QUALITY ASSURANCE/WORK PLAN

JUNIATA RIVER
SMALL WATERSHED STUDY—MORRISON COVE AREA

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I. PROJECT NAME

Juniata River Small Watershed Study

II. PROJECT OFFICERS

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IV. DATE OF PROJECT INITIATION

October 2004; sampling begins April 2005

V. PROJECT DESCRIPTION

A. Objective and Scope

The Susquehanna River Basin Commission (Commission) has been conducting water quality and biological surveys on selected streams within each major subbasin on a 10- to 12-year cycle, as part of the Commission's continuing program for assessment of water quality in the Susquehanna River Basin. In 1998, the Commission reevaluated its subbasin survey program and added a Year 2 component to better assist local interests and to perform more detailed studies in selected watersheds.

During July–November 2004, Commission staff conducted a survey of the Juniata Subbasin. The data collected during this survey provided a qualitative assessment of conditions in the basin. The Commission has been involved with a groundwater management plan initiative and through this planning process has identified potentially stressed areas throughout the Susquehanna basin. Potentially Stressed Areas (PSAs) are areas of high water use that are approaching, or have exceeded, the sustainable limit of the available resource. One of these PSAs is Morrison Cove in Bedford and Blair Counties, Pa.

The Commission proposes to perform a small watershed survey in the Morrison Cove area, which encompasses the Yellow Creek, Halter Creek, Plum Creek, Clover Creek, and Piney Creek Watersheds during FY-2005. In addition to potential groundwater problems, Yellow Creek is impaired due to agricultural problems, while portions of Halter and Plum Creeks are impacted by stormwater flows.

This watershed assessment will provide valuable biological, chemical, and habitat information to the Commission and other interested parties, including the Bedford and Blair County Conservation Districts and the Juniata Clean Water Partnership. It also will characterize hydrology in a high-use area using the chemical information collected for use in the Commission's project review activities and any future groundwater studies in the area. Streams to be sampled include: Yellow Creek, Halter Creek, Plum Creek, Clover Creek, Piney Creek, Potter Creek, and Three Spring Creek, as well as several springs. Commission staff will perform extensive coordination with the watershed groups, county conservation districts, local citizens, and other interested parties. Figure 1 shows the location of the Morrison Cove study area.

B. Data Usage

Data collected during this survey will be used by the Commission, watershed groups, and conservation districts to conduct watershed management planning from both a water quality and water quantity perspective. Water typing will facilitate a more complete characterization of groundwater and surface-water interaction in the Morrison Cove area. Water typing consists of characterizing the geochemical composition of water into principle forms. Types of natural waters include calcium bicarbonate, calcium sulfate, and sodium chloride. Most streams in an area are of the same general type and are influenced by the same factors; thus, changes in the chemical composition can provide insight into water source areas and impact of contaminants on water quality. For example, limestone and dolomite areas are generally characterized by calcium bicarbonate water; however, water characterized by magnesium bicarbonate water may indicate a dolomitic source. Changes in water quality down a stream from calcium bicarbonate to magnesium bicarbonate or visa versa can indicate a major change in the contributing area to stream flow.

Since water quality and quantity are both major points of concern in the area, it is important to identify the source and extent of possible contaminants in order to manage the resource more effectively. The study also will provide information to: (1) assess the chemical, physical, and biological condition of the streams within the watershed; (2) document changes in stream quality over time; and (3) identify major sources of pollution and lengths of stream impacted. Data collected during the survey also will be used in completing the Commission's Consolidated Listing Report and in reviewing projects affecting water quality and water quantity in the Morrison Cove area. Additionally, through extensive coordination and training activities, the Commission hopes to increase the quality and amount of information collected by volunteer monitors in the Morrison Cove region.

C. Monitoring Network Design and Rationale

The Morrison Cove area was chosen for a small watershed study for several reasons. The area has been identified as a PSA by Commission staff, as well as containing several water quality impaired segments. The sampling sites listed in Tables 1 and 2 were selected so the Commission could collect biological, water quality, and habitat data from stream segments as well as water quality information from several spring sources. The information collected from the stream segments will allow Commission staff and other interested parties to determine lengths and severity of impacted streams.

The water chemistry data collected in this survey will be used determine water typing, serving a variety of purposes. First, because the constituents of water are directly related to the geologic formation of origin, it is possible to determine the source of the water for streams and springs. There are distinct geologic units within the Morrison Cove region that have known chemical properties, and the source of springs and surface water will be determined based on these chemical signatures (i.e. Ca^{+2}/Mg^{+2}). For example, water originating from the Gatesburg formation has a low Ca^{+2}/Mg^{+2}, low specific conductance, and high pH. The data for sodium, calcium, magnesium, potassium, chloride, nitrate, sulfate, silica, alkalinity and hardness, coupled with field measurements of temperature, pH, and specific conductance, will allow for an accurate source determination from among the major geologic formations in Morrison Cove.

