GENERIC QUALITY ASSURANCE PROJECT PLAN

For

Monitoring Networks to Document Long-Term Conditions and Detect Changes in High Quality Wadeable Streams

A collaboration among:

U.S. Environmental Protection Agency
U.S. Geological Survey
State and Tribal Agencies
River Basin Commissions
Universities

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I. INTRODUCTION

The United States Environmental Protection Agency (U.S. EPA) is working with its regional offices, states, tribes, river basin commissions and other entities to establish Regional Monitoring Networks (RMNs) to detect climate change effects and other changes in condition in least disturbed (Stoddard et al. 2006), freshwater, wadeable streams. RMN surveys build on existing bioassessment efforts, with the goal of collecting comparable data that can be pooled at a regional level. The need for RMNs stems from the lack of long-term, contemporaneous biological, thermal, and hydrologic data, particularly at minimally disturbed sites (Stoddard et al. 2006). High quality waters are being targeted because they are the standard against which other bioassessment sites are compared.

Addendums with more region-specific information are available and will be updated by each EPA Region/RMN lead, then posted along with this Quality Assurance Project Plan (QAPP), on the RMN SharePoint site. The three addendums are:

1. Signature pages with monitoring site details for each regional partner (template in Attachment A). As organizations choose to participate in their regional RMN network, the signed and dated addendums must be submitted to the EPA regional and national leads.
2. Project personnel from the regional partners and description of scoping meetings (template in Attachment B).
3. Protocols that are agreed upon by each regional working group (template in Attachment C).

This generic QAPP is designed to detail the core requirements for participating in the national network. Participants may choose to add to this for their own organization's interest by developing an additional QAPP that covers additional monitoring and assessment constituents. The core details of this generic QAPP are not to be altered. If this QAPP needs to be amended, it will be opened up for discussion, reviewed and changed by EPA's national leads. Updates to this QAPP will be documented in Section VIII, QAPP Revision History. Updates will be available to partners on the RMN SharePoint site and emailed to EPA Regional leads.

II. PROJECT DESCRIPTION

A. OBJECTIVE AND SCOPE STATEMENT

EPA and collaborators have developed recommendations in collaboration with the regional working groups on best practices for the collection of biological, thermal, hydrologic, physical habitat, and water chemistry data at RMN sites. These best practices, which are the basis of this Quality Assurance Project Plan (QAPP), are described in detail in two EPA reports (EPA 2014, EPA 2016). The best practices are intended to increase the comparability of data being collected at RMN sites, improve our ability to detect long-term trends by minimizing biases and variability, and to ensure that the data are of sufficient quality to meet data quality objectives. Figure 1 shows the chart of responsibilities for this project.

Figure 1. This chart shows the lines of communication and the roles of responsibility for sampling, data management and QA/QC throughout this project.

B. DATA USAGE

Data collected from RMN sites will serve many purposes, including documenting current conditions at high quality sites and tracking changes at these sites over time. These data will provide important information on whether benchmarks are shifting over time, and if so, whether these changes are associated with changing thermal and hydrologic conditions. RMN data from high quality sites can also be used for the Clean Water Act Section 303(d) Program, since protection planning priorities will be incorporated into the 2016 reporting cycle (EPA 2013), and may also be used for other EPA programs, such as the EPA Healthy Watersheds Program (EPA 2011).

Other potential short and long-term uses of data being collected from RMN sites include:

- Quantifying natural variability
- Informing criteria development or refinement (e.g., defining natural conditions)
- Detecting temporal trends in biological, thermal, hydrologic, habitat, and water chemistry data
- Detecting trends attributable to climate change
- Investigating relationships between biological, thermal, and hydrologic data
- Testing hypotheses and predictive models related to future species distributions and thermal and hydrologic conditions
- Exploring ecosystem responses and recovery from extreme weather events

C. MONITORING DESIGN

Sampling efforts at the RMNs are concentrated at a core group of sites called 'primary' sites. The primary RMN sites are the sites at which efforts are being made to collect biological data on an annual basis and to install continuous temperature and hydrologic monitoring sensors. The overall goal is to sample at least 30 primary sites across the analysis unit (e.g., EPA region, ecoregion) that have comparable environmental conditions and biological communities.

The site selection process is a balancing act that takes into account numerous considerations, which are summarized in Table 1. High quality sites that are sampled as part of existing networks are targeted (where available), as are sites with low potential for future development. To select high quality sites, a standardized procedure for characterizing the level of anthropogenic disturbance was developed across RMNs (EPA 2016). Because of the limited funding for RMN implementation, practical considerations have to be taken into account as well. For example, some of the primary RMN sites have higher than desired levels of disturbance but have lengthy historical records, are part of existing monitoring networks, or have existing equipment like a USGS gage. Accessibility and opportunities for partnership or collaboration are also important considerations.

