ASSESSMENT OF NUTRIENT SOURCES FROM MAINSTEM AND SELECTED WATERSHEDS IN THE SUSQUEHANNA RIVER BASIN

Quality Assurance/Quality Control Plan SRBC-QA048
October 2013 – December 2015

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1.0 PROJECT DESCRIPTION

1.1 Background

Nutrients and SS entering the Chesapeake Bay (Bay) from the Susquehanna River Basin contribute to nutrient enrichment problems in the Bay (USEPA, 1982). In 1985, the Pennsylvania Department of Environmental Protection (PADEP) Bureau of Laboratories, the U.S. Environmental Protection Agency (USEPA), the U.S. Geological Survey (USGS), and the Susquehanna River Basin Commission (SRBC) conducted a five-year study to quantify nutrient and SS transported to the Bay via the Susquehanna River Basin. The initial network consisted of two mainstem sites on the Susquehanna and 10 tributary sites with the goal of developing baseline nutrient loading data. After 1989, several modifications to the network occurred, resulting in the current network consisting of 26 sites with five in New York, one in Maryland, and 20 in Pennsylvania.

1.2 Objective and Scope

A) Existing Monitoring

This sampling effort is the continuation of the 2013 network which included discontinuation of sampling at the Tioughnioga at Itaska, N.Y. The scope of the monitoring program includes the following objectives:

1.2.1 To measure concentrations and estimate nutrient and suspended-sediment loads in the Susquehanna River at Towanda, Danville, and Marietta, Pa.; the West Branch Susquehanna River at Lewisburg, Pa.; the Juniata River at Newport, Pa.; and the Conestoga River at Conestoga, Pa.

1.2.2 To establish a sound database for government, agriculture, industry, and the public to most effectively plan and implement immediate and long-range nutrient reduction efforts.

B) Enhanced Monitoring

While watershed model runs are used to predict the effectiveness of management actions to reduce loads, a nontidal water quality network is critical to measure and assess the actual nutrient and sediment concentration and load reductions in the tributary strategy basins across the watershed. Therefore, a nontidal water quality network has been designed for the Bay watershed, building from and integrating existing state and federal (USGS and USEPA) monitoring programs, by the Chesapeake Bay Program Office (CBPO) Non-Tidal Water Quality Workgroup (NTWG). The scope of the project includes the following objectives:

1.2.3 To measure and assess the actual nutrient and sediment concentration and load reductions in the tributary strategy basins across the watershed.

1.2.4 To improve calibration and verification of the partners' watershed models.

1.2.5 To help assess the factors affecting nutrient and sediment distributions and trends.

C) Status and Trends Analysis

This project will provide a trend update for the six long-term SRBC monitoring stations. The analyses will use the latest statistical protocols developed by the investigators in dialogue through the Chesapeake Bay Program's Non-Tidal Workgroup, including adjustments for variations in flow, where appropriate, and selected application of nonlinear trend techniques. The trend analyses for water quality will include, at a minimum, where available, the following parameters: total and dissolved nitrogen; total and dissolved phosphorus; total and dissolved kjeldahl nitrogen; total and dissolved nitrate + nitrite; total and dissolved ammonia; dissolved orthophosphate; total organic carbon; total suspended solids; and suspended sediment. The scope of work for the project includes the following objectives:

1.2.6 To compile water quality data sets into a single database for trend analysis.

1.2.7 To process compiled datasets using USGS approved regression techniques to generate all trend statistics including flow corrected trends.

1.3 Data Usage

The environmental measurements and analysis will provide baseline nutrient loading data for the mainstem and the selected major tributaries in sufficient detail to:

1.3.1 Allow model refinement and verification;

1.3.2 Track and better define nutrient loading dynamics;

1.3.3 Relate measured load fluctuations to changes in water discharge due to precipitation events of varying intensities, durations, and seasons; and

1.3.4 Evaluate nutrient loading trends.

1.4 Monitoring Network Design and Rationale

This section provides the rationale for establishing the sampling network that includes a series of mainstem and major tributary sites. All sites have been co-located with USGS stream gaging stations to obtain discharge data. The latitude and longitude of these sites and location map can be found in Appendix A. Existing long-term SRBC monitoring sites are listed under Group A, and enhanced monitoring sites are listed under Group B.

1.4.1 Group A

Susquehanna River at Towanda, Pa.

The Susquehanna River at Towanda was selected because it represents the contribution from New York State, although the drainage area does include a part of the Tioga River Basin in northern Pennsylvania and an area along the northern tier counties of northeastern Pennsylvania. The drainage area at Towanda is 7,797 square miles.

Susquehanna River at Danville, Pa.

The Susquehanna River at Danville has a drainage area of 11,220 square miles and includes part of northcentral Pennsylvania and much of southcentral New York. Data collected at Danville represent the loadings from the mainstem Susquehanna River.

West Branch Susquehanna River at Lewisburg, Pa.

Data collected from the West Branch Susquehanna River at Lewisburg represent the loadings from a major tributary to the mainstem. The West Branch Susquehanna River includes much of northcentral Pennsylvania and has a drainage area of 6,847 square miles. This watershed is predominantly forested (81 percent). The combined drainage area at Lewisburg and Danville represents 65.7 percent of the total Susquehanna River Basin.

Juniata River at Newport, Pa.

The Juniata River at Newport, another major tributary to the mainstem Susquehanna River, drains much of the southcentral area of Pennsylvania and has a drainage area of 3,354 square miles. The combined drainage area at Newport, Lewisburg, and Danville represents 77 percent of the total Susquehanna River Basin and 88.9 percent of the watershed above Harrisburg, Pa.

Susquehanna River at Marietta, Pa.

The Susquehanna River at Marietta is the southern-most sampling site upstream from the reservoirs on the Lower Susquehanna River and represents the inflow to the reservoirs from its 25,900-square-mile drainage area. This drainage area represents 94.5 percent of the total Susquehanna River Basin.

Conestoga River at Conestoga, Pa.

Data collected from the Conestoga River at Conestoga provide loadings from a major tributary watershed that is actively farmed and is experiencing an increase in agricultural nutrient management programs. Additionally, this watershed is experiencing an increase in urban and suburban development. The drainage area of this basin at the sampling site is 470 square miles.

1.4.2 **Group B**

The following rationale was considered and stations meeting the conditions below were given priority status when selecting sites for Group B:

a. Sites that are located at outlets of major streams draining the tributary strategy basins.
b. Sites that are located in areas within the tributary strategy basins that have the highest nutrient delivery to the Bay.
c. Sites that represent the overall range of conditions in the Bay watershed. This would include ranges of loads from different land cover types (urban, agriculture, and forestland covers), diverse physiographic/geologic settings, and different watershed sizes.