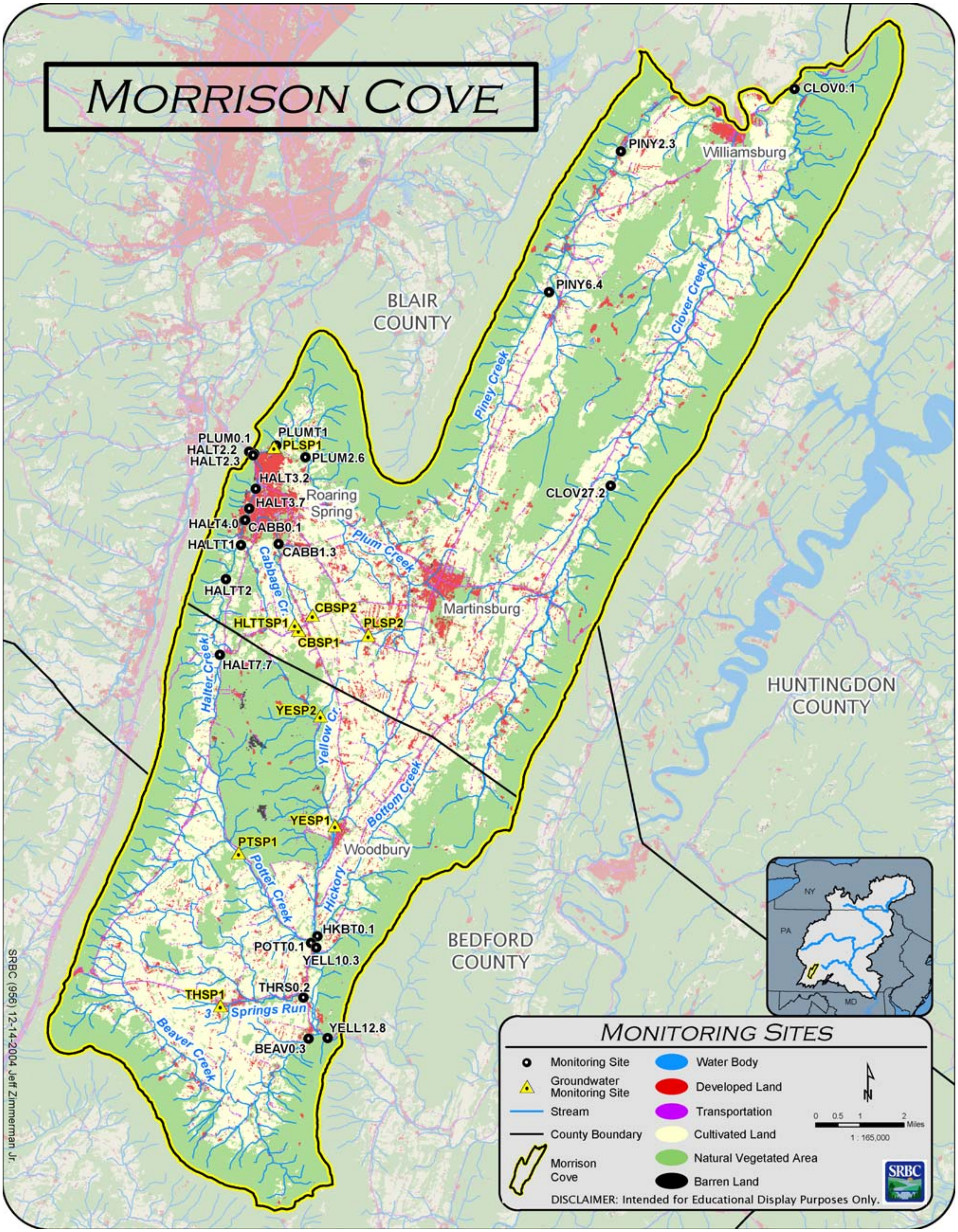


Figure 1. Location of the Morrison Cove Study Area and Station Locations

Table 1. Morrison Cove Stream Station Locations

Station #	County/State	USGS Quad	Latitude	Longitude	Site Description
PLUM0.1	Blair/PA	Roaring Spring	40.3521	-78.4055	At weir near mouth of Plum Creek, along SR 2008
PLUM2.6	Blair/PA	Roaring Spring	40.3513	-78.3836	Plum Creek Upstream of Timber Ridge Rd. crossing
PLUMT1	Blair/PA	Roaring Spring	40.3550	-78.3962	Unnamed tributary to Plum Creek upstream of SR 2008 crossing
HALT2.2	Blair/PA	Roaring Spring	40.3528	-78.4077	Halter Creek at Rt 36 Bridge downstream of Plum Creek, exit point out of Morrison Cove
HALT2.3	Blair/PA	Roaring Spring	40.3516	-78.4060	Halter Creek at weir along Rt. 36 downstream of New Enterprise quarry
HALT3.2	Blair/PA	Roaring Spring	40.3405	-78.4047	Halter Creek above old railroad bridge, downstream of sewage treatment plant
HALT3.7	Blair/PA	Roaring Spring	40.3339	-78.4073	Halter Creek downstream of Cabbage Creek at TR 333 crossing
HALT4.0	Blair/PA	Roaring Spring	40.3300	-78.4094	Halter Creek upstream of Cabbage Creek at TR 351 crossing
HALT7.7	Bedford/PA	Roaring Spring	40.2853	-78.4189	Most upstream site on Halter Creek, at Cross Cove Rd. bridge
HALTT2	Blair/PA	Roaring Spring	40.3103	-78.4169	Unnamed tributary into Halter Creek coming off Dunning Mountain ridge along Burkettown Rd.
CABB0.1	Blair/PA	Roaring Spring	40.3301	-78.4090	Near mouth of Cabbage Creek, downstream of waterfall area
CABB1.3	Blair/PA	Roaring Spring	40.3223	-78.3945	Cabbage Creek at the intersection of Clossen and S. Main St.
HALTT1	Blair/PA	Roaring Spring	40.3217	-78.4106	At mouth of unnamed tributary into Halter Creek above Cabbage Creek, along TR 609
HKBT0.1	Bedford/PA	New Enterprise	40.1922	-78.3751	Near mouth of Hickory Bottom Creek upstream of Rt. 36 bridge
THRS0.2	Bedford/PA	New Enterprise	40.1717	-78.3807	Near mouth of Three Springs Run upstream of Rt. 36 bridge
POTT0.1	Bedford/PA	New Enterprise	40.1899	-78.3778	Near mouth of Potter Creek upstream of Rt. 36 bridge
BEAV0.3	Bedford/PA	New Enterprise	40.1581	-78.3782	Near mouth of Beaver Creek behind trailer park off of SR 1005
YELL10.3	Bedford/PA	Hopewell	40.1884	-78.3756	Yellow Creek upstream of Rt. 36 bridge
YELL12.8	Bedford/PA	New Enterprise	40.1584	-78.3701	Yellow Creek downstream of Beaver Creek, exit point out of Morrison Cove
PINY2.3	Blair/PA	Williamsburg	40.4545	-78.2500	Piney Creek upstream of T 431 bridge
PINY6.4	Blair/PA	Frankstown	40.4073	-78.2800	Piney Creek at T 381 bridge, upstream of large unnamed tributary
CLOV0.1	Blair/PA	Williamsburg	40.4761	-78.1758	Near mouth of Clover Creek along SR 2013
CLOV27.2	Blair/PA	Martinsburg	40.3433	-78.2523	Clover Creek at Furnace Rd. crossing, upstream of large unnamed tributary

Table 2. Morrison Cove Spring Station Locations

Station #	County/State	USGS Quad	Latitude	Longitude	Site Description
PLSP1	Blair/PA	Roaring Spring	40.3545	-78.3973	Springs along Weitzel Hill Rd
PLSP2	Blair/PA	Martinsburg	40.2925	-78.3554	Spring at Cove Lane Rd.(SR 2006)
CBSP1	Blair/PA	Roaring Spring	40.2939	-78.3855	Spring on western branch of the headwaters of Cabbage Creek at SR 2004
CBSP2	Blair/PA	Roaring Spring	40.2988	-78.3796	Spring on eastern branch of the headwaters of Cabbage Creek at SR 2004
HLTTSP1	Blair/PA	Roaring Spring	40.2956	-78.3871	Spring at TR 609 in headwaters of UNT HC 1
YESP1	Bedford/PA	Roaring Spring	40.2655	-78.3754	Spring in western branch of the headwaters of Yellow Creek along T 638
YESP2	Blair/PA	Martinsburg	40.2691	-78.3355	Spring in eastern branch of the headwaters of Yellow Creek at T 645 crossing
PTSP1	Bedford/PA	New Enterprise	40.2195	-78.4095	Spring along Potter Creek at Rt 868
THSP1	Bedford/PA	New Enterprise	40.1686	-78.4163	Spring along Three Springs Run at Rt 869

