New Jersey Department of Environmental Protection
Water Resources Management
Water Monitoring and Standards
Bureau of Freshwater and Biological Monitoring

Work/Quality Assurance Project Plan

Stream Monitoring for Effects on Water Quality by Road Salt Application

2019-2020

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1.0 Project Name : Stream Monitoring for Effects on Water Quality by Road Salt Application; 2019-2020

2.0 Project Requested by :
NJDEP, Bureau of Freshwater and Biological Monitoring and Bureau of Analysis Restoration and Standards

3.0 Date of Project :
2019-2020

4.0 Project Fiscal Information: Job Number 35950000, Activity Code V38A

5.0 Project Officer :
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6.0 Quality Assurance Officer :
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7.0 Special Training Needs/Certification

Assistants to the project will be trained in the operation and use of all sampling equipment. The training will entail calibration methods, deployment techniques and data retrieval from the equipment. The Project Officer or designee will be responsible for any necessary training.

The Bureau of Freshwater and Biological Monitoring is certified by the Office of Quality Assurance (certified lab ID # 11896) for the following parameters during field work for this project: temperature, pH, conductance, dissolved oxygen (DO), turbidity.

8.0 Project Description:

8.1 Objective

This is a continuation of a project started in 2017 to assess the effects on water quality due to road salt application. This will be accomplished through continuous year-round monitoring of specific conductance as a surrogate measure for road salt chemicals. Specific conductance measurements will be entered into a database that will examine critical high specific conductance levels observed in the winter, the duration of these elevated levels, and comparisons to baseline levels and normal fluctuations throughout the year in a variety of New Jersey's non-tidal, freshwater streams.

Historical specific conductance data obtained through discrete sampling shows that during winter months (December to March), levels of specific conductance in non-tidal freshwater streams increase significantly during and after significant

snowfall events. This suggests that road salt application may be impacting water quality in these streams, but little is known about the duration or maximum values of these elevated levels.

Studies have shown significant transfer of total dissolved solids and chloride from impervious surfaces (e.g. road ways and parking lots) to adjacent water bodies after winter snowfall events. This transfer can be evident in specific conductance measurements, since specific conductance is sometimes used as a surrogate measurement of total dissolved solids and chloride.

Because the melting of snow after snowfall events is somewhat unpredictable, it is difficult to deploy staff to take targeted, discrete total dissolved solids and chloride samples. The use of data loggers will provide insight into water quality problems between scheduled discrete sampling events.

Data obtained through this project will allow for more in-depth assessment of specific conductance data as it relates to winter precipitation/snow events. In addition, data will assist in the determination of site-specific relationships between specific conductance, chloride and total dissolved solids. Information on these relationships may inform as to the determining factors influencing surface water chloride and TDS levels. Finally, data will be evaluated against geographic information system (GIS) coverages. Due to the range of variation in stream type, ground water / surface water interactions and adjacent land uses; a statewide database of continuous specific conductance data requires multiple years to develop. The data collected for this project will build on the Bureau's previous work (2011-2019). In addition, the United States Geological Survey maintains a limited number of stations where continuous specific conductance is recorded. This information can also be used to evaluate some of the objectives of this project.

8.2 Data Usage

Project data will be used to assess levels of specific conductance in relation to winter precipitation/snow events. By developing a database which exhibits winter maximum values, staff can assess whether the application of road salt before, during and after snowfall events and below freezing temperatures, has a significant impact on water quality. Data will also be used to assess the severity of potential impacts to inform and develop specific education and outreach materials in terms of best practices to minimize impacts of road de-icing. The Bureau of Freshwater and Biological Monitoring and the Bureau of Environmental Analysis and Restoration will also review data to determine if additional study or a modification of the study is necessary to effectively assess impacts of road salt operations on stream water quality.

8.3 Monitoring Design

Specific conductance data loggers are deployed year-round in targeted non-tidal, freshwater streams (See Site List Attachment A, Table 1), which are expected (based on historical discrete sample data) to exhibit elevated levels of specific conductance in winter months (December – March).

Discrete samples for total dissolved solids and chloride will also be collected at least six times annually (January, March, May, July, September, November) during data logger deployment. Samples will be collected as grab samples and submitted to a certified laboratory (New Jersey Department of Health; NJDOH).

Sites were selected with input from the Bureau of Environmental Analysis, Restoration and Standards (BEARS). Sites were specifically targeted through the following procedure:

1. Created a list of HUC14s either impaired or with high values of TDS or chloride (44 HUCs).

2. Excluded those HUCs already monitored for specific conductance for earlier rounds of this project.

3. Of the 33 remaining HUC14s, sample site selection excluded the HUC14 "Cape May Tribs West" due to potential issues of salt water impacts.

4. Of the 32 remaining HUC14s, sample site selectionexcluded the HUC14 "Metedeconk R SB (above I-195 exit 21)" because recent data suggests improved water quality.

5. Of the remaining 31 HUC14s, sample site selection excluded those with $R^2 >$ 0.80 for both the correlations of TDS:SC and Cl-:SC and/or the number of water quality samples should be sufficient (# >20) for data analysis.

6. Of the remaining 13 HUC14s, if one monitoring station was used to list 2 HUCs, the listing monitoring station is recommended for continuous monitoring, to represent both HUC14s (9 HUCs remaining).

7. The HUC14 "Red Root Creek / Crows Mill Creek" was eliminated because past sampling revealed that it is a very small tributary and goes dry in the summer.

8. Since continuous data sites are focused in the north east, two sites were added that have high values for TDS and Cl^-: Pond Run (maximum TDS=1480 mg/L; maximum Cl^-=810 mg/L) and Cooper R (Wallworth gage to Evesham Rd) (maximum TDS=445 mg/L; maximum Cl^-=200.2 mg/L), for a total of 10 sites.

8.4 Monitoring Methods/Frequency

Locating data loggers in free-flowing areas will ensure that data loggers record data which is representative of stream flow (i.e. not in impounded areas or areas where flow is impeded by debris or adjacent structures). Data loggers will be secured to the stream bottom using stainless steel cable, the units positioned

approximately six inches off the bottom. Units will also be placed in deeper areas of the stream, to reduce the possibility of the unit being frozen in ice.