The initial selection of sites was designed to support a network for the tributary basins. These sites will be evaluated for representativeness of watershed characteristics, which is important for model calibration and simulation. In the future, the network may be modified to ensure that these objectives are met.

Group B sites in Pennsylvania, Maryland, and New York include:

Susquehanna River at Smithboro, N.Y.
Chemung River at Chemung, N.Y.
Cohocton River near Campbell, N.Y.
Susquehanna River at Conklin, N.Y.
Unadilla River at Rockdale, N.Y.
Susquehanna River near Wilkes-Barre, Pa.

West Branch Susquehanna River near Karthaus, Pa.
West Branch Susquehanna River near Jersey Shore, Pa.
Penns Creek at Penns Creek, Pa.
Raystown Branch Juniata River at Saxton, Pa.
Shermans Creek near Dromgold, Pa.
Conodoguinet Creek near Hogestown, Pa.
Swatara Creek near Hershey, Pa.
West Conewago Creek near Manchester, Pa.
Pequea Creek near Martic Forge, Pa.
Bald Eagle Creek near Castanea, Pa.
East Mahantango Creek near Dalmatia, Pa.
Paxton Creek near Penbrook, Pa.
Kishacoquillas Creek near Reedsville, Pa.
Octoraro Creek at Richardsmere, Md.

Samples collected at these sites will be used for load and trend determination. Therefore, the criteria for determining sampling frequency are based on loads, which have more stringent requirements. To effectively capture the loads being transported, 20 samples will be collected per year, consisting of 12 monthly samples and eight storm samples. Two storm samples will be collected on different days during each of four storms per year (one per season), targeting the rising and peak flow of the storm.

1.5 Monitoring Parameters and Frequency of Collection

Filtered and unfiltered samples will be analyzed for physical characteristics and constituents listed in Table 1.

Samples from base flow conditions will be collected manually once a month at Group A stations. Samples will be collected from at least four verticals, based on the width of stream, across the section, and composited using the equal-width sampling procedure.

An additional date-based random flow sample will be collected at all sites around the twelfth of each month, plus or minus three days if it falls on the weekend, regardless of the stream discharge. If a base flow sample cannot be collected at Group A sites because of fluctuating discharges, a sample will be collected in its place at a discharge that is different from that of the random sample. If a storm sample is collected on the random sample date, it will be considered the random sample.

Storm runoff samples for all sites will be collected during four high flow events per year, targeting one storm per season. Two discreet samples will be

collected per storm, targeting one sample during the rise and one during the peak of flow on different days.

Table 1. Parameters for Physical Characteristics and Other Constituents

Parameter	Number of Samples	Sample Matrix	Analytical Method Reference	Sample Preservation	Holding Time
Dissolved Oxygen	1,448	Water/sediment	Instream field measurement at each vertical	N/A	None
pH	1,448	Water/sediment	Instream field measurement at each vertical	N/A	None
Temperature	1,448	Water/sediment	Instream field measurement at each vertical	N/A	None
Specific Conductance	1,448	Water/sediment	Instream field measurement at each vertical	N/A	None
Suspended Sediment	552	Water/sediment	SRBC*	N/A	N/A
Suspended Sediment	416	Water/sediment	USGS*	N/A	N/A
Sand-Fine Splits	208	Water/Sediment	USGS*	N/A	N/A
Total Nitrogen	1,248	Water/sediment	SM. 4500-Norg-D**	Chill at 4°C	None
Dissolved Nitrogen	1,248	Water	SM. 4500-Norg-D**	Chill at 4°C	None
Total Kjeldahl Nitrogen +	200	Water/sediment	USEPA 351.2	Chill at 4°C H_2SO_4 to pH<2	28 Days
Dissolved Kjeldahl Nitrogen +	200	Water	USEPA 351.2	Chill at 4°C H_2SO_4 to pH<2	28 Days
Total Ammonia	1,448	Water/sediment	USEPA 350.1	Chill at 4°C H_2SO_4 to pH<2	28 Days
Dissolved Ammonia	1,448	Water	USEPA 350.1	Chill at 4°C H_2SO_4 to pH<2	28 Days
Total Nitrate + Nitrite	1,448	Water/sediment	USEPA 353.2	Chill at 4°C	48 Hours
Dissolved Nitrate + Nitrite	1,448	Water	USEPA 353.2	Chill at 4°C	48 Hours
Total Phosphorus-TP	1,448	Water/sediment	USEPA 365.1	Chill at 4°C H_2SO_4 to pH<2	28 Days
Dissolved Phosphorus-DP	1,448	Water	USEPA 365.1	Chill at 4°C H_2SO_4 to pH<2	28 Days
Dissolved Orthophosphate	1,448	Water	USEPA 365.1	Chill at 4°C	48 Hours
Total Suspended Solids	1,248	Water/sediment	USGS-I-3765/3767 and SM 2540E	N/A	7 Days
Total Suspended Solids	200	Water/Sediment	SM 2540 D +	N/A	7 Days
Total Organic Carbon	1,248	Water/sediment	SM 5310C	Chill at 4°C H_2SO_4 to pH<2	28 Days
Total Organic Carbon	200	Water/sediment	SM20 5310C +	Chill at 4°C H_2SO_4 to pH<2	28 Days

*TWRI Book 3, Chapter C2 and Book 5, Chapter C1, Laboratory Theory and Methods for Sediment Analysis (Guy and others, 1969)
**Standard Methods, 19th Edition
+ New York analysis – ALS Environmental, Inc.

Additional storm runoff samples will be collected for Group A sites, including a fifth storm event targeted for the spring. In addition to the two discreet samples mentioned above, a minimum of four discreet samples over the hydrograph (two on the rising and two on the falling stage) will be sent to the laboratory for analysis for Group A sites.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Data collection will be conducted by the SRBC with cooperation from the PADEP Bureau of Laboratories (PADEP Lab) and the Bureau of Conservation and Restoration (BCR), Division of Conservation. New York sites will be sampled by the New York State Department of Environmental Conservation (NYSDEC) during the months of April through September.

2.1 Data Collection and Analysis

2.1.1 SRBC
Project Officer: Kevin H. McGonigal
Quality Assurance Officer: James P. Shallenberger
Data Analysis: Kevin H. McGonigal

2.1.2 PADEP Lab
Director: Martina McGarvey
Inorganic Section Chief: Bill Mowery
Quality Assurance Officer: James Yoder

2.1.3 NYSDEC
Contact: Jacqueline Lendrum

2.1.4 ALS Environmental
Project Manager: Janice Jaeger (New York Sampling)
Project Manager: Vicky Forney (PA field blank analyses)

2.2 Project Coordination and Overview

2.2.1 PADEP, BCR, Division of Conservation
Project Officer: Steven W. Taglang
Overall Project Responsibility: Steven W. Taglang

2.2.2 USEPA Chesapeake Bay Program Office
Project Officer: Peter Tango and Nita Sylvester
Quality Assurance Officer: Richard Batiuk

Data collection and data analysis will be performed by SRBC. Compliance with the Quality Assurance/Quality Control Plan (QAPP) will be the responsibility of each agency's Quality Assurance Officer. Quarterly reports documenting data collection activities will be sent to the PADEP BCR Project Officer.

