CHESAPEAKE BAY WATER-QUALITY MONITORING PROGRAM

WEST VIRGINIA NONTIDAL NUTRIENT AND SEDIMENT SAMPLING

QUALITY ASSURANCE PROJECT PLAN

Effective Date Oct. 1, 2015

WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION, DIVISION OF WATER AND WASTE MANAGEMENT

IN COOPERATION WITH THE
U.S. GEOLOGICAL SURVEY

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QUALITY ASSURANCE PROJECT PLAN

for the

West Virginia Non-Tidal Monitoring Program
NUTRIENT AND SEDIMENT SAMPLING

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for the period of

Water Year 2016

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A. Project Management

A.1 Introduction

This Quality-Assurance Project Plan (QAPP) describes quality-assurance goals and measures for the Non-Tidal Monitoring program designed to support Chesapeake Bay restoration programs.

The project, the *Non-Tidal Monitoring Program*, includes the monitoring of nutrient and suspended-sediment concentrations and streamflow in selected West Virginia tributaries of the Potomac River. This project is supported through West Virginia Department of Environmental Protection (WVDEP) and U.S. Geological Survey (USGS) cooperative funds. The objectives of this project are to:

- characterize nutrient and sediment concentrations in terms of flow and load for ten (10) West Virginia tributaries to the Potomac River;
- provide nutrient and sediment data for calibration of the Chesapeake Bay Watershed model (WSM) and loading inputs to the Chesapeake Bay Water-Quality (WQ) model; and
- integrate the information collected in this program with other elements of the monitoring program to gain a better understanding of the processes affecting the water quality of the Chesapeake Bay.

The WVDEP and the USGS conduct this project cooperatively. Sampling events, goals, and objectives for this project are overseen by the USGS Project Chief, Douglas B. Chambers.

A.2 Distribution List

This QAPP will be distributed to the following project participants:

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A.3 Project/Task Organization

Douglas B. Chambers, USGS, is the Project Chief for the West Virginia Non-Tidal Monitoring Program and is responsible for the technical design, operation, and execution of the program as outlined in the annual scope of work to WVDEP. He is also responsible for the evaluating and describing of collected data, quality assurance and quality control for the program, and producing USGS reports. Doug is also the Water-Quality Specialist for the USGS West Virginia Water Science Center.

John Wirts, WVDEP, DWWM, Watershed Assessment Branch, serves as the Project Coordinator for the Potomac River Non-Tidal Monitoring Program. He is tasked with assuring that all project commitments, the project timetable, and deliverables are completed.

A.4 Problem Definition/Background

The decline in water quality of the Chesapeake Bay within the last decade has, in large part, been attributed to excessive nutrients entering the estuary from its surrounding tributaries. In an effort to improve the water quality of the Bay, Federal, State, and local governments have initiated point and non-point source nutrient-reduction programs within the tributary basins discharging to the Bay. Monitoring at key sites can help to quantify improvements in water quality and verify the effectiveness of nutrient-control measures implemented in the watersheds.

In addition, the quality of the river discharge, and the timing and magnitude of the pollutant concentrations and loads delivered to the estuary are important data needed to enhance knowledge of or need to strengthen other components of the Chesapeake Bay water-quality monitoring program. The integration of all of these components will lead to a better understanding of the factors influencing water quality that can then be translated into better water-quality management for the Bay and its tributaries.

With these general goals in mind, the West Virginia Department of Environmental Protection (WVDEP), in cooperation with the USGS, initiated the West Virginia portion of the Non-Tidal Monitoring Program as part of the Chesapeake Bay Water-Quality Monitoring Program.

The Chesapeake Bay Non-Tidal Water Quality Monitoring Work Group and the State of West Virginia selected six Potomac River tributaries – Patterson Creek, the South Branch of the Potomac River, Cacapon River, Warm Springs Run, Opequon Creek, and Rockymarsh Run–for sampling. Additionally, Mill Creek, a tributary of Opequon Creek, will be sampled. Combined, these streams contribute over 30 percent of the flow to the Potomac River above Point of Rocks, Maryland and they contribute nutrients and sediments from a wide range of land-use, geologic, and hydrologic conditions. A sampling site will be established near the most downstream stream flow gaging station on each stream to monitor nutrient and sediment concentrations and streamflow to help calculate transport of these nutrient and sediment loads to the Potomac River and, ultimately, to Chesapeake Bay.

A.5 Project/Task Description

Water-quality samples that are representative of the entire river cross section are collected and later analyzed to determine concentrations of selected nutrient species and suspended sediment in the river. These samples are collected during different seasons across different flow regimes. When combined with the continuous, 15-minute flow record from the USGS gage at each station, it is possible to estimate nutrient and sediment loads on a monthly and annual basis with a known level of confidence. Additionally, water-quality field measurements are made for dissolved oxygen, pH, alkalinity, specific conductance, water temperature and air temperature.

The USGS's National Field Manual for the Collection of Water-Quality Data (Wilde and others, 1998, http://water.usgs.gov/public/owq/FieldManual/index.html) describes the sampling process in detail. Data-collection quality will be monitored by the assessment of field blanks and replicates and by annually conducting and documenting the results of random field audits.

Streamflow, nutrient, and suspended-sediment concentration data sets from each monitoring station will be forwarded to John Wirts at WVDEP by March 30 of each year for the previous USGS water year (October thru September). Semi-annual reports describing field activities, quality-control results, and data-management issues will be submitted with preliminary data to John Wirts on 15 November and 15 May.

A.6 Data-Quality Objectives and Criteria for Measurement Data

This study provides West Virginia resource managers with information that can help to quantify changes in water quality, quantify nutrient loads critical for evaluating progress towards reducing controllable nutrients to the Chesapeake Bay, and verify the effectiveness of nutrient-control measures taken in the watersheds. These data can be also be used to calibrate or validate models used to calculate watershed capload allocations. A calibrated model was developed that can simulate constituent relationships, seasonal variation, and changes in trends. As a result, water-quality samples need to be collected monthly throughout the year under different streamflow conditions to determine loads within a known confidence interval. Once completed, this information is then given to researchers and Bay resource managers.

Quality-control samples, both replicate samples and blanks, will be collected for each station. The project has a goal of a minimum of three quality –control samples per site consisting of at least two replicate samples and a field blank unless an increased number is warranted. Detailed quality assurance procedures are described for NWQL in Maloney (2005), and for the USGS Kentucky Sediment Laboratory in Shreve and Downs (2005).