Table 3. Monitoring Parameters

Parameter	Number of Samples	Analytical Sample Matrix	Method Reference	Sample Preservation	Holding Time
Flow	NA	NA	Buchanan and Somers, 1969	NA	NA
Temperature	150	aq.	In situ	none	0
Dissolved Oxygen	150	aq.	In situ	none	0
Conductivity	150	aq.	In situ	none	0
pH	150	aq.	In situ	none	0
Total Sodium	150	aq.	EPA 200.7[1]	preserve w/HNO_3 to a pH <2	6 months
Alkalinity	150	aq.	SM 2320B[2]	cooling to 4^{o} C	14 days
Total Magnesium	150	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Calcium	150	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Sulfate	150	aq.	EPA 300.0	cooling to 4^{o}C	28 days
Total Potassium	150	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Chloride	150	aq.	EPA 300.0	cooling to 4^{o} C	28 days
Total Nitrate	150	aq.	EPA 300.0	cooling to 4^{o} C	48 hours
Total Silica	150	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Hardness	150	aq.	SM 2340 A+B and EPA 200.7	cooling to 4^{o} C	14 days
Macroinvertebrates	30		Barbour and others, 1999	preserve in denatured alcohol	1 year

1. United States Environmental Protection Agency
2. Standard Methods for the Examination of Water and Wastewater.

Quarterly sampling and analyses will assist Commission staff with determining any seasonal changes in the water chemistry and may infer the sensitivity of the system to precipitation trends. In addition, the water chemistry data will be used to provide evidence of anthropogenic influence in the surface water and spring samples.

Various water quality monitoring data currently exists for the Morrison Cove area. Commission and the Pennsylvania Fish and Boat Commission (PAFBC) staff performed fish surveys in the Halter and Plum Creek watersheds during spring 2004 in association with a project review application. Additionally, Commission staff assessed the Yellow Creek watershed in 2002 for the PADEP State Surface Water Assessment Program (SSWAP); PAFBC surveyed the Halter, Plum, Piney, and Clover Creek watersheds for the SSWAP in 2000. This information includes macroinvertebrate, habitat, and basic water chemistry data. Trout Unlimited and Blair County Senior Services have been collecting data in various streams throughout the area; the Commission will seek to incorporate all monitoring data into its evaluation of the stream conditions.

D. Monitoring Parameters

Parameters of interest are listed in Tables 3 and 4. Discharge will be measured manually at all stations using standard U.S. Geological Survey (USGS) equipment and methods (Buchanan and Somers, 1969). Macroinvertebrate data will be comprised of a list of different genera collected and an estimate of population density. Chemical water quality and flow information will be collected quarterly, while physical habitat information and biological samples will be collected once during the spring sampling period.

VI. PROJECT FISCAL INFORMATION

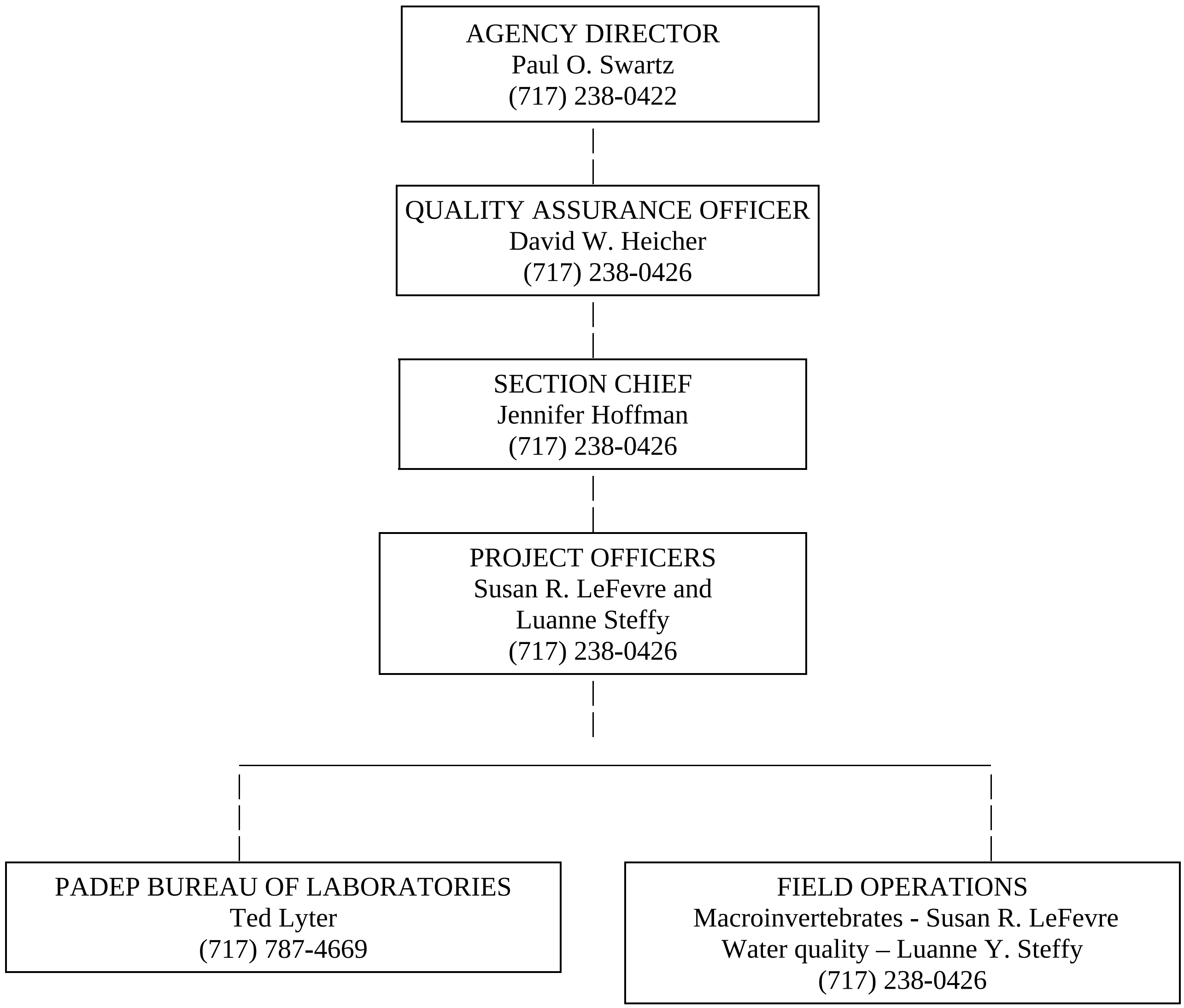
See U.S. Environmental Protection Agency (USEPA) grant application.