Data loggers will be deployed year-round. Specific conductance measurements will be recorded every 0.5 hrs to monitor general trends and brief, but potentially significant changes in specific conductance.

Discrete grab samples for total dissolved solids and chloride will be collected six times annually during data logger deployment. In addition, analyze immediately parameters will be measured on site at the time of sample collection.

These discrete samples will be taken at all sites outlined in this QAPP except for 01467150 Copper River at Haddonfield. This site is a fixed site within the ASWQMN and therefor total dissolved solids and chloride samples are already collected quarterly at this location. ASWQMN data will be used for analysis at this location.

9.0 Sampling Procedures

9.1 General Procedures: Samples for conventional parameters (total dissolved solids, and chloride) and field parameters will be collected every other month starting in March. Discharge (flow) measurements at each station will be taken during each sampling event by BFBM staff utilizing USGS procedures. A full explanation of BFBM's procedures for discharge measurement can be found in Attachments C. Sample bottles for analytical parameters will be provided by the New Jersey Department of Health (NJDOH). Sample volume and container type will be as described in the respective laboratory's "Quality Manual" and/ or SOP, approved by the NJDEP Office of Quality Assurance (OQA). Additional information on sample requirements is included in data management tables of Attachment A.

9.2 Cleaning Sample Equipment: Because the possibility of contamination of samples is great, all sampling devices used to collect water quality samples for the parameters listed will be cleaned between each use using a 1% solution of lab detergent (Liquinox) and Deionized (PICO) water, followed by a thorough rinse with deionized (PICO) water. All equipment cleaning will be performed at BFBM's preparation laboratory.

9.3 Field Precautions for Invasives: To prevent the potential spread of nuisance or invasive organisms such as Didymosphenia sp. from stream to stream, all sampling equipment, waders, etc. will be decontaminated in the field between sites by spraying with an antibacterial spray such as Fantastik Heavy Duty All Purpose Cleaner (active ingredients; dimethyl benzyl ammonium chlorides and ethylbenzyl ammonium chlorides). Also, the use of felt-soled waders will be avoided.

9.4 In-Stream Analytical Sampling Procedures and Parameters: The collection of water quality samples will be center-flow grabs. Field readings for analyze immediately parameters (dissolved oxygen, pH, specific conductance, water temperature, air temperature and turbidity) will be made at each site during each sampling event. The chemical and field parameters are listed in Attachment A (Tables 4 & 5). Discharge measurements will be made at each station (where applicable) during each sampling event using BFBM standard operating procedures (Attachments C).

10.0 Data Quality Requirements

10.1 Data Loggers

Data will be collected using ONSET HOBO Conductivity Data Loggers (model #s 024-001 and U24-002). Data loggers will be deployed for 1 year starting in March. The data will be uploaded from the loggers about once every three months during this time. The data loggers will be deployed and utilized in accordance with the manufacturer's instructions. Additional information is available at manufacturer's website http://www.onsetcomp.com/products/data-loggers/conductivity-and-salinity.

Prior to deployment and immediately following deployment, data loggers will be checked with a conductance standard to ensure readings are within manufacturer's stated accuracy. The standard used to verify readings will be certified traceable to NIST Aqueous Electrolytic Standard Reference Solution 3193 (750 uS/cm @ 25.0 °C , since this will be the approximate expected conductivity at selected stations). To verify data quality side by side specific conductance readings will be made with a specific conductance meter probe that has been calibrated according to manufacturer's instructions at the time of data logger deployment and when data loggers are retrieved. Specific conductance measurements from the data logger will not be accepted if comparative measurements are not within the stated accuracy of the method, which is +/- 1 %. Below are the manufacturers stated accuracies for the units being deployed.

	U24-001	U24-002 & U24-002C
Range	0-10,000 µS/cm	100-65,000 µS/cm
Accuracy		
Low Range:	0 – 2,500 µS/cm 3% or 5 µS/cm Whichever is greater	100 – 55,000 µS/cm 3% or 50 µS/cm Whichever is greater
Full Range:	0 – 10,000 µS/cm 3% or 20 µS/cm	100 – 65, 000 µS/cm up to 5%

Data handling is accomplished by downloading specific conductance measurements using HOBO unit software (HOBOware)directly to an Excel Spreadsheet, then into a DEP database. Automated data handling eliminates transcription errors associated with manual data entry.

10.2 Field Measurements of Analyze Immediately Parameters

The Bureau of Freshwater and Biological Monitoring is certified by the Department's Office of Quality Assurance for specific conductance, pH, dissolved oxygen, water temperature and turbidity measurements.

All pH meters, dissolved oxygen meters, conductivity meters and thermometers shall be operated and maintained according to the "Regulations Governing the Certification of Laboratories and Environmental Measurements", N.J.A.C. 7:18. The Bureau is certified by the Office of Quality Assurance (certified lab ID # 11896) for all parameters listed below:

Temperature, pH, Conductance and DO are measured using a Hach model # HQ40D. The Hach HQ40D is a multi-parameter water quality system that combines temperature, pH, conductance, and Luminescent Dissolved Oxygen (LDO) probes into one meter.
Temperature: The probe is calibrated with a NIST certified thermometer on a quarterly basis. Records of the calibration shall be maintained by the Bureau.
pH: The probe is calibrated on a daily basis per the manufacturer recommendations. The pH meter is calibrated each day of use, including calibration with three standard pH buffers bracketing the value to be measured. After calibration, a standard buffer with pH within the calibration range shall be measured without any control adjustments to check the calibration. When the pH meter is in use for longer than a 3 hour period, the pH of the third buffer shall be checked once every three hours. If the pH differs by more than 0.2 pH units from the standard buffer value, the meter shall be recalibrated. Records of all calibrations and calibration checks shall be maintained in the field log.
Conductance: The probe is calibrated on a daily basis per the manufacturer recommendations. The probe is calibrated each day of use with a certified standard which corresponds to the expected range of the values to be measured. Records of all calibrations and calibration checks shall be maintained in the field log.
DO: A Winkler check is performed on a weekly basis and the meter (Hach HQ40D) is barometrically compensated and checked at each sampling site. Records of all calibrations and calibration checks shall be maintained in the field log.
Turbidity: HACH Model 2100Q turbidimeter is calibrated once a month per manufacturer recommendations. The meter is then checked with certified standards for accuracy within the calibration range during each day of use. Records of all calibrations and calibration checks shall be maintained in the field log.