Variability for a replicate sample pair is quantified by calculating the relative percent difference (RPD) of the samples. The RPD was calculated using the following formula:

$$\left(\frac{|R_1 - R_2|}{\left(\frac{R_1 + R_2}{2}\right)}\right) X\ 100,$$

where R_1 is the concentration of the analyte in the first replicate sample and R_2 is the concentration of the analyte in the second replicate sample. Generally, concentrations in replicate sample pairs should differ by no more than 15 percent RPD for dissolved constituents and 20 percent RPD for suspended constituents.

Field blank results are expected to be below the reporting level for that analyte. The detection of an analyte in a field blank triggers a series of actions to identify the source of contamination. These actions include when increasing the number of blanks and analyzing equipment, laboratory, and source solution blank samples.

A.7 Special Training Certification

Field sampling teams will be led by USGS personnel trained in water-quality sampling operations, record management, quality-assurance procedures, instrument operations and maintenance, and troubleshooting. Laboratory personnel must be trained in analytical methods, quality-control procedures, record management, maintenance and troubleshooting.

A.8 Documentation and Records

Water-quality field measurements of temperature, dissolved oxygen, pH, alkalinity, and specific conductance are recorded at each site. Additionally, water-quality samples are collected and submitted for analysis to the USGS National Water-Quality Laboratory in Denver, Colorado. Samples are evaluated for total dissolved nitrogen, particulate nitrogen, dissolved nitrite, dissolved nitrate plus nitrite, dissolved ammonia, total phosphorus, dissolved orthophosphate, and total suspended solids. Suspended sediments are analyzed at the USGS Sediment Laboratory in Louisville, Kentucky.

All data will be recorded using standardized data sheets for the specific projects (Attachment A). These data will be keyed into the USGS data management systems by technicians who collect the data. These data will be provided to WVDEP in hard copy in the form of tables and data summaries. Electronic data will be submitted with the final deliverables in ASCII text files and spreadsheets via CD-ROM or by email.

B. Measurement/Data Acquisition

B.1 Experimental Design

This document provides a detailed description of the monitoring and analysis components of a study conducted by the WVDEP, in cooperation with the USGS, to quantify nutrient and suspended-sediment contributions of 10 West Virginia tributaries to the Potomac River.

The number of events to be sampled and the number of samples per event is based on the requirements of the Chesapeake Bay Non-Tidal Monitoring Network. Water-quality samples need to be collected monthly during base flow and under various stormflow conditions. "Continuous" flow measurements also need to be collected.

Station Description

Monitoring stations were selected from a list of Chesapeake Bay Program priority monitoring sites. The location of the monitoring sites and drainage area information are presented in table 1.

Table 1. Location of West Virginia Non-Tidal Monitoring sites.

Station Name	USGS Station Identification	Latitude	Longitude	Drainage (sq. mi.)
Abram Creek at Oakmont, WV	01595300	39° 22' 00"	79° 10' 45"	42.6
Patterson Creek near Headsville, WV	01604500	39º 26' 35"	78º 49' 20"	221
South Branch Potomac River near Springfield, WV	01608500	39º 26' 49"	78º 39' 16"	1,461
Cacapon River near Great Cacapon, WV	01611500	39º 34' 56"	78º 18' 36"	675
Warm Springs Run near Berkeley Springs, WV	01613030	39°39'27.6"	78°12'18.3"	6.76
Back Creek at Jones Springs, WV	01614000	39° 30' 43"	78° 02' 15"	235
Mill Creek at Bunker Hill, WV	01616400	39°20'04.6"	78°03'12.3"	19.8
Opequon Creek near Martinsburg, WV	01616500	39º 25' 25"	77º 56' 20"	273
Rockymarsh Run at Scrabble, WV	01618100	39°28'59.1"	77°49'54.6"	15.9
Shenandoah River at Millville	01636500	39°16'55"	77°47'22"	3,041

B.2 Sampling Method

USGS personnel, with assistance from WVDEP and WVDA personnel, collect all water-quality samples at each of the seven West Virginia Non-Tidal Monitoring stations in accordance with the USGS National Field Manual for the Collection of Water Quality Data (Wilde and others, 1998).

Routine samples are collected monthly and stormflow samples are collected seasonally, with an average coverage of two storms per season. A two-person sampling team, typically consisting of either two experienced USGS Hydrologic Technician or a USGS Hydrologic Technician and an assistant from WVDEP, will collect routine monthly samples. The monitoring program emphasizes the collection of water-quality samples during periods of high flow (storm-event sampling), because most of the river-borne nutrient and suspended-sediment load is associated with storm events. Teams of two USGS Hydrologic Technicians will collect samples during high-flow events, events where stream flow increases at least two-fold over antecedent conditions. Discrete samples are collected during storm events, and can be collected during the rise, peak, or fall of the hydrograph. No more than one sample per day will be collected at each site, although storm samples may be collected on successive days during the same event. Discharge data are also collected for each of the streams throughout the period.

Routine and stormflow samples are collected using the equal-width increment (EWI) method. This method involves the collection of water-quality samples at the centroids of equal width increments along the river cross section. Water-quality samples are collected using the appropriate isokinetic sampler (table 2). These samplers hold either a 1-liter polyethylene bottle or a polyethylene bag. Samplers designed for shallow, wadeable conditions are mounted on a wading rod and samplers designed for deep conditions are lowered to the water using bridge crane. The general approach is to collect depth-integrated water samples using the Equal-Width Increment (EWI) sampling method, with minor variations to conform to site conditions. However, stream conditions, such as insufficient depth or velocity during periods of low-flow, may preclude the use of an isokinetic sampler. Under these conditions samples will be collected at multiple verticals across the stream width using a non-isokinetic sampler, typically an open-mouthed bottle or weighted-bottle sampler.

Sample volumes collected as part of EWI sample or a multiple vertical non-isokinetic sample will be composited in an 8-liter polypropylene churn splitter. All sample aliquots for analysis, whether whole-water or filtered, will be taken from the churn splitter.

Table 2. Isokinetic samplers and their associated use criteria.