All Pennsylvania water samples will be taken to the PADEP Lab. Appropriate quality assurance measures for sample analyses and lab procedures, as established by the PADEP Lab, will be the responsibility of the Inorganic Section Chief and the Quality Assurance Officer for the lab. Resolution of problems will be the responsibility of the Inorganic Section Chief and the respective Quality Assurance officers.

Project coordination and review will be the responsibility of the PADEP BCR Project Officer. Appropriate quarterly progress reports will be sent to the USEPA Project Officer by the PADEP BCR. Any problems that occur that cannot be solved by the project officers of each agency will be resolved by the identified PADEP BCR responsible individual.

New York samples will be collected by SRBC during October to March and by NYSDEC from April to September. Quality assurance of sample collection will be insured by both following the sample procedure listed in section 4.0. Water samples and duplicates collected at New York sites will be sent to ALS Environmental for analysis. Samples will be analyzed according to the lab's approved QAPP. Additionally, ALS Environmental in Middletown, Pa will be analyzing Pennsylvania field blanks. Contact information for ALS Environmental is as follows:

ALS Environmental
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623
Phone: (585) 288-5380
Janice Jaeger, Project Manager
Janice.Jaeger@alsglobal.com

ALS Environmental
34 Dogwood Lane
Middletown, PA 17057
Phone: (717) 944-5541
Vicki Forney
vicki.forney@alsglobal.com

Sand/fine particle analysis and sediment analysis for storm samples will be conducted at the USGS Sediment Lab in Kentucky. Contact information for the USGS Sediment Lab is as follows:

Aimee C. Downs, Laboratory Chief
KY Water Science Center Sediment Laboratory
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299
acdowns@usgs.gov
Phone: (502) 493-1916
Fax: (502) 493-1909

Suspended-sediment analysis for routine sampling at Group A sites will be conducted at SRBC.

3.0 QUALITY ASSURANCE OBJECTIVES

Data collected during this study will be used to help define magnitude, timing, and severity of nutrient and suspended-sediment inputs to the Bay and to provide a comparison with data collected from the Susquehanna River at Conowingo, Md. For this reason, several quality assurance objectives must be met.

3.1 Detection Limits

Analytical methods and detection limits must be compatible with those used by other data collection agencies.

The analytical methods and detection limits selected for the constituents of concern were determined by consultation with the USGS and the PADEP Lab to assure compatibility of the results. Detection limits, accuracy, and precision data contained in the Quality Assurance Plan for the PADEP Lab have been found acceptable for this project. A list of the constituents and their detection limits are presented in Table 2.

Table 2. Detection Limits

Parameter	Detection Limits for ALS Environmental (mg/l)	Detection Limits for PADEP Labs (mg/l)
Total Nitrogen	N/A	0.040
Dissolved Nitrogen	N/A	0.040
Total Kjeldahl Nitrogen	0.050	N/A
Dissolved Kjeldahl Nitrogen	0.050	N/A
Total Ammonia	0.05	0.020
Dissolved Ammonia	0.05	0.020
Total Nitrite + Nitrate	0.002	0.040
Dissolved Nitrite + Nitrate	0.002	0.040
Total Phosphorus-TP	0.002	0.020
Dissolved Phosphorus-DP	0.002	0.020
Orthophosphate-P	0.001	0.002
Total Suspended Solids	1.0	2.000*
Total Organic Carbon	1.0	0.500

* Reporting limit

3.2 Representativeness-Site Representation

The collection of water quality samples representative of river conditions is essential for the program to be successful. Spatial variability inherent to a sampling site is addressed by taking depth-integrated, isokinetic water samples across the cross section at the sampling site; the sample thus reflects the composite effect of occurrences upstream from the site. Data will be collected within the same time frame at all locations. Therefore, data collected at all sites should be representative of conditions in the Susquehanna River Basin within a specified timeframe. Collection of greater than 90 percent of the programmed samples will be considered as fulfilling the program objective.

3.3 Data Comparability

Use of USEPA-approved laboratory methods and USGS field techniques provide a uniform methodology for both field and laboratory analysis. Data from this project are intended to be comparable with data collected for the Chesapeake Bay River Input Monitoring Program. To ensure data are comparable with the River Input Program, similar data collection methods and analysis are used. The PADEP Lab routinely analyzes CBP split samples and USGS reference samples to check the comparability of the field and laboratory data.

3.4 Precision and Accuracy

Variability within the PADEP Lab will be quantified with field-split samples. Field blanks will be used to determine total measurement error due to contamination. If contamination of the blank is found, additional field blanks will be submitted, along with samples from the same volume of distilled water poured

directly into the precleaned sample bottle. This procedure will help to determine the source of contamination. Samples sent to the laboratory for analyses will include 5 percent field-split samples and 5 percent field blanks. Duplicate sample results with greater than 20 percent error from the split sample will be discarded. Field blank results should be less than 5 percent of the lowest value in the sample batch. Variability among laboratories will be quantified through the use of Chesapeake Bay Program field-split duplicate samples that will be sent to the USGS and the PADEP laboratories. This activity is being conducted in cooperation with the USGS Water Science Center in Catonsville, Md., which has the responsibility for interlaboratory quality assurance.

Detection limits, accuracy, and precision of data are included in each lab's individual Quality Assurance Plan and are acceptable for this project. For all analytes, 10 percent of samples analyzed have duplicates completed. For all analytes, a spike analysis is completed for every 10 samples. Recovery amounts are listed in Table 3. Data analysis methods will be based on approved USEPA and USGS techniques.

Table 3. Recovery Amounts

Parameter	Spike Recovery Limits %		Duplicate Max Variation %	
	PADEP	ALS	PADEP	ALS
Total Nitrogen	± 10%	N/A	± 10%	20%
Dissolved Nitrogen	± 10%	N/A	± 10%	20%
Total Kjeldahl Nitrogen	± 10%	71-120	± 10%	20%
Dissolved Kjeldahl Nitrogen	± 10%	71-120	± 10%	20%
Total Ammonia	± 10%	90-110	± 10%	20%
Dissolved Ammonia	± 10%	90-110	± 10%	20%
Total Nitrite + Nitrate	± 10%	90-110	± 10%	20%
Dissolved Nitrite + Nitrate	± 10%	90-110	± 10%	20%
Total Phosphorus-TP	± 10%	81-112	± 10%	20%
Dissolved Phosphorus-DP	± 10%	81-112	± 10%	20%
Orthophosphate-P	± 10%	90-110	± 10%	20%
Total Suspended Solids < 100 mg/L	± 10%	80-120	± 10%	20%
Total Suspended Solids >100 mg/L	± 20%	80-120	± 10%	20%
Total Organic Carbon	± 20%	86-117	± 10%	20%

4.0 SAMPLING PROCEDURES

All samples will be depth-integrated, isokinetic samples, using USGS standard equipment and techniques. A complete description of the sampling procedures used for this study can be found in Brown and others (1970), in Guy and Norman (1970), and in USGS (2006). Descriptions of sampling devices are found in the National Handbook of Recommended Methods for Water-Data Acquisition, Chapter 3, pp. 3-18 to 3-24. Equipment used includes the DH-48 modified with a tale fin to aid in stabilization.