Flow: Discharge measurements will be made at each station (where applicable) during each sampling event using BFBM's standard operating procedures (Attachment C) or United States Geological Survey procedures https://pubs.usgs.gov/tm/tm3-a8/pdf/tm3-a8.pdf. Several sites have USGS flow gages present, flow information will be taken from the gage instead of the Flow Tracker at these sites.

Other Parameters:
Barometer: Thommen TX Mechanical Barometer. Measured for LDO meter compensation only. Not used for project's data objectives.
Ambient Air Temperature: Measured for general information purposes only. Not used for project's data objectives.

Relevant Documents
Bureau of Water Monitoring Certified SOP, for field measurements and calibrations.
NJDEP Field Sampling Procedures Manual (August 2005).
NJAC 7:18 - Regulations Governing the Certification of Laboratories and Environmental Measurements.

10.3 Discrete samples for total dissolved solids and chloride
Total dissolved solids and dissolved chloride samples will be collected as per "NJDEP Field Sampling Procedures Manual," August 2005; the document available online at the NJDEP's webpage, <http://www.state.nj.us/dep/srp/guidance/fspm/ >. The chemical and field parameters that will be collected as part of this project are listed in Attachment A. Tables 4 and 5

10.4 Laboratory Analysis
Analytical samples will be delivered to the NJ Dept. of Health (certification # 11036) and testing will be done by a method for which the laboratory has certification (Attachment A, Table 6). Quality control procedures (including required calibrations and quality control procedures required by regulation or by the method) shall be defined in the laboratory's Quality Manual (QM) or Standard Operating Procedures (SOPs). The QM and SOPs must be approved by the NJDEP Office of Quality Assurance (OQA).
The reporting levels listed in Attachment A. Table 6 are **required** for this project.

10.5 Sample Containers: Sample containers shall be dedicated, single-use. Sample containers shall be provided by the DOH certified laboratory.

10.6 Sample Retention: All samples must be retained by the laboratory until such time that BFBM approves the reported results or holding times expire.

10.7 Chain of Custody: Chain of custody forms are required for all samples forwarded to a NJ certified laboratory for testing. Information to be recorded includes all information required by N.J.A.C. 7:18-5.6(d) and 8.5(c).

10.8 Resource Needs: Approximately 0.5 FTEs will be required for this project.

11.0 Data Validation

The Project Officer and the Supervisor are responsible for all initial data validation. If apparent anomalous data is suspected the Project Officer and/or the Supervisor will review the sampling procedures with the field sampler to make sure the proper collection and preservation procedures were followed.

If the data is still suspect, the NJDOH will be contacted. An internal review of their laboratory procedures and/or calculations used in the analysis of the suspect sample; with special emphasis on transcription of data to assure that no transposition of figures occurred will be conducted. The NJ certified laboratory will be asked to check on equipment calibration, and may be requested to reanalyze the retained portion of the sample. (Samples are to be retained by the laboratory for the duration of each analytes respective holding time.)

If no problems are found in the analytical laboratory procedures, the data may then be compared to any historical data that might have been collected at the same site prior to the most recent sampling event to see if similar anomalies might have been found previously. The suspect data may also be compared to literature values or standard analytical treatises to verify the results are within the limits of accuracy of the test method.

For continuous monitoring of conductivity and water temperature, once the data has been downloaded, it will be screened by the Project Officer. Usability of the dataset will be determined by checks for Drift, errors present (if any) and their extent. Data loggers deployed in the field will be checked for Drift at both time of deployment and retrieval. This check will consist of using another meter alongside the first and comparing readings between the two units

For the Drift check, the difference between the two units will be measured and checked against the following parameter criteria:

Parameter	Minimum	Maximum
Temperature	0.1° C	1.5° C
Specific Conductivity	1%	25%

Should the difference found to be below the Minimum criteria threshold, then the data will be reported as is.

Should the difference fall between the Minimum and Maximum values, the data will then be reported with a qualifier, modifying the value listed via a plus/minus percentage or unit(s).

Should the difference exceed the Maximum range, then the data for that parameter will be deleted. Once the comparison check is completed, the data will be screened for errors. Sources of errors can be attributed to the following:

1. Non-stream conditions readings (open air, data outside realistic ranges)
2. Hardware failure
3. Tampering (causing non-stream readings)
4. Fouling.

Errors involving loss of data (i.e. out of water) will be truncated from the dataset. Errors that involved hardware failure and fouling will result in the truncation of data from the moment of failure to the point of normal operation (if any).

If no obvious problems are found after these reviews, the complete data set will be reported with the suspect data identified as such. The Bureau will then conduct its own review of the data, as it relates to the objectives(s) and data accuracy required in this project.

12.0 Data Storage

12. 1 Continuous Data

Continuous specific conductance data from data loggers will be stored in NJDEP's DWM&S Continuous Data Monitoring Program's website (http://njdep.rutgers.edu/continuous/). Graphical representations of the data will be stored internally in Bureau databases/spreadsheets.

12. 2 Precipitation Data

Daily precipitation data collected by the National Oceanic and Atmospheric Administration (https://www.ncdc.noaa.gov/cdo-web/) is available to assess the amount of precipitation and more specifically, snowfall. Bureau staff will download applicable data and store locally to compare with continuous and analytical data.

12. 3 Field and Laboratory Analyses

Analytical data for grab samples submitted to laboratory and data from analyze immediately parameters will be entered into New Jersey's Water Quality Data Exchange (WQDE) and will be accessible through the USEPA and the National Water Quality Monitoring Council's Water Quality Portal by June of the following year it is received from the analytical laboratory. The data will be

entered with the Project ID "SALT". All raw data records shall be maintained for a period of no less than five years. See Attachment A for Data Management information.