VII. SCHEDULE

	2004			2005												2006							
Activity	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**
Coordination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Water Quality Sampling							X			X			X			X							
Macroinvertebrate Sampling							X																
Identify Macroinvertebrates													X	X	X								
Compile and Evaluate Data													X	X	X	X	X	X	X				
Report Writing																		X	X	X	X		
Final Report																						X	

VIII. PROJECT ORGANIZATION AND RESPONSIBILITY

A. Project Organization



B. Project Responsibility

1. Sampling operations—S. LeFevre, SRBC
2. Sampling QC—L. Steffy, SRBC
3. Laboratory analysis—T. Lyter, PADEP
4. Laboratory QC—T. Lyter, PADEP
5. Data processing activities—S. LeFevre, SRBC
6. Data processing QC—L. Steffy, SRBC
7. Data quality review—S. LeFevre, SRBC
8. Performance auditing—D. Heicher, SRBC
9. Systems auditing—S. LeFevre, SRBC
10. Overall QA—D. Heicher, SRBC
11. Overall project coordination—D. Heicher, SRBC

IX. DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Table 4. Data Quality Requirements and Assessments

Parameter	Detection Limit (mg/l)	Accuracy[1]	Precision[2]
Total Sodium	0.2	+/-10%	+/-10%
Total Alkalinity	0	+/-10%	+/-10%
Total Potassium	0.5	+/-10%	+/-10%
Total Nitrate	0.04	+/-10%	+/-10%
Total Magnesium	0.01	+/-10%	+/-10%
Total Calcium	0.03	+/-10%	+/-10%
Total Chloride	0.5	+/-10%	+/-10%
Total Sulfate	1	+/-10%	+/-10%
Total Silica	0.5	+/-10%	+/-10%
Total Hardness	0.11	+/-10%	+/-10%
Macroinvertebrates	NA	NA	+/- 10%

1. Calculate Accuracy using the formulas:

   For matrix spikes: $\%R = 100 \times \frac{S - U}{C_{sa}}$

   %R = percent recovery
   S = measured concentration in spiked aliquot
   U = measured concentration in unspiked aliquot
   C_{sa} = actual concentration of spike added

   For standard reference material: $\%R = 100 \times \frac{C_m}{C_{rm}}$

   %R = percent recovery
   C_m = measured concentration of standard reference material
   C_{rm} = actual concentration of standard reference material

2. Calculate precision using the formula: $RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100$

   RPD = relative percent difference
   C_1 = larger of two observed values
   C_2 = smaller of two observed values

A. Data Representativeness

Water samples are collected at six points along a transect across the stream with depth-integrating samplers. The depth-integrating sampler provides a composite of the whole water column. Vertical samples are composited in a churn, where the final sample is withdrawn. This provides a composite sample representing average stream quality.

Sampling stations are placed at specific locations, such as the mouths of streams, headwater areas, below significant tributaries, and at spring locations to accurately determine the extent and amplitude of nonpoint pollution in the watershed and to perform basic water typing. Additionally, macroinvertebrate sampling will occur in riffle/run habitats (where available) to help ensure that the samples are representative of the best available habitat conditions.

B. Data Comparability

The purpose of this QA plan is to eliminate factors in sampling and analysis that reduce the comparability of data collected at different points in space and time. All sampling, analysis, and processing procedures are standardized to ensure comparability. One field crew is used to collect samples at all sites to reduce variability in sampling.

C. Data Completeness

Collection of 95 percent of the total programmed samples will be deemed as fulfilling the project objectives**.**

Completeness can be calculated using the formula: $\%C = 100 \times \frac{V}{N}$

%C	=	percent completeness
V	=	number of measurements judged valid
N	=	total number of measurements necessary to achieve a specific statistical level of confidence in decision making

X. SAMPLING PROCEDURES

A. Sample Collection

Water samples are collected using depth-integrating samplers. Samples are collected using a hand sampler by wading. The sampler is faced upstream into the current to prevent collection of sediments kicked up by the sampler or field personnel. At each station, six vertical samples are collected, composited in a churn splitter, and churned while the sample bottle is filled.

B. Water Samples

Three-quarters of a liter of water will be collected at each station for laboratory analysis. The samples consist of one 250-ml bottle for metals analysis, and one 500-ml bottle for all additional parameters. The samples for metals analyses will be acidified to pH 2 or less with 1 N nitric acid. Duplicate samples will be collected at a frequency of one per day, or one per 10 samples, whichever is more frequent. The samples will be chilled on ice, and shipped within 24 hours to the Pennsylvania Department of Environmental Protection (PADEP) Lab.

C. Field Chemistry

Temperature and dissolved oxygen are measured using a YSI dissolved oxygen meter. Conductivity is measured using a VWR conductivity meter. A Cole-Parmer meter is used to measure pH. Alkalinity and acidity are measured using field titrations. Alkalinity is measured in the field by titrating a known volume of sample water to pH 4.5 with 0.02N H_2SO_4. (See SOP, Attachment A.) Acidity is measured in the field by titrating a known volume of sample water to pH 8.3 with 0.02 N NaOH. (See SOP, Attachment B.) Titrations are measured using syringes. Separate syringes will be used for sulfuric acid and for sodium hydroxide. Magnetic stirring bars and beakers will be thoroughly rinsed with distilled water and with sample water to be tested before titrations are conducted. Personnel conducting field titrations will be required to undergo six months of on-the-job training with an experienced field person.

D. Discharge Measurements

At all stations, flow measurements are made by field personnel using a pygmy or AA meter, flow rod, headset, and standard USGS procedures (Buchanan and Somers, 1969). All staff are required to participate in computer-assisted training provided by USGS entitled “Measurement of Stream Discharge by Wading,” Water Resources Investigations Report 00-4036, by K.M. Nolan and R.R. Shields and to undergo six months of on-the-job training with an experienced staff member, as well as a yearly field check.