A copy of the sample identification and lab request form is found in Appendix B. Information on the form includes the collector's name and telephone number, date, time, sample number, and stream name. The first four digits of the sample number identify the collecting agency (SRBC) and the last three digits identify the sample in sequential order.

All water quality parameters including temperature, dissolved oxygen, conductivity, and pH, will be taken instream at each vertical, and the median value will be recorded. During times when this is not possible due to high flow, all water quality will be taken from the composite sample after the water quality sample has been processed from the churn.

Whole-water (unfiltered) samples will be collected to ensure that the samples are representative of stream conditions. Samples will be collected by compositing depth-integrated samples from equal increments of discharge along the cross section in a precleaned churn splitter. Sample bottles will be filled while gently churning the water. Field-split samples will be collected by filling sample bottles from the same volume of water in the churn splitter. Samples will be filtered in the field. All automatically collected samples are composited on a time-weighted basis.

Field-blank samples will be processed in the field. Water for blank samples will be transported to the sampling site and processed through the pre-cleaned sampling equipment and churn splitter before filling the sample bottles. Field blanks collected in Pennsylvania will be analyzed at ALS Enviromental in Middletown, Pa. and field blanks from NY will be analyzed at ALS Enviromental in Rochester NY.

Appropriate labels with the sample number, location, date, time, and fixative (where appropriate) will be affixed to each sample container. Samples will be stored on ice and transported to the lab within 24 hours of collection.

The standard USGS depth-integrating sampler, USDH-48 with epoxy coating, will be used on the larger river and stream sites when stream flows are low and velocities do not exceed 1.5 meters per second (m/s). A ¼ inch nozzle will be used for higher flows when velocities greater than 1.5 m/s. A newly cleaned glass bottle will be used each sampling day. Bottles are cleaned in the lab using standard detergent. Sample bottles are rinsed with river water prior to sample collection.

All equipment will be cleaned with 0.1 percent v/v ratio of Liquinox: tap water and rinsed with tap water after each sampling trip. The equipment will be rinsed with river water at each site prior to sample collection and rinsed with distilled water after completion of sample collection at the site.

5.0 SAMPLE CUSTODY PROCEDURES

Immediately upon collection, samples will be chilled on ice and transported to the lab within 24 hours. The lab will perform the necessary analyses within the holding time limits specified in its Quality Assurance Plan.

All samples will be submitted with the appropriate analysis request form (Appendix B), as provided by the PADEP Lab and ALS Environmental. This form includes the site location, name of person collecting the sample, and the standard analysis code, as well as any other pertinent information the lab or the sampler needs for future reference.

Field-tracking forms are not needed, since only one person will be handling and transmitting samples to the lab. A field notebook will be kept by personnel collecting the samples. A copy of the note sheet is included in Appendix B. Data to be recorded in the field notebook include the date, time, weather, field data collected, and any comments the collector has concerning the conditions at the site or problems encountered while collecting the sample.

Custody of samples at the lab will follow procedures as established by each lab's individual Quality Assurance Plan, with appropriate documentation.

6.0 CALIBRATION PROCEDURES AND PREVENTIVE MAINTENANCE

Field staff will be utilizing YSI multi-probe meters for instream measurement of pH, specific conductivity, dissolved oxygen, and temperature during routine samples. During times when this is not possible due to high flow, all water quality will be taken from the composite sample after the water quality sample has been processed from the churn. Every instrument used to collect water quality data will be sent to YSI Inc. annually for formal calibration checks and maintenance as well as checked for accuracy as follows.

6.1 Specific Conductance Meter

Primary Meter: YSI 650 MDS with 6820 V2 logger will be used. SRBC personnel will keep meters in working order and calibrated monthly against one specific conductance standard (usually 1000 umhos/cm), obtained within six months.

Acceptance Criteria:

Standards (<1,000 umhos/cm) ± 4 percent
(>1,000 umhos/cm) ± 3 percent

Backup Meter: Cole Parmer model 1481-61 conductance meter with 500 series cell probe will be used. SRBC personnel will keep meters in working order and calibrated monthly against one specific conductance standard (usually 1000 umhos/cm), obtained within six months.

6.2 pH Meter

Primary Meter: YSI 650 MDS with 6820 V2 logger will be used. SRBC personnel will calibrate meteres daily prior to use using two pH buffer standards (7 and 10), purchased within six months to insure the meters are working properly.

Backup Meter: Cole Parmer model 5996-70 pH meter will be used. SRBC personnel will calibrate meteres daily prior to use using two pH buffer standards (7 and 10), purchased within six months to insure the meters are working properly.

6.3 Thermometer

YSI models 650 MDS with 6820 V2 logger will be used. The sondes utilize a thermistor of sintered metallic oxide that changes predictably in resistance with temperature variation. The algorithm for conversion of resistance to temperature is built into the sonde, software, and accurate temperature readings in degrees Celsius, Kelvin, or Fahrenheit are provided automatically. No calibration or maintenance of the temperature sensor is required.

In accordance with the 2008 CBPO Nontidal WQ Procedures, thermistor will be checked annually during formal YSI maintenance service.

6.4 Dissolved Oxygen Meter

Primary Meter: YSI models 650 MDS with 6820V2 logger with optical DO sensor will be used. Meters will be calibrated daily prior to sample collection using the air calibration chamber in water method.

Backup Meter: YSI model 95. Meters will be calibrated daily prior to sample collections using the air calibration chamber in water method.

6.5 Turbidity Meter

Meter: YSI model 650 MDS with 6820V2 logger with optical Turbidity sensor (6136) will be used. Meters will be calibrated monthly prior to sample collection using 0 NTU and 126 NTU YSI recommended standards.

6.6 Maintenance of Calibration Records

Staff will maintain records of instrument calibrations, repairs, and maintenance in the "Water Quality Field Instrument Calibration Log," and will report any abuse or neglect of equipment or calibration schedules to the Project Officer.