13.0 Performance System Audits

All NJ certified laboratories used are subject to audits and to the requirements of the OQA Laboratory Certification Program as well as internal performance evaluations. The OQA will be notified of field monitoring schedules for possible audits.

14.0 Data Reporting

14.1 Continuous Data

All continuous data will be downloaded and processed through the device's dedicated software. Once the data has been downloaded and validated, it will then be exported into an Excel spread sheet format for storage and reporting.

Continuous Monitoring data will be stored on a local server at the Bureau and at the Division of Water Monitoring & Standards Continuous Data Monitoring website hosted by Rutgers University. The website for this is located at http://njdep.rutgers.edu/continuous/

14.2 Laboratory and Field Data

Final analytical data will be reported to the Bureau from the laboratory employed for this project, in the form of electronic and/ or hard copies of the lab sheets; or in a tabulated form within 40 calendar days from receipt of sample. All data shall be reported in a complete and concise fashion and shall meet the reporting requirements of NJAC 7:18. Routine quality control results must be retained on file for review by the Bureau and the Office of Quality Assurance.

Final data and evaluations will be available to the Bureau of Environmental Analyses, Restoration and Standards for use in the generation of the biennial New Jersey Integrated Water Quality and Assessment Report [305(b) and 303(d)].

15.0 Corrective Action / Assessment, Oversight, and Response

The Project Officer will be responsible for the oversight of all activities relating to this project. The Project Officer will assess field collection functions and make corrections when necessary to maintain the data accuracy as defined in this plan. If any changes or modifications are made to this plan regarding data collection, as it relates to the objectives(s) and data accuracy required in this project, all original signees of the QAPP will be notified.

Attachment A:
DATA MANAGEMENT TABLES

For Data Management purposes, Water Chemistry is defined as parameters analyzed by a lab; Field measurements are defined as analyze immediately parameters.

Table 1. Monitoring Locations

HUC14	HUC14 Name	Location ID	Monitoring Location Name	Latitude Degrees	Longitude Degrees
020301030 10030	Great Brook (above Green Village Rd)	BFBM000206	Silver Brook on James St.	40.762019	-74.486910
020301030 10170	Passaic R Upr (Rockaway to Hanover RR)	01379580	PASSAIC R EAGLE ROCK AVE	40.827638	-74.335083
020301040 20030	Elizabeth R (below Elizabeth CORP BDY)	01393450	ELIZABETH R AT URSINO LAKE AT ELIZABETH NJ	40.675070	-74.222200
020301040 50040	Rahway River (Kenilworth Blvd to EB / WB)	01394620	RAHWAY RIVER AT KENILWORTH NJ	40.673340	-74.312920
020301041 00010	Manasquan R (above 74d17m50s road)	01407821	Manasquan River at Georgia Rd.	40.211898	-74.295701
020301051 20020	Green Bk (N Plainfield gage to Blue Bk)	01403465	GREEN BROOK ON RAYMOND RD	40.641036	-74.413727
020301051 20120	Ambrose Brook (below Lake Nelson)	AN0425A	AMBROSE BROOK AT BEHMER ROAD	40.547325	-74.463763
020301051 60050	Tennent Brook (above 74d 19m 05s)	BFBM000029	Tennent Brook On Route 9	40.415345	-74.305308
020401052 40040	Pond Run	01463920	POND RUN NEAR WHITE HORSE NJ	40.215643	-74.690385
020402021 10050	Cooper River (Rt 130 to Wallworth gage)	01467150	COOPER R AT HADDONFIELD NJ	39.903200	-75.021800

Table 2. Sample Types

STATION ID	Field Msr/Obs	Flow	Water Chemistry	Continuous Monitoring	Biological Sampling	Sediment Collection	Bacteria Collection	Habitat	Metrics	Indices
BFBM000206	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01379580	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01393450	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01394620	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01407821	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01403465	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
AN0425A	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
BFBM000029	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01463920	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
01467150	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO

Table 3. Partner Information

STATION ID	Field Msr/Obs	Flow	Water Chemistry	Continuous Monitoring	Biological Sampling	Sediment Collection	Bacteria Collection
BFBM000206	DEP	DEP	DEP	DEP	No	No	No
01379580	DEP	DEP	DEP	DEP	No	No	No
01393450	DEP	GAGE	DEP	DEP	No	No	No
01394620	DEP	GAGE	DEP	DEP	No	No	No
01407821	DEP	DEP	DEP	DEP	No	No	No
01403465	DEP	DEP	DEP	DEP	No	No	No
AN0425A	DEP	DEP	DEP	DEP	No	No	No
BFBM000029	DEP	DEP	DEP	DEP	No	No	No
01463920	DEP	DEP	DEP	DEP	No	No	No
01467150	DEP	GAGE	DEP	DEP	No	No	No

Table 4. Field Parameters

Field Name	**WQDE Name**	**Media**	**Units**
DO	Dissolved oxygen (DO)	Water	mg/l
Water Temp	Temperature, Water	Water	deg C
Spec Cond	Specific conductance	Water	uS/cm
pH	pH	Water	None
Flow	Flow	Water	cfs
Barometric Pressure	Barometric Pressure	Air	mmHg
DO Sat	Dissolved oxygen saturation	Water	%
Temperature, air	Temperature, air	Air	deg C

Table 5. Laboratory Parameters

Analysis (lab name)	EPA Characteristic Name	Result Sample Fraction	Result Measure Unit	Result Value Type	Sample Collection Type	Sample Collection Equipment
NEW JERSEY DEPARTMENT OF HEALTH - 11036	Chloride	Total	mg/l	Actual	Grab	Water Sampler (Other)
NEW JERSEY DEPARTMENT OF HEALTH - 11036	Total dissolved solids	Total	mg/l	Actual	Grab	Water Sampler (Other)

