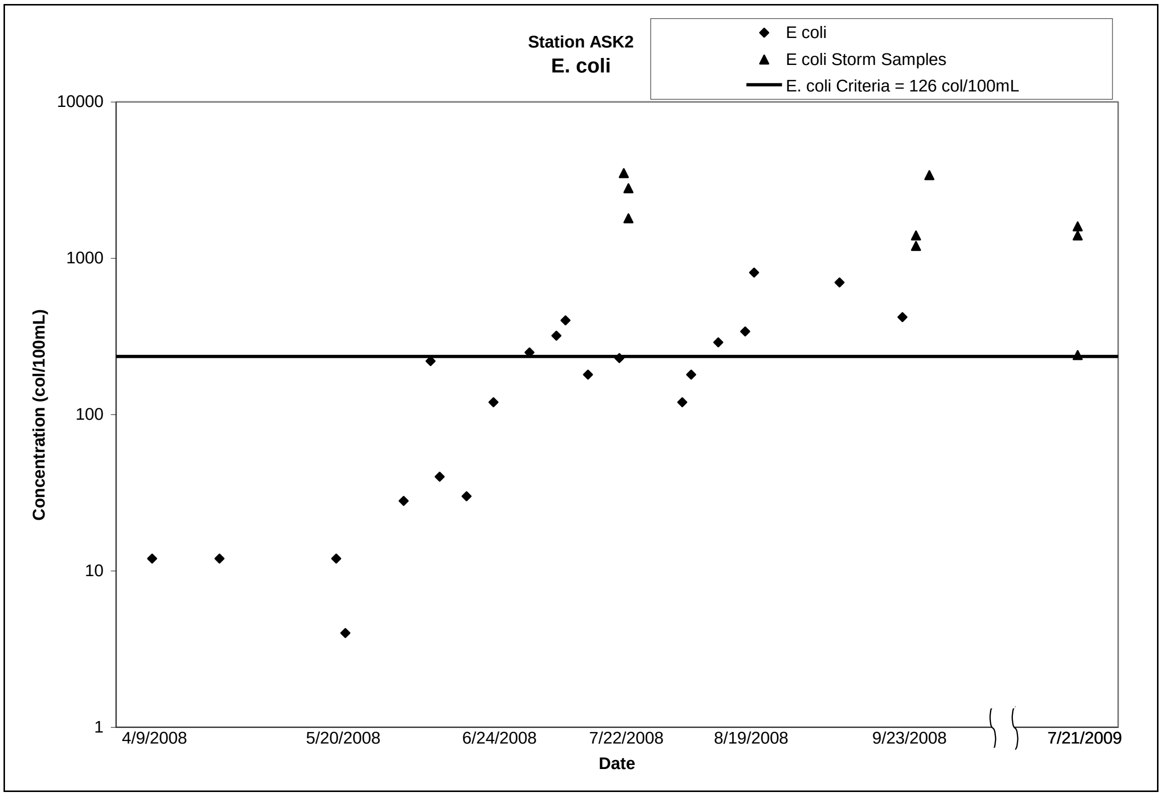

Station ASK1
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
100000
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