6.7 Preventative Maintenance

6.7.1 Conductivity–dip cell
Staff will wash the conductivity cell with distilled water and river water. The cell will be shaken dry and stored.

6.7.2 pH–combination electrode
The electrode will be stored according to operating manual instructions.

6.7.3 Dissolved oxygen meter
Meters will be stored according to operating manual instructions.

6.7.4 Churn splitter
SRBC staff will churn with distilled water and river water before collecting a sample at each site. SRBC staff also will rinse and scrub the churn splitter and filter with Liquinox detergent and tap water prior to each sampling day.

6.8 <u>Backup Instruments and Equipment</u>

Backup instruments and equipment also will be maintained, as described above.

7.0 DOCUMENTATION, DATA REDUCTION, AND REPORTING

Samples collected in the field will be labeled at the time of collection. PADEP sample bottles are labeled with a seven-digit identification number, sampling date, and time. The seven-digit identification number consists of a four-digit collector identification number and a three-digit sample number. This identification information also is recorded on a laboratory submission sheet. One form is submitted with each set of samples and also includes an analysis code that designates the laboratory analyses to be conducted. Laboratory results from PADEP will be received by electronic transfer. ALS Environmental will submit electronic copies of data from New York and Pennsylvania field blanks.

All project data will be entered into the SRBC computer-data files. On completion of data entry, they will be retrieved, and visually checked by project personnel to insure that data were entered correctly. The data will be served on SRBC's web site

(www.srbc.net). New York data will be submitted by SRBC through the CBPO's Data Upload and Evaluation Tool (DUET). All parameters will be reported in mg/l.

8.0 DATA ANALYSIS

Loads and flow-adjusted trends are estimated using the USGS 7-parameter, log-linear regression model (ESTIMATOR version 2000-04) developed by Cohn and others (1989) and described in Langland and others (1999). This estimator relates the constituent concentration to water discharge, seasonal effects, and long-term trends, and computes the best-fit regression equation. Daily loads of the constituents then are calculated from the daily mean water discharge records. Trends in flow are calculated using S-Plus with the USGS ESTREND library addition (Schertz and others, 1991).

9.0 INTERNAL QUALITY-CONTROL CHECKS

SRBC personnel will receive results of analyses, and will submit copies of the analyses and "primary printouts" to project personnel. Personnel will review results for accuracy and acceptability within five to ten days after receipt, using their analytical experience and knowledge of water quality of streams in the basin. The data will be verified by comparing values with ranges of values from prior sampling and by review of data plots.

If an error in an analysis is detected or suspected, the questionable value will be noted and a rerun will be requested. Rerun data will be reviewed by the project personnel, and appropriate changes will be made in the computer files. If results of field-split duplicate samples are different but are within quality assurance specifications, the average of the two values will be reported.

10.0 ANALYTICAL PROCEDURES

Pennsylvania samples will be analyzed by the PADEP Laboratory. Pennsylvania field blanks and New York samples will be analyzed by ALS Environmental. The methods used by the laboratory are listed in Table 1. Laboratory quality assurance procedures, including use of standard reference materials, are documented in the specific lab's Standard Operating Procedures.

11.0 PERFORMANCE AND SYSTEM AUDITS

11.1 Laboratory

Analytical and quality assurance procedures for each laboratory are detailed in the labs' Quality Assurance Plan. Duplicate samples will be submitted to the PADEP, ALS, and USGS laboratories by the field personnel, as directed above. The total number of quality assurance samples submitted will be at least 10 percent of the samples analyzed. The appropriate Quality Assurance Officer and Project Officer will review results for necessary action. Any problems, which cannot be resolved by SRBC personnel, will be deferred to the PADEP BCR Project Officer for solution.

Chesapeake Bay Tributary Split Samples (Blue Plains) are delivered to PADEP Lab, and the results are compared to other Bay laboratories. USGS nutrient reference samples are analyzed once or twice a year.

11.2 Field

Field personnel will be subjected to performance audits for pH and specific conductance. The USGS Water Science Center in New Cumberland will schedule audits annually using standard samples provided by the USGS Central Lab. Results will be verified by the USGS Central Lab. The SRBC Project Officer is responsible for verifying that all field personnel are competent in the collection techniques before participation in any fieldwork. Any unsatisfactory results will be cause for a repeat audit, at the discretion of the Project Officer.

11.3 System Audit

This audit is made by the appropriate agency Quality Assurance Officer as a qualitative and quantitative inspection and review of the total measurement system. Audits include reviews of the following:

11.3.1 Organization and responsibility--Is the quality-control organization operational? Are quality-control and system audits properly made and documented?

11.3.2 Data collection--Are written data collection procedures available and followed? Are personnel completing all record forms and identification labels?

11.3.3 Sample collection--Are written sample collection procedures available and followed? Do personnel use the required containers? Are containers clean to prevent contamination?

11.3.4 Sample analysis--Are written analysis procedures available and followed?

11.3.5 Human errors--Are data checks made and actions taken to control human errors? Is the program of pass-fail checks for operations in use? Does checking show that the desired quality assurance level is met?

11.3.6 Measurement comparisons--Are results from measurements-comparison testing reviewed and used?

The role of audits in the overall measurement program is one of verification. While audits do not improve data quality, if all work is correctly performed, they do provide assurance that the work prescribed for the measurement program has been conducted properly. A summary of all audit results will be submitted to SRBC and PADEP BCR, and will include the following: the purpose of the audit; personnel audited; activities audited; tests observed; documents and data reviewed; work performance and errors in procedures observed; corrective actions recommended and a deadline for completion of corrective actions; and a provision for verification of completion of corrective actions.

12.0 PREVENTIVE MAINTENANCE

All lab equipment will be maintained as specified in each lab's individual Quality Assurance and Work Plans.

The appropriate Quality Assurance Officer will keep maintenance records of all equipment and calibration procedures. The Project Officer will review these records periodically.

All field equipment will be maintained as described in Section 6.0.

13.0 ROUTINE PROCEDURES FOR DATA PRECISION, ACCURACY, AND COMPLETENESS

Assessment of data precision and accuracy for the monitoring program will consist of collecting and analyzing duplicate, field-split duplicate, and blank samples. The purpose of these quality assurance practices is to check the precision of the laboratories that provide water analyses and data for the program's use and to verify that the laboratories are producing comparable results. These criteria will be evaluated in terms of the standard deviation(s) and the coefficient of variation (cv) for each of the constituents analyzed. The number of QA samples is described in Section 3.3.

All data will be verified and submitted to the USEPA CBPO according to procedures established in the latest Data Submission Guidelines and Water Quality Data Management Plan.

Load calculations will be made using an established method that is consistent with the methods used by the Harrisburg division of USGS, SRBC, and USGS in Maryland and approved by the CBPO NTWG.