Sampler Designation	Nozzle ID (in)	Con-tainer Size	Maximum Depth (ft)	Minimum Velocity (ft/sec)	Maximum Velocity (ft/sec)	Un-sampled Zone (in)	Weight (lbs)
US DH-81	3/16	liter	9	2.0	6.2	4	1
US DH-81	1/4	liter	9	1.5	7.6	4	1
US DH-81	5/16	liter	9	2.0	7	4	1
US DH-2	3/16	liter	35	2.0	6	3.5	30
US DH-2	1/4	liter	20	2.0	6	3.5	30
US DH-2	5/16	liter	13	2.0	6	3.5	30
US DH-95	3/16	liter	15	1.7	6.2	4.8	29
US DH-95	1/4	liter	15	2.0	7.4	4.8	29
US DH-95	5/16	liter	13.3	2.0	7.0	4.8	29
US D-95	3/16	liter	15	1.7	6.2	4.8	64
US D-95	1/4	liter	15	1.7	6.7	4.8	64
US D-95	5/16	liter	15	2.0	6.7	4.8	64

Abram Creek
USGS personnel collect water samples from Abram Creek at the Oakmont streamflow gaging station. At low flows samples will be collected by wading, using a USGS DH-81 sampler, at or downstream from the Mineral County Route 2 bridge. At storm flows samples will be collected using either a D-95 sampler or DH-95 sampler suspended from the Mineral County Route 2 bridge.

Patterson Creek
USGS personnel collect water samples from Patterson Creek at the Headsville streamflow gaging station. At low flows samples will be collected by wading, using a USGS DH-81 sampler. At storm flows

samples will be collected using either a D-95 sampler or DH-95 sampler suspended from the WV Route 46 bridge near Champwood, WV, downstream from the gaging station.

South Branch Potomac River
USGS personnel collect samples from the South Branch Potomac River near Springfield using the EWI method. At low flows samples will be collected by wading, using a USGS DH-81 sampler. At storm flows samples will be collected using either a D-95 or a DH-95 sampler suspended from the W. Va. Secondary Route 3 bridge downstream from the gaging station.

Cacapon River
USGS personnel collect Cacapon River water samples at the USGS gaging station near Great Cacapon. At low flows samples will be collected by wading, using a USGS DH-81 sampler. At storm flows samples will be collected using a DH-95 sampler suspended from the W. Va. Secondary Route 7 low-water bridge up to a stage of 4 feet, when sampling from the low-water bridge becomes dangerous. At stages exceeding 4 feet samples will be collected from the WV Route 9 bridge using a D-95 sampler suspended from a bridge crane.

Warm Springs Run
USGS personnel collect Warm Springs Run water samples at the USGS gaging station near Berkeley Springs. At low flows samples will be collected by wading, using a USGS DH-81 sampler. At storm flows samples will be collected using a either a D-95 sampler or DH-95 sampler suspended from a bridge crane on the Morgan County Route 38-8 (Jimtown Road) bridge.

Back Creek
USGS personnel collect Back Creek water samples at the USGS gaging station at Jones Springs. At low flows, samples will be collected by wading, using a USGS DH-81 sampler, downstream from the bridge. At storm flows, samples will be collected using a either a D-95 sampler or DH-2 sampler suspended from the Berkeley County Route 6 bridge.

Mill Creek
USGS personnel collect Mill Creek water samples at the USGS gaging station at Bunker Hill. At low flows, samples will be collected by wading, using a USGS DH-81 sampler. At storm flows, samples will be collected using a either a D-95 sampler or DH-2 sampler suspended from a bridge crane on the U.S. Highway 11 bridge.

Opequon Creek
USGS personnel collect Opequon Creek water samples at the stream flow gaging station near Martinsburg. Low-flow samples will be collected by wading at a cross section about 40 feet upstream from the bridge using a USGS DH-81 sampler. Storm-flow samples will be collected using a either a D-95 sampler or DH-2 sampler suspended from the bridge on State Route 9, at the gaging site.

Rockymarsh Run
USGS personnel collect Rockymarsh Run water samples at the USGS gaging station at Scrabble. All samples will be collected from the County Road 5 (Scrabble Road) bridge. At low flows, samples will be collected using a USGS DH-81 sampler. At storm flows, samples will be collected using either a USGS DH-81 sampler or a DH-95 sampler.

Shenandoah River
USGS personnel collect all Shenandoah River water samples from the WV 115 bridge. Low-flow samples will be collected with a DH-95 if stream velocities are sufficient to use this sampler or an open-

mouth bottle if velocities are insufficient. Storm-flow samples will be collected with either a DH-95 or a D-95depending on stream velocities.

Constituents Monitored

The monitoring program focuses on quantifying the water quality and loads of major nutrient species and suspended sediment from Abram Creek, Patterson Creek, South Branch of the Potomac River, Cacapon River, Warm Springs Run, Back Creek, Mill Creek, Opequon Creek, Rockymarsh Run, and Shenandoah River. Chemical parameters monitored for the program include:

WTC	water temperature, °C
SC	specific conductance
pH	pH
DO	dissolved oxygen
Turb	turbidity
TDN	total dissolved nitrogen
PN	total particulate nitrogen
NO_2	dissolved nitrite
NH_4	dissolved ammonia as N
NO_{23}	dissolved nitrate plus nitrite as N
TP	total phosphorus
o-PO_4	dissolved orthophosphorus as P
TSS	total suspended solids
SSC	total suspended sediment

Analytical methods for these constituents are shown in table 3.

B.3 Sample Handling and Custody

Sample Treatment and Preservation

Water-quality samples collected by the USGS (Wilde and others, 1998) are split using a polypropylene churn splitter. The composite sample is introduced into a pre-cleaned plastic churn splitter and sub-samples for whole-water, total-dissolved solids, and suspended sediment concentration analysis are drawn while churning at a rate of 1.0 ft/second. An aliquot of water drawn from the churn is passed through a glass-fiber filter and the material retained on the filter is analyzed for total particulate nitrogen concentration. The remaining samples are filtered on site for dissolved-constituent analysis using a 0.45-micrometer (average pore size, polycarbonate) capsule filter (Wilde and others, 1998). Sulfuric acid (4.5N) is added to the bottle to be analyzed for whole-water nutrients for preservation Nutrient samples are placed immediately on ice and chilled to a temperature of 4 degrees Celsius. Nutrient and total suspended solids samples are shipped to the USGS NWQL in Denver, CO according to USGS National Water Quality Laboratory guidance. Suspended-sediment samples are shipped to the USGS Sediment Laboratory in Louisville, Kentucky, for analysis.

