

**QUALITY ASSURANCE PROGRAM PLAN**

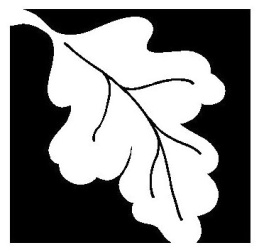
**Chloride Monitoring & Assessment**

Massachusetts Department of Environmental Protection

Bureau of Water Resources, Division of Watershed Management - Watershed Planning Program

CN # 540.0

November 2020



COMMONWEALTH OF MASSACHUSETTS

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October 2020

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# FOREWORD

This Quality Assurance Program Plan (QAPP) pertains specifically to surface water quality monitoring for chloride in rivers and lakes.

This chloride monitoring QAPP is in addition to programmatic elements described in WPP’s program QAPP (2020-2024) available here: <http://www.mass.gov/eea/agencies/massdep/water/watersheds/environmental-monitoring-quality-management-program.html>.

This chloride monitoring QAPP provides the foundation for additional sampling & analysis plans developed annually to describe basin-specific or project-specific monitoring plans (e.g., precise locations for sampling).

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# SECTION A: PROJECT MANAGEMENT

## A3. DISTRIBUTION LIST

The following groups have been made aware of this QAPP:

* MassDEP, DWM-WPP staff
* Wall Experiment Station laboratory (selected staff persons)
* USEPA-New England (relevant staff persons)

Electronic copies of this QAPP have been placed on the DWM-WPP network drive, the MassDEP enterprise drive and the MassDEP website: <https://www.mass.gov/guides/water-quality-monitoring-quality-management-program>.

## A4. PROJECT DESCRIPTION & ORGANIZATION

This QAPP covers ambient surface water monitoring related to chloride concentrations in water conducted by the Watershed Planning Program (WPP).

Figure 1 provides an overview of specific personnel involved in data collection and use at DWM-WPP. Table 1 provides more detailed descriptions of the roles and responsibilities for these DWM staff and state/ contract laboratory staff (as of June 2020). Because DWM-WPP is responsible for monitoring statewide, program staff are based in Worcester, MA.

Table 1: Program Roles and Responsibilities specifically related to chloride monitoring

| Personnel, Title and/or Primary role | Responsibilities |
| --- | --- |
| Peter Mitchell, Monitoring Survey Coordinator | Field coordinator for chloride project. Designing sampling and analysis plans, coordinating surveys, preparing technical memoranda and related tasks |
| Shervon De Leon, Field and Lab Operations Coordinator | Oversees DWM-WPP field and laboratory operations including instrument calibration, post-field checks, maintenance, data uploads, and laboratory and field safety. |
| Mason Saleeba, TMDL coordinator | Technical oversight for chloride project. TMDL surveys and development, data analysis, project management, etc. |
| Suzanne Flint, QA Officer | Overall quality assurance and quality control for environmental monitoring and data handling at DWM-WPP. |
|
| Arthur Johnson, Monitoring Coordinator | Manages the planning and coordination of all environmental monitoring by BWR-WPP including technical oversight, staff assignments, and scheduling. |
| Richard Chase, Data & Assessment Coordinator | Advisory role for the chloride project; oversees CWA §305(b) assessments and management of DWM-WPP monitoring data and associated QA/QC |
| Barbara Kickham, TMDL Coordinator | Manages development and implementation of Total Maximum Daily Loads (TMDLs) for State waters. |
| Peter Piro, Wall Experiment Station (WES) Lab, Lawrence, MA. | Responsible for inorganic lab management (inc. chloride) |

NOTE for SECTION A5: See also annual sampling & analysis plans (SAPs) for additional, project-specific objectives. Stand-alone SAPs are developed each year, based on current monitoring needs.

## A5 PROJECT GOALS AND OBJECTIVES

WPP’s surface water monitoring efforts support MassDEP’s programmatic goals and functions to preserve, protect, assess and restore water quality. The overall goal of the chloride monitoring project is to provide water quality data and information on streams, rivers, lakes and ponds to support the following objectives:

* Determine the general extent and magnitude of chloride impairments within MA (due primarily to road salt application)
* Assess the status or condition of Massachusetts’ waters (CWA §305(b)) with respect to chloride levels, in comparison to the adopted surface water quality standards for chloride
* Refine the chloride:specific conductance regression model, as additional data are collected
* Explore TMDL-related strategies to address chloride imairments (CWA §303(d))
* Develop supporting data for policies, guidance and/or standards related to the chloride pollutant

As part of its long-term strategy, DWM-WPP aims to utilize monitoring data from or collaborate directly with other agencies and programs to supplement DWM-WPP’s. Other programs include, for example, the Massachusetts Drinking Water Program (surface water source waters), Massachusetts Division of Conservation and Recreation (Quabbin and Wachuset Reservoir data), Massachusetts Office of Coastal Zone Management, National Estuaries Partnership Programs (MassBays, Buzzards Bay, and Narragansett Bay), USGS, Massachusetts Wetlands Program, academic institutions, volunteer groups, and University of Massachusetts.

## A6 PROJECT SCHEDULING & COORDINATION

The schedule and logistics for DWM-WPP’s chloride monitoring typically involves a 9-12 month data collection, and are dependent on several factors, including:

* available staff
* available resources (equipment, funds, laboratories, etc.)
* anticipated data needs (internal)
* related efforts by others (e.g., planned/on-going projects, monitoring, etc.)

Coordination between DWM-WPP staff helps to formulate sampling plans. Information from other groups, such as USEPA, USGS, Mass. DCR, Mass. DFG, other Mass DEP programs, consultants and contractors and volunteer monitoring associations, also assists in allocating monitoring resources.

DWM-WPP Survey Coordinators play the lead role in planning and conducting field surveys for water quality (chloride) surveys. Survey planning usually includes the following tasks:

* Identification of sampling/data need
* Discussions with project partners and interested parties
* Development of project-specific Sampling & Analysis Plans
* Field-reconnaissance of watersheds to be sampled
* Designing economical and efficient field survey routes to be taken by survey crews
* Documenting required survey routing, station information and logistics in crew-specific Survey Books
* Pre-logging samples into the WES State Laboratory Information Management System (WinLIMS)
* Setting up fieldsheets and field tablets with preliminary information
* Scheduling field crew members and vehicles (with DWM-WPP’s Monitoring Coordinator)
* Preparing crew-specific, pre-labeled sample containers, and
* Scheduling and assembling required field gear for field crews

## A7 DATA QUALITY OBJECTIVES AND CRITERIA

Quality assurance activities, as detailed in this and other DWM-WPP QAPPs, result in data of known and documented quality. Parameter-specific data quality objectives (DQOs) are outlined in Table 2.

Failure to meet these planned DQOs may subject project data to qualification or censoring during post-monitoring quality control review, but decisions to censor or qualify data are not based solely on meeting DQOs. DWM-WPP uses all available information and best professional judgement in its evaluation of data quality.

The data quality concepts of precision, accuracy, representativeness, completeness and comparability and sensitivity (PARCCS) are discussed below, along with other data quality issues, such as holding time, sensitivity and detection limits.

###### A7.1 Accuracy

Accuracy is determined by how close a reported result is to a true or expected value and the degree to which bias is avoided or minimized.

Laboratory accuracy will be determined by following the policy and procedures provided in the laboratory’s Quality Assurance Plan and analyte-specific DWM-WPP SOPs. These generally employ estimates of percent recoveries for known internal standards, matrix spikes and performance evaluation samples, and evaluation of blank contamination.

Accuracy for multi-probe measurements is tested prior-to-use using standards that bracket the measurement range and after use checked against standards to determine if probes remained in calibration at the end of the measurement period. An NIST-certified thermometer is used to periodically check thermometer accuracy. Lower limit accuracy for dissolved oxygen (DO) is checked using a zero DO standard. The post-sampling checks of each unit ensure that the readings taken during the survey(s) were within QC acceptance limits for each multi-probe analyte.

###### A7.2 Precision

Precision is a measure of the degree of agreement among repeated measurements and is estimated through sampling and analysis of replicate (e.g., duplicate, triplicate) samples*.*

Laboratory precision of lab duplicates will be determined by following the policy and procedures provided in the laboratory’s Quality Assurance Plan and individual DWM-WPP SOPs. This varies depending on the lab and analyte, but typically involves analysis of same-sample lab duplicates and matrix spike duplicates.