14.0 CORRECTIVE ACTION

Corrective action is taken immediately upon discovery of a problem. Project personnel will interact constantly to coordinate project activities. Additionally, meetings with personnel from all agencies will be held at the discretion of the PADEP BCR Project Officer. Data and data-collection activities are discussed constantly and evaluated. Corrective action is taken immediately by the appropriate agency Project Officer, if evaluation indicates action is necessary. Laboratory corrective action is the responsibility of the Lab Quality Assurance Officer. Any issues that cannot be resolved by the Lab Officer and the SRBC Officer, will be referred to the PADEP BCR Project Officer or his/her supervisor for action.

15.0 REPORTS

Quarterly reports will be submitted by SRBC to the PADEP BCR Project Officer. These quarterly reports will include a description of activities completed during the quarter, as well as any problems encountered. Data analysis results will be summarized. A description of activities planned for the next quarter also will be included.

A quarterly report will be submitted to USEPA, CBPO Project Officer by the PADEP BCR Project Officer as part of the quarterly grant report.

A final report also will be submitted by SRBC annually that summarizes the results to the PADEP BCR Project Officer.

For the enhanced Group B sites and trends work, a semi-annual progress report and final report will be completed and submitted to the CBPO.

16.0 REFERENCES

Brown, E., M.W. Skougstad, and M. Fishman. 1970. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. U.S. Geological Survey Techniques of Water Resources Investigation, Book 5, Chapter A1.

Cohn, T.A., L.L DeLong, E.J. Gilroy, R.M. Hirsch, and D.E Wells. 1989. Estimating Constituent Loads. Water Resources Research, 25(5), pp. 937-942.

Guy, H.P. and V.W. Norman. 1969. Field Methods for Measurement of Fluvial Sediment. U.S. Geological Survey Techniques of Water Resources Investigation, Book 3, Chapter C2 and Book 5, Chapter C1.

Langland, M.J., J.D. Bloomquist, L.A. Sprague, and R.E. Edwards. 1999. Summary of Trends and Status for Flow, Nutrients, Sediments at selected Nontidal Sites, Chesapeake Bay Basin, 1985-99. U.S. Geological Survey (Open-File Report 01-73), 20 pp.

Schertz, T.L., R.B. Alexander, and D.J. Ohe. 1991. The computer program EStimate TREND (ESTREND), a system for the detection of trends in water quality data: U.S. Geological Survey Water-Resources Investigations Report 91-4040, 63 pp.

U.S. Geological Survey. 2006. Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4. Accessed 2/6/12. http://pubs.water.usgs.gov/twri9A4/.

APPENDIX A

LOCATION DATA

TABLE A1. LATITUDE AND LONGITUDE OF SAMPLING SITES

Existing SRBC sites (Group A sites)	Latitude	Longitude
Susquehanna River at Towanda, Pa. (James Street Bridge)	41°47'27"	76°26'40"
Susquehanna River at Danville, Pa.	40°57'29"	76°37'10"
Susquehanna River at Lewisburg, Pa.	40°58'05"	76°52'25"
Juniata River at Newport, Pa.	40°28'42"	77°07'46"
Susquehanna River at Marietta, Pa. (Rt. 30 Bridge)	40°02'08"	75°31'23"
Conestoga River at Conestoga, Pa.	39°56'20"	76°23'15"
Enhanced Sites (Group B sites)	**Latitude**	**Longitude**
Susquehanna River at Smithboro, N.Y.	42°02'02"	76°24'02"
Cohocton River near Campbell, N.Y.	42°15'09"	77°13'01"
Chemung River at Chemung, N.Y.	42°00'10"	76°38'06"
Susquehanna River at Conklin, N.Y.	42°02'07"	75°48'12"
Unadilla River at Rockdale, N.Y.	42°22'40"	75°24'23"
Susquehanna River near Wilkes-Barre, Pa.	41°15'03"	75°52'52"
West Branch Susquehanna River near Jersey Shore, Pa.	41°12'08"	77°15'05"
Penns Creek at Penns Creek, Pa.	40°52'00"	77°02'55"
Bald Eagle Creek near Castanea, Pa.	41°07'36"	77°25'60"
Shermans Creek near Dromgold, Pa.	40°20'46"	77°11'31"
Conodoguinet Creek near Hogestown, Pa.	40°15'08"	77°01'17"
Swatara Creek near Hershey, Pa.	40°17'54"	76°40'05"
West Conewago Creek near Manchester, Pa.	40°04'56"	76°43'13"
Pequea Creek near Martic Forge, Pa.	39°53'53"	76°20'32"
West Branch Susquehanna River near Karthaus, Pa.	41°07'03"	78°06'33"
Raystown Branch Juniata River at Saxton, Pa.	40°12'57"	78°15'56"
Octoraro Creek at Richardsmere, Md.	39°41'25"	76°07'41"
East Mahantango Creek near Dalmatia, Pa.	40°36'40"	76°54'44"
Paxton Creek near Penbrook, Pa.	40°18'30"	76°51'00"
Kishacoquillas Creek near Reedsville, Pa.	40°39'17"	77°35'00"