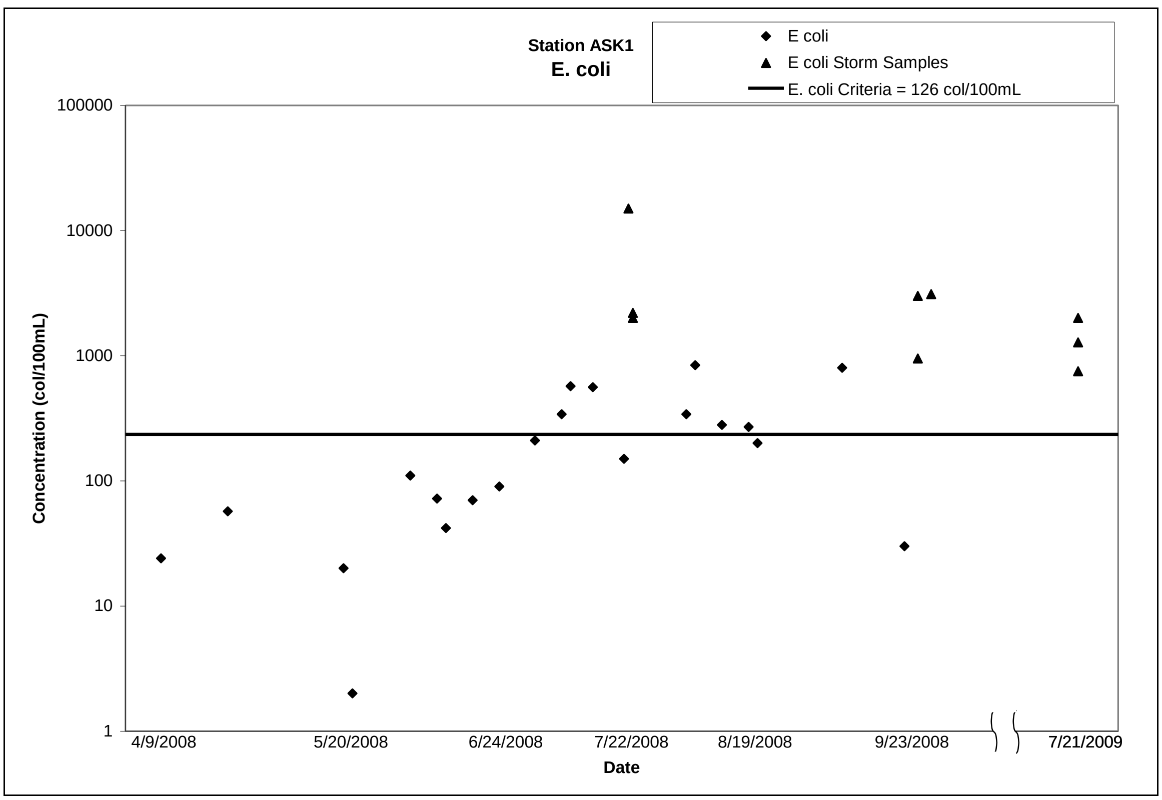

Station BB2
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
Concentration (col/100mL)
100000
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