Table 3. Chesapeake Bay Non-Tidal Monitoring sampling parameters.
[NA, not applicable; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; FNU, formazin nephelometric units; wf, filtered water sample; wu, unfiltered water sample, USGS, United States Geological Survey; NWQL, National Water Quality Laboratory; KYSL, Kentucky Sediment Laboratory, WVWSC, West Virginia Water Science Center; NFM, National Field Manual]

Analyte	**Parameter Code**	**Duet Method Code**	**Unit**	**Reporting level**	**Analyzing Entity**	**Method**	**Method Reference**
Ammonia as N, wf	00608	NH4F	mg/L	0.01 mg/L	USGS NWQL	colorimetry, salicylate-hypochlorite	Fishman (1993)
Nitrite as N, wf	00613	NO2F	mg/L	0.001 mg/L	USGS NWQL	colorimetry	Fishman (1993)
Nitrate and Nitrite as N, wf	00631	NO23F	mg/L	0.04 mg/L	USGS NWQL	colorimetry, enzyme reduction-diazotization	Patton and Kryskalla (2011)
Total Particulate Nitrogen	49570	PN	mg/L	0.03 mg/L	USGS NWQL	Combustion and Thermal Conductivity	EPA 440.0
Total Nitrogen, wf	62854	TDN	mg/L	0.05 mg/L	USGS NWQL	Alkaline persulfate digestion	Patton and Kryskalla (2003)
Phosphorus, wf	00666	TDP	mg/L	0.003 mg/L	USGS NWQL	colorimetry	EPA 365.1
Orthophosphate as P, wf	00671	PO4F	mg/L	0.004 mg/L	USGS NWQL	colorimetry, DA, Phosphomolybdate	Fishman (1993)
Phosphorus, wu	00665	TP	mg/L	0.01 mg/L	USGS NWQL	Alkaline persulfate digestion	Patton and Kryskalla (2003)
Total suspended solids, Residue at 105 °C	00530	TSS	mg/L	15 mg/L	USGS NWQL	Gravimetry	Fishman and Friedman (1989)
Suspended sediment concentration	80154	SSC_TOTAL	mg/L	0.5 mg/L	USGS KYSL	Hydroscopic glass-fiber filtration	Shreve and Downs (2005)
Suspended sediment, sieve diameter, percent smaller than 0.0625 millimeters	70331	SSC_%FINE	percent	NA	USGS KYSL	seive, gravimetry	Shreve and Downs (2005)

Table 3. Chesapeake Bay Non-Tidal Monitoring sampling parameters (continued).

[NA, not applicable; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; FNU, formazin nephelometric units; wf, filtered water sample; wu, unfiltered water sample, USGS, United States Geological Survey; NWQL, National Water Quality Laboratory; KYSL, Kentucky Sediment Laboratory, WVWSC, West Virginia Water Science Center; NFM, National Field Manual]

Analyte	**Parameter Code**	**Duet Method Code**	**Unit**	**Reporting level**	**Analyzing Entity**	**Method**	**Method Reference**
Water temperature	00010	WTEMP	° C	NA	USGS WVWSC	--	USGS NFM, Chapter A6 (variously dated)
Specific conductance	00095	SPCOND	µS/cm	0.1 µS/cm	USGS WVWSC	--	USGS NFM, Chapter A6 (variously dated)
pH	00400	PH	Standard units	NA	USGS WVWSC	--	USGS NFM, Chapter A6 (variously dated)
Dissolved oxygen	00300	DO	mg/L	0.2 mg/L	USGS WVWSC	--	USGS NFM, Chapter A6 (variously dated)
Turbidity	73680	TURB_FNU	FNU	0.1 FNU	USGS WVWSC	--	USGS NFM, Chapter A6 (variously dated)

B.4 Analytical Methods

Analytical Methods employed Analytical methods for these constituents are documented in table 3 and described in the USGS National Water-Quality Laboratory documents.

Laboratory Analysis

Water-quality samples collected by the USGS for the Non-Tidal Monitoring Program are analyzed by the USGS National Water-Quality Laboratory (NWQL) in Denver, CO. Analytical techniques employed by the laboratory are documented in table 3. Sediment samples are analyzed by the USGS Sediment Laboratory in Louisville, Kentucky (Shreve and Downs, 2005).

B.5 Quality Assurance/Quality Control

Quality assurance and quality control are a significant component of the monitoring program. The quality-assurance effort includes documentation of concentration variability within the cross section, sediment-transport analysis, quality assurance of sample-collection techniques and field personnel, and accounting for variability within and among the analyzing laboratories. Sample collection and processing, and data handling are performed in accordance with the USGS West Virginia Water Science Center's Water-Quality Quality Assurance plan. Quality-assurance results can be obtained from: USGS West Virginia Water Science Center, at 11 Dunbar Street, Charleston, WV, 25301.

Laboratory quality-control methods are documented in the USGS National Water-Quality Laboratory Quality Management System (Maloney, ed. 2005); available at http://pubs.usgs.gov/of/2005/1263/.

Field quality control is checked during random field audits. The Quality Assurance officer assures that samples were collected, labeled, and preserved according to standard operating procedures. A field checklist will be prepared, and a summary report will be submitted. All USGS field staff that collect samples are enrolled in the USGS's National Field Quality Assurance Program (NFQA). The NFQA provides blind samples to be measured for pH, specific conductance, and alkalinity and are used as a measure of staff proficiency.

Both blanks and replicates are collected at every site each year. Blank samples are used to determine the extent to which sampling procedures may contaminate samples, thereby biasing analytical results. Replicate samples are used to determine the variability inherent in the collection and analysis of environmental samples. Together, blank and replicate samples can be used to characterize the accuracy and precision of water-quality data. All quality-assurance samples were collected and processed according to protocols described in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, 2006).

At least one field blank is collected at each site. Field blanks are collected in the field, with a volume of inorganic blank water being passed through each piece of equipment used in sample collection. Detection of an analyte above the method reporting level will prompt either additional field blanks or equipment blanks in order to isolate the source of contamination.