E. Macroinvertebrates

Macroinvertebrate assessments are adapted from Rapid Bioassessment Protocol (RBP) III, described by Barbour and others (1999). Macroinvertebrate sampling is conducted in the best available riffle/run habitats at each station. Sampling is conducted by placing a 600 micron, 1-square-meter kick screen perpendicular to the current and raking the substrate so dislodged macroinvertebrates are carried into the screen. Two kick screens are composited into one sample at each site. Duplicate samples are collected at 10 percent of the sites (or one site per day). All collected specimens are preserved in 95 percent ethanol and returned to the Commission office for identification and enumeration. Subsampling and sorting procedures are based on the 1999 RBP document (Barbour, and others, 1999). In the laboratory, composite samples are sorted into 200-organism subsamples using a gridded pan and a random numbers table. The organisms contained in the subsamples are identified to genus (except Chironomidae and Oligochaeta), when possible, and enumerated. Benthic macroinvertebrates are identified by professional biologists**,** with a Master-of-Science degree in biology, skilled at recognizing most benthos to the family level by sight, and to the genus level with appropriate keys. Biologists also attend the annual Mid-Atlantic Water Pollution Biology Workshop in Berkley Springs, WV, and the annual Pennsylvania State Biologist Workshop. Work is supervised by Mr. David W. Heicher, who was formerly Assistant Benthos Section Leader for Icthyological Associates, Inc. in Stamford, N.Y. Mr. Heicher has 15 graduate level credits in courses related to macroinvertebrate identification, including Entomology, Aquatic Insect Ecology, Identification and Quantification of Invertebrates, and his M.S. thesis research.

After sampling has been completed at a given site, all equipment that has come in contact with the sample will be rinsed thoroughly, examined carefully and picked free of algae or debris before sampling at the next site. Additional organisms that are found on examination are placed into the sample containers.

F. Physical Habitat Assessment

Physical habitat conditions at each station are assessed using a slightly-modified version of the habitat assessment procedure outlined by Barbour and others (1999). Eleven habitat parameters are field-evaluated at each site and used to calculate a site-specific habitat assessment score. Physical habitat assessments are performed for riffle/run or glide/pool areas, depending on stream type. Figure 2 and Table 5 show habitat assessment forms and the criteria used to evaluate habitat in riffle/run streams and Figure 3 and Table 6 show forms and criteria used to evaluate habitat in glide/pool stream types.

G. Training Records

Training records will be maintained in the Watershed Assessment and Protection Division files by the Quality Assurance Officer.

Figure 2.   Rifle/Run Habitat Assessment Sheet

Riffle/Run Habitat Assessment Sheet

Stream	**Date**
Station ID	**Time**
Sample #	**Crew**

Location Description:

Stream type: Limestone Sandstone Valley Headwater Large River Glacial Other ______________________

Habitat Assessment		**Weather Conditions**
Parameter	Score	Air Temperature © ___________________
1. Epifaunal Substrate		Current Conditions: Sunny Cloudy Partly Cloudy Present Precipitation: None Rain Snow Mixed Precip. Heavy? (> 1 inch) Yes No
2. Instream Cover		Precip. Within Last 24 Hours: None Rain Snow Mixed Precip. Heavy? (> 1 inch) Yes No Ice Present at Site? Yes No
3. Embeddedness		**Functionally Important Stream Characteristics**
4. Velocity/Depth Regimes		
5. Sediment Deposition		
6. Channel Flow Status		
7. Channel Alteration		**Predominant Substrate Material (circle one)** Bedrock (> 160 inches in diameter) Boulder (10 – 160 inches in diameter) Cobble (2.5 – 10 inches in diameter) Gravel (0.1 – 2.5 inches in diameter) Sand/Silt/Clay (< 0.1 inches in diameter)
8. Frequency of Riffles		
9. Condition of Banks (Score each bank)		Residential / Commercial Industrial / Cropland Nursery / Pasture
Left Bank		Abd. Mining / Old Fields Forest / Other
Right Bank		**Comments:**
10. Vegetative Protective Cover (score each bank)		
Left Bank		
Right Bank		
11. Riparian Vegetative Zone Width (score each bank)		
Left Bank		**Temp.** / **Cond.** / **D.O.**
Right Bank		**pH** / **Acid.** / **Alk.**

Table 5. Riffle/Run Habitat Assessment Criteria

Habitat Parameter	Category			
	Optimal (20-16)	**Suboptimal (15-11)**	**Marginal (10-6)**	**Poor (5-0)**
1. Epifaunal Substrate	Well-developed riffle/run; riffle is as wide as stream, and length extends 2 times the width of stream; abundance of cobble	Riffle is as wide as stream, but length is less than 2 times width; abundance of cobble; boulders and gravel common	Run area may be lacking; riffle not as wide as stream, and its length is less than 2 times the stream width; some cobble present	Riffle or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking
2. Instream Cover	>50% mix of boulders, cobble, submerged logs, undercut banks or other stable habitat	30–50% mix of boulder, cobble, or other stable habitat; adequate habitat	10–30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable	<10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious
3. Embeddedness	Gravel, cobble, and boulder particles are 0–25% surrounded by fine sediments	Gravel, cobble, and boulder particles are 25–50% surrounded by fine sediments	Gravel, cobble, and boulder particles are 50–75% surrounded by fine sediments	Gravel, cobble, and boulder particles are >75% surrounded by fine sediments
4. Velocity/Depth Regimes	All 4 velocity/depth regimes present (slow/deep, slow/shallow, fast/deep, fast/shallow)	Only 3 of 4 regimes present (if fast/shallow is missing, score lower than if missing other regimes)	Only 2 of 4 regimes present (if fast/shallow or slow/shallow are missing, score low)	Dominated by 1 velocity/depth regime
5. Sediment Deposition	Little or no enlargement of islands or point bars, and <5% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from coarse gravel; 5–30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, coarse sand on old and new bars; 30–50% of the bottom affected; sediment deposits at obstructions; moderate deposition of pools prevalent	Heavy deposits of fine material, increased bar development; >50% of the bottom changing frequently; pools almost absent due to sediment deposition
6. 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 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
7. Channel Alteration	No channelization or dredging present	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 yr) may be present, but not recent	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted	Banks shored with gabion or cement; >80% of the reach channelized and disrupted

Table 5. ***Riffle/Run Habitat Assessment Criteria*** *(continued)*

Habitat Parameter	Category			
	Optimal (20-16)	**Suboptimal (15-11)**	**Marginal (10-6)**	**Poor (5-0)**
8. Frequency of Riffles	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the stream width is between 15-25	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is >25
9. Condition of Banks (score each bank 0-10)	Banks stable; no evidence of erosion or bank failure; 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 banks in reach have areas of erosion; high erosion potential during floods	Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars
10. Vegetative Protective Cover (score each bank 0-10)	>90% of the streambank surfaces covered by vegetation; vegetative disruption through grazing or mowing minimal	70-90% of the streambank surfaces covered by vegetation; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation	<50% of the steambank surfaces covered by vegetation; disruption is very high; vegetation removed to 5 cm or less
11. Riparian Vegetative Zone Width (score each bank 0-10)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, 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 only minimally	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities

Figure 3. Glide/Pool Habitat Assessment

Glide/Pool Habitat Assessment Sheet

Stream	**Date**
Station ID	**Time**
Sample #	**Crew**
Location Description:	
Stream Type: Limestone Sandstone Valley Headwater Large River Glacial Other __	

Habitat Assessment	
Parameter	Score
1. Epifaunal Substrate	
2. Instream Cover	
3. Pool Substrate Characterization	
4. Pool Variability	
5. Sediment Deposition	
6 Channel Flow Status	
7. Channel Alteration	
8. Channel Sinuosity	
9. Condition of Banks (Score each bank)	
Left Bank	
Right Bank	
10. Vegetative Protective Cover (score each bank)	
Left Bank	
Right Bank	
11. Riparian Vegetative Zone Width (score each bank)	
Left Bank	
Right Bank	

Weather Conditions	
Air Temperature (°C)	
Current Conditions: Sunny Cloudy Partly Cloudy	
Present Precipitation: None Rain Snow Mixed Precip.	
Heavy? (> 1 inch) Yes No	
Precip. Within last 24 Hours: None Rain Snow Mixed Precip.	
Heavy? (>1 inch) Yes No	
Ice Present at Site? Yes No	

Functionally Important Stream Characteristics

Predominant Substrate Material (circle one)
Bedrock (>160 inches in diameter)
Boulder (10-160 inches in diameter)
Cobble (2.5 – 10 inches in diameter)
Gravel (0.1 – 2.5 inches in diameter)
Sand/Silt/Clay (<0.1 inches in diameter)

Residential	%	Commercial	%
Industrial	%	Cropland	%
Nursery	%	Pasture	%
Abd. Mining	%	Old Fields	%
Forest	%	Other	%

Comments:

Temp.	**Cond.**	**D.O.**
pH	**Acid.**	**Alk.**

Table 6. Glide/Pool Habitat Assessment Criteria

Habitat Parameter	Category			
	Optimal (20-16)	**Suboptimal (15-11)**	**Marginal (10-6)**	**Poor (5-0)**
1. Epifaunal Substrate	Preferred benthic substrate abundant throughout stream site and at stage to allow full colonization (i.e., log/snags that are not new fall and not transient)	Substrate common, but not prevalent or well-suited for full colonization potential	Substrate frequently disturbed or removed	Substrate unstable or lacking
2. Instream Cover	>50% mix of snags, submerged logs, undercut banks or other stable habitat; rubble, gravel may be present	30-50% mix of stable habitat; adequate habitat for maintenance of populations	10-30% mix of stable habitat; habitat availability less than desirable	Less than 10% stable habitat; lack of habitat obvious
3. 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
4. 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
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of island or point bars	20-50% affected; moderate accumulation; substantial sediment movement only during major storm event; some new increase in bar formation	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial movement during storm events	Channelized; mud, silt, and/or sand in braided or non-braided channels; pools almost absent due to substantial sediment deposition
6. 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 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

Table 6. Glide/Pool Habitat Assessment Criteria *(continued)*

Habitat Parameter	Category			
	Optimal (20-16)	**Suboptimal (15-11)**	**Marginal (10-6)**	**Poor (5-0)**
7. Channel Alteration	No channelization or dredging present	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 yr) may be present, but not recent	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted	Banks shored with gabion or cement; >80% of the reach channelized and disrupted
8. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line.	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 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long time.
9. Condition of Banks (score each bank 0-10)	Banks stable; no evidence of erosion or bank failure; side slopes generally <30%; little potential for future problems; <5% of bank affected	Moderately stable; infrequent, small areas of erosion mostly healed over; side slopes up to 40% on one bank; slight erosion potential in extreme floods; 5-30% of bank in reach has areas of erosion	Moderately unstable; moderate frequency and size of erosional areas; side slopes up to 60% on some banks; high erosion potential during extremely high flow; 30-60% of bank in reach has areas of erosion	Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; on side slopes; side slopes >60% common; 60-100% of bank has erosional scars
10. Vegetative Protective Cover (score each bank 0-10)	>90% of the streambank surfaces covered by vegetation; vegetative disruption through grazing or mowing minimal	70-90% of the streambank surfaces covered by vegetation; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation	<50% of the steambank surfaces covered by vegetation; disruption is very high; vegetation removed to 5 cm or less
11. Riparian Vegetative Zone Width (score each bank 0-10)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clearcuts, 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 only minimally	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities

XI. SAMPLE CUSTODY PROCEDURES

Water quality samples are delivered to the laboratory by the collectors or shipped to the PADEP Lab by overnight courier service. A sample submission sheet, provided by PADEP Lab, is included for each sample sent to the PADEP Lab by Commission staff. This submission sheet contains all relevant information about the sample, including collector, date, time, location, and method of preservation (if needed). Sample numbers, as well as field chemistry and flow data, are stored in a field logbook and checked against sample numbers received from PADEP Lab. For macroinvertebrate samples, a logbook is kept containing information regarding the collection, preservation, subsampling, and identification of the macroinvertebrates. The station identification data are recorded on each macroinvertebrate sample and entered into a logbook in the field. This logbook is used to track the macroinvertebrate sample though the laboratory process. Commission staff members are responsible for entering the date and their initials for each sample during processing and identification of the sample.

XII. CALIBRATION PROCEDURES AND PREVENTATIVE MAINTENANCE

A. Dissolved Oxygen (DO) Meter

A YSI model dissolved oxygen meter is calibrated using the air-saturated chamber technique prior to use each day. This calibration test is repeated in the event of a membrane replacement or other maintenance that may affect the accuracy of the meter.

B. Specific Conductance Meter

The VWR conductivity meter is calibrated prior to sampling by checking the meter readings against three fresh specific conductance standards. Calibration checks are made after every 10 samples. Results are recorded in the calibration log, and new rating curves are generated, as necessary.

Acceptable Criteria	
Standards (<1000 µmhos/cm)	$\pm$ 4%
(>1000 µmhos/cm)	$\pm$ 3%

C. pH Meters

The meter is calibrated against three buffers daily, before and after use. Calibration checks are made after every 10 samples. These checks are recorded in the calibration log.

D. Flow Meter

Current meters are sent to the manufacturer for calibration, as necessary. Spin tests are performed before and after each day of use.

XIII. DOCUMENTATION

Water and macroinvertebrate sample bottles are labeled at the time of collection. Water samples are labeled with a seven-digit identification number, the station, date, and time, and whether any fixatives were added to the sample. This information is recorded on laboratory analysis forms. One copy is submitted to the laboratory with the sample, while another is retained as a record. Results of field chemistry are recorded on this form.