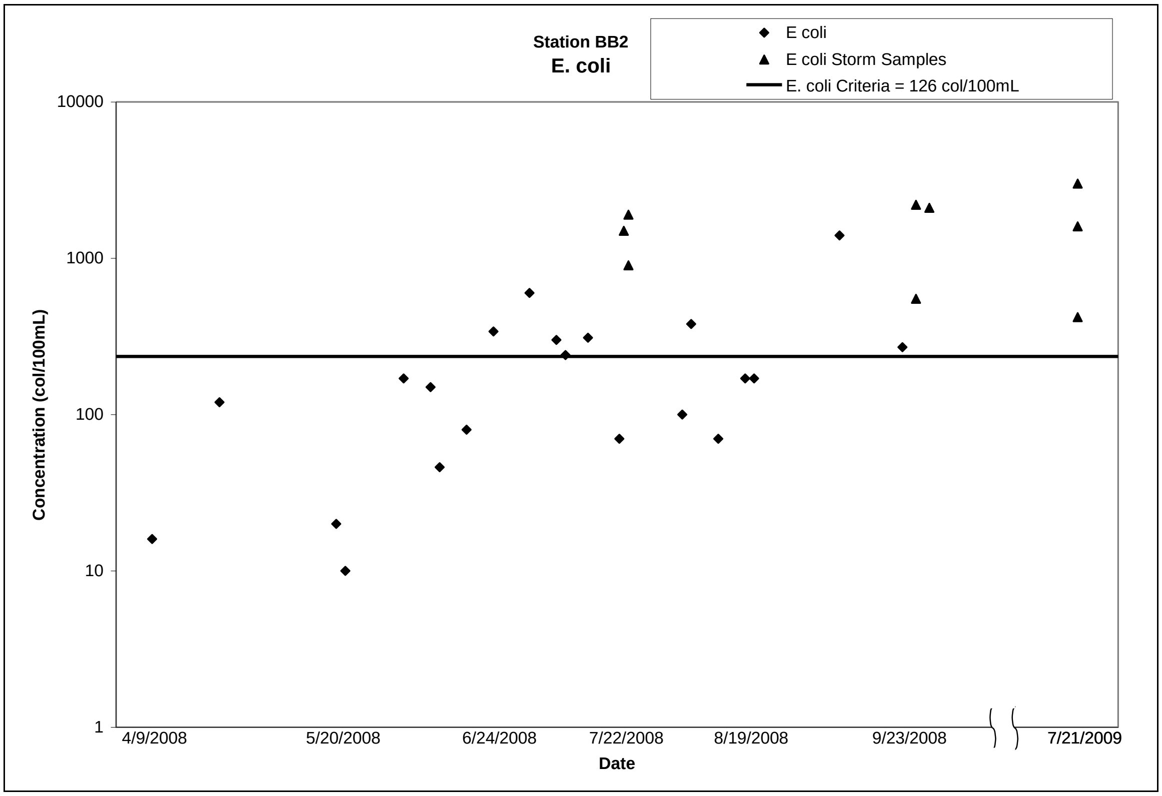

Station BB1
Fecal Coliform
Fecal Coliform
Fecal Coliform Storm Samples
Fecal Coliform Criteria = 400 col/100mL
Concentration (col/100mL)
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