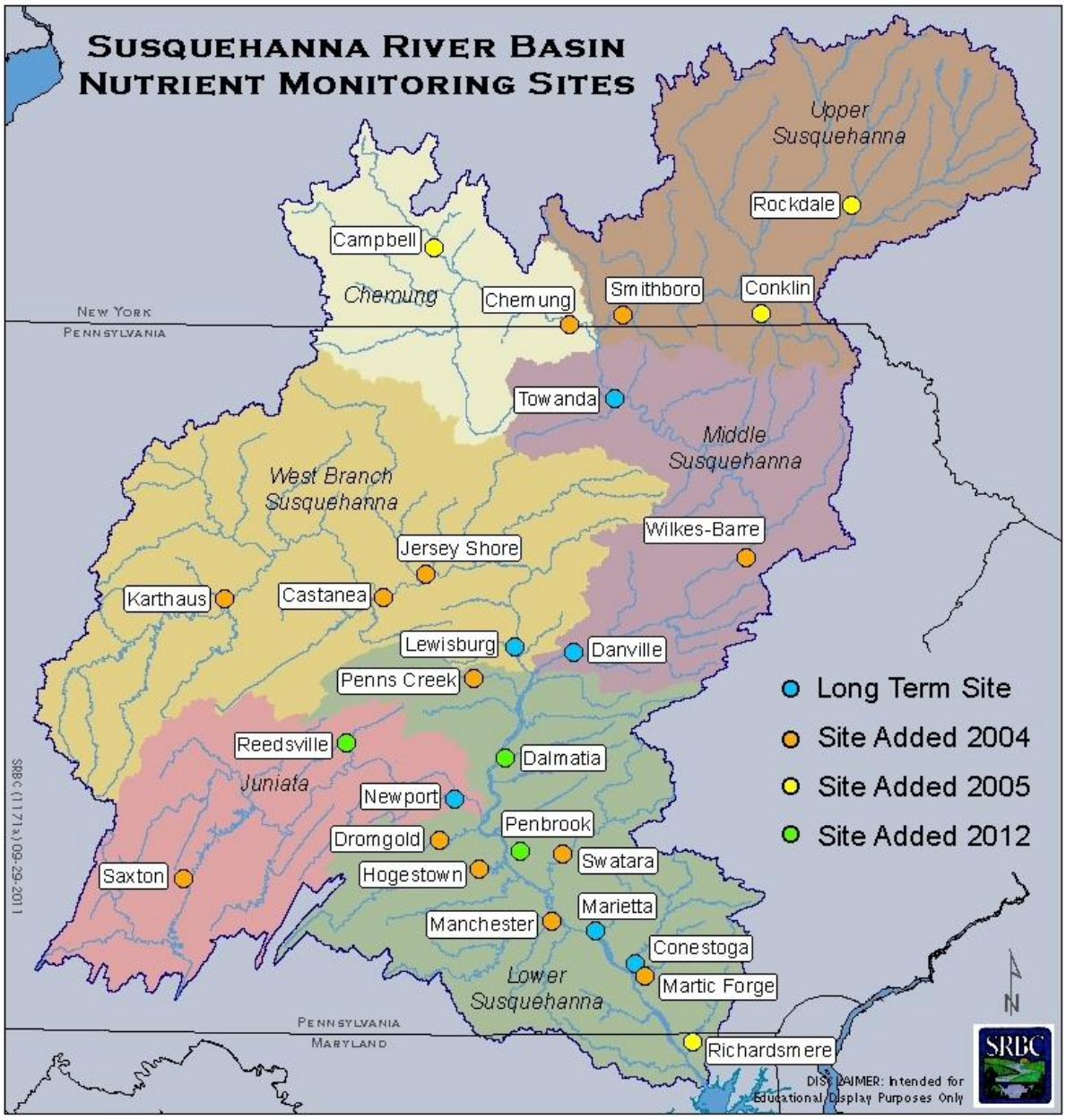

Figure A1. Sampling Site Locations

APPENDIX B

FORMS

FIELD NOTES

SAMPLE NUMBER ______________________ **LOCATION** ____________________
DATE _____________________ **FLOW** ____________________
TIME _____________________
pH _____________________
COND. _____________________
TEMP. _____________________
D.O. _____________________
ACID. _____________________
ALK. _____________________

SAMPLE NUMBER ______________________ **LOCATION** ____________________
DATE _____________________ **FLOW** ____________________
TIME _____________________
pH _____________________
COND. _____________________
TEMP. _____________________
D.O. _____________________
ACID. _____________________
ALK. _____________________

SAMPLE NUMBER ______________________ **LOCATION** ____________________
DATE _____________________ **FLOW** ____________________
TIME _____________________
pH _____________________
COND. _____________________
TEMP. _____________________
D.O. _____________________
ACID. _____________________
ALK. _____________________

SAMPLE NUMBER ______________________ **LOCATION** ____________________
DATE _____________________ **FLOW** ____________________
TIME _____________________
pH _____________________
COND. _____________________
TEMP. _____________________
D.O. _____________________
ACID. _____________________
ALK. _____________________

3800-FM-WSFR0121 8/2009

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Sample Submission Sheet

PA DEP Bureau of Laboratories

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

# of Unpreserved Bottles:		
Tests	# of bottles	Fixative
Metals		HNO3
Phenols		H2SO4
CN		NaOH
NA/K		HNO3
Spl. Inorg/Nutrients		H2SO4

Organic Bottles Submitted			
Bottle	Test	# of bottles	Fixative
40mL VOA amber	TOC		H2SO4
40mL VOA amber	DOC		H2SO4
1 L amber			
500 mL amber			
Other:	Bacteria		Pre-cl'd
Other:			

LAB USE ONLY

Lab Number:

Date Received:

Received By:

Temp. ≤ 6°C

Collector ID | **Sequence No.** | **Date Collected** (MM, DD, YY) | **Time Collected** (HH MM)

Reason Code | **Cost Center Code** | **Program Code** 0 0 0 1 | **STD Analysis Code**

Matrix Code | **Residual Chlorine** Yes No | **pH less than 2.0** Yes No | **Legal Seal Number:**

Legal Seal Intact: Y N

Additional Analysis

How Shipped:
- ☐ US Cargo
- ☒ Hand Delivered
- ☐ Other _____

Collectors Name: (printed) Kevin McGonigal

Phone: 238-0426 X 105

Relinquished By: (signature) _____

Date: _____

Station Number (WQN0###)

W Q N 0

Station Name _____

Sampling Location _____

Stream Name _____

Stream Code | River Mile Index

Latitude (DMS) | Longitude (DMS)

FIELD RESULTS:

Temp.(°c)	(00010)	
pH (units)	(00405)	
D.O. (mg/l)	(00300)	
Sp. Cond. (µmhos)	(00094)	
Gage (ft)	(00065)	
Flow (cfs)	(00061)	
Secchi Disk	(00078)	

Comments:

One Copy of This Sheet Goes To: a) 625 Broadway, 4th Floor, Albany, New York 12233-3502
b) With sample to contract lab c) Retain for your records

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

CONTRACT LAB SAMPLE INFORMATION SHEET

Print Legibly

Clear Form

CAUTION (check if applicable)

☐ Lab personnel are expected to use caution when handling DEC samples, however, please use special caution when handling this sample since it is believed to contain significant concentrations of hazardous and/or toxic material(s).

CHECK THE BOX PRECEDING THE REQUESTED ANALYSIS

PRIORITY POLLUTANTS (Water and Wastewater Title 40 Part 136)—SPDES

- ☐ 1. 13PP Metals
- ☐ 2. Cyanide
- ☐ 3. BOD
- ☐ 4. CBOD
- ☐ 5. COD
- ☐ 6. pH
- ☐ 7. Settleable Solids
- ☐ 8. Total Solids
- ☑ 9. TSS
- ☐ 10. Sulfate
- ☐ 11. Reactive Phosphorus
- ☑ 12. Total Phosphorus
- ☑ 13. Nitrate/Nitrite
- ☑ 14. Ammonia
- ☐ 15. TKN
- ☐ 16. Total Phenols
- ☑ 17. TOC
- ☐ 18. Oil/Grease
- ☐ 19. Halogenated Volatiles (USEPA 601 GC)
- ☐ 20. Aromatic Volatiles (USEPA 602 GC)
- ☐ 21. Volatiles (USEPA 624 GC/MS)
- ☐ 22. Low-Level Volatiles (USEPA 524.2 GC/MS)
- ☐ 23. Acids/Base/Neutrals (USEPA 625 GC/MS)
- ☐ 24. Pesticides/PCBs (USEPA 608 GC)
- ☐ 25. PCBs at 0.065 µg/L (USEPA 608 GC)
- ☐ 26. PCBs congener method (1668A HRGC/HRMS)
- ☑ 27. Other TPO4, DPO4, TN, DN