Table 1. Main considerations when selecting primary sites for the RMNs.

Consideration	Desired characteristics at primary sites
Existing monitoring network	Located in established long-term monitoring networks to build upon data already being collected by states, tribes, RBCs, and others.
Disturbance	Low level of anthropogenic disturbance.
Potential for future disturbance	Located in watersheds that are protected from future development.
Sampling record	Lengthy historical sampling record for biological, thermal or hydrological data.
Equipment	Co-located with existing equipment (e.g., USGS gage, weather station).
Classification	Sites with similar environmental and biological characteristics, which minimizes natural variability across sites, improves power for detecting long-term trends and allows for pooling of data within and across regions.
Longevity	Accessible (e.g., day trip), opportunities to share the workload with outside agencies or organizations.

D. SAMPLING PROCEDURES

Samples will be collected according to this generic QAPP, attachments, and the detailed protocols in the most current version of EPA (2016). On any occasion that the participating organization Project Lead(s) determine that another procedure must be used to meet the project's objectives, it will be documented with a description of the circumstances requiring its use. Sampling personnel must have qualifications as described in the Training Section. Locational data (latitude/longitude) for sites and areas, must meet EPA's locational data policy requirements.

i. In-situ Temperature and Water Level Measurements

Water and air temperature measurements are collected at each primary RMN site. At sites with active USGS gages, discharge data are obtained from the USGS National Water Information System web site (http://waterdata.usgs.gov/nwis). At ungaged sites, as resources permit, equipment (primarily pressure transducers) are installed to record water level measurements. As described in Section 2.D.i.f, organizations are encouraged to take periodic discharge measurements and develop flow rating curves so that the water level data can be converted to discharge. Sensors are deployed year-round where feasible. In places where streams become completely frozen during the winter, pressure transducers may be removed during winter months if freezing will result in damage to the equipment.

a. Equipment at ungaged sites

Temperature measurements at RMN sites are generally collected by stand-alone units (e.g., Onset HOBO proV2) or by pressure transducers that record both temperature and pressure. The temperature sensors, whether standalone or located in the transducer, must have a minimum accuracy of ±0.5°C and capture the full range of temperatures that are expected to occur at the RMN sites. The pressure transducers have an accuracy of ≤ 0.015 ft and capture the maximum expected range of stream stages for the site. Sensors are encased in housings to protect them from currents, debris, ice, and other stressors, and to prevent direct solar radiation from hitting them, as this may bias the temperature measurements. Staff gages are installed at sites with pressure transducers. The staff gages allow for instantaneous readings in the field, verification of transducer readings, and correction of transducer drift.

b. *Configuration of sensors*

Stand-alone temperature sensors are configured to record measurements at intervals of 30 minutes or less. Pressure transducers are configured to record pressure and temperature every 15 minutes.

Sensors should be configured to:

- Record on the hour (xx:00), half hour (xx:30), or quarter hour (xx:15 or xx:45)
- Record in consistent units (temperature - degrees Celsius; water level – feet)
- Record in military time (if this is an option)
- Record in local standard time (e.g., UTC-5 for sites in the Eastern Time zone) instead of daylight savings time.

For more detailed information on sensor configuration, reference the most current version of the EPA report titled ‘Best Practices for Continuous Monitoring of Temperature and Flow in Wadeable Streams’ (EPA 2014).

c. Location of sensors/equipment

Sensors are deployed in the same locations over time to minimize the chances of detecting false trends related to movement of the sensor. If the sensor(s) must be moved, this is noted on the field forms. The sensor is installed in a location that is representative of the characteristics of the reach from which the biological data are being collected (e.g., no tributaries are entering or exiting between the sensor and the biological sampling site).

Each sensor is accurately georeferenced by recording global positioning system (GPS) coordinates (latitude and longitude) for the exact site at which each sensor is deployed. The coordinates are recorded in decimal degrees, using the NAD83 datum. The accuracy of the coordinates is verified in the office or

laboratory with Geographic Information System [GIS] software or Google Earth. If GPS coordinates are not available on-site, the sensor location is marked on a map and the coordinates are determined later using desktop software. At least one set of photographs are taken to document the sensor location. The photos are taken looking upstream and downstream, and include specific and easily identifiable objects such as large trees, large stable boulders, large woody debris, and point bars.

Field crews complete a field form like the one shown in Attachment D (located on the RMN SharePoint site) to document sensor deployment. The exact time at which the sensor is correctly positioned in the field must be recorded so that observations recorded before that time can later be removed during data processing (Section IV).