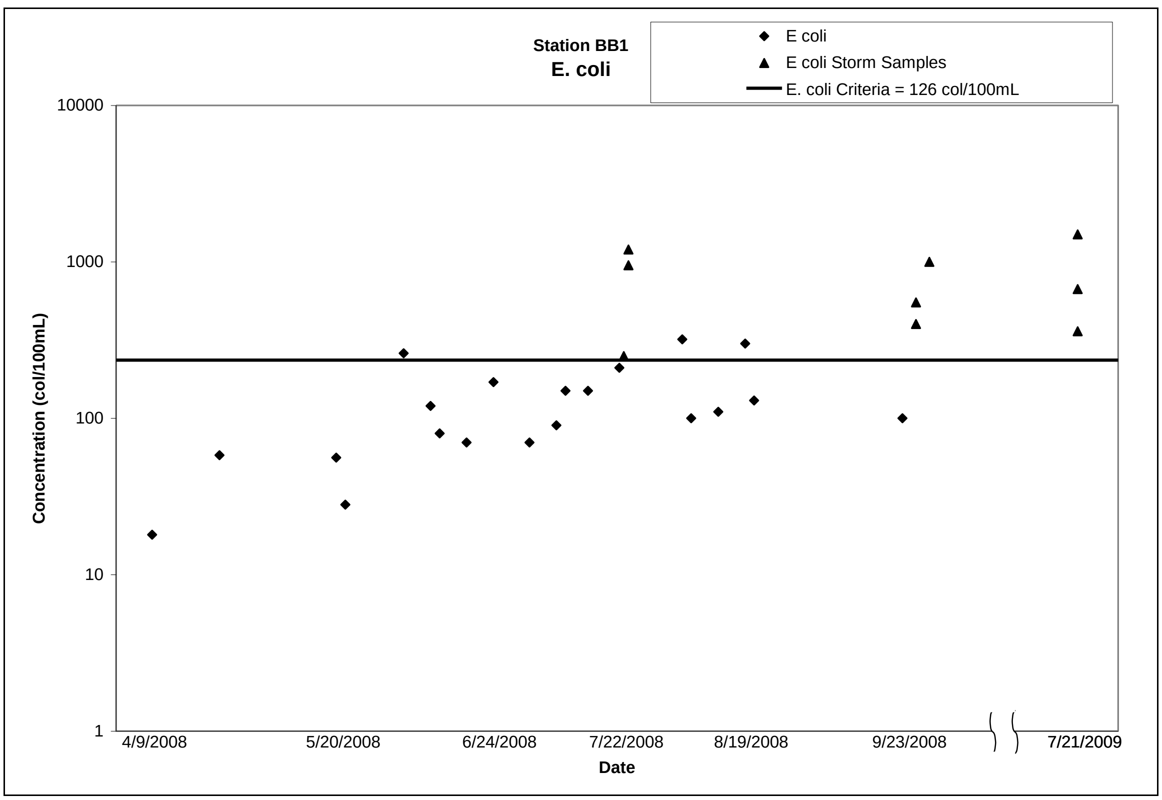

Station ASK3
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

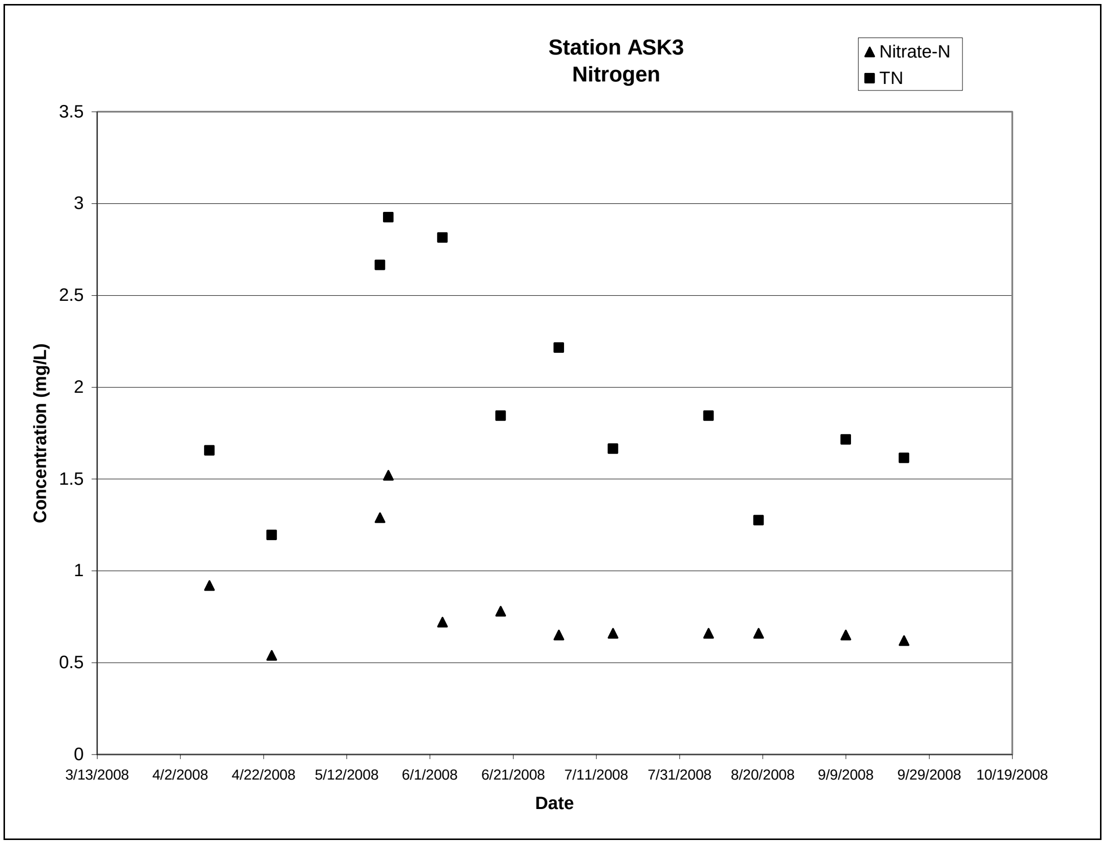

Station ASK2
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
10000
1000
100
10
1
Concentration (col/100mL)
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