Overall precision objectives using relative percent difference (RPD) of field duplicate samples vary depending on the parameter and typically range from 10-25% RPD. DWM-WPP recognizes that precision estimates based on small numbers can result in relatively high RPDs (due to small number effect).

Precision of the multi-probe measurements can be determined by taking duplicate (via a second placement of the unit) readings at the same station location. This is sometimes performed for lake surveys. Multi-probe precision objectives generally range from 5-10 % RPD depending on the parameter.

###### A7.3 Representativeness

Representativeness refers to the extent to which measurements characterize the true environmental condition*.* Sampling locations and survey times are selected to ensure that the samples taken represent typical field conditions at the time and location of sampling, and not anomalies due to uncommon effects. In some cases, stations are chosen to evaluate site-specific impacts (i.e. “hot spots”) which dictate the representativeness of distinct conditions. Other factors, such as seasonality and weather conditions, must be considered by data users when evaluating what the resulting data are representative of (e.g., wet weather water quality).

###### A7.4 Completeness

Completeness refers to the amount of valid data collected using a measurement system. It is expressed as a percentage of the number of valid measurements that should have been collected*.* For DWM-WPP monitoring, the completeness criterion is typically 80-100%. This assumes that, at most, one event out of five might be cancelled for some reason that could cause an incomplete data set with up to 20 % of the planned-on data not obtained.

###### A7.5 Comparability

Comparability refers to the extent to which the data from a study is comparable to other studies conducted in the past or from other areas. For DWM-WPP monitoring, the use of standardized sampling and analytical methods, units of reporting, and site selection procedures help to ensure comparability of data. Review of existing data and methods used to collect historical data have been reviewed and taken into account in the sampling design. Efforts to enhance data comparability are made where possible and appropriate.

###### A7.6 Sensitivity

Sensitivity characterizes the ability of the method or instrument to discriminate between measurement responses. The specifications for sensitivity are unique to each analytical instrument and are typically defined in laboratory Quality Assurance Plans (QAP) and SOPs.

###### A7.7 Detection Limits

In general, detection limits define the smallest amount of analyte that can be detected above signal noise and within certain confidence levels. Typically, Method Detection Limits (MDL) are calculated in the laboratory by analyzing a minimum of seven low-level standard solutions using a specific method. (Detection limits in the traditional sense do not apply to some measurements such as pH and temperature that have essentially continuous scales.) Multiplication factors are typically applied to MDL values by labs to express Minimum Reporting Limits (MRL) which define a level above which there is greater confidence in reported values.

###### A7.8 Holding Times

The standard method holding time (maximum allowed time from collection to analysis) for chloride samples is 28 days. Where established holding times are exceeded, violations are taken into account during the data validation process.

###### A7.9 Standard Protocols

The use of approved field and laboratory SOPs by DWM-WPP and its agents provides a high level of assurance that programmatic data quality objectives shall be met consistently. As noted above, use of standard methodologies also helps data comparability and accuracy.

###### A7.10 Performance Auditing

Subject to adequate time and resources, scheduled and unscheduled field audits are conducted by DWM-WPP’s QA Analyst to evaluate implementation of field methods, consistency with this QAPP and compliance with sampling SOPs. Due to limited resources and multiple staff involved, DWM-WPP’s QA Analyst annually prioritizes which field audits to do.

Checks on laboratory analytical accuracy and precision for chloride water samples are done annually using double-blind QC samples prepared by WPP using KCL specific conductance standard solutions and delivered to WES for analysis. All audit results are compared to “true” values/results, evaluated against acceptance limit criteria and used to help validate the data. Results are also provided to lab analysts, survey coordinators and data users.

Table 2: Data Quality Objectives for DWM-WPP Chloride Monitoring

| Analyte | Analytical Method(s) | Units | Expected Range  (appx.) | Method Detection Limit (MDL) 1 | Minimum Reporting Limit (MRL)1 | Accuracy 2 (+/-) | Overall Precision (RPD or other) 2 | Resolution |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **DWM-WPP Instruments (Hydrolab® Series 5; YSI EX01; Onset conductivity loggers** | | | | | | | | |
| Temperature | SM 2550 | °C | 0-30° C | NA | NA | +/- 0.15 °C | +/- 0.2°C | 0.01 °C |
| Temperature (deployed) | SM 2550 | °C | 0-30° C | NA | NA | +/- 0.3 °C | +/- 0.3 °C between deployed and side-by-side QC reading | 0.01 °C |
| Specific Conductance | SM 2510 | µS/cm | 75-700 µS/cm (fresh) | NA | NA | +/- 1% of reading | 5% | 4 digits |
| Specific Conductance  (deployed) | SM 2510 | µS/cm | 75-700 µS/cm (fresh) | NA | NA | +/- 2% of reading | 5% between deployed and side-by side QC reading | 4 digits |
| Total Dissolved Solids (TDS) - calculated value | --- | mg/l | 50-5000  (fresh-brackish) | --- | --- | --- | 10% | 0.1 mg/L |
| **Laboratory** | | | | | | | | |
| Chloride | SM-4500-Cl-E | mg/l | 0-100 mg/L | --- | 1.0 mg/L | 90-110 % recovery for QC std. and LFM | 20% | NA |

1) Detection and reporting limit information in Table 2 is based primarily on the WES lab, unless otherwise noted for DWM-WPP and other labs.

2) Accuracy and precision goals are based on potential error introduced via both field and lab activity. The analytical method limits are published in the analytical method and/or provided by the lab, as are the achievable laboratory limits. Multi-Probe information for accuracy, precision and resolution is based on manufacturer’s specifications. RPD precision objectives relate to field duplicates.

## A8 TRAINING

Annual and/or as needed training in field and laboratory methods and procedures is provided to staff (full time and seasonals) to ensure consistent adherence to SOPs and data quality. The main focus of this training is to review both the fundamentals and finer details of sample collection, associated documentation, lab requirements and protocols and safety issues. Types of training specific to the chloride project is summarized in Table 3.

Table 3: Types of DWM-WPP Training

| Training | Description | Trainer(s) |
| --- | --- | --- |
| Health & Safety | Discussion of safety precautions both in the field and in the lab | Shervon De Leon, Peter Mitchell |
| Multi-probe and logger use | Discussion and practicum on how to use Hydrolab, Onset and YSI multi-probe units in the field to collect water quality data (single-use and deployment of loggers) | Shervon De Leon, Peter Mitchell |
| Water quality surveys (general) | Discussion of survey preparation, field procedures and special considerations | Peter Mitchell |
| Decontamination for invasives control | Overview of decontamination issues and requirements for DWM-WPP surveys to prevent the spread of invasive organisms | Shervon De Leon, Peter Mitchell |
| Field metadata and lab data reporting and management | Review of procedures for lab recordkeeping and data entry into DWM-WPP databases for both field and lab data | Tom Dallaire, Jane Ryder, Kari Winfield, Suzanne Flint |

All field survey crew personnel and WES/DWM-WPP lab personnel are trained in the proper application of standard operating procedures (SOPs). Training can take place in the office, field or laboratory, and can take place prior to data collection and/or “on the job.” DWM-WPP training activity is documented using standard training signature sheets. All training records are stored at DWM-WPP’s offices in Worcester, MA.

## A9 DOCUMENTATION AND RECORDS

###### The following paper/electronic records are kept for the chloride project.

###### A9.1 Field Records

* WPP Field Sheets (paper) (using paper field sheets (waterproof “Rite-in-the-Rain” paper is used exclusively). Paper field sheets are then scanned to create an electronic backup record. Example documentation procedures include, but are not limited to: Use of indelible ink (not pencil), No omissions in the data (completeness),100% QC checks on any manually-entered data, No use of erasing, "white-outs", removal of pages, and multiple crossovers to correct errors.
* EQuIS EDGE electronic fieldsheet forms (using field tablets at each site), starting in 2021. E-field data are then uploaded directly to DWM-WPP’s EQuIS water quality database.
* Survey guidebooks are provided to each crew lead by the Survey Coordinator. These books contain detailed driving directions and maps to each sequential sampling station, along with photos, helpful hints, contact information and survey-specific emergency hospital locations.
* Multiprobe and Deployed Logger Files. Electronic records include field data and calibration files from attended and unattended multiprobe deployments and associated side-by-side QC measurements.
* Other Digital Field Records.Use of digital cameras (and video as appropriate) for photo documentation and GPS for geo-referencing augment metadata information.