Parameter	Laboratory	Lab Number	Method	Method ID Context	Lower Reportin Limit
Chloride	NEW JERSEY DEPARTMENT OF HEALTH - 11036		4500-CL(E)	APHA	2.5
Total dissolved solids	NEW JERSEY DEPARTMENT OF HEALTH - 11036		2540-C	APHA	1

Table 6. Laboratory Analytical Methods and Detection Limits Table 7. Data Inventory Supplement

Parameter	Laboratory	Method	Method ID Context	Lower Reporting Limit	units	Method Detection Limit	Holding Time	Preservative
Chloride	NEW JERSEY DEPARTMENT OF HEALTH - 11036	4500-CL(E)	APHA	2.5	mg/l	0.113	28 days	Ice to 4 deg C
Total dissolved solids	NEW JERSEY DEPARTMENT OF HEALTH - 11036	2540-C	APHA	1	mg/l	1	7 days	Ice to 4 deg C

Table 7. Data Inventory Supplement

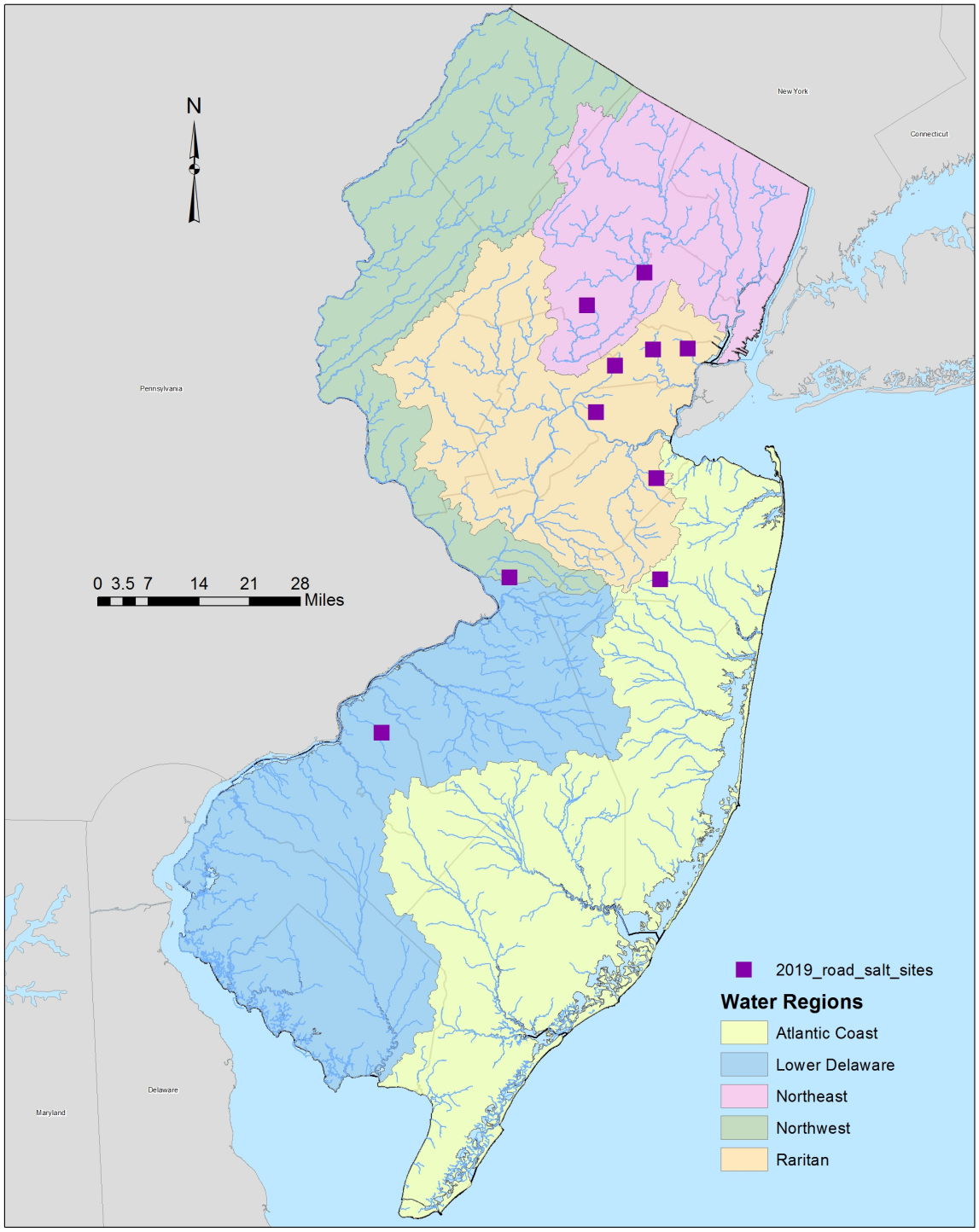
Geographic Regions	Statewide
Counties	Morris, Union, Monmouth, Middlesex, Mercer, Camden
Dates	3/1/2019 - 3/1/2020
Status	Future/Planned
Sample Frequency	Other
Seasons Sampled	Spring, Summer, Fall, Winter
Waterbody Type	River/Stream
Salinity Category	Fresh
Tidal Influence	Non-tidal
Project Description	Through continuous year-round monitoring, develop a specific conductance database that will examine critical high winter specific conductance levels and the duration of elevated levels in a variety of New Jersey's non-tidal, freshwater streams. Historical specific conductance data obtained through discrete sampling shows that during winter months (December to March), levels of specific conductance in non-tidal freshwater streams increase significantly during and after significant snowfall events. This
Parameters analyzed type	Chemical/Physical (Conventionals)

Table 8. Data Management Supplement

QAPP network path file location?	V:\LUM\BFBM\Bfbm\Quality Assurance Plans\Calendar Year 2019QAPPS\Roadsalt2019
Where will data be recorded in field (media)	Paper
If on tablets or phones, will download at office occur or will you connect wirelessly?	NA
If on tablets or phones, who will do the download?	NA
If data collected electronically, where will it be stored?	V:\LUM\BFBM\Bfbm\Continous Monitoring\HOBODATA\Road Salt\2019
Format to be received from Lab	LIMS
Method of receipt from lab/s	
Personnel receiving outside lab data	BFBM Leigh Lager
Is data expected to go to WQDE/STORET?	Yes
Data manager - (Bureau and Name)	BFBM Leigh Lager