Replicate samples will be collected at least twice per year at each site. Two types of replicates samples will be collected at each site, a split replicate or a concurrent replicate. A split replicate is a second aliquot drawn from the same depth- and width-integrated composite sample and serves as a measure of variability within sample processing and laboratory analysis. A concurrent replicate is from an additional depth- and width-integrated composite sample collected at the same time as the main sample and serves as a measure of variability within the sampling process. Results for the main and replicates samples should typically agree within 15-20 relative percent difference.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

All instruments and sampling equipment used are owned and maintained by the USGS WVWSC. Instrument probes are cleaned and thoroughly inspected between sampling events. If any probe is not functioning correctly, it is determined whether it is necessary to perform maintenance and/or replace (retire) the instrument.

Physical sampling gear is inspected before each use to assure that all parts are intact. Any gear that shows operational deficiency is not used until repairs can be made. Any gear that is not repairable is replaced.

B.7 Instrument Calibration and Frequency

The meters used to determine field parameters are calibrated daily. Specific instructions for calibration are found in the operating manuals provided with the instrument. Fresh standards are available for calibration prior to each sampling period. The field technician is responsible for appropriate calibration. Instruments used and calibration acceptance limits are presented in Table 4. Hydrologic technicians adhere to USGS calibration criteria (USGS NFM, variously dated).

Table 4. Field measure ment instruments and calibration criteria for West Virginia Non-Tidal Monitoring Network.

[°C, degrees Celsius; µS, microSiemen; cm, centimeter; mg/L, milligram per liter; FNU, formazin nephelometric units]

Parameter	Sensor type	USGS calibration criteria
Water temperature, in °C	Elecronic thermister	±0.2
Specific conductance, in µS/cm at 25° C	Specific conductance sensor	±5 or ±3% of measured value, whichever is greater
pH	Electrochemical sensor	±0.2
Dissolved oxygen, in mg/L	Optical luminescence sensor	±0.3
Turbidity, in FNU	monochrome near infra-red LED light, 780-900 nm, detection angle 90 +-2.5 degrees	±0.5 or ±5% of measured value, whichever is greater

A calibration record is maintained for each unit in a logbook. This log serves as documentation for pre- and post-calibration information for each parameter recorded. The log is useful in determining drift in a probe, which indicates that maintenance is necessary for maintenance. The field technician remains aware of questionable performance of any instruments, and determines when it is necessary to perform maintenance and/or replace an instrument.

B.8 Inspection Acceptance Requirements for Supplies and Consumables

The field technician routinely inspects equipment and supplies. The field technician is responsible for determining when supplies and consumables should be discarded. Special attention should be paid to the condition of any filtration supplies (filters, bottles, etc.) and ultra-clean gear to assure that they are uncontaminated. If contamination is suspected, the supplies should be discarded. Any supplies that have exceeded their expiration date are disposed of.

B.9 Data Acquisition

Streamflow data is a necessary data input in the load estimation model. Site summaries of historic streamflow conditions are shown in Table 5. Period of record indicates the period for which there are published discharge values for the USGS station. The annual mean for the period of record is the arithmetic mean of the individual daily-mean discharges for the designated period of record. The highest and lowest daily means are the maximum daily-mean discharge and minimum daily-mean discharge, respectively, for the designated period of record.

Daily-mean discharges are computed by applying the daily mean stages (gage heights) to the stage-discharge curves (James and others, 2003). The USGS provides stage and discharge data for gaging stations on the internet. These data may be accessed at http://wv.usgs.gov.

B.10 Data Management

All data will be recorded using the PCFF software package or standardized data sheets (see Attachment B) for the specific projects. Data sheets will be coded with a site code (station name and station number, date, collection time, and collector's initials). These data will be entered into the USGS's National Water Information System's QWDATA water-quality database by the technicians who collect the data. All data files will be documented in metadata files. Data files will be maintained on the USGS computer network and backed up by on tape and at an offsite computer. The USGS WV Water Science Center in Charleston will house the archived copies of paper forms collected before the use of PCFF, and electronic .pdf-format field forms are maintained in the data archive directory of the WV-WSC file server. Summary statistics are calculated and diagnostic graphs are prepared to identify anomalies in the data. All data anomalies are verified against the raw data and corrected if necessary. If data do not meet data-quality objectives, the values are flagged for exclusion from the data set and reasons for exclusion documented. USGS staff transmit data annually to the Chesapeake Bay Program through the Data Upload and Evaluation Tool (DUET). DUET runs a series of logic and completeness tests to validate the data submission. Metadata files created by the data manager and linked to the data files also will be transferred to WVDEP. Additionally, further data requests can be coordinated by contacting Doug Chambers at the USGS West Virginia Water Science Center.

Table 5. Potomac River Non-Tidal Monitoring site drainage area and historic streamflow conditions.
[mi^2, square miles; ft^3/s, cubic feet per second]

Period of Record	Drainage (sq. mi.)	Period of Record Annual Mean discharge (ft^3/s)	Highest Daily Mean discharge (ft^3/s)	Lowest Daily Mean discharge (ft^3/s)
Abram Creek at Oakmont, WV (01595300)				
1956 to 1982, 2012 to Present Year	42.6	68.4	1,480	0.20
Patterson Creek near Headsville, WV (01604500)				
1938 to Present Year	221	173	11,100	0.48
South Branch Potomac River near Springfield, WV (01608500)				
1894 to 1896 (fragmentary), 1899 to 1901, 1903 to 1906, 1928 to Present Year	1,461	1,353	145,000	52
Cacapon River near Great Cacapon, WV (01611500)				
1922 to 1995, 1996 to Present Year	675	592	67,900	26
Warm Springs Run near Berkeley Springs, WV (01613030)				
2011 to Present Year	6.76	8.11	192	2.2
Back Creek near Jones Springs, WV (01614000)				
1928 to 1931, 1938 to 1975, 1992 to 1998, 2004 to Present Year	235	198	14,800	1.1
Mill Creek at Bunker Hill, WV (01616400)				
2011 to Present Year	18.4	16.8	293	2.2
Opequon Creek near Martinsburg, WV (01616500)				
1905 to 1906, 1947 to Present Year	273	246	15,000 (estimated)	26
Rockymarsh Run at Scrabble, WV (01618100)				
2008 to Present Year	15.9	11	119	3.40
Shenandoah River at Millville, WV (01636500)				
April 1895 to March 1909, August 1928 to present year	3,041	2,755	192,000	194

C. Assessment/Oversight

C.1 Assessment and Response Actions

The USGS quality-assurance officer will conduct random field and office audits to ensure that data collection and data manipulation follow guidelines set forth in the to the quality-assurance plan. A minimum of one field audit will be conducted each year. The field audit will consist of examining all aspects of the field collection for accuracy and adherence to sampling procedures. The field audit will be representative of all sites, but will not necessarily require a visit to each site. A summary report documenting the field activities will be provided. Office audits will be conducted to ensure that all logs are completed and up-to-date, and that proper data management and manipulation is being conducted. The principal investigator will be immediately notified of any deficiencies and take immediate corrective actions.