###### A9.2 Laboratory Records

* WES laboratory (Lawrence, MA) completedchain-of-custody (COC) forms generated by prelogging samples in WES’ WinLIMS is used to transfer sample custody for all samples from DWM-WPP staff to the WES laboratory. Electronic copies of completed COC forms are scanned and stored on a shared network drive by WES.
* WES laboratory LIMS data. WES tracks and reports sample data via a web-based Laboratory Information Management System (WinLIMS) system.
* WPP probe calibration and maintenance books.
* Contract lab EDDs (if WES not used) using DWM-WPP’s standard format and specification so that contract lab data can be uploaded to DWM-WPP’s database system with minimal transcription error.
* WPP probe request forms

###### A9.3 Sampling Station Registration

Prior to visiting sampling stations for data collection, DWM-WPP’s electronic station definition files are updated to create new (proposed) stations where needed. Each unique location (or station) sampled is given a “Unique ID” number and description including latitude/longitude. Unique IDs are recorded on all fieldsheets, along with a field sheet number, prior to entry of fieldsheets in another database. At the completion of the survey season, pre-registered station locations are verified as those sampled. ​ All station information is maintained in a database.

# SECTION B: DATA GENERATION AND ACQUISITION

## B1 SAMPLING PROCESS DESIGN

In addition to WPP’s program QAPP and this project specific QAPP for chloride monitoring, detailed Sampling and Analysis Plans (SAPs) are also developed annually to specify where, when and why chloride monitoring is planned. For details regarding chloride project-specific sampling locations, schedules, logistics, etc., see the separate and individual Sampling & Analysis Plans (SAPs).

Road salt used is usually sodium chloride (NaCl) and is applied to roadways in winter as a deicer and has been found to be the major source of salt in Massachusetts streams. Chloride is a recognized pollutant with potential to impair waterbodies and impact biological communities and has been shown to contribute to year-round elevated chloride levels in streams and groundwater.

This multi-year project involves collection of continuous conductivity data to estimate chloride levels using DWM-WPP’s conductivity-chloride regression developed. Estimated chloride data will help assess the effects of seasonal road salt (NaCl) applications on surface water quality and may be compared with EPA ambient criteria for acute and chronic toxicity. The results of this study have the potential to influence DEP water quality alert levels for chloride and provide baseline data for potential future development of Total Maximum Daily Loads (TMDLs).

The EPA recommended acute criterion for chloride is 860 mg/L (one-hour average) and the chronic criterion is 230 mg/L (four-day average). Neither value is to be exceeded more than once every three years. For the 2018 reporting cycle DWM-WPP analysts developed and validated a linear regression model to estimate chloride concentrations from specific conductance (SC) measurements (MassDEP, 2018). Model validation testing also proved it to be sufficiently accurate and robust to reliably predict chloride concentrations using SC as a surrogate in Massachusetts freshwaters according to the following equation:

Y=0.2753X – 18.987 (R2 = 0.9445, P<0.001),

where Y is chloride concentration and X is specific conductance at 25°C

Sampling locations often focus on streams near major highways or in heavily urbanized areas. Monitoring is designed to run from about October to June (at a minimum), covering the winter season.

Continuous conductivity data will be collected using HOBO U24 freshwater data loggers. Attended, discrete quality control (QC) readings will be taken at each visit using separate YSI/Hydrolab multiprobe instruments. On three of the survey rounds, water samples will be collected for chloride (only) and analyzed by the WES lab. Conductivity data will be analyzed using DWM-WPP’s chloride regression tool, which was previously verified, to estimate ambient chloride levels.

###### B1.9 How Data Are Used

In addition to direct uses, such as comparison to State ambient water quality standards or EPA criteria, specific ways in which DWM-WPP’s final data are used include but are not limited to:

* Assessment decision-making as directed in the latest Consolidated Assessment and Listing Methodology (CALM). DWM-WPP’s current CALM guidance is made available on MassDEP’s website (<https://www.mass.gov/guides/watershed-planning-program>). Versions of the CALM are specific to bi-annual Integrated List Reports, and document the procedures used to make assessment and listing decisions. When making chloride impairment decisions, a safety factor is applied to estimated chloride concentrations to account for model uncertainty.
* TMDL-related data analyses and determinations
* Regression model refinement

Farmington Watershed

## B2 SAMPLING METHODS

###### B2.1 Sampling-Related SOPs

All DWM-WPP field sampling follows the most current and approved DWM Standard Operating Procedures (SOPs), as listed in Table, along with applicable standard reference documents used to help formulate them.

Table 8: DWM-WPP Field Method SOPs

| Control Number(s) | SOP subject matter | Applicable “Standard” Method Reference(s) |
| --- | --- | --- |
| CN 0.2 | Field safety | --- |
| CN 0.21 | Incident Report Form | --- |
| CN 1.21 | Sample collection (general) | - USGS TWRI Book 9 USGS. National Field Manual for the Collection of Water-Quality Data (1998)  - Standard Methods for the Examination of Water and Wastewater (21st edition, 2005) |
| CN 1.25 | GPS data collection | --- |
| CN 1.96 | WinLIMS pre-login (WES lab only) | --- |
| CN 4.25 | Multiprobe use | - Hydrolab, YSI, Onset manuals |
| CN 4.28 | Hydrolab Quickguide |  |
| CN 4.34 | YSI EX01 Quickguide |  |
| CN 4.41 | Multiprobe deployment | - Hydrolab, YSI, Onset manuals |
| CN 4.81 | Onset COND/T logger Quickguide | - Onset DO/T meter manual |
| CN 59.6/59.95 | Decontamination to prevent the spread of invasives | --- |
| CN 103.5 | Onset HOBO Shuttle Quickguide | - Onset manual |
| CN 349.0 | Continuous Conductivity | --- |
| CN 535.0 | WPP COVID-19 Safety Guidance | --- |

###### B2.2 Field Safety

DWM-WPP’s survey coordinators and crewmembers are trained in field safety issues, use best professional judgment to safeguard crew members, and at no time allow personal health & safety to be compromised. The “SAFETY FIRST” principle applies at all times.

###### B2.3 Field Equipment

A partial list of primary field equipment used by DWM-WPP is provided in Table 9.

Table 9: DWM-WPP Field Equipment and Supplies

| Equipment or Service | CN # reference | NOTES |
| --- | --- | --- |
| Field kits | CN 0.2 | Each includes first aid kit |
| PFDs | CN 0.2 | --- |
| Cleats for boots | CN 0.2 | For added traction when wading |
| Digital cameras | --- | Station photo records, reconnaissance, etc. Refer to Manufacturer’s manuals. |
| GPS units (hand-held and vehicle) | --- | Manufacturer’s manuals. |
| Multi-probe loggers for unattended deployment | CN 4.41 | DO/T primarily. Also pH and conductivity feasible for deployment |
| 4+ parameter multi-probes (attended) | CN 4.24/4.25 | DO/T/pH/conductivity/etc. |
| Probe deployment tubes | CN 4.41 | Multiple sizes depending on logger type deployed |
| NIST-traceable thermometers | CN 103.1 | Field/lab QC for temperature |
| QC audit samples | --- | Quantitative QC known samples for specific conductance |

###### B2.4 Bottle Group, Type and Preservative for Chloride

Bottle group designations, associated parameters, and bottle type and preservative requirements for chloride water samples are shown in Table 10.

Table 10: Bottle Group Codes, Container Types and Field Preservation Methods for DWM-WPP Samples 1

| ANALYTE GROUP & Bottle code | | PARAMETERS | | Bottle type(s) (2) | SPECIAL preservative (3) |
| --- | --- | --- | --- | --- | --- |
| WATER | | | | | |
| “Nutrients” | N | | chloride | HDPE (250-500 mls) | H2SO4 (9N, 1 ml.) to pH < 2 |

(1) For any given analyte, bottle type and preservative recipe are generally independent of analytical method. Differences in required preservative within a bottle group are addressed on a case-by-case basis.

(2) In all cases, new, pre-cleaned bottles are used.

(3) Wet ice to < 6 deg. C in dark cooler is standard short-term storage for all water samples

(4) Acid addition for preservation is typically done in the field or at the lab within 24 hours

## B3 SAMPLE HANDLING AND TRACKING

###### B3.1 Assignment of LOCATION ID#s (Station ID and Unique ID)

Prior to each survey, the Survey Coordinator must verify that each station has been given two location-specific IDs: a project-specific Station ID# (e.g., BB01) and more importantly, a permanent Unique ID# (e.g., W0657). Both ID#s are used on DWM-WPP fieldsheets.