Results of laboratory analyses are entered into a computer database. Data entries are verified, and reductions are performed using computer files to eliminate transcription errors. Field chemistry and laboratory analysis sheets are retained for a period of two years and subsequently archived. Excel spreadsheets containing all information are retained on the Commission's server for ready access.

Databases for all water quality, physical habitat, field chemistry, and macroinvertebrate data consist of Excel spreadsheets developed for in-house needs. The databases are located on the Commission's server. Back-up copies are retained by the project manager in addition to a copy kept in the filing system with hard copies of the data sheets. Currently, staff are developing an Access database for data storage and to assist in transferring data to USEPA's STORET.

Macroinvertebrate bottles are labeled with the station and date. A logbook is kept for all sites, containing information on the macroinvertebrate sample collection, such as station number, stream name, date, the number of bottles, and the person who collected the sample. Identification is conducted by staff biologists at the Commission office, where additional information such as dates of subsampling and identification and the personnel associated with each activity is added to the logbook. Log sheets (Figure 4) are used to record the number of specimens for each genus identified. This information is transcribed into Excel spreadsheets and verified. The data will be entered into STORET at a later date.

XIV. DATA REDUCTION

Water quality data are formatted into tables by station. The data are compared to state standards and to other limit values based on current state and federal regulations or references for approximate tolerances of aquatic life. The differences between each value and the limit value are calculated for each site, and if the value does not exceed the limit value, the site is given a score of zero. If the limit value is exceeded, the difference is listed, and an average of all the parameters for each site is calculated.

Data reduction procedures are similar to those described in RBP III (Barbour and others, 1999). The data for each station are reduced to the following metrics: (1) taxa richness; (2) modified Hilsenhoff Biotic Index; (3) percent Ephemeroptera; (4) percent contribution of dominant taxon; (5) number of Ephemeroptera/Plecoptera/Trichoptera taxa; (6) percent Chironomidae; and (7) Shannon Weiner Diversity Index. These metrics are quantified and compared to a reference station with the best available conditions based on physical habitat, water quality, and macroinvertebrate information.

The subsample data are used to generate scores for each of the seven macroinvertebrate metrics listed above. Each metric score is then converted to a biological condition score, based on the percent similarity of the metric score, relative to the metric score of the reference site. The sum of the biological condition scores constitutes the total biological score for the sample site, and total biological scores are used to assign each site to a biological condition category. A sampling site that scores 83 percent or greater, as compared to the reference site, is designated nonimpaired. A score of 79 to 54 percent is termed slightly impaired; moderately compared conditions are characterized as 50 to 21 percent of the reference site; and a score of less than 17 percent is designated severely impaired.

Habitat assessment scores of sample sites are compared to those of the reference sites to classify each sample site into a habitat condition category. Habitat parameters for riffle-run and glide-pool habitat types are listed in Tables 4 and 5, respectively. A site that scores 90 percent or greater as compared to the reference score is designated excellent (comparable to reference). A habitat score of 75 to 89 percent is designated supporting; partially supporting conditions are characterized as 60 to 74 percent of the reference score; and a score of less than 60 percent is determined to be nonsupporting.

Figure 4. Benthic Macroinvertebrate Enumeration Sheet

MACROINVERTEBRATE ENUMBERATION LIST

SITE ________________________ **DATE SAMPLED__________________**
IDENTIFIED BY: _____________ **DATE IDENTIFIED: _______________**

FAMILY/GENUS	NUMBER OF INDIVIDUALS
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
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18.	
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20.	
21.	
22.	
23.	
24.	
25.	
26.	

XV. DATA VALIDATION

Primary responsibility for data validation lies with the project officer. The collector may assist the project officer in determining the acceptability of the data based on his knowledge of the stream conditions. Field collections are conducted according to the above methodology to insure accurate data. The use of duplicates, reviewed by the project officer, also validates the water quality analyses. The data go through a series of validations as they are entered into the database, including checking values for duplicate samples against one another, comparing computer entries to field and laboratory data sheets, looking for data gaps and missing information, checking flow calculations, and examining raw data for outliers or inappropriate measurements. A separate staff member also checks the information after input to ensure correct data entry.

Five percent of the macroinvertebrate samples identified by one biologist are validated by a second biologist and recorded in the logbook. A biologist also spot-checks five percent of the samples picked by laboratory personnel during subsampling and records the samples in the logbook.

XVI. PERFORMANCE AND SYSTEMS AUDITS

A. Laboratory Analyses

Analytical and quality assurance procedures for the PADEP Lab are detailed in the QA plan submitted by the laboratory. The laboratory analyzes a matrix spike/matrix spike duplicate at a frequency of one per ten samples per matrix. Duplicate samples will be submitted to the laboratory (at least one per 10 samples). PADEP Lab is certified by USEPA for drinking water parameters; the laboratory ID number is PA00001.

B. Field Procedures

Field operator techniques are tested annually for pH, specific conductance, and alkalinity with USGS standard samples. In addition, Commission staff is tested annually in the collection of flow measurements. The project officers are responsible for insuring that all field personnel are competent in measurement and collection techniques prior to fieldwork. The project officers also are responsible for insuring the quality of all equipment and reagents. The quality assurance officer also performs a field audit near the beginning of sampling. The field audit for this project is scheduled for June 2005, weather and stream flows permitting.

Duplicate tests are performed on alkalinity and acidity in the same proportion as other duplicate analyses and results with a relative percent difference of 10 are acceptable. Temperature readings from the dissolved oxygen meter are checked against a standard laboratory thermometer. These checks are performed prior to fieldwork.

C. Biological Sampling

A second biologist verifies the identifications on five percent of the sorted samples.

XVII. CORRECTIVE ACTION

Implementation of corrective action involving any of the sampling procedures, equipment, or data reduction and processing is the responsibility of the project officer. The QA officer is responsible for seeing that such corrective action is done. Implementation of corrective action involving laboratory analyses is the responsibility of the laboratory analysis officer, with oversight by the laboratory quality control officer.

The results of any corrective actions taken will be documented by the individual(s) taking the necessary actions.

XVIII. REPORTS

A report describing the results of the monitoring program will be published in summer 2006. This report will include a description of the methods and data analysis. Conclusions and recommendations will be made, as appropriate. The data will be available on the Commission's website (www.srbc.net). In addition, the data are utilized by Commission staff for project review and for inclusion in the Commission's Consolidated Listing report. The data collected for this project will be useful for water typing in the Morrison Cove Watershed.

XIX. DATA QUALITY OBJECTIVES

Parameters with state or federal standards or references for approximate tolerances of aquatic life are listed in Table 7 below. Water quality data collected during this project will be compared against Pennsylvania state standards as well as the limits listed in Table 7. Macroinvertebrate and physical habitat data will be compared against a reference station with best available conditions in the watershed as described in Section XIV.