The project coordinator will continually monitor the logs and records associated with the project to assure that project schedules are being met. The project coordinator will immediately take any corrective action necessary if project schedules and procedures are being violated. The quality-assurance officer will perform and report on technical system audits and data-quality audits. Data-quality assessments will be conducted to determine whether the assumptions were met.

A USGS Water Science Center Water-Quality Review is held every three years by the USGS Regional Water-Quality Specialist and Regional Staff. Field methods are observed for consistency with USGS procedures and the District water-quality database (QWDATA) and the national database (STORET) are in agreement.

C.2 Reports to Management

Progress reports will be submitted from the USGS to WVDEP to describe semi-annual project activities (Attachment B). Any deviations from scheduled project activities will be noted and the effect of these deviations on the final project outcome will be described. Corrective measures will also be suggested. The Project Chief (USGS) will be responsible for producing and distributing progress reports. Additionally, progress will be reviewed during USGS West Virginia Water Science Center reviews held three times a year.

D. Data Validation and Usability

D.1 Data Review, Validation, and Verification

Data will be verified using a previously developed data quality-control system. After being scrutinized during the data-entry phase, data are analyzed and plotted to examine any outliers or anomalies. These are then examined, verified, and corrected if necessary. Field audits are performed to assure that all data are collected according to standard operating procedures, and that the collection effort is consistent and equal. The USGS Project Chief is responsible for performing quality control, or assuring that quality control is performed by appropriate staff.

All field logs and information are thoroughly reviewed prior to data analysis to assure that all data were collected uniformly. Any data that are not collected according to standard operating procedures are examined to determine whether they are representative. All quality-assurance reports are examined prior to data analysis to verify that data were properly and consistently collected. Any deviations in data collection are taken into account during data analysis. All calibration logs are examined to determine how well the measurement instruments performed. If there appears to be significant drift in instrument performance, the data are adjusted accordingly. Original (raw) data are retained by the Project Chief.

D.2 Validation and Verification Methods

The field technician or senior field staff person will verify all data entered in the field. This person will examine all data entry to ensure that they are accurate and complete. All field validation must occur prior to leaving the site.

A substantial effort is incorporated into the monitoring program to document and ensure quality assurance (QA) and quality control (QC). The quality-assurance effort includes documentation of observed concentration variability within the cross section, sediment transport analysis, quality assurance of sample-collection techniques and field personnel, and the variability within and among the analyzing laboratories. Field quality control is verified during random field audits. The QA officer assures that samples are collected, labeled and preserved in accordance with standard operating procedures. Field blanks and trip blanks are submitted to evaluate the potential for contamination of samples during their collection, processing, and transport.

E. References

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Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., eds, 1998, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, Handbooks for Water-Resources Investigations, [variously paged].

F. Log of Significant Changes

Changes to the West Virginia portion of the Non-Tidal Monitoring Network are described below. These changes include start of sampling at any station, changes to analytical methods, and change I location of sample collection.

Date	Change
8 June 2005	USGS West Virginia Water Science Center began collecting depth- and width-integrated samples using isokinetic samplers at four Non-Tidal Monitoring stations; Patterson Creek near Headsville, WV (USGS 01604500), South Branch Potomac River near Springfield, WV (USGS 01608500), Cacapon River near Great Cacapon, WV (01611500), and Opequon Creek near Martinsburg, WV (01616500).
7 May 2009	Opequon Creek storm sample collection site moved from Paynes Ford Bridge to new WV Route 9 bridge. The new bridge offers safer sampling much closer to the streamflow gage and the low-flow sampling site.
14 June 2011	The collection of samples from Rockymarsh Run at Scrabble, WV (USGS 01618100) began using the sample sampling methods as the first four stations.
12 July 2011	The collection of samples from Warm Springs Run near Berkeley Springs, WV (USGS 01613030) and Mill Creek at Bunker Hill, WV (USGS 01616400) began.
11 June 2012	The collection of samples from Abram Creek at Oakmont, WV (USGS 01595300) and Back Creek near Jones Springs, WV (USGS 01614000) began.
14 June 2012	Collection of samples from the Shenandoah River at Millville, WV (USGS 01636500) began. This sampling was funded by the Maryland Department of Natural Resources.
10 December 2012	Changed analytical method for total nitrogen from direct analytical determination using the alkaline persulfate method to the summation of total dissolved nitrogen and total particulate nitrogen. This change affected all stations except the Shenandoah River at Millville, where this method had been used from the beginning of sample collection.

Attachment A: Example of Quarterly Report to West Virginia Department of Environmental Protection

SAMPLE

West Virginia Non-Tidal Monitoring Program : *Semi-Annual Progress Report*

Monitoring Sites:

- (01604500) Patterson Creek near Headsville, WV
- (01608500) South Branch of the Potomac River near Springfield, WV
- (01611500) Cacapon River at Great Cacapon, WV
- (01613030) Warm Springs Run near Berkeley Springs, WV
- (01616400) Mill Creek at Bunker Hill, WV
- (01616500) Opequon Creek near Martinsburg, WV
- (01618100) Rockymarsh Run at Scrabble, WV

Report Period: May 1, 2011 – November 30, 2011
Funding: West Virginia Department of Environmental Protection (WVDEP) and U.S. Geological Survey (USGS)
Start Date: June 2005
Completion Date: continuous

Project Personnel: USGS Chief: Doug Chambers; USGS Lead Technician: Jeremy White and additional assistance from various other USGS and WVDEP personnel.