Attachment B

Stream Monitoring for Effects on Water Quality by Road Salt Application - 2019 Sites



ATTACHMENT C:

Standard Operating Procedure for Making Discharge Measurements in Wadable, Non-tidal, Freshwater Streams with a Handheld Acoustic Doppler Velocimeter (ADV); revised 12/18/2018

With additional guidance from the United States Geological Survey, the New Jersey Department of Environmental Protection's Bureau of Fresh Water and Biological Monitoring (NJ DEP/BFBM) has adopted the Standard Operating Procedures for using a handheld ADV (Flowtracker and Flowtracker 2) from the manufacturer (Sontek) and the United States Geological Survey Techniques of Water-Resources Investigations Reports (https://pubs.usgs.gov/twri/index-last.html)

I. **Diagnostic Test Before Use** – Before any sampling run, or quarterly, a system diagnostics test called a "beam check" should be performed in a lab environment. A beam check should show that signal amplitude plots from each probe are roughly the same and should show noticeable peaks for "sample volume', "boundary reflection" and "noise level". If not, it is possible the probe(s) may be damaged. A complete description of "beam check" can be found in the manual. Should the meter fail the beam check, it will be removed from service and sent back to the manufacturer for repair.

II. **Site Selection** - To ensure that quality discharge measurements are made, it is important to select a location which minimizes the amount of interference and error during the measurement. Ideally, the location should be at a section of stream which is as straight as possible. If possible, avoid bends in the stream and areas of dead water. A general rule of thumb is that a transect location should be a distance (upstream and downstream) of 2X the width of the stream from any type of control, such as a riffle or pool or incoming tributary. Flow at the location should be as close to being laminar as possible. Once the location is selected, any moveable obstructions (small rocks, tree branches, macrophytes) should be removed from the transect.

III. **Setting up a tagline** - A tagline consisting of a tape measure will be set up perpendicular to the stream flow. The tape measure units should be in feet with sub-increments in 10ths of a foot. It is important that the line is taught and secure. Once established, a stream width will be determined from wetted edge to wetted edge. Edges (right or left) will be determined by looking downstream.

IV. **Measuring discharge** - Measuring discharge involves wading across the stream/ river while taking measurements of water depth and velocity at different locations (based on International Organization for Standardization/USGS procedures) along a transect. By combining this information, the total discharge can be calculated.

Preparation

Divide the river cross-section into a number of stations appropriate for its width.
According to the United States Geological Survey, 25-30 stations will give a

representative measurement. There is a limitation however for streams <8.25 feet wide. The meter's probes collect measurements 4 inches from the probe face, perpendicular to stream flow. Increments less than 4 inches (0.3 feet) will result in overlapping measurements. In these cases, it is acceptable to have as many increments as the stream width will allow. Below is a chart that can be used to determine how many increments to use for streams less than 8.25'

Stream Width	Number of Increments
8'	23
7.5'	21
7'	20
6.5'	18
6'	17
5.5'	15
5'	14
4.5'	12
4'	11
3.5'	9
3'	7
2.5'	6
2'	5
1.5'	3
1'	2
<1'	1

These are general guidelines and actual on-site conditions will determine how many increments can be done for a given stream. It should also be noted that the meter is incapable of measuring flows at a depth less than 3", so increments at those depths may need to be omitted. Depending on site conditions, alternate methods may be necessary to accurately measure discharge in very small streams. Non-wadable streams also require the use of different methods and equipment.

The starting edge is then established. The meter automatically defaults to left edge (descending bank or facing downstream), so it is advisable to begin on the left edge. If it is not possible, then the operator must change the starting edge to right (see manual). The operator must then establish the increments that will be used to measure velocity for the given stream width. For example, if the stream is 26 feet width, the increment is 1.04 feet (26/25). This will give the operator the minimum required number of stations (25).

Facing upstream, orient the hand held ADV perpendicular to the tagline Velocity data is recorded once per second for the entire averaging time (40 seconds), and then averaged to compute the mean velocity. Quality control data is also reviewed and displayed; you will be alerted to any unexpected values. If the velocity measurement is found to be unsatisfactory, you should repeat the measurement.

During the entire measurement, the probe's X-axis must be maintained perpendicular to the tagline. The probe should be held away from underwater obstacles that may disturb the flow. Do not turn the hand held ADV into the direction of flow, as it will automatically account for flow direction when making discharge measurements.

Measuring Discharge

Follow manufacturer's guidelines for the correct procedure for measuring discharge using the Flowtracker or Flowtracker 2. A copy of the Quick Start Guide for each meter is attached.

V. Quality Assurance Procedures

To ensure accuracy, NJDEP/BFBM will follow manufactures instructions for determining probe/meter condition. This consists of a beam check and ping test. The beam check is performed in a lab quarterly. The ping test is done in stream daily. These tests ensure that the meter and probe are operating within the manufacturers guidelines. If either of these tests are failed, no discharge measurement will be made and the meter will be sent back to the manufacturer for repair.

NJDEP/BFBM has also developed a quality assurance check for utilizing the handheld ADV. Each staff member trained to obtain discharge measurements will be required to have a flow comparison check against an existing USGS real-time gage. Any flow comparison at a USGS real-time station that is off more than 20% will be repeated. If the repeated measurement is still off by more than 20%, then that staff member will undergo additional training. After the comparison is completed a hard copy will be stored of both the samplers discharge measurement and the ADR flow rate. Once staff are trained, they must perform these comparisons quarterly for a period of two years. If all eight comparisons are within 20% of the real-time gage readings, then comparisons will only be required once per year. If comparisons are not within 20% then, staff will be evaluated by a supervisor or project manager and will have to restart the two-year period of quarterly comparisons.