Water quality data also will be used for water typing purposes as described in Section V.C.

Table 7. Water Quality Standards and Aquatic Life Tolerances

<table>
<tr><th>Parameter</th><th>Limit</th><th>Reference Code</th><th>Reference Code & References</th></tr>
<tr><td>Temperature</td><td>> 25 degrees</td><td>a,e</td><td rowspan="14">a. http://www.pacode.com/secure/data/025/chapter93/s93.7.html
b. Gagen and Sharpe (1987) and Baker and Schofield (1982)
c. http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm
d. http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm
e. http://www.hach.com/h2ou/h2wtrqual.htm
f. http://sites.state.pa.us/PA_Exec/Fish_Boat/education/catalog/pondstream.pdf
g. http://www.dec.state.ny.us/website/regs/part703.html</td></tr>
<tr><td>Dissolved Oxygen</td><td>< 4 mg/l</td><td>a,g</td></tr>
<tr><td>Conductivity</td><td>> 800 µmhos/cm</td><td>c</td></tr>
<tr><td>pH</td><td>< 5</td><td>b,e</td></tr>
<tr><td>Alkalinity</td><td>< 20 mg/l</td><td>a,f</td></tr>
<tr><td>Total Nitrate</td><td>> 1.0 mg/l</td><td>d</td></tr>
<tr><td>Total Hardness</td><td>> 300 mg/l</td><td>d</td></tr>
<tr><td>Total Magnesium</td><td>> 35 mg/l</td><td>g</td></tr>
<tr><td>Total Sodium</td><td>> 20 mg/l</td><td>g</td></tr>
<tr><td>Total Chloride</td><td>> 150 mg/l</td><td>a</td></tr>
<tr><td>Total Sulfate</td><td>> 250 mg/l</td><td>a</td></tr>
<tr><td>Total Potassium</td><td>None</td><td></td></tr>
<tr><td>Total Calcium</td><td>None</td><td></td></tr>
<tr><td>Total Silica</td><td>None</td><td></td></tr>
</table>

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SUSQUEHANNA RIVER BASIN COMMISSION

STANDARD OPERATION PROCEDURE (SOP)
FOR DETERMINATION OF ALKALINITY

Prepared by: Charles S. Takita Date: September 15, 2000
WQ Program Specialist

Reviewed by: David W. Heicher Date: September 18, 2000
Quality Assurance Coordinator

Procedural Section

1.0 Scope & application

1.1 This method is applicable to surface waters, sewage and industrial wastes.
1.2 The method is applicable for all ranges of alkalinity.

2.0 Summary of method

2.1 The alkalinity of a sample is its quantitative capacity to react with a strong acid to a certain pH. The pH of the unaltered sample is determined and a measured amount of standard acid is added to lower the pH to an endpoint of 4.5.

3.0 Interference

3.1 The sample must be analyzed as soon as practical; preferably, within a few hours.
3.2 Substances, such as salts of weak organic and inorganic acids present in large amounts, may cause interference in the electrometric pH measurements.
3.3 Oil and grease, by coating the pH electrode, may also interfere, causing sluggish response.

4.0 Apparatus

4.1 Analog field pH meter
4.2 Syringe with 0.2 ml graduation
4.3 Magnetic stirrer
4.4 Stirring bars
4.5 Glass beaker, 100 ml
4.6 Graduated cylinder, 50 ml

5.0 Reagent

5.1 0.02N H_2SO_4

6.0 Procedure

6.1 Measure 50 ml of sample with graduated cylinder and pour into the 100 ml beaker.
6.2 Measure the pH of the sample.
6.3 Using the syringe, drop 0.02N H_2SO_4 into sample in increments of 0.5 ml or less until the pH in the sample approaches 4.5 then add H_2SO_4, dropwise, pausing between drops to allow the pH to stabilize until a pH of 4.5 is reached.
6.4 Determine the amount of 0.02N H_2SO_4 added to sample.

7.0 Calculation

7.1 Calculate alkalinity, as mg/l, using the following formula:

$$\text{Alkalinity, mg/l as } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{ml of sample}}$$

where:

A = ml of H_2SO_4 used
N = normality of H_2SO_4

Quality Control and Quality Assurance

1.0 Choose one sample from the set of analyses and run a duplicate. Results should be within 10 percent.

Reference

1.0 Standard Methods for Examination of Water and Wastewater, 17^{th} Edition.

SUSQUEHANNA RIVER BASIN COMMISSION

STANDARD OPERATION PROCEDURE (SOP)
FOR DETERMINATION OF ACIDITY

Prepared by: Charles S. Takita Date: September 15, 2000
WQ Program Specialist

Reviewed by: David W. Heicher Date: September 18, 2000
Quality Assurance Coordinator

Procedural Section

1.0 Scope & application

1.1 This method is applicable to surface waters, sewage and industrial wastes, particularly mine drainage and receiving streams, and other wastes containing ferrous iron and other polyvalent ions in a reduced state.
1.2 The method is applicable for samples with acidities less than 1,000 mg/l using a 50 ml sample.

2.0 Summary of method

2.1 The acidity of a sample is its quantitative capacity to react with a strong base to a certain pH. The pH of the sample is determined and a measured amount of standard alkali is added to raise the pH to 8.3.

3.0 Interference

3.1 Suspended matter present in the sample or precipitates formed during the titration may cause a sluggish electrode response. This may be offset by allowing a 15-20 second pause between additions of titrant or by slow dropwise addition of titrant as the endpoint is approached.

4.0 Apparatus

4.1 Analog field pH meter
4.2 Syringe with 0.2 ml graduation
4.3 Magnetic stirrer
4.4 Stirring bars
4.5 Glass beaker, 100 ml
4.6 Graduated cylinder, 50 ml

5.0 Reagent

5.1 0.02N NaOH

6.0 Procedure

6.1 Measure 50 ml of sample with graduated cylinder and pour into the 100 ml beaker.
6.2 Measure the pH of the sample.
6.3 Using the syringe, drop 0.02N NaOH into sample in increments of 0.5 ml or less until the pH in the sample approaches 8.3 then add NaOH, dropwise, pausing between drops to allow the pH to stabilize until a pH of 8.3 is reached.
6.4 Determine the amount of 0.02N NaOH added to sample.

7.0 Calculation

7.1 Calculate acidity, as mg/l, using the following formula:

$$\text{Acidity, mg/l as } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{ml of sample}}$$

where:

A = ml of NaOH used

N = normality of NaOH

Quality Control and Quality Assurance

1.0 Choose one sample from the set of analyses and run a duplicate. Results should be within 10 percent.

Reference

1.0 Standard Methods for Examination of Water and Wastewater, 17^{th} Edition.