Project Objectives:

Determine the ambient concentration of nutrient and suspended sediment water-quality samples collected over a range in flow conditions in four West Virginia tributaries to the Potomac River: Patterson Creek, the South Branch of the Potomac River, The Cacapon River, Warm Springs Run, Mill Creek, Opequon Creek, and Rockymarsh Run.

Sampling Events:

	Sample Type		
	Routine	**Storm**	**QA/QC**
Patterson Creek Nr Headsville	6	4	2
So. Br. Potomac @ Springfield	6	3	1
Warm Srpings Run	6	3	1
Mill Creek @Bunker Hill	6	4	1
Cacapon River @ Great Cacapon	6	4	1
Opequon Cr. Nr Martinsburg	6	3	1

SAMPLE

Attachment B: Example of archived electronic field form in .pdf format produced by the PCFF program.

Attachment C: Example of archived electronic National Water Quality Laboratory Analytical Service Request in .pdf format produced by the PCFF program.

U.S. GEOLOGICAL SURVEY- NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

THIS SECTION MANDATORY FOR SAMPLE LOGIN

LAB USE ONLY SAMPLE ID NUMBER	WV User Code	GR15LM00EFN5X00 Project Account	LAB USE ONLY NWQL LABORATORY ID

01595300	2015 09 09	12:35	WS	9
STATION ID	Begin Date (YYYYMMDD)	Begin Time	Medium Code	Sample Type

304 590 1276			dbchambe@usgs.gov
Science Center Contact Phone Number	End Date (YYYYMMDD)	End Time	**Science Center Contact Email**

SITE / SAMPLE / SPECIAL PROJECT INFORMATION (Optional)

State	County	Source Agency	Analysis Status*	Hydrologic Condtion*	Hydrologic Event*	Chain of Custody	Sample Set
		USGS	U	9	9		

NWQL Proposal Number NWQL Contact Name NWQL Contact Email Program/Project

Station Name: ABRAM CREEK AT OAKMONT, WV Field ID

Comments to NWQL:
250 ml used for TPCN

HAZARD (please explain):

ANALYTICAL WORK REQUESTS: SCHEDULES AND LAB CODES (A=add D=delete)

SCHED1: 2532

Lab Code: 2756 D

SHIPPING INFORMATION (please fill in number of containers sent)

1 FCC 1 SUSO 1 TPCN 1 WCA

NWQL Login Comments:

Collected by: **M.A. Gress** Phone No.: **804 291 6729** Date Shipped: 09/11/2015

FIELD VALUES

Lab/P Code	Value	Remark	Lab/P Code	Value	Remark	Lab/P Code	Value	Remark
21/00095 Specific Conductance uS/cm @ 25 deg C	640		51/00400 pH Standard Units	7.68		2/ALK Alkalinity - IT mg/L as CaCO3		

Lab/P Code	Value
PCFF/___	7

USDA ☐

Lab Use Only

NWIS RECORD NUMBER

Printed from PCFF 7.2R0 Revised 07/07

Form 9-3094
(February 2015)

*MANDATORY FOR NWIS

U.S. GEOLOGICAL SURVEY- NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

THIS SECTION MANDATORY FOR SAMPLE LOGIN

LAB USE ONLY SAMPLE ID NUMBER	WV User Code	GR15LM00EFN5X00 Project Account	LAB USE ONLY NWQL LABORATORY ID

01595300 STATION ID

2015 09 09 Begin Date (YYYYMMDD) | **12:35** Begin Time | **WS** Medium Code | **9** Sample Type

304 590 1276 **Science Center Contact Phone Number**

End Date (YYYYMMDD) | End Time

dbchambe@usgs.gov **Science Center Contact Email**

SITE / SAMPLE / SPECIAL PROJECT INFORMATION (Optional)

State	County	Source Agency	Analysis Status*	Hydrologic Condtion*	Hydrologic Event*	Chain of Custody	Sample Set
		USGS	U	9	9		

NWQL Proposal Number | NWQL Contact Name | NWQL Contact Email | Program/Project

Station Name: **ABRAM CREEK AT OAKMONT, WV** Field ID

Comments to NWQL:
250 ml used for TPCN

HAZARD (please explain):

ANALYTICAL WORK REQUESTS: SCHEDULES AND LAB CODES (A=add D=delete)

SCHED1: 2532

Lab Code: 2756 D

SHIPPING INFORMATION (please fill in number of containers sent)

1 FCC 1 SUSO 1 TPCN 1 WCA

NWQL Login Comments:

Collected by: **M.A. Gress** Phone No.: **804 291 6729** Date Shipped: 09/11/2015

FIELD VALUES

Lab/P Code	Value	Remark	Lab/P Code	Value	Remark	Lab/P Code	Value	Remark
21/00095 Specific Conductance uS/cm @ 25 deg C	640		51/00400 pH Standard Units	7.68		2/ALK Alkalinity - IT mg/L as CaCO3		

Lab/P Code	Value
PCFF/___	7

USDA ☐
Lab Use Only

NWIS RECORD NUMBER

Printed from PCFF 7.2R0 Revised 07/07

Form 9-3094
(February 2015)

*MANDATORY FOR NWIS

November 2006

U. S. GEOLOGICAL SURVEY SURFACE-WATER QUALITY

FIELD ID ____________________

NWIS RECORD NO (01) 01500266

Station No. USGS 01595300 Station Name ABRAM CREEK AT OAKMONT, WV

Sample Date 09/09/2015 Mean Sample Time (watch) 12:35 End Date End Time

Sample Medium (WS) Surface water Sample Type (9) Regular

Sample Purpose (71999): (40) SW Network Purpose of Site Visit (50280)(1001) Fixed frequency SW

Project No. GR15LM00EFN5X00 Project Name CBP EPA QC Samples Collected? ☐

Sampling Team MAG/CJM Team Lead Signature ____________________ Date __________

Temperature, air(Method:Temperature, air, liq-in-glass)	00020	THM05	29.5	deg C
Temperature, water(Method:Temperature, water, thermistor)	00010	THM01	19.97	deg C
Air pressure(Method:Atmospheric pressure, barometer)	00025	BAROM	716	mm/Hg
Specific cond at 25C(Method:Specific conductance sensor)	00095	SC001	640	uS/cm @25C
Air pressure(Method:Atmospheric pressure, barometer)	00025	BAROM	716	mm/Hg
Dissolved oxygen(Method:Diss oxygen, luminescence sensor)	00300	LUMIN	8.51	mg/l
pH(Method:pH, field, electrometric)	00400	PROBE	7.68	std units
Turbidity, Form Neph(Method:YSI Environmental, sensor 6136)	63680	TS087	0.1	FNU