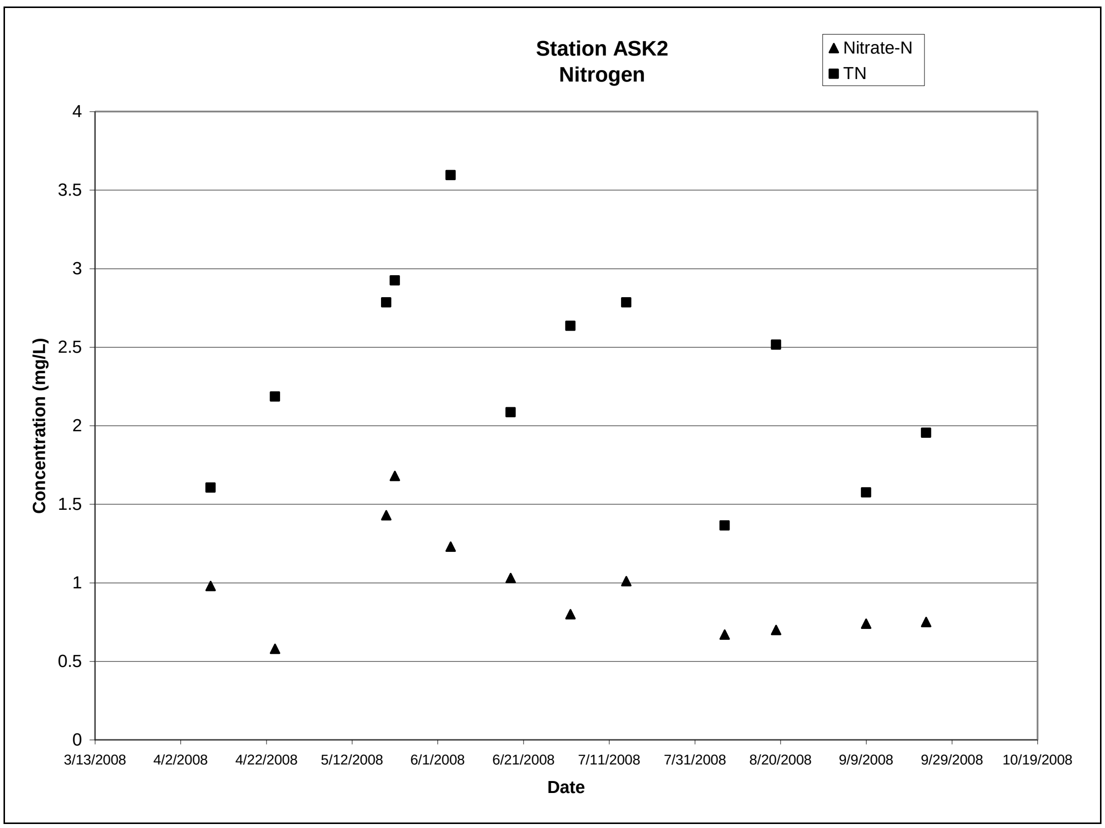

Station ASK2
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
Concentration (col/100mL)
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