All discharge measurements made should have the flow rate (cubic feet per second) and also be designated a rank (see below) which determines the quality of measurement. NJDEP/BFBM ranks the quality of stream flow measurements by summing the International Organization of Standardization and Statistical uncertainty percentages that are calculated within the data file.

Sum of Percent Uncertainty:	**</= 5.0%**	**Very Good**
	> 5.0 and </= 10.0%	**Good**
	>10.0% and </= 20.0%	**Fair**
	> 20.0%	**Poor**

All ranks should be entered with the data on all lab analysis and field sheets.

Bureau of Freshwater and Biological Monitoring Standard Operating Procedure for Making Discharge Measurements in Non-Wadable, Non-tidal, Freshwater Streams with a boat mounted Acoustic Doppler Current Profiler); December 2018

With guidance provided by the manufacturer's manual and the United States Geological Survey field manual titled *Measuring Discharge with Acoustic Doppler Current Profilers from a Moving Boat*, the Bureau of Freshwater and Biological Monitoring (NJDEP-BFBM) has adopted the following Standard Operating Procedures.

USGS Field Manual:

Mueller, D.S., Wagner, C.R., Rehmel, M.S., Oberg, K.A,, and Rainville, Francois, 2013, Measuring discharge with acoustic Doppler current profilers from a moving boat (ver. 2.0, December 2013): U.S. Geological Survey Techniques and Methods, book 3, chap. A22, 95 p., http://dx.doi.org/10.3133/tm3A22.

- Discharge measurements will be made using the *SonTek/YSI RiverSurveyor M9* acoustic Doppler current profiler (ADCP). The ADCP will be mounted to an unmanned, tethered, boat. Operation will take place from the streambank utilizing a temporary cableway or from the downstream side of a bridge.
- Measurements with the boat-mounted ADCP will be performed by a two-person field crew. One member will be responsible for the moving and guiding of the tethered boat while communicating to the other field crew member who will be operating a field computer.
- Manufacturer provided software will be used collecting and analyzing of discharge data

2.0 Prior to Site Visit: In addition to the ADCP, boat, and field computer; ensure that all auxiliary equipment has been collected for a site visit. This includes GPS antenna, power & communications module, and USB radio antennas, and accompanying cable connectors. A checklist is recommended. Tether lines of site-appropriate length and carabiners should be checked for wear and tear to ensure that they are field ready. Check ADCP batteries to ensure there is a proper charge and voltage to conduct the discharge measurement and confirm that the field computer is fully charged. Spare batteries should also be brought.

3.0 Site Selection: Transects used for measurements should be in a straight channel with smooth laminar flow and depths suitable for the operation of a boat-mounted ADCP. Cross sections should avoid obstructions in the water column such as snag piles of large woody debris or heavy aquatic vegetation, to avoid any interference between

beams from the ADCP to the stream bottom. If measuring from a bridge, measurements should be taken on the downstream side to provide better control of the tethered boat during operation. Measurement sites should seek to avoid sources of magnetic influence. Such sources of interference can cause errors in calibration and headings from the internal compass in the ADCP.

4.0 Streamside and Roadside Safety: When working in and around a stream or river, life vests should be worn. When performing measurements from a bridge, additional safety procedures should be implemented. All field staff should wear a high-visibility vest. Furthermore, traffic cones should be placed around the work area, along with any additional precautions needed to aid motorists in early identification early and clear recognition of the work area.

5.0 Setup and Pre-Measurement Tests

5.1 Mounting of ADCP and accessories

5.1.1 The ADCP should be mounted so that the transducer depth is shallow as possible, while also ensuring that the transducers are completely submerged at all times during the discharge measurement.

5.1.2 Insert batteries into Power and Communications Module (PCM). As the PCM does not have an on/off button, it is recommended to not store the batteries within the unit when in storage in order to maximize battery life between charges.

5.1.3 Once equipment has been fully installed and connected, communication between the ADCP and field computer is to be established using USB radio and launching the *RiverSurveyor Live* software.

5.2 Diagnostic Test: After establishing communication, a system test should be performed which verifies that there is a proper battery voltage and that compass, recorder, and temperature sensors are in working condition. A system PASS will indicate that all components are functional for a discharge measurement.

5.3 Site information: The following site information should be recorded into the *RiverSurveyor* program before beginning any discharge measurement.

a. Site Name
b. Station Number
c. Location; include municipality and county
d. Party; operator of ADCP, field computer, and any other supporting staff

e. Boat/Motor
f. Measurement number
g. Comments; weather or stream conditions that may affect the discharge measurement.

5.4 System Settings

5.4.1 Transducer depth: This is the distance from the vertical beam of the mounted ADCP to the water surface and should be measured and entered into the *RiverSurveyor* program

5.4.2 Magnetic Declination: Variations in the magnetic field on the Earth's surface can result in an angular difference between the magnetic north and "true North". This variation, called magnetic declination, needs to be accounted for when performing compass calibration at the site of discharge measurement. The magnetic declination is obtained by entering the site coordinates into a declination calculator provided by NOAA.
Magnetic Field Calculator:
https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml

5.5 Compass calibration: Prior to any measurements, a calibration of the unit's internal compass should be performed to ensure proper headings are recorded while moving across the transect. The compass calibration will be performed on-site, under similar environmental conditions where the measurement will occur. When possible the sources of potential magnetic interference are to be avoided. Examples include bridges or buildings with large amounts of ferromagnetic metals used in their construction. To perform the calibration, the operator will rotate the mounted ADCP in two complete circles while varying pitch and roll (in a figure-8 formation) and trying to simulate conditions that will be experienced when deployed. The *RiverSurveyor Live* program will indicate whether magnetic influence is acceptable and the calibration was successful with an error from calibration value of less than 0.5 degrees. Sometimes site locations do not allow for the elimination of magnetic influence needed for successful calibration. If a successful calibration on site is not attainable, the error in heading detected by the calibration should be noted by the field crew and considered when analyzing the quality of the discharge data.