SAMPLING INFORMATION

Parameter	Value
Analysis Status	(U) Unrestricted
Hydrologic Condition	(9) Stable, normal stage
Hydrologic Event	(9) Routine sample
Sample method (82398)	(15) Multi Verticals EWT
Nozzle Dia (72220)	
Splitter type(84171)	(30) CS p 8L cubtnr spgt
Splitter ID:	

Sampler Type (84164) (3044) US DH-81
Sampler ID:
Sampler Bag/Bottle Material(84182): (2) Plastic

Nozzle Material(72219)

SAMPLING CONDITIONS

Cross Section: Open
Type of Flow: Riffle
Stage: Stable Normal
Stream Mixing: well mixed
Stream Color: Clear
Bottom Conditions: Boulder,Cobble
Sample location, upstream (72105/) ft 25
Weather Comments

Sky Cloudy
Temperature: Hot
Wind Speed(00035):
Percent Cloud Cover (00032):
Days Since last rainfall event (72053):
WeatherCode (00041)

Field Sample Comments (for NWIS, 300 characters max.):

No Nozzle, no flow from US RB Trib.

FIELD OBSERVATIONS

Floating debris, severity(01345): **None**
Suds, severity(01305): **None**
Float.Garbage, svrty(01320): **None**
Turbidity, severity(01350): **None**

Floating algae mats, severity(01325): **None**
Odor, severity(01330): **None**
Dead fish, severity(01340): **None**
Oil & grease, severity(01300): **None**

LOT NUMBERS

25mm glass fiber filter	
47mm Baked glass fiber filter	
Disk Filter	21854151

Pesticide Spike (acid):	
Pesticide Spike (Base):	
VOC spike:	

Volume of filtered water for PC/PIC	250
Filter A	50424716
Filter B	50424716
Filter C	50424716

	Lot Number	Description
OTHER:		
OTHER:		
OTHER:		
OTHER:		
OTHER:		

NWIS LOT NUMBERS:

NWIS LOT #	(pcode)	Description	Manufacture Lot #
40176	(99156)	H2SO4, 4.5N (1:7), 1mL, Whole Water (WCA), Nutrient/Carbon	SA-5040030

CROSS SECTION/PROFILE NOTES

No. of sampling pts. (00063/)	count	10	Right Bank	0
Stream width (00004/)	ft	18	left Bank:	18
Stream velocity (81904/V-EST)	ft/sec	1.5 ≤	Mean Depth (ft):	
Transit rate, sampler (50015/)	ft/sec	0.1	Ice Cover (%)	
			Ice Thickness (in)	

METER MAKE/MODEL: **13F100389/6920 V2**

STA	ft From R Bank	TIME	DEPTH ()	SAMPLE DEPTH ()	pH (00400) Method (PROBE)	T°C (00010) Method (THM01)	SC (00095) Method (SC001)	DO (00300) Method (LUMIN)	TUR (63680) Method (TS087)	NWIS DB	NWIS RECORD
	1.8	12:45	0.4		7.72	20	639	8.48	0.1	98	01501008
	5.4	12:46	0.5		7.69	19.97	639	8.47	0.1	98	01501009
	9	12:47	1.2		7.68	19.94	640	8.51	0.1	98	01501010
	12.6	12:48	1.2		7.67	19.95	640	8.56	0	98	01501011
	16.2	12:49	0.7		7.67	20.03	640	8.58	0	98	01501012

Temperature, water -Temperature, water, thermistor (00010/THM01)

Mtr W-no. or thermometer no. 13F100389 Date NIST/ASTM checked:

Temperature subsample from or measurement location: Median (Cross Section)

Field Readings

MEDIAN:	RMK	Qualifier
19.97 deg C		

pH -pH, field, electrometric (00400/PROBE)

METER MAKE/MODEL: SERIAL (13F100389) MAKE/MODEL:Constance

Thermister Check:

pH subsample from or measurement location: Median (Cross Section)

Temp	pH Chart	Inital Read	Calibrated?	After Adj.	Slope	Millivolts
			☐			
			☐			
			☐			

Field Readings

MEDIAN:	RMK	Qualifier
7.68 std units		

Specific cond at 25C -Specific conductance sensor (00095/SC001)

METER MAKE/MODEL S/N 13F100389 Thermister Check:

Sample: Median (Cross Section)

Temp	Inital Read	Calibrated?	After Adj.	pct. error
		☐		
		☐		
		☐		

Field Readings

Correction Factor:

MEDIAN	RMK	Qualifier
640 uS/cm @25C		

Dissolved oxygen -Diss oxygen, luminescence sensor (00300/LUMIN)

Thermister Check Date:

D.O. Zero Check Date:

METER MAKE/MODEL S/N 13F100389

Calibration : Sample: Median (Cross Section)

CALIB. TEMP ° C	BAROMETRIC PRESSURE mm Hg	DO TABLE READING mg/L	SALINITY CORR FACTOR	DO BEFORE ADJ.	DO AFTER ADJ.

FIELD READINGS

MEDIAN	RMK	Qualifier
8.51 mg/l		

Turbidity, Form Neph -YSI Environmental, sensor 6136 (63680/TS087)

METER MAKE/MODEL S/N 13F100389 Date last checked:

Sample: Collection Time: Measurement Time:

Measurement: Median (Cross Section)

Sample diluted ☐ VOL. OF DILUTION WATER (mL) SAMPLE VOLUME (mL)

Calibration Criteria ±0.5 TU or ± 5%	Lot Number	Date Prepared	Expiration Date	Concentration	Temperature °C	Inital Insturment Reading	Reading after adjustment

FIELD READINGS

MEDIAN	RMK	Qualifier
0.1 FNU		

Calibration Notes and Remarks

Approvals:

22 Dec 2015

Douglas B. Chambers, Project Chief, USGS

Date

12/28/15

John Wirts, Project Coordinator, WVDEP

Date

1/5/2015

Matthew Monroe, Environmental Coordinator, WVDA

Date

12/21/2015

James Hargett, CBPO Project Officer

Date

12/15/2015

Richard Batiuk, CBPO QA Officer

Date