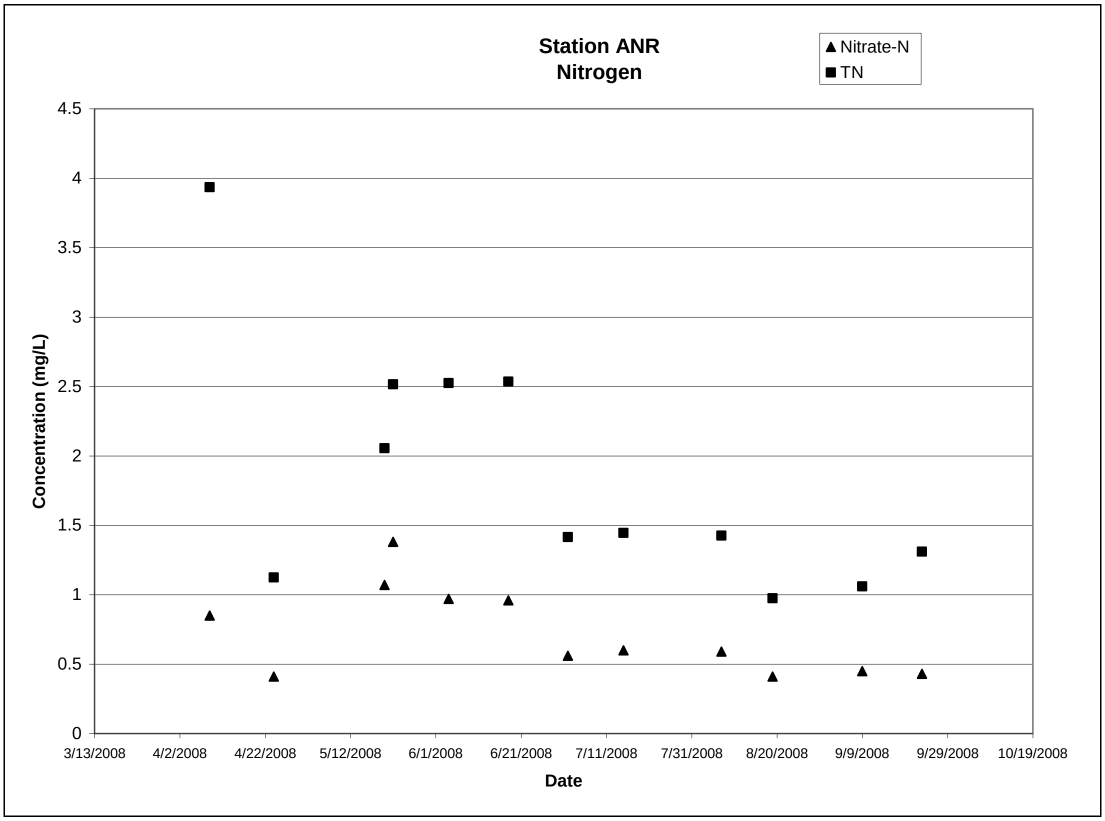

Station ASK1
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
Concentration (col/100mL)
100000
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