CONTRACT LABORATORY PROTOCOLS

- ☐ 28. (ALL) - Water - Includes 29-33
- ☐ 29. Base/Neutral/Acid (B/N/A) Water (GC/MS)
- ☐ 30. Volatile Organic Analysis (VOA) Water (GC/MS)
- ☐ 31. Pesticides/PCBs Water (GC/MS)
- ☐ 32. 23 Metals in Water
- ☐ 33. Cyanide in Water
- ☐ 34. Dioxin - Water (1613B GC/MS)
- ☐ 35. (ALL) - Soil/Sediments - Includes 36-40
- ☐ 36. Base/Neutral/Acid (B/N/A) Soil/Sediments (GC/MS)
- ☐ 37. Volatile Organic Analysis (VOA) Soil/Sediments (GC/MS)
- ☐ 38. Pesticides/PCBs Soil/Sediments (GC)
- ☐ 39. 23 Metals in Soil/Sediments
- ☐ 40. Cyanide in Soil/Sediments
- ☐ 41. Doixin - Soil/Sediments (1613B GC/MS)
- ☐ 42. Other _____

HAZARDOUS WASTES/RCRA ANALYSIS SW-846

- ☐ 43. EP Toxicity
- ☐ 44. Corrosivity
- ☐ 45. Ignitability
- ☐ 46. Reactivity
- ☐ 47. TCLP
- ☐ 48. EP Toxicity (Metals Only)
- ☐ 49. TCLP (Metals Only)
- ☐ 50. Metals—17 Hazardous
- ☐ 51. Percent Solids
- ☐ 52. VOA (USEPA 8260 GC/MS)
- ☐ 53. BNA (USEPA 8270 GC/MS)
- ☐ 54. Pesticides (USEPA 8081GC/ECD)
- ☐ 55. PCBs (USEPA 8082 GC/ECD)
- ☐ 56. Dioxin (USEPA 8280 GC/MS)
- ☐ 57. Other _____

MUNICIPAL SLUDGE

☐ 58. RS-01 ☐ 59. RS-02 ☐ 60. Other _____

COLLECTED BY:	TELEPHONE NUMBER: (717) 476-7206	REGION NO.:

CONTRACT LABORATORY: Columbia Analytical Services	COUNTY:	SAMPLING DATE:	MILITARY TIME:

SAMPLE MATRIX:

☐ Air ☐ Soil/Sediment ☐ Groundwater ☑ Surface Water ☐ Wastewater ☐ Other _____

CASE NO.	SDG NO.	SAMPLE NO.	CHECK FOR MS/MD	TYPE OF SAMPLE
			☐ This Sample	☐ Grab ☑ Composite ☐ Term _____

☐ Check if there will be more samples with this SDG sent in this calendar week.

SAMPLING POINT:

Report via Category B, unless checked ☐

Check if field duplicate ☐ | Outfall Number

Check if sampling is part of inspection ☐

FLOW: _____ GPD _____ MGD

SPDES NUMBER/REGISTRY NUMBER

ALS Environmental

34 Dogwood Lane
Middletown, PA 17057
P. 717-944-5541
F.717-944-1430

CHAIN OF CUSTODY/ REQUEST FOR ANALYSIS

ALL SHADED AREAS MUST BE COMPLETED BY THE CLIENT / SAMPLER. INSTRUCTIONS ON THE BACK.

COC #: _____ of _____

ALS Quote #:412329

Client Name: Susquehanna River Basin Commission
Address: 4423 N. Front Street
Harrisburg, PA 17110-1788
Contact: Kevin McGonigal
Phone#: 717-476-7206
Project Name/#: 1303-06K
Bill To: Accounts Payable: Kelly Maher

TAT [x] Normal-Standard TAT is 10-12 business days.
[ ] Rush-Subject to ALS approval and surcharges.
Date Required: _____ Approved By: _____
Email? [x] -Y kmcgonigal@srbc.net
Fax? [ ] -Y No.: _____

				Container Type	PL	PL	PL	PL	PL	AG			
				Container Size	250	500	500	500 Filt	500	40			
				Preservative	HNO3	H2SO4	None	H2SO4	None	H2SO4			
				ANALYSES/METHOD REQUESTED									
Sample Description/Location (as it will appear on the lab report)	Sample Date	Time	*G or C	**Matrix	Metals:Al,Fe,Mn,Ni,Zn,Mg,Cu,Pb	Phos, Ortho P,NO2,NO3,NH4,TKN	Cl,Sulfate,SPC,TSS,TDS,pH,Ca	Diss P,OrthoP,NO2,NO3,NH4,TKN	Alkalinity	TOC			
					Enter Number of Containers Per Sample or Field Results Below.								
1			C	OL	1	1	2	1	1	2			
2													
3													
4													
5													
6													
7													
8													
9													
10													

Receipt Information (completed by Receiving Lab)

Cooler Temp: _____ Therm ID: _____
No. of Coolers: _____

	Y	N	Initial
Custody Seals Present?			
(if present) Seals Intact?			
Received on Ice?			
COC/Labels Complete/Accurate?			
Cont. in Good Cond.?			
Correct Containers?			
Correct Sample Volumes?			
Correct Preservation?			
Headspace/Volatiles?			

Courier/Tracking #:

Sample/COC Comments

ALS Field Services: __Pickup __Labor __Composite Sampling __Rental Equipment __Other:_____

Project Comments: Equipment Blanks

LOGGED BY(signature): DATE TIME
REVIEWED BY(signature): DATE TIME

Relinquished By / Company Name	Date	Time	Received By / Company Name	Date	Time
1			2		
3			4		
5			6		
7			8		
9			10		

Data Deliverables: [x] Standard [ ] CLP-like [ ] USACE [ ]

Special Processing: USACE [ ] Navy [ ]

State Samples Collected In: [ ] NY [ ] NJ [x] PA [ ] NC [ ]

Reportable to PADEP? Yes [x]
PWSID # _____

Sample Disposal: Lab [x] Special [ ]

EDDS: Format Type- MS Excel

* G=Grab; C=Composite **Matrix - Al=Air; DW=Drinking Water; GW=Groundwater; Ol=Oil; OL=Other Liquid; SL=Sludge; SO=Soil; WP=Wipe; WW=Wastewater

ALS ENVIRONMENTAL SHIPPING ADDRESS: 34 DOGWOOD LANE, MIDDLETOWN, PA 17057

Rev 10/11