5.6 Moving-Bed Test: The ADCP measures the velocity of the boat using bottom-tracking pings while moving along the transect. In some cases, moving-bed conditions may be present at the measurement site. This occurs when sediment moving along the streambed causes the measured boat velocity

to be biased in the upstream direction. A stationary moving-bed test will be conducted at every first-time site visit and during preceding visits when moving bed conditions are suspected. Streams experiencing flooding conditions or high levels of sediment transport are the most likely candidates of streams that could have moving bed. The moving bed test includes selecting locations in the cross section where sediment transport along the streambed is suspected to be highest, thus giving the highest potential for moving-bed conditions. The tethered-boat with the ADCP should be held in a stationary position for a total of 5 minutes minimum while collecting samples. The stationary boat will appear to be moving upstream on the bottom-tracking plot if a moving-bed condition is present. If a moving bed is determined to be present, GPS will be used instead of the Bottom Tracking method to determine boat speed if possible.

5.7 Setting up edges: Prior to taking discharge measurements; cones, flagging tape, or another kind of visual aid will be place at both the estimated beginning and end edges on the left and right banks of the stream. The left and right bank is determined by facing downstream of the sampling location. The beginning and end edges should be in an area of suitable depth and velocity and placed far enough away from the water's edge to avoid interference from the beam (typically the width should be greater than or equal to the depth of the water at that location). A tagline or laser rangefinder will be used to determine the distance from these edges to the nearest edge of water. The edge shape should also be determined which will be used in extrapolation of discharge data in the unmeasured area of stream between the edge of water and the edges of the measured transect. Edge shape will be categorized as a "sloped bank" or "vertical bank".

6.0 Performing Discharge Measurement: The discharge measurement is calculated by moving the boat-mounted ADCP across a transect that collects continuous measurements of water depth and velocity, and then combining this measurement this with estimated discharge of areas the ADCP cannot measure (stream edges and areas closest to the streambed and water surface).

6.1 Following configuration and pre-measurement tests, the tethered boat with the mounted ADCP should be positioned at the pre-determined starting edge. Data collection will begin by pressing "START" in the *RiverSurveyor Live* program.

6.2 Computer operator will press "START EDGE" and begin recording data. While holding the ADCP as stationary as possible, a minimum of 10 samples will be collected at the starting edge.

6.3 After collecting starting edge measurements, the crew member operating the field computer will press "START MOVING" and alert the operator of the tethered boat to begin moving across the transect.

6.4 Care is to be taken to made sure the speed and direction of the boat-mounted ADCP is as constant as possible while moving across the transect. This is to reduce errors and variability in measurements introduced by erratic movements by the boat. The boat speed should be less than or equal to the speed of the water in stream.

6.5 As the boat approaches the streambank opposite of the starting edge, start to slow the boat down and come to a gentle stop at the pre-determined ending edge.

6.6 Once the boat has reached the ending edge, maintain a stationary position and advise the operator of the field computer to press "END EDGE".

6.7 Similar to the starting edge; a minimum of 10 samples should be collected at the ending edge. Once satisfied, the computer operator will press "END TRANSECT". This will save the measurement and automatically open a new tab to begin a new transect.

6.8 Begin a new transect using the same procedure. The ending edge will now become the starting edge and vice versa. Reciprocal measurements should be collected to account for any directional bias.

6.9 Real-time QA/QC warnings are provided the *RiverSurveyor Live* software. These warnings should be checked by the field computer operator during the discharge measurement for any irregularities or possible sources of errors while moving across the transect.

6.10 Any measured edge discharges should not be greater than 5% of total discharge. If this occurs, consider moving the edge closer to the water's edge to capture more of the discharge within the measured area.

6.11 A minimum of 4 transects (2 reciprocal pairs) are to be collected. If after 4 measurements, all calculated flows are within 5% of the calculated mean, no additional measurements are required. If any discharge measurement is out of this range, then two additional measurements will be made to smooth out variability between measurements.

7.0 Post-Processing: After retrieving the boat and mounted ADP from the stream, the collected discharge data stored on the unit should be immediately downloaded and backed up onto the field computer. Only after confirming data has been uploaded onto the computer, can the ADP and other equipment be packed up. Upon returning to the office, discharge data will be transferred from the field computer onto the DEP network.

8.0 Quality Assurance Procedures

8.1 To ensure equipment is in working-order, the following checks and tests will be performed on a quarterly basis:

8.1.1 A beam check using the BeamCheck test from software provided by the manufacturer. This test should be performed using multiple beam frequencies.

8.1.2 Cleaning of the transducers to remove the build-up of material on the transducer faces. This can be performed using a mild soap detergent and sponge.

8.1.3 Checks will be made to ensure that the software and firmware are up-to-date. The bureau will follow the guidance of the Hydroacoustic Work Group within the USGS Office of Surface Water. Recommendations from the work group are provided at the following website, https://hydroacoustics.usgs.gov/movingboat/m9s5.shtml

8.2 Staff members qualified for performing discharge measurements with the ADCP will be required to do a semi-annual flow measurement comparison at a site co-located with a USGS real-time gage. Flow comparisons should not differ by more than 5%. Any readings that differ more than 5% from that of the real-time gage will be repeated. If readings still differ by more than 5%, the ADP instrument will be inspected for any defects and field conditions will be considered for any possible influences. If no defects are detected, the staff member will undergo additional training and an internal field audit will be performed by the Project Officer or Supervisor. A hard copy of both completed comparison measurements and corresponding gage data will be stored and placed into records.

8.3 The quality of stream flow measurements with a boat-mounted ADCP will be calculated by determining the percent variation between measurements and the mean discharge. The following percentages will be used to rate the measurement.

1. Very good (</=2%)
2. Good (2% < and </=5%)
3. Fair (% 5< and </=8%)
4. Poor (>8%)

All projects and staff using the boat-mounted ADV should adhere to the Standard Operating Procedures listed.

Addendum

Due to the amount of time that passed during the QAPP signature approval process the sampling schedule has been adjusted. Continuous monitoring will now occur from March 2019 through June 2020; while discrete sampling will now occur every other month from August 2019 through June 2020.