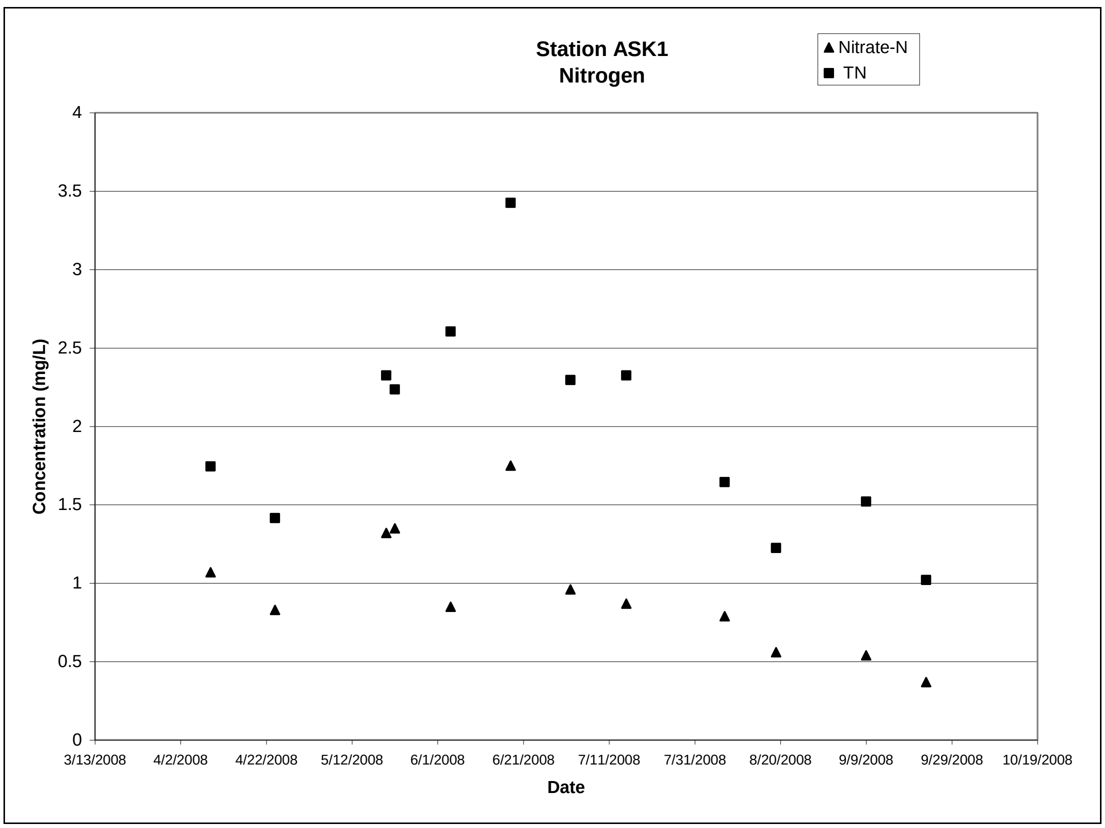

Station BB2
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
Concentration (col/100mL)
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

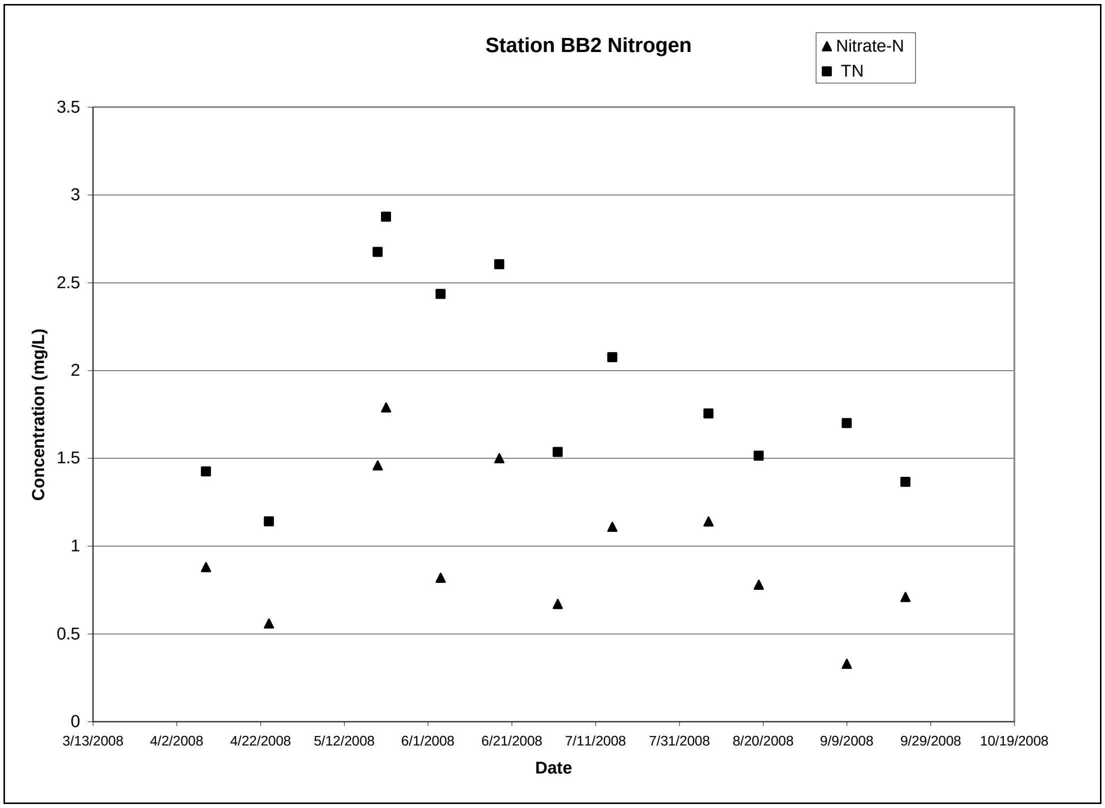

Station BB1
E. coli
E coli
E coli Storm Samples
E. coli Criteria = 126 col/100mL
Concentration (col/100mL)
10000
1000
100
10
1
4/9/2008
5/20/2008
6/24/2008
7/22/2008
8/19/2008
9/23/2008
7/21/2009
Date