Water Temperature Sensors

Water temperature sensors are deployed in locations with as many of the following characteristics as possible, prioritized in this order:

- In areas of well-mixed water
- Of sufficient depth to keep the sensor submerged year round
- Stable and easy to relocate
- Protected from physical impacts associated with high flow events
- Low human activity to reduce vandalism and accidental snagging

Where feasible, water temperature sensors are placed approximately 6 inches above the stream bottom. If this is not possible and sensors are placed on the stream bottom, crews should note this on the field form.

Instream Pressure Transducers

Instream pressure transducers are installed in pools that have: 1) minimal turbulence; 2) downstream control features (e.g., riffle or bridge or culvert that is narrower than the stream channel and constricts flow); and 3) have an adequate cross section for discharge measurements within the reach.

Air temperature sensors and pressure transducers

Air temperature sensors and on-land pressure transducers (or components) are placed at a height of 2 meters, or approximately 6 feet, off the ground. The location of the air temperature sensor in relation to the water temperature sensor remains constant throughout the period of data collection. If the riparian zone is forested, the air temperature sensor is mounted to the tree that is: 1) nearest the water temperature sensor; and 2) large enough to support the radiation shield and sensor (ideally >12 inches (0.305 meters) in diameter). The sensor is attached to the tree's north side, out of direct sunlight. Efforts are made to minimize the amount of other vegetation near the sensor. If a suitable tree is not available, the sensor is attached to the north side of an existing or constructed stable structure (e.g., fence post). Efforts are made to hide the devices from view to reduce the chance of vandalism. If feasible, equipment should be labeled with

the organization name and contact information in case it is located by outside entities.

d. Maintenance of sensors

After the initial deployment, sites are visited as frequently as possible to check the condition of the sensors, gather data for mid-deployment accuracy checks (see Section III.C.ii.c) and offload data. More frequent site visits help ensure the longevity of the sensors and data quality. Records of these checks are kept on field forms like the one shown in Attachment E (located on the RMN SharePoint site). Typical maintenance checks include:

- Looking for signs of movement, physical damage, vandalism, or other disturbance, particularly after high flows and floods and periods of ice cover. If movement occurs and the elevation between the staff gage and the transducer changes (e.g., due to sediment accumulation or scour), the equipment is secured (if necessary) and resurveyed (see Section II.D.i.e). Any differences in gage and transducer elevation are noted on the field form. If a sensor is constantly shifting, an alternative location is considered (and if the sensor is moved, the new location is documented on the field form).
- Ensuring that the (in-water) sensors are submerged. If the sensor is dewatered, this is noted on the field form. If the sensor is consistently dewatered, an alternative location is considered (and if the sensor is moved, the new location is documented on the field form).
- Ensuring that the sensors are not buried in sediment. If the sensor is buried, this is noted on the field form and the sediment is removed. If the sensor is consistently buried in sediment, an alternative location is considered (and if the sensor is moved, the new location is documented on the field form).
- Removing anything that could bias the measurements. This includes:
    - Clearing leaf litter and debris, which may pile up against the staff gage, transducer, and downstream control. This material is cleared at the beginning of a site visit, as it could impact gage height. The stage before and after debris clearing is noted on the field form. Stage data may be corrected if changes are detected.
    - Cleaning sediment or algae from the sensors. These can cause fouling and inaccurate readings. Sensor manuals are consulted for specific instructions on cleaning and maintenance.
- Checking the condition of desiccant packets (vented pressure transducers only). The vented cable needs to remain dry in order for the sensor to function properly. Different transducers use different types of packets, and the lifespan of these packets varies depending on site-specific conditions (e.g., how much moisture is present in the air).
- Ensuring that moisture is not filling the bottom of the canister that houses the on-land, non-vented pressure transducer. If moisture inundates the ports through which the barometric pressure is compensated, the measurements will be inaccurate.

- Cleaning the staff gage with a scrub brush (especially during the summer months) so that the gage can be accurately read. Rust marks are painted over with enamel paint to improve durability.
- Checking the battery life of the sensor (if appropriate).
- Taking photos to document any changes to the monitoring location (particularly those that could influence readings).

e. Elevation surveys

Elevation surveys are performed at sites with pressure transducers, using survey equipment that is maintained and operated in accordance with manufacturer specifications and the organization's standard operating procedures (SOPs) and quality assurance protocols. Both the gage/transducer and staff gage are surveyed. A benchmark and one or two other permanent reference markers are established at each site. The benchmark serves as the predominant reference point while the permanent reference marker(s) provide a backup in case the benchmark is destroyed and allows for a check of benchmark movement. Ideally, at least one reference marker should be located outside of the floodplain. Examples of good reference markers include a bolt installed in a bridge, tree, large boulder or utility pole. Survey information is recorded on field forms like the one shown in Attachment F (located on the RMN SharePoint site).

Elevation surveys are performed when new pressure transducers and staff gages are installed. After the initial survey, surveys are performed at least once a year to identify if and when movement occurs. This is particularly important after high flow events and periods of extended ice cover. After the survey is completed, if the final elevation does not match the starting elevation (within 0.01 ft; or, if survey equipment permits, within 0.003 ft), the entire survey is repeated. Once the survey is completed successfully, the elevation of all survey points are compared to previously surveyed elevations to determine if movement occurred (sites are considered stable if elevations differ by less than 0.015 ft (Kenney 2010)). If movement has occurred, adjustments are made to the data or gage, as appropriate.

During the early phases of the RMN project, elevation surveys were not performed at some sites. In these situations, elevation surveys will be conducted as soon as feasible.

For more detailed information on elevation surveys, reference Kenney (2010) and the most current version of EPA (2014).

f. Discharge estimates

At some ungaged sites, organizations are collecting discharge measurements to develop stage-discharge rating curves, which will allow water level measurements to be converted to discharge (EPA 2014). The equipment is

maintained and operated in accordance with manufacturer specifications and the organization's standard operating procedures (SOPs) and quality assurance protocols.

To establish a rating curve at a new site, a minimum of 5 to 10 discharge measurements are made at a variety of stages, covering as wide a range of flows as possible. The rating curve is produced by plotting instantaneous flow measurements and stage heights. After establishing a rating curve, discharge is measured quarterly. If quarterly measurements are not possible, discharge is measured at least once annually, and if possible, also after large storms or any other potentially channel-disturbing activities, to verify or (if needed) update the curve. If new measurements are more than 15% off the rating curve, follow-up measurements are made to identify whether a shift has occurred and, if necessary, to establish a new rating curve.

When making discharge measurements, crews select a cross section with the following characteristics:

- A relatively straight stream channel with defined edges and a fairly uniform shape
- Limited vegetative growth, large cobbles, and boulders
- No eddies, slack water, or turbulence
- Depths greater than 0.5 feet and velocities greater than 0.5 feet per second
- Similar flow to that at the water level sensor (e.g., within the same reach as the sensor, with no tributaries or drainpipes located between the cross section and the gaging station)

Discharge measurements are recorded on field forms like the ones shown in Attachment G (located on the RMN SharePoint site). For more detailed information, including considerations for both low and high flow measurements, reference Rantz et al. (1982), Chase (2005), Shedd (2011) and the most current version of EPA (2014).

ii. Field Observations and Sample Collections

In addition to in-situ temperature and water level measurements, data and information common to all participants includes physical habitat and photo documentation, chemical data collection, and biological sampling. Each organization may also choose to collect data and information not included as part of the national network, and the organization's quality assurance will apply. Organizations may choose to append additional information to this generic plan for approval, with a separate form or letter, by their quality assurance officer.

a. Physical habitat and photo documentation

Partners within each RMN will collect a common set of habitat parameters at primary RMN sites. Participants may choose to add to this for their own organization's interest. The parameters and habitat collection protocols that are agreed upon by each regional working group are attached to this generic QAPP as Addendum 3 (see Attachment C, located on the RMN SharePoint site, for template).

Collection of the following types of quantitative habitat data are encouraged:

- Geomorphological
  - Bankfull width (reach-wide mean or at an established transect)
  - Bankfull depth (reach-wide mean or at an established transect)
  - Reach-scale slope
- Habitat
  - Substrate composition (pebble counts to get percent fines, percent sand, etc.)
  - Flow habitat types (percent riffle, percent pool, percent glide, percent run)
  - Canopy closure (measured with spherical densitometer, mid-stream and along bank)

In addition, field crews will take digital photographs that show the near-stream habitat where biological data are being collected and provide qualitative evidence of changes in geomorphology (e.g., lateral and vertical channel stability). The photographs are taken from the same location(s) each year. The location is accurately georeferenced with global positioning system (GPS) coordinates (latitude and longitude) in decimal degrees, using the NAD83 datum.

For more detailed information on physical habitat assessments and photo documentation at RMN sites, reference EPA (2016).

b. Chemical Data Collection

The following *in situ*, instantaneous water quality parameters are collected when biological sampling is conducted at RMN sites:

- Specific conductivity (µS/cm)
- Dissolved oxygen (mg/L and %)
- pH

In addition, partners within each RMN will collect a common set of grab sample water quality data (e.g., alkalinity, major cations, major anions, trace metals, nutrients) at primary RMN sites. If resources permit, these collections will occur multiple times per year during different flow conditions. Participants may choose to add to this for their own organization's interest. The parameters and protocols that are agreed upon by each regional working group are attached to

this generic QAPP as Addendum 3 (see Attachment C, located on the RMN SharePoint site, for template).

For more detailed information on the collection of water chemistry data at RMN sites, reference EPA (2016).

c. Biological Samples

Macroinvertebrates are collected at least one time annually at primary RMN sites by trained personnel. Collection of fish and periphyton is optional but encouraged, with fish being higher priority than periphyton. The collection and processing protocols that are agreed upon by each regional working group are attached to this generic QAPP as Addendum 3 (see Attachment C, located on the RMN SharePoint site, for template). The minimum sampling requirements consistent across all RMNs for each community are the following:

- Macroinvertebrates
  - Samples are collected at least one time annually
  - Samples are collected by a trained biologist
  - Sampling occurs during a consistent time period each year, ideally within 2 weeks of a set collection date (see Addendum 3 for region-specific index period)
  - Samples are processed in the laboratory by trained individuals
  - Identifications are done by a trained macroinvertebrate taxonomist to a level of taxonomic resolution agreed upon by the regional working group (see Addendum 3 for details)
  - Samples from each primary RMN site are preserved and archived (referred to as “voucher samples”)

- Fish
  - Samples are collected by a trained biologist
  - Sampling occurs during a consistent time period, ideally within 2 weeks of a set collection date.
  - Identifications are done to the species-level (where practical) by a trained fish taxonomist

- Periphyton
  - Samples are collected by a trained biologist
  - Sampling occurs during a consistent time period each year, ideally within 2 weeks of a set collection date
  - Identifications are done to the species-level (where practical) by a trained algal taxonomist.

E. MONITORING PARAMETERS

Table 2. Summary table of parameters (required and optional) and reporting requirements for primary RMN sites.

Parameter	Status	SOP/Protocol	Minimum data reporting requirements	Minimum metadata reporting requirements
Macroinvertebrates	Required	RMN or Organization (if comparable to RMN)	Site, collection date, taxa list, life stage, number of individuals	Collection and processing methods, person collecting sample, person sorting sample, taxonomist(s), percent subsampled
Fish	Optional	RMN or Organization (if comparable to RMN)	Site, collection date, taxa list, number of individuals	Collection and processing methods, field crew, taxonomist(s)
Algae	Optional	RMN or Organization (if comparable to RMN)	Site, collection date, taxa list, number of individuals	Collection and processing methods (including gear type), person collecting sample, taxonomist(s), percent subsampled
Water temperature (°C) (year-round at 30-minute intervals or less)*	Required	RMN or Organization (if comparable to RMN)	Site, date, time, all measurements (after data are reviewed and corrected - see Section IVA)	Sensor model and serial number
Air temperature (°C) (year-round at 30-minute intervals or less)*	Required	RMN or Organization (if comparable to RMN)	Site, date, time, all measurements (after data are reviewed and corrected - see Section IVA)	Sensor model and serial number
Water level (ft) (year-round at 15-minute intervals or less)*	Required**	RMN or Organization (if comparable to RMN)	Site, date, time, all measurements (after data are reviewed and corrected - see Section IVA)	Sensor model and serial number

* In places where streams become completely frozen during the winter, sensors may be removed during winter months if freezing will result in damage to the equipment.

**Water level sensors may be installed as resources permit.

Table 2. continued…

Parameter	Status	SOP/Protocol	Minimum data reporting requirements	Minimum metadata reporting requirements
Discharge (cfs)	Required*	RMN or Organization (if comparable to RMN)	Site, date, time, all measurements (after data are reviewed and corrected - see Section IVA)	Number of discharge measurements, equipment used to make discharge measurements, software used to develop flow-rating curve
Habitat assessment	Required	RMN or Organization (if comparable to RMN)	See Addendum 3 for region-specific details	See Addendum 3 for region-specific details
Photo documentation	Required	RMN or Organization (if comparable to RMN)	At least one set of photographs looking upstream and downstream from the same location each year	Name of photographer
pH (S.U.)	Required	Organization	One measurement	Sensor model and serial number
Dissolved oxygen (mg/L and %)	Required	Organization	One measurement	Sensor model and serial number
Specific conductivity (µS/cm at 25˚C)	Required	Organization	One measurement	Sensor model and serial number
Water quality grab samples	Optional	RMN or Organization (if comparable to RMN)	See Addendum 3 for region-specific details	Laboratory method, name of laboratory

*Discharge measurements may be taken over time, as resources permit. They are not required if the stream is gaged.

RECOMMENDED SAMPLING SCHEDULES

Minimum sampling frequencies for required parameters are listed in Table 3. Addendum 3 contains region-specific schedules for required and optional parameters chosen by the regional working group.

Table 3. Recommended Sampling Schedules for Required Parameters

Parameter	**Minimum Sampling Frequency of Required Parameters**	**SOP/Protocol**
Macroinvertebrates	Once/year within the RMN target period	RMN or Organization (if comparable to RMN)
Water temperature (°C)	Year-round at 30-minute intervals or less*	RMN or Organization (if comparable to RMN)
Air temperature (°C)	Year-round at 30-minute intervals or less	RMN or Organization (if comparable to RMN)
Water level** (ft)	Year-round at 15-minute intervals or less* (annual elevation survey checks)	RMN or Organization (if comparable to RMN)
Discharge^ (cfs)	Varies^^	RMN or Organization (if comparable to RMN)
Habitat assessment	Once/year	RMN or Organization (if comparable to RMN)
Photo documentation	Once/year	RMN or Organization (if comparable to RMN)
pH	Once/year	Organization
Dissolved oxygen (mg/L and %)	Once/year	Organization
Specific conductivity (µS/cm at 25˚C)	Once/year	Organization

*In places where streams become completely frozen during the winter, sensors may be removed during winter months if freezing will result in damage to the equipment.
**Water level and discharge measurements are collected as resources permit.
^Discharge measurements are not required if the stream is gaged.
^^A minimum of 5 to 10 discharge measurements are made at a variety of stages to establish a rating curve. If resources permit, discharge is measured quarterly after the rating curve is established. Otherwise, at a minimum, discharge is measured at least once annually, and if possible, also after large storms or any other potentially channel-disturbing activities, to verify or (if needed) update the curve.

III. DATA QUALITY

A. DATA REPRESENTATIVENESS/COMPLETENESS

Samples and continuous monitoring data must be representative of the wadeable stream at the time of collection. However, an evaluation of critical samples will determine if data are incomplete, and the organization's Project Manager will determine if data meet quality

objectives, or if the sampling process needs to be reviewed for change or corrections.

B. DATA OBJECTIVES

Table 4. Data quality objectives for required parameters.

Parameter	Sample Matrix	Accuracy	Precision
Temperature	Water and air	±0.5°C	<0.5°C
Water Level	Water	≤ 0.015 ft	Typically 0.2% of full scale of measurement
Discharge	Water	5%	5%
Minimum number of measurements for rating curve	Water	5	5
Dissolved Oxygen (mg/L)	Water	±0.1 mg/L	≤0.05 mg/L
pH (S.U.)	Water	± 0.08 or ± 0.15	± 0.08 or ± 0.15
Specific conductivity (µS/cm at 25˚C)	Water	±1 µS/cm or ±2%	±1 µS/cm or ±2%

C. QUALITY CONTROL

Each RMN partner must follow organizational field quality control procedures, and quality control field samples will be collected as appropriate. All meters and other field equipment as necessary will be calibrated and/or checked against acceptable standards of measure prior to use according to the organization's written operating procedures and manufacturers' manuals. Each participating entity should identify a QA Coordinator in their Sampling and Analysis plan who can oversee sampling and data collection. Documentation of quality checks will be maintained by each organization, in particular each QA Coordinator.

i. Annual Visit(s)
At a minimum, sites are visited annually (e.g., in conjunction with the biological sampling events). When feasible, more frequent visits are made, particularly to check for movement of the sensors after high flow events and periods of extended ice cover. A mid-deployment field form like the one found in Attachment E (located on the RMN SharePoint site) is completed during each site visit. Field personnel will document anything that could affect the quality of the data, such as signs of physical damage, vandalism, leaf packs, fouling from sediment or algae, or other disturbance, and will take photographs to document any changes to the monitoring location (for more information on maintenance of sensors, see Section II.D.i.d).

ii. Equipment Accuracy checks

Organizations are encouraged to perform as many of the accuracy checks listed below as possible. These checks will improve data quality and allow for data to be corrected (if needed). At a minimum, pre-deployment checks are required.

a. *Pre-Deployment Check - Required*

Crews are required to perform either single- or multi-point pre-deployment accuracy checks on temperature sensors (either stand-alone or built-in the pressure transducers) to verify that the sensors meet the accuracy quoted by the manufacturer. Differences in readings from the sensors and National Institute of Standards and Technology (NIST)-calibrated thermometer should not exceed the accuracy quoted by the manufacturer (for sensors deployed at RMN sites, that number is ±0.5°C or, in some cases, ±0.2°C). Sensors that have anomalous readings are set aside for further testing or returned to the manufacturer for replacement. Accuracy checks are documented on forms like the one shown in Attachment H (located on the RMN SharePoint site). Documentation of these checks will be maintained by the organization.

Prior to deployment, battery life is also checked. Sensors with low battery levels are removed from circulation. In addition, checks are made to ensure that the sensors are launching and downloading data properly.

b. *Initial Deployment Check - Optional but Encouraged*

After the sensor is correctly positioned, a temperature measurement is taken with a NIST-calibrated thermometer. The measurement is taken as close as possible to the sensor and as close as possible to the time when the sensor is recording a measurement. Field personnel must ensure that sufficient time has passed to allow the NIST-calibrated field thermometer to stabilize before recording the measurement. This measurement is used to help determine when the temperature measurements from the sensor stabilize. The measurements that occur during the stabilization period are later removed or ‘trimmed’ during data processing. To avoid trimming temperature data, some organizations use the ‘delayed launch’ feature to configure the sensor to start recording measurements several hours after deployment (which allows time for the sensor measurements to stabilize).

For pressure transducers, after the sensor is correctly positioned, a staff gage reading or water depth measurement is taken over the transducer with a stadia rod or other measuring device. To minimize the chance of a faulty measurement, measurements are taken as close as possible to the time that the pressure transducer is recording a measurement, and efforts are made to get as stable a reading as possible (if flows are fluctuating rapidly at the time of the measurement, note this on your field form and try to record the depth as accurately as possible).

This information is recorded on a sensor deployment form like the one shown in Attachment D (located on the RMN SharePoint site). Field personnel should note on the field form whether the time is standard or daylight savings time.

c. *Mid-Deployment Check(s) - Optional but Encouraged*

For water temperatures sensors, instantaneous temperature measurements are collected near the sensors with a NIST-calibrated thermometer. To minimize the chance of a faulty measurement, measurements are taken as close as possible to the sensor and as close as possible to the time when the sensor is recording a measurement. Field personnel must ensure that sufficient time has passed to allow the thermometer to stabilize before recording the measurement.

For pressure transducers, a staff gage reading or water depth measurement is taken over the transducer with a stadia rod or other measuring device. Measurements are taken as close as possible to the time that the pressure transducer is recording a measurement, and efforts are made to get as stable a reading as possible.

Information is recorded on a mid-deployment field form like the one shown in Attachment E (located on the RMN SharePoint site). Field personnel should note on the field form whether the time is standard or daylight savings time.

d. *Biofouling Check - Optional but Encouraged*

The sensor is removed and gently cleaned (per manufacturer's instructions) to remove any biofilm or sediment. Then the cleaned sensor is returned to the stream. The time at which the "pre-cleaning" measurement was made and the time of the first "post-cleaning" measurement is noted on the field form, and readings are compared.

e. *Post-Deployment Check - Optional but Encouraged*

After the standalone temperature sensors are retrieved and brought back to the office or laboratory, either a single- or multi-point accuracy check is performed to verify that the sensors meet the accuracy quoted by the manufacturer.

iii. <u>Discharge Measurement Checks</u>

The following checks are optional but encouraged:

- Duplicate measurements, ideally with a different person making each measurement. The measurements may be along the same or different cross-sections. The difference between the two measurements should be less than 5%.
- Periodically check the accuracy of measurements by making measurements that can be compared to a standard, such as a real-time USGS gage, or to those obtained by an experienced hydrographer from the USGS or another agency.

iv. <u>Biological Data QA/QC</u>

QA/QC procedures are performed in accordance with the regional protocols described in Addendum 3.

v. Water Quality Sample Criteria
QA/QC procedures are performed in accordance with the regional protocols described in Addendum 3. Data that does not meet QC criteria will be flagged by the laboratory and reviewed by the organization project leads and a determination will be made regarding use of that data, and any follow up steps to identify and correct any source(s) of deficiency.

D. SAMPLE CUSTODY PROCEDURES

At this time, unique sample and station identifiers are being assigned by the RMN partners. Samples will be collected in accordance with each organization's chain of custody protocols. Each sample will be given a unique identification number, and laboratory samples will be accompanied by chain of custody (C-O-C) documentation for delivery and transferring of custody.

In-situ measurement sensors will be located and secured according to the protocols most current for protection and continuous operation without disturbance. Evidence of disturbance between placement and maintenance visits will be the first observations made by field personnel. Any signs of disturbance will be noted in detail on the field log forms, and reported to the Field Lead and Project Lead. Decisions regarding changes in arrangements or sites will be discussed, and decisions documented and shared with the EPA regional coordinator. All samples collected will follow strict C-O-C protocols. Organizations without current C-O-C protocols will adopt and train staff on written protocols prior to collecting field samples for this project. C-O-C forms will be generated by the field team and accompany samples as they are transferred to the lab and then proper lab protocols are followed.

E. CORRECTIVE ACTIONS

Any corrective action regarding field work, and onsite meters, will be determined by Field Leads, documented as necessary, and discussed with the Project Lead.

Any significant issue with laboratory performance identified by the Chemistry Laboratory will require that the Project Lead be notified immediately and appropriate corrective action taken.

Visits by the National Project Coordinators or other participating organizations may be possible as a means to gage consistency of data accumulation and documentation across network participants, or to help investigate any technical issues.

IV. DATA MANAGEMENT

A. DATA REVIEW

Analytical data will be reviewed initially by the laboratory and field team leader according to their organizations protocols. Then data will be reviewed against the criteria presented in this Project Plan. Any limitations on the use of data will be documented and explained. Field data will be compiled and reviewed by field team leads, and any corrective actions or issues that are needed will be brought to the organization's Project Lead.

Before the continuous temperature, water level or discharge data are submitted to the EPA Regional Lead, they must be reviewed and corrected (if needed). At this time, a workgroup is developing scripts and procedures for reviewing the continuous data. Steps will include (at a minimum):

- Trimming data to remove measurements taken before and after the sensor is correctly positioned
- Plotting all of the measurements and visually checking the data for missing values and abnormalities

Optional checks will include plotting more than one set of measurements on the same graph, such as:

- Air and stream temperature
- Stream temperature and water level or discharge
- Data from different sites
- Data from different years
- Data from the nearest active weather station
- Data from the nearest USGS gage

Plots are reviewed for:

- Missing data
- A close correspondence between water and air temperature (this indicates that the stream sensor may have been out of the water)
- Diel fluxes with flat tops, or "chatter" in the gage height record (this indicates that the sensor may have been buried in sediment)
- Water level values of 0 (this could mean that the pressure transducer was dewatered. With vented transducers, another possibility is that moisture got into the cable and caused readings of zero water depth)
- Water level values that are negative. This could mean that:
  - the land-based transducer is not close enough to the stream pressure transducer to accurately capture barometric pressure
  - if the land-based transducer is housed in PVC pipe that has a solid bottom, condensation and laterally blown rain and snow may have collected in the bottom

- Outliers or rapidly fluctuating values (it is possible that the sensor moved, e.g., due to a high flow event or vandalism).

While scripts and procedures are being developed for the data review, each organization will retain, store, and back up their original raw continuous data files. Once the scripts and procedures have been developed, organizations will receive detailed instructions and training on how to review (and if necessary, correct) the data, and will be asked to submit their reviewed and corrected continuous data to the EPA Regional Coordinator on a on a schedule that is agreed upon by the Organization and the EPA Regional Coordinator.

Some organizations already have systems and procedures in place for processing and reviewing continuous data. In these situations, the organizations can continue to use their own procedures, as long as those procedures meet the minimum data review requirements for the RMNs.

The national data storage systems for biological, water quality and habitat data will only be populated by data the meets the data quality objectives (DQOs) defined in this generic QAPP and those for supplemental measurements the participating organizations generate under their quality assurance system.

The data, once verified by the generating organization for meeting QA requirements, will be considered public information, and used for assessments under the Clean Water Act reporting requirements. Data will be uploaded into a national data system, when available. Until that time, data will be maintained by the monitoring agency, with at least minimum content and statistical requirements. Until data are verified, they are considered preliminary, and availability is at the discretion of the monitoring agency's policies. Nationally, data will be processed using applications for checking on data that are outside expected ranges, missing reasonable units of measure, and missing key metadata.

B. DATA CUSTODY AND SHARING

Individual organizations will be custodians and owners of the continuous monitoring data and the individual sample results. Data must be documented for traceability from calibration, calibration checks, maintenance, sampling, post-calibration checks, data download, data verification with any needed qualifiers or rejection, data summaries, and uploads to state and national data systems. Chain of custody labels and forms must be used and maintained for collection at all sites. On an annual basis, the QA coordinator or a designee for each organization should perform and document an internal audit for at least one site's sampling, analytical results, and documentation.

For individual samples that are collected for biological, habitat, and water quality constituents, all data must be uploaded to a national water data system such as STORET

or NWIS for sharing with EPA and other partners. Each organization is responsible for verifying that the shared data meets the data quality requirements as outlined in this QAPP.

The EPA and partners are working on developing systems that will allow organizations to access data and metadata that are being collected at primary RMN sites. When the system is in place, RMN partners will receive detailed instructions on how to upload their data into the shared system, and will be asked to submit their data on a schedule that is agreed upon by the Organization and the EPA Regional Coordinator. The data flow and relationships to current data management systems are shown in Figure 2 and described in Michael Baker International et al. (2015). Data limitations will be identified as part of user instructions of the data management system. Until the system is in place, the individual organizations will be custodians and owners of the continuous monitoring data and the individual sample results. All raw data files will be backed up and stored in a centralized location that is protected from corruption by computer viruses, unauthorized access, and hardware and software failures. Until a national data management is available, each participating organization is responsible for backing up and storing data files.

Until EPA and its partners develop and implement a national data managment system for continuous monitoring data, EPA and partners are providing webinars for discussion and presentation of systems for managing data, checking data quality, and generating statistical analyses.