###### B3.2 Assignment of SAMPLE ID#s (“OWMID”)

Sample identification numbers are systematically allocated by DWM-WPP’s Database Manager. Printed OWMID # labels are provided to each project Principle Investigator for use on the fieldsheet forms. Six-digit ID# (e.g., 36-2105) labels are affixed on the fieldsheets for each separate sample, using designated, 2-digit project prefixes.

###### B3.3 WinLIMS Pre-login

For samples planned to be delivered to the WES lab, samples are pre-logged into the WES WinLIMS database using a WinLIMS web interface customized for DWM-WPP use. The specific procedures for pre-logging samples in this way are provided in CN 001.96.

###### B3.4 Sample Bottle Labeling

Bottle labels are printed on waterproof label-paper by the survey coordinators as part of the survey preparation. Pre-printed bottle labels are affixed to bottles prior to the bottles getting wet.

###### B3.5 Sample Preservation and Transport

Chloride samples are delivered to the state laboratory, Wall Experiment Station (WES) in Lawrence, Massachusetts. If WES is unavailable for any reason, samples will be delivered to a contract lab. All samples taken are preserved in coolers containing wet ice to <6 deg. C. during transport. Samples may be delivered directly from the field to the lab or held temporarily in a storage fridge at DWM-WPP before delivery to WES. The storage fridge at DWM-WPP is monitored daily for storage temperature (<6 deg.C). The Chain of Custody is used to sign samples in and out of the DWM-WPP storage fridge.

Because chloride analyses are typically done using the “nutrient” bottle (acid-preserved), samples for chloride only are preserved with sulfuric acid (9N) immediately after collection. Acid preservative for “nutrient” samples is added from purchased vials in the field by DWM-WPP field staff.

###### B3.6 Sample Delivery (and Use of Chain-of-Custody (COC) Forms)

When field samples arrive at the lab, the DWM-WPP staff relinquishes custody of samples to the laboratory staff. The sample containers are removed from the shipping or transportation cooler and visually inspected for damage such as leakage, breakage, or contamination. The samples received are then compared with accompanying custody and analysis specification forms to make sure that the paperwork agrees with the labels on each sample container. All individuals who handle samples are required to sign and date the COC forms.

###### B3.8 Lab Sample Tracking

The Wall Experiment Station (WES) tracks samples via a Laboratory Information Management System (WinLIMS). Similar systems are used for any contract labs used.

## B4 ANALYTICAL METHODS

All DWM-WPP samples are analyzed using standard protocols contained in accepted WES Lab. Analyses are consistent with each lab’s laboratory Quality Assurance Plan and Lab Safety Plan.

###### B4.1 WES and Contract Lab SOPs

The WES lab employs the following primary laboratory procedures for chlorides samples (Table 12). If needed, when using external contract labs, state-certification for method-specific project analytes (via the MassDEP Laboratory Certification Office) is preferred, but not essential.

Table 12: WES Lab Analysis Method SOPs for Chloride Samples

| Lab | Document Title |
| --- | --- |
| WES | Laboratory Quality Assurance Plan |
| WES | SM 4500 ClˉE – Determination of Chloride |

###### B4.2 Analytical Methods, Reporting Units and Holding Times

The methods and associated holding times for common DWM-WPP parameters are provided in Table 12 primarily for methods used by the WES and DWM-WPP labs, but also for those that may be employed by contract labs to be used from 2020-2024 (based on past experience). In many cases, DWM-WPP’s contract labs use the same or similar standard methods (and associated holding times). DWM-WPP ensures that identical (or similar) established methods are employed by all contract labs in order to be able to compare data from different labs. Detection limits (MDLs, MRLs, RLs) using these methods can vary within labs (temporally) and among different labs. Typically, none of DWM-WPP’s aqueous samples are frozen prior to analysis, except in cases of anticipated and unavoidable holding time exceedances. Decisions to freeze samples, such as nutrients, are avoided as much as possible, and when necessary, the resulting data are automatically qualified (when freezing is not a standard preservation step) or censored as appropriate during DWM-WPP’s data validation.

Table 13: Analytical Methods and Holding Times

| Parameter | Units | Method(s) | Holding Time (days) |
| --- | --- | --- | --- |
| WATER | | | |
| Chloride | mg/L | SM 4500-CL-(E) | 28 |
| Sulfate and Chloride | mg/l | EPA 300.0 | 28 |

\* Changes to analytes and/or methods shall be noted in annual addendums

###### B4.3 Laboratory Data Reporting Formats

WES Lab and contract lab final data and associated internal lab QC results are provided to DWM-WPP’s Data Management Team in digital format (e.g., WinLIMS downloads, pdf e-files, or Electronic Data Deliverables in Excel format). Hard copy data reports, when provided, are placed in project folders. The WES Lab data can be accessed by DWM-WPP through the WinLIMS system as soon as data are finalized. These represent final laboratory data for DWM-WPP review and subsequent data validation. Following preliminary DWM-WPP QC review for completeness and typographic errors, lab data can be released to the monitoring survey coordinators and other data users as “raw” data (QC status 1).

###### B4.4 WES Lab Data Qualifiers

The WES Lab makes every effort to avoid the use of data qualifiers through sound lab practices, including efficient sample tracking, diligent reagent preparation and quality control, multi-level data reviews, and re-testing as needed. In some instances, however, qualification of data is necessary and, in all cases, helpful when needed. WES laboratory staff may use the following standard data qualifiers/text results, as reported via the WinLIMS:

WES WinLIMS Qualifiers:

* B = Analyte detected in a blank (LRB-MB, FB-FRB, or TB) above the QC Limit. Results are qualified when the field sample concentration is less than 10 times the concentration in the blank
* B1 = Analyte detected in a blank (LRB-MB, FB-FRB, or TB) above QC Limit. Results are qualified
* BNC = Required FB-FRB or TB not collected/received
* E = Estimated Result: Exceeds the upper cal. range or the upper bacterial count limit
* HA = Samples analyzed past holding time
* HA-Hg = Holding time not met but previous studies by WES show that frozen fish samples are stable for mercury for at least one year
* HR = Samples received past holding time
* J1 = Estimated Result: LFM-MS outside acceptance limits; if biased high, field sample results < 1/3 MRL or < MRL are NOT qualified
* J2 = Estimated Result: LFB-LCS outside acceptance limits; if biased high, field sample results < 1/3 MRL or < MRL are NOT qualified
* J3 = Estimated Result: SAMPLE DUPL, FIELD DUPL, LFB-LCS Duplicate, or LFM-MS Duplicate outside acceptance limits; if the duplicate recovery is biased high, field sample results < 1/3 MRL or < MRL are NOT qualified
* J4 = Estimated Result: Dilution water supersaturated with oxygen
* J5 = Estimated Result: QCS, QCS-LC, QCS-HC, or QCS-SRM outside acceptance limits; if biased high, field sample results < 1/3 MRL or < MRL are NOT qualified
* J10 = Insufficient sample volume received to run method-required LFM-MS
* J11 = Insufficient sample volume received to run method-required sample duplicate or LFM-MS duplicate
* JO = Other QC criteria not met (see comments)
* L = Estimated Result: Below the lower calibration range
* M = Estimated Result: Analyte concentration ≥ MDL but ˂ MRL
* N = GC/MS non-target tentatively identified compound (TIC)-no standard available for quantitation
* R = Data rejected due to severe QC, quantitation, and/or qualitative ID deficiencies
* SC = Incorrect sample container used
* SP = Sample preserved improperly in the field
* ST = Sample temperature outside of acceptance limits at receipt

## B5 QUALITY CONTROL

By providing important information necessary to assess data quality, DWM-WPP’s quality control program serves to minimize cumulative uncertainty for measured variables. Lab audits will continue as usual for the WES lab and contract labs as resources allow.

###### B5.1 Field Quality Control

DWM-WPP surveys are planned well in advance to ensure proper coordination takes place among all parties, to allow adequate preparation time for crews and to ensure proper procedures are followed. Well-planned and executed surveys help to minimize field error.

To estimate the overall precision or repeatability of results, a subset of DWM-WPP field samples are replicated by taking co-located, simultaneous, duplicate grab samples. Approx. 10% of the total number of samples and a minimum of one per survey per analyte group is typically collected. Where co-located, simultaneous, duplicategrab samples cannot be taken for any reason, it is noted on the fieldsheet what alternate type of field duplicate (e.g., sequential duplicate) was actually taken. On a project-specific basis, QC samples may be taken at a higher percentage.

In addition, ambient field blanks or equipment blanks if appropriate are taken at 10% of total samples to evaluate if any sample contamination may have occurred due to improper sample collection, atmospheric fallout or other causes. Blank samples may be taken at a higher percentage, depending on the project.

Performance Evaluation (PE) or diluted Certified Reference Material samples may also be delivered to a lab to evaluate lab analytical accuracy and precision. Typically, DWM-WPP evaluates a sub-set of analyses each year by providing labs with QC samples for which DWM-WPP knows the “true” concentrations (e.g., E. coli count, nutrient/metal concentrations, etc.). These QC samples may be single-blind (sample type known by the lab, but not concentration) or double-blind (concentration unknown AND sample disguised as a real sample). These are prepared by DWM-WPP, by its agents, or are purchased through a Proficiency Test (PT) provider.

Training sessions for DWM-WPP field monitoring staff are held each spring, prior to any field surveys, to ensure that field measurements and samples will be taken consistent with accepted, approved SOPs. For experienced staff, these can be a basic review session, but for seasonal staff, a more thorough approach is taken to cover all aspects of field work. In addition, field audits can be performed by DWM-WPP’s QA Analyst to ensure consistent application of field protocols among different field crews.

###### B5.2 Lab Quality Control

DWM-WPP requires sufficient laboratory quality control for all its data generation activities. Laboratory quality control processes are described in the WES Lab and DWM-WPP Lab QAPs and SOPs, as well as in the QA documentation for contract labs. Required lab quality control procedures include but are not limited to detailed recordkeeping, SOPs that are current/updated, participation in proficiency testing studies, use of appropriate QC samples (e.g., lab blank, reagent blanks, sample duplicate and matrix spike analyses), and keeping internal control and calibration charts. Operating specifications for DWM-WPP’s reagent water system are detailed in Table 15. For all labs used, DWM-WPP requests that laboratory quality control data be included with submitted data packages. Analysis of these lab QC data helps inform DWM-WPP’s data validation process.

Table 15: Operating Specifications for DWM-WPP Reagent Water System

|  |  |
| --- | --- |
| Manufacturer/Brand | Thermo Scientific E-pure® |
| Series | 1090 |
| Water quality output | Type 1 RGW per ASTM D1193; 18.2 M-ohm-cm |
| Max. flow rate | 2.5 LPM (pressure-feed @ 60 HZ) |
| Feedwater reqts. | HQ tap water or better |
| Resistivity measurement | 0.01-18.2M-ohm-cm (temperature-compensated at 25 deg. C); +/-3% |
| Treatment methods (cartridges) | Cellulose/resin filtration (pretreatment), ion-exchange (deionization), activated carbon organics filtration, 0.2u final filtration |
| # cartridges | 4 |

Table 16: Field Sampling Quality Control Requirements for Water Quality Analytes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| QC SAMPLE TYPE | Frequency | Corrective Action | Persons Responsible for Corrective Action | Data Quality Indicator | Measurement Performance Criteria |
| Ambient Field Blanks and/or Equipment Blanks, or Trip Blanks (as approp.) | Minimum 10% of samples collected, and a minimum of 1 per survey | Qualify or censor data as necessary | Survey Coordinator and QA Analyst | Accuracy (contamination) | No target analytes exceeding MDL (preferred) or RL |
| Field Duplicates | Minimum 10% of samples collected, and a minimum of 1 per survey | Evaluate and compare lab dups and field dups (overall precision). Censor or qualify data as necessary | Survey Coordinator and QA Analyst | Overall Precision | See Table 2 for precision DQOs |
| Performance Evaluation (PE) Samples | 1-2 occasions per season, per lab and per analyte group | Discuss with lab; rerun test samples. Censor or qualify data as necessary | QA Analyst and lab QC officer | Accuracy | Same as QC/PT sample acceptance criteria (provided by PT lab) |
| Cooler Temperature Blank \* | Each cooler | Add more ice; drain cooler water | Survey crew leader | Accuracy (preservation) | 0-6 deg. C |

\* or use infrared temperature gun

Table 18: Field and Laboratory Quality Control Requirements for ATTENDED Multi-Probe Instruments

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| QC SAMPLE TYPE | Frequency/  Number | Method/SOP QC Acceptance Limits | Corrective Action (CA) | Persons Responsible for Corrective Action | Data Quality Indicator | Measurement Performance Criteria |
| Pre-Calibration (or pre-deployment) | Each day used | See SOP (CN 4.25, 4.28, 4.29, 4.31, 4.61, 4.70, 4.81, 4.85) and multi-probe instrument manuals | Re-calibrate to within allowable specs. | Field & Lab Operations Coordinator & QA Analyst | Accuracy/bias Contamination | Must meet or exceed instrument accuracy specs |
| Field Duplicate reading (Lakes only) | Approximately 10% of sites, minimum of one per trip | RPD < 10% | Re-deploy and start reading sequence again | Field survey crew leader | General precision | RPD < 10% |
| Instrument Blank | After pre & post calibrations | No target compounds > lowest calibration standard | Retest and/or qualify data | Field & Lab Operations Coordinator & QA Analyst | Accuracy/bias Contamination | No target compounds> lowest calibration level |
| Post-Survey (or post-deployment) Check and User Report | End of each day or after deployment | See SOPs (CN 4.25, 4.28, 4.29, 4.31, 4.61, 4.70, 4.81, 4.85) and multi-probe instrument manuals | If outside acceptance limits, discard or qualify data | Field & Lab Operations Coordinator & QA Analyst | Accuracy/bias Contamination | Must meet or exceed instrument accuracy specs |

Table 19: Field and Laboratory Quality Control Requirements for UNATTENDED Continuous Loggers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| QC SAMPLE TYPE | Frequency/  Number | QC Acceptance Limits | Corrective Action (CA) | Persons Responsible for Corrective Action | Data Quality Indicator | Measurement Performance Criteria |
| Pre-Deployment QC Check | Before every use for each sensor | Temperature: +/- 0.3 deg. C (vs. NIST-certified lab thermometer)  Sp.Cond:  3% or 15 uS/cm (low)  3% or 30uS/cm (high)  (vs. lab standard)  Time: +/- 1 minute | Replace with more accurate sensor | Field & Lab Operations Coordinator & QA Analyst | Accuracies for D.O., temperature, Sp.cond., and time compared against 100% saturation concentration, lab standard, NIST-traceable thermometer and PC network clock, respectively | See SOP (CN 103.1 & CN 349.0) and sensor specifications |
| During-Deployment QC checks (Field Duplicate readings) | Each sensor; min. 1X/month (or more freq. for shorter duration deployments) | Temperature: +/- 0.5 deg. C (vs. NIST-certified lab thermometer)  Sp.Cond:  +/- 10 uS/cm (low)  +/- 40 uS/cm (high)  Time: +/- 1 minute | Replace with more accurate sensor; re-deploy | Project Coordinator & QA Analyst | Accuracy as above | See SOP (CN 103.1 & CN 349.0) and sensor specifications |
| Post-Deployment Checks | After every use for each sensor | Temperature: +/- 0.5 deg. C (vs. NIST-certified lab thermometer)  Sp.Cond: 3% or 15 uS/cm (low)  3% or 30uS/cm (high)  (vs. lab standard)  Time: +/- 1 minute | If data outside acceptance limits, discard or qualify data | Field & Lab Operations Coordinator & QA Analyst | Accuracy as above | See SOP (CN 103.1 & CN 349.0) and sensor specifications |

## B6 FIELD EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

All field equipment used by DWM-WPP to collect environmental data is inspected, maintained, calibrated (as applicable) and tested prior to use.

In addition to rigorous pre-survey calibrations, water quality instruments are also checked following use to ensure they were operating properly during field data collection. A summary of inspection and maintenance procedures for each instrument type is contained in Table 20.

Table 20: DWM-WPP Field Equipment Calibration, Inspection and Maintenance

| Instrument | Person(s) Responsible | Frequency of Calibration | Inspection Activity and Frequency | Maintenance Activity and Frequency | Testing Activity and Frequency | Corrective Action (CA) | SOP Reference |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Multiprobes: \*  Hydrolab® Series 5  YSI EXO1 | Shervon De Leon  Dahlia Tympanick  Monitoring Coords. | Pre-cal/re-cal prior to and within 24 hours of use  Post-use QC checks | Visual & Electronic; Monthly and/or before each use | Hardware & Software Repair and maintenance as needed. | Pre-survey calibration & post-survey QC checks | Re-calibrate as necessary during pre-calibration; censoring or qualifying data if post-survey check indicates excessive drift or inaccuracies in comparison to pre-calibrated readings and standard solutions | CN 4.25, CN 4.33, CN 4.34 |
| NIST-traceable thermometer (field) | Shervon De Leon  Monitoring Coords. | Annually, and as needed based on QC checks. | Visual & Electronic; Before and after each use | As needed | Annual (Spring) comparison to NIST-traceable thermometer | Replace unit as needed | CN 4.25  CN 103.1 |
| Cond/Temp loggers | Shervon De Leon  Dahlia Tympanick | Before and after field deployment | Visual & Electronic; Before and after each use | NA | Annual (Spring) QC check against DWM-WPP NIST-traceable thermometer and PC network clock, per SOP. | Replace with working sensor. | CN 349.0 |
| GPS (vehicle; hand-held) | Shervon De Leon  Monitoring Coords. | --- | Settings (annually) | As needed per manual | Annually | --- | --- |

\* DWM-WPP checks temperature loggers and probes annually against a NIST-traceable thermometer at near 0.0 o C and room temperature (approx. 20-22 o C).

## B7 LAB INSTRUMENT CALIBRATION, INSPECTION AND MAINTENANCE

All laboratory instruments involved in analyses of DWM-WPP samples are inspected, maintained, calibrated (as applicable) and tested prior to use. Details on the calibration of each DWM-WPP lab analytical instrument are contained in Table.

For detailed descriptions of calibration procedures for WES and other lab instrumentation, see the applicable lab QAPs and SOPs, adopted herein by reference.

Table 21: DWM-WPP Analytical Instruments Calibration and Maintenance

| Instrument | Person(s) Responsible | Frequency of Calibration | Inspection Activity and Frequency | Maintenance Activity and Frequency | Testing Activity and Frequency | Corrective Action (CA) | SOP Reference |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NIST-traceable thermometer (lab) \* | Shervon De Leon | Annually, and as needed based on QC checks. | Visual & Electronic; Before and after each use | As needed | Annual re-calibration by manufacturer vs. NIST-certified | Send to manufacturer for re-calibration per SOP | CN 4.25  CN 103.1 |
| Barnstead E-PURE®  reagent water system | Shervon De Leon | NA | Weekly and prior to every use (general operation) | Annually and as needed (Change DI/AC cartridges, 0.2 final filter; disinfect)  O-ring replacement | Prior to every use | Yes. Varies.  If < 18.2 meg.Ω-cm  If leaking  If low flow/clog  Pump problem | CN 4.99 |

\* The NIST-traceable thermometer is calibrated annually at four temperatures (from 0-100 o C) and issued a traceable certificate. The calibration is in accordance with ISO 17025 and ANSI/NCSL Z540-1.

## B8 INSPECTION OF SUPPLIES

Based on their individual responsibilities, designated DWM-WPP staff are responsible for ensuring the adequacy of supplies and equipment necessary to perform monitoring surveys. Equipment and supplies are ordered annually and as needed to meet specific monitoring and analytical needs. Wherever feasible, DWM-WPP strives to avoid or minimize the use of hazardous materials, to minimize the environmental impacts of its purchasing decisions, and to make cost-effective purchasing decisions. Table 22 provides some examples of types of supplies used by DWM-WPP (not exhaustive).

Following use, efforts are made to recycle used supplies wherever possible at the 8 New Bond St. location. Disposal of liquid and solid wastes is done in the most environmentally sensitive ways possible, and in compliance with applicable Massachusetts regulations.

Table 22: DWM-WPP Supplies

|  |  |  |
| --- | --- | --- |
| WPP STAFF | PROGRAM AREA(S) | TYPES OF SUPPLIES |
| Shervon De Leon | Laboratory and Field Operations | Sampling devices, multi-probe units and supplies, analytical kits, Colilert® / Enterolert® reagents and supplies, sample bottles, QC samples, cameras, GPS units, etc. DIW system maintenance supplies, probes and sonde parts, calibration reagents, water system cartridges, etc. |
| Shervon De Leon | Lab and Field Safety | Safety equipment and first aid supplies |
| Robin Murphy | Vehicles | Maintenance items for vehicles |
| James Meek  Dan Davis  **Peter Mitchell**  Dahlia Tympanick  Allyson Yarra | Monitoring | Project-specific supplies and equipment as needed |
| Shervon De Leon  Dan Davis | Purchasing | Procurement of all field, lab and safety equipment and supplies |

NOTE FOR SECTION B9: See also annual project-specific Sampling & Analysis Plans (SAPS) in Appendix G and in the annual QAPP addenda.

## 

## B9 NON-DIRECT MEASUREMENTS & USE OF SECONDARY DATA

Given the inherent limitations of any monitoring program, use of reliable, quality-controlled data from external sources has become an integral part of DWM-WPP’s decision-making. Both in planning its own data collection work and evaluating other’s available data, DWM-WPP assembles data and information from a wide variety of sources. Although DWM-WPP’s use of secondary data is combined with its own primary data, the uses are generally consistent with EPA-New England guidance for projects using only secondary data (USEPA; <http://www.epa.gov/region1/lab/qa/pdfs/EPANESecondaryDataGuidance.pdf>).

###### B9.1 Sources of Information

Potential sources of secondary data that meet DMW-WPP’s needs include, but are not limited to, monitoring data reports from federal, state and municipal programs, various non-governmental organizations (NGO), grant-funded (CWA §314, 319, 104, or 604(b)) projects and volunteer monitoring organizations. The following partial list provides some of the possible sources of information for DWM’s watershed assessment, TMDL and other work.

Federal Agencies

* U.S. Environmental Protection Agency (EPA)
* National Estuaries Program (NEP)
* U.S. Fish and Wildlife Service (USFWS)
* U.S. Army Corps of Engineers (ACOE)
* National Oceanographic and Atmospheric Administration (NOAA)
* U.S. Geological Survey (USGS)
* Natural Resources Conservation Service (NRCS)
* National Ecological Observatory Network (NEON)

State Agencies

* Department of Environmental Protection - Drinking Water Program
* Department of Environmental Protection - Wetlands and Waterways Program
* Department of Environmental Protection - Watershed Permitting Program
* Massachusetts Office of Coastal Zone Management (CZM)
* Massachusetts Department of Conservation and Recreation (DCR)
* Massachusetts Department of Fish and Game (DFG)
* Massachusetts Division of Marine Fisheries (DMF)
* Massachusetts Division of Ecological Restoration (DER)
* Massachusetts Department of Public Health (DPH)
* Massachusetts Water Resources Authority (MWRA)
* Massachusetts Office of Geographic and Environmental Information (MassGIS)

Municipalities

* Municipal Conservation Commissions (non-point source assessment)
* Municipal and Industrial NPDES Permit Monitoring Requirements (including service contracts for toxicity testing)
* Public drinking water system testing

Private Consulting Firms

* Misc. project data

Academic and Research

* Colleges, universities and other academic/research institutions
* Scientific/engineering literature, including conference and symposium papers

Volunteer Monitoring Organizations

* Watershed associations
* Lake & Pond associations
* Citizen monitoring groups

###### B9.2 Types of Non-Direct Data

The types of secondary data gathered by DWM-WPP for potential use vary widely depending on the source (chemical, biological, ecological, regulatory, etc.). These may include:

* measured surface water quality/quantity data
* hydrologic and water quality model output
* measured pollutant loads
* literature values and data
* historical environmental data
* geographic information system data
* weather records.

## B10 DATA MANAGEMENT

See WPP’s program QAPP (CN 520.0).

# SECTION C: ASSESSMENT AND OVERSIGHT

## C1 CORRECTIVE ACTIONS

Recognizing MassDEP’s commitment to continual improvement and the common QA theme of “Plan-Do-Check-Act”, DWM-WPP takes corrective actions when necessary based on a graded approach. Problems encountered that have a direct and meaningful effect on data quality are dealt with using formal corrective action forms and communications. Less important issues are resolved on a case-by-case basis using more informal methods (e.g., email clarification).

###### C1.1 Field-Related Evaluation and Correction

Review of field activities related to data integrity and safety is the joint responsibility of the Survey Coordinator for each project, DWM-WPP’s Monitoring Coordinator, the Field & Lab Operations Coordinator and the QA Analyst.

Although infrequently done due to staffing limitations, DWM-WPP’s field audit process calls for the QA Analyst to accompany survey crews to evaluate adherence to the applicable SOPs and the program QAPP by crews and individual crew members. These field audits attempt to evaluate at least one survey per watershed and, ideally, each survey crew member a minimum of one time. DWM-WPP sampling staff in need of performance improvements may be directed to re-read the relevant standard operating procedure and/or may be re-trained. If errors in sampling techniques are consistently identified, mandatory re-training will be scheduled.

When necessary, Root Cause Analyses (RCA) are conducted to determine the primary causal factors that led to an incident and to develop corrective actions. RCAs are performed by the Field & Lab Operation Coordinator.

###### C1.2 Lab-Related Evaluation and Correction

DWM-WPP’s QA Analyst has the primary responsibility to ensure that data from laboratories are consistently of known, documented and usable quality. This is done mainly by reviewing lab reports for errors, inconsistencies and poor QC results, but also via frequent communication with lab staff. Ideally, the need for corrective action can be communicated in a timely fashion to avoid future problems and/or data censoring.

For all labs used, the QA Analyst works with each lab to avoid misunderstandings early on. This includes visits to contract labs to discuss method and logistical specifics. In addition, external, single- and double-blind laboratory audits using quantitative QC check samples are typically initiated by DWM-WPP for nutrients (TP, NH3-N, TN, NO3-NO2), bacteria and metals. DWM-WPP also performs self-audits for Colilert® bacteria analysis using semi-quantitative PE samples (*E. coli* within a defined range).

Assessment of laboratory performance is mainly the responsibility of individual labs used (e.g., WES) prior to data transmittal. Lab audits are conducted by the Field & Lab Operation Coordinator and/or QA Analyst.

###### C1.3 Database-Related Evaluation and Correction

DWM-WPP’s Database Manager is responsible for ensuring that housed data are secure, organized, accessible and free from systematic error. The need for corrective actions concerning the database system is attenuated somewhat by the “built-in” QA inherent in database development and maintenance (e.g., locked computer code, redundancy checks, etc.). Nevertheless, issues can arise that require resolution. Database-related issues and problems can be brought to the attention of the Database Manager by any staff, but the corrective actions needed to resolve problems are handled by the DWM-WPP data management group. Corrective actions take place as soon as possible and can include:

* Changes to database to correct for transcription errors, based on data entry QC
* Changes to VB code
* Changes to import files based on new or updated information, such as WinLIMS data corrections and updates

###### C1.4 Incident and Corrective Action Forms

Incident Forms are available for use for reporting issues related to safety or data quality. RCAs or Corrective Action Forms can be used for further documentation and for recommended improvements. These forms can also be used for all field and laboratory deviations and deficiencies that cannot be handled immediately. Refer to DWM’s Corrective Action Procedures SOP (CN 5.0) for more information.

## C2 REPORTING

###### C2.1 Internal and On-Line Data Reporting

As data are finalized, final data are made available to staff using MS Excel spreadsheets and MS Access by project. The internal data warehouse includes standard statistical calculations. As DWM-WPP’s EQuIS database is fully implemented, data will be made available to staff through EQuIS.

DWM-WPP water quality data are made available to the public via the MassDEP website ([https://www.mass.gov/guides/water-quality-monitoring-program-data#-data-files](https://www.mass.gov/guides/water-quality-monitoring-program-data#-data-files-)). The following dataset types are available to the public:

* Water quality laboratory data: water quality data generated via laboratory analysis; collected at monitoring stations throughout the Commonwealth.
* Water quality attended probe data: discrete probe data for parameters such as dissolved oxygen, temperature, pH, and specific conductance.
* Water quality continuous probe statistical summaries by deployment: statistical summaries of the unattended, continuously-logged data (e.g., averages, maximums, minimums, etc.).
* Water quality continuous probe statistical summaries by station: summary water quality information based on multiple deployments at each individual station in a given data year.
* Water quality continuous probe data (available upon request): water quality readings from continuous probes deployed for durations from a few days to several months at individual stations. Most deployments include data collected every 30 minutes.

###### C2.2 DWM-WPP Technical Memoranda

Using final data, DWM-WPP staff develop project-specific Technical Memoranda summarizing findings. These reports are made available internally, as well posted to DEP’s web site (<https://www.mass.gov/guides/water-quality-technical-memoranda>).

###### C2.3 EPA Database Reporting

Once data are finalized, data are exported to EPA’s STORET Water Quality Exchange (WQX) network (<https://www.epa.gov/waterdata/water-quality-data-wqx>). DWM-WPP’s goal for assembling, validating and finalizing laboratory, instrument and biological data is within 6-9 months of data collection. The frequency of water quality data transmittals to WQX may vary from once per year to several times per year, depending on the availability of final data.

DWM-WPP also employs the ATTAINS to track water quality assessment decisions, including causes and sources of impairment (<https://www.exchangenetwork.net/data-exchange/assessment-tmdl-tracking-and-implementation-system/>).

###### C2.4 Water Quality Assessments

Results of monitoring efforts, combined with all other reliable information, constitute the basis for making water quality assessments. The Consolidated Assessment and Listing Methodology (CALM) guidance document contains MassDEP’s reasoning and justification for site-specific designated use decisions. The 2018 CALM is here: <https://www.mass.gov/files/documents/2018/05/07/2018calm.pdf>.

Use-attainment determinations are made for each waterbody segment for which adequate data and information are available. (Many waters remain not assessed for one or more uses in any given assessment cycle and many small and/or unnamed streams and ponds have never been monitored and assessed). Results of DEP water quality assessments are available at: <https://www.mass.gov/lists/water-quality-assessment-reports-blackstone-through-islands-watersheds> and <https://www.mass.gov/lists/water-quality-assessment-reports-merrimack-through-weymouth-weir-watersheds>.

###### C2.5 Integrated List

On a biennial basis, DWM-WPP generates an *Integrated List of Waters (ILW)* that combines reporting elements required by CWA §305(b) and §303(d). The ILW report presents the individual categories of Massachusetts’ waters for the current CWA listing cycle. Each waterbody or segment is listed in one of the following five categories:

Category 1: Unimpaired and not threatened for all designated uses

Category 2: Attaining some uses and not assessed for others

Category 3: No uses assessed (insufficient information to make assessments for any uses)

Category 4a: TMDL is completed

Category 4b: Impairment controlled by alternative pollution control requirements

Category 4c: Impairment not caused by a Pollutant - TMDL not required

Category 5: Impaired for one or more uses and requiring a TMDL

The latest version of the Integrated List can be found on the MassDEP web page: <https://www.mass.gov/lists/integrated-lists-of-waters-related-reports>.

###### C2.6 TMDLs

Section 303(d) of the Clean Water Act and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the maximum allowable loading of pollutants that a waterbody can receive and still meet the SWQS established for protecting public health and maintaining the designated beneficial uses of those waters. TMDL analyses are based on available data and information and documented in TMDL reports. Final reports are posted at: <https://www.mass.gov/lists/total-maximum-daily-loads-by-watershed>.

###### C2.7 TMDL Modeling Reports

As described in DWM-WPP’s TMDL Modeling QAPP (Appendix A), selection and use of models will be thoroughly documented in Modeling Reports.

# SECTION D: DATA VALIDATION AND USEABILITY

## D1 DATA REVIEW AND VALIDATION

DWM-WPP uses standardized procedures for managing, reviewing and validating primary water quality data.

###### D1.1 “QC Status” Levels for DWM-WPP Data

The following categories of “data readiness” are used at DWM-WPP, as it relates to the use and transmission of draft and final data. All DWM-WPP data are categorized into five levels, depending on and reflecting the status of review and validation (finalization). The preferred QC Status levels for use and/or release of DWM-WPP data are QC Status 4 (final) and QC Status 5 (final, published). Although not recommended, all levels (QC1-5) can be shared with others if requested (e.g. for Freedom of Information Act purposes) with the appropriate disclaimers based on the QC status of the data.

**QC Status 1**:Raw data. Generally not suitable for use or transmission, but can be transmitted to other parties upon request provided data are sent as “DRAFT” with standard disclaimers.

**QC Status 2**:Draft data that has been entered into the appropriate DWM-WPP electronic system or database and for which data entry QC has taken place. This stage is for technical QC review.

**QC Status 3**:Draft data for which technical QA/QC review (e.g. QC sample results, outlier identification, comparison to project QAPP DQOs, etc.) has taken place. This stage is for project-level review.

**QC Status 4**: Final Data. This level of data reflects project-level review by appropriate staff for reasonableness, completeness and acceptability. These data can be freely used and cited in documents without caution or caveat (reviewed and approved by all appropriate DWM-WPP staff).

**QC Status 5**: Final data in a published, citable report. The QC Status 4 guidelines stated above apply to the data contained in a report. QC4-level data have been reviewed and approved by all appropriate DWM-WPP staff.

###### D1.2 DWM-WPP Final Data Qualifiers

Standard data symbols are used to denote specific problems or issues for final datum. These are applied to both qualified and censored data to provide data users with additional information.

**General Symbols (applicable to all data types):**

“ **##** ” = Censored data (i.e., data that has been discarded for some reason; check qualifier symbol for cause(s)).

“ **\*\*** ” = Missing data (i.e., data that should have been reported, but were not for any reason other than no water).

“ **--** ” = No data (i.e., data not collected nor intended)

“ **^^** ” = No water (i.e., a special case of missing data due to dry/no water conditions)

“ **<MRL**” = Less than method reporting limit (MRL). Denotes a sample result that went undetected using a specific analytical method, or was detected but the result is less than the allowable reporting limit. The actual, numeric MRL is specified (e.g. <0.2).

**Probe-specific Qualifiers:**

“ **i** ” = inaccurate readings from probe likely; may be due to:

* significant pre-survey calibration problems or lacking pre-calibration/check
* post-survey checks outside typical acceptance ranges at post-field calibration checks
* lack of calibration of the depth sensor prior to use or negative depth readings
* checks against laboratory analyses
* water temperatures < 0.1˚C (likely iced conditions)
* to qualify anomalous points in continuous data likely to be caused by instrument problems

“ **m** ” = method not followed; one or more protocols contained in the probe SOP not followed, i.e. operator error (eg. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.

“ **s** ” = field sheet recorded data were used to accept data (i.e., not data electronically recorded in a data logger or in cases where data logging is not possible (e.g., single-probes)).

“ **u** ” = unstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc. See Section 4.1 for acceptance criteria. Also used to indicate instability in deployed/continuous readings.

“ **c** ” = unit not calibrated for a particular parameter and/or greater than calibration standard used for pre-calibration, or outside the acceptable range about the calibration standard. Typically used for conductivity (>718, 1,413, 2,760, 6,668 or 12,900 uS/cm) or turbidity (>10, 20 or 40 NTU). It can also be used for TDS and Salinity calculations based on qualified (“c”) conductivity data, or that the calculation was not possible due to censored conductivity data ( TDS and Salinity are calculated values and entirely based on conductivity reading).

“ **r** ” = data may not be representative due to circumstances and/or conditions at the time of sampling; used to indicate unrepresentative conditions (e.g. probe out of water, backwatered by beaver dam, probe buried, probe iced in) in continuous readings.

“ **t** ” = tidal influence likely (not indicative of freshwater flow)

**Lab Sample-Specific Qualifiers:**

“ **a** ” = accuracy as estimated at WES Lab via matrix spikes, PT sample recoveries, internal check standards and lab-fortified blanks did not meet project data quality objectives for program or QAPP.

“ **b** ” = blank contamination in lab reagent blanks and/or field blank samples (indicating possible bias high and false positives).

“ **d** ” = precision of field duplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP. Batched samples may also be affected.

“ **e** ” = not theoretically possible. Specifically, used for bacteria data where colonies per unit volume for e-coli bacteria > fecal coliform bacteria, for lake Secchi and station depth data where a specific Secchi depth is greater than the reported station depth, and for other incongruous or conflicting results.

“ **f** ” = frequency of QC duplicates did not meet data quality objectives for program or QAPP.

“ **h** ” = holding time violation (usually indicating possible bias low)

“ **j** ” = ‘estimated’ value; can be used for lab-related issues where certain lab QC criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used to report sample data where the sample concentration is less than the ‘reporting’ limit or RDL and greater than the method detection limit or MDL (MDL < x < RDL). Also used to note where values have been reported at levels less than the MDL. Also used for estimated ranges based on known metadata.

“ **m** ” = method SOP not followed, only partially implemented or not implemented at all, due to complications with sample matrix (e.g. sediment in sample, floc formation), lab error (eg. cross-contamination between samples), additional steps taken by the lab to deal with matrix complications, lost/unanalyzed samples, use of expired reagents and missing data.

“ **p** ” = samples not preserved per SOP or analytical method requirements.

“ **r** ” = data may not be representative due to circumstances and/or conditions at the time of sampling, including the possibility of “outlier” data.

“ **t** ” = tidal influence likely (not indicative of freshwater flow)

## D2 DATA VALIDATION METHODOLOGY

See WPP’s program QAPP (CN 520.0).

## D3 DATA USABILITY

Data of known and documented quality (i.e. “QC Status 4” and “5”) can be used without caveat for analysis, decision making and reporting (as described in Section C2). The extent to which data are determined to be useful is an on-going in-house evaluation based on cumulative confidence (and uncertainty) in the data, data conclusiveness and results of QC and data analyses. If certain data do not meet the program Data Quality Objectives (DQO’s), data may be censored, qualified or left as draft subject to further review. Any limitations on data use will be detailed in both interim and final reports.

Final monitoring data are used in project-specific technical memoranda, which include summary quality control evaluations. These memoranda support determinations made as part of the watershed assessment and TMDL development processes.

The successfulness of DWM-WPP monitoring is evaluated on a continuous basis. Data for each project are evaluated with regard to both programmatic and project-specific objectives. Final data are used to answer important questions related to the current health of surface waters in the Commonwealth and to the potential for improvements in environmental quality.

## APPENDICES (by reference)

Appendix A: DWM-WPP Annual Sampling & Analysis Plans (SAPs) for 2020/21

CN 540.0 Chloride Project – Nashua SAP 2020-21

CN 541.0 Chloride Project – Concord SAP 2020-21

Appendix B: WES Laboratory QA Plan and SOPs

Lab QA Plan Laboratory Quality Assurance Plan

SM 4500-Cl-B - Chloride

Appendix C: DWM-WPP Monitoring, Analytical and Data Management SOPs

CN 000.2 - Field Safety.doc

CN 000.21 - Incident Report Form\_2020

CN 000.35 - Laboratory Safety Plan for 8 New Bond location

CN 001.21 - Field Sampling

CN 001.27 - Property Access WORKING DRAFT

CN 001.28 - Property Access (forms)

CN 001.3 - Sample Collection Pole

CN 001.35 - Hinged Pole Sampler (DRAFT)

CN 001.96 - WinLIMS\_SamplePreLog 2019

CN 004.25 - Water Quality Multiprobes DRAFT

CN 004.28 - Hydrolab Multiprobe Quickguide for Field Use

CN 004.29 - Hydrolab Multiprobe Quickguide for Calibration and File Management

CN 004.29b - Hydrolab MS5 Calibration QuickGuide 2019

CN 004.32 - YSI EXO1 Calibration and Download QuickGuide 2019

CN 004.33 - YSI EXO1 Multiprobe Field Operation QuickGuide 2019

CN 004.34 - YSI EXO1 Calibration and Download QuickGuide 2002

CN 004.41 - Multiprobe Deployment

CN 004.99 - Barnstead E-PURE 2019

CN 005.0 - Corrective Action

CN 056.15 - Data Validation Processes (summary)

CN 056.3 - Data Validation Decision Table

CN 056.4 - Data Validation\_Attended Probe Data\_4-12

CN 056.5 - Data Validation\_Unttended Probe Data\_11-2012

CN 056.61 - Data Validation\_Laboratory Data

CN 056.9 - Data Validation\_Overview

CN 059.6 - Field Equipment Decontamination (invasives)

CN 059.95 - Quickguide for Field Equipment Decontamination (2020)

CN 103.5 - Hobo Shuttle Quickguide

CN 349.0 - Continuous Conductivity Monitoring

CN 349.5 - Conductivity Correction Factor Calculator

CN 535.0 - WPP COVID-19 Safety Guidance 2020