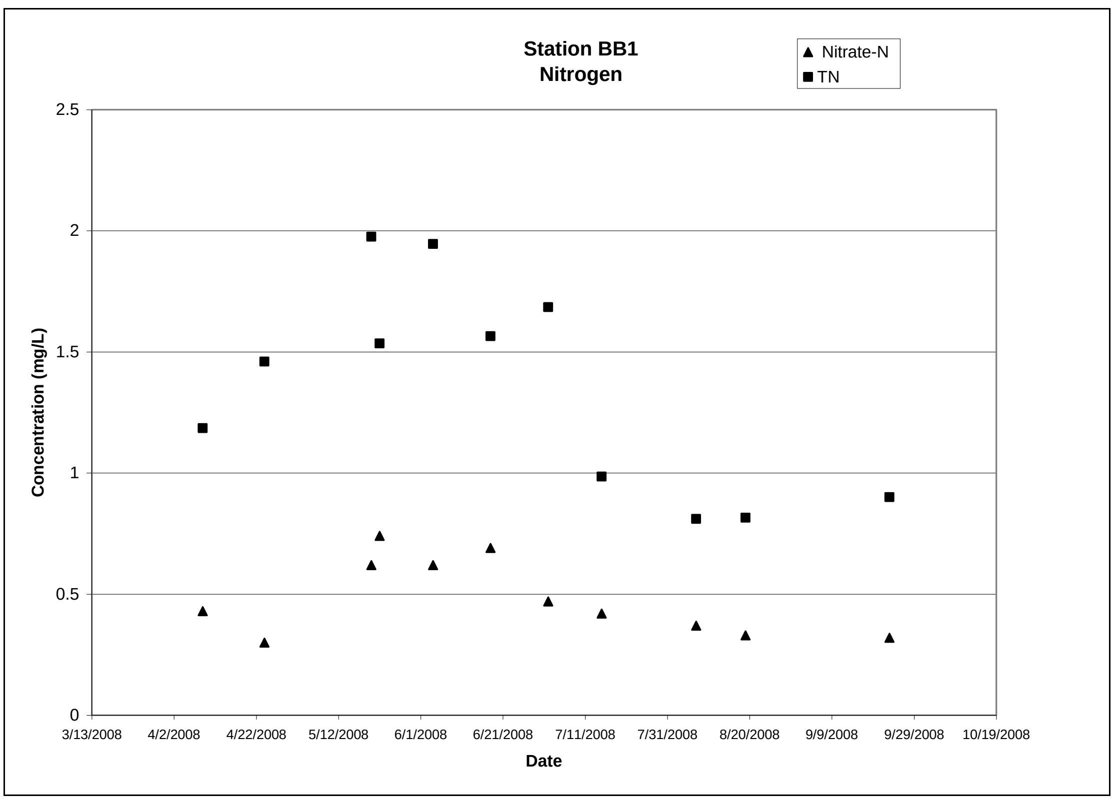

Station ASK3
Nitrogen
Nitrate-N
TN
Concentration (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date


Station ASK2
Nitrogen
Nitrate-N
TN
Concentration (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date


Station ANR
Nitrogen
Nitrate-N
TN
Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date


Station ASK1
Nitrogen
Nitrate-N
TN
Concentration (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date


Station BB2 Nitrogen
Nitrate-N
TN
Concentration (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date


Station BB1
Nitrogen
Nitrate-N
TN
Concentration (mg/L)
0
0.5
1
1.5
2
2.5
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008
9/29/2008
10/19/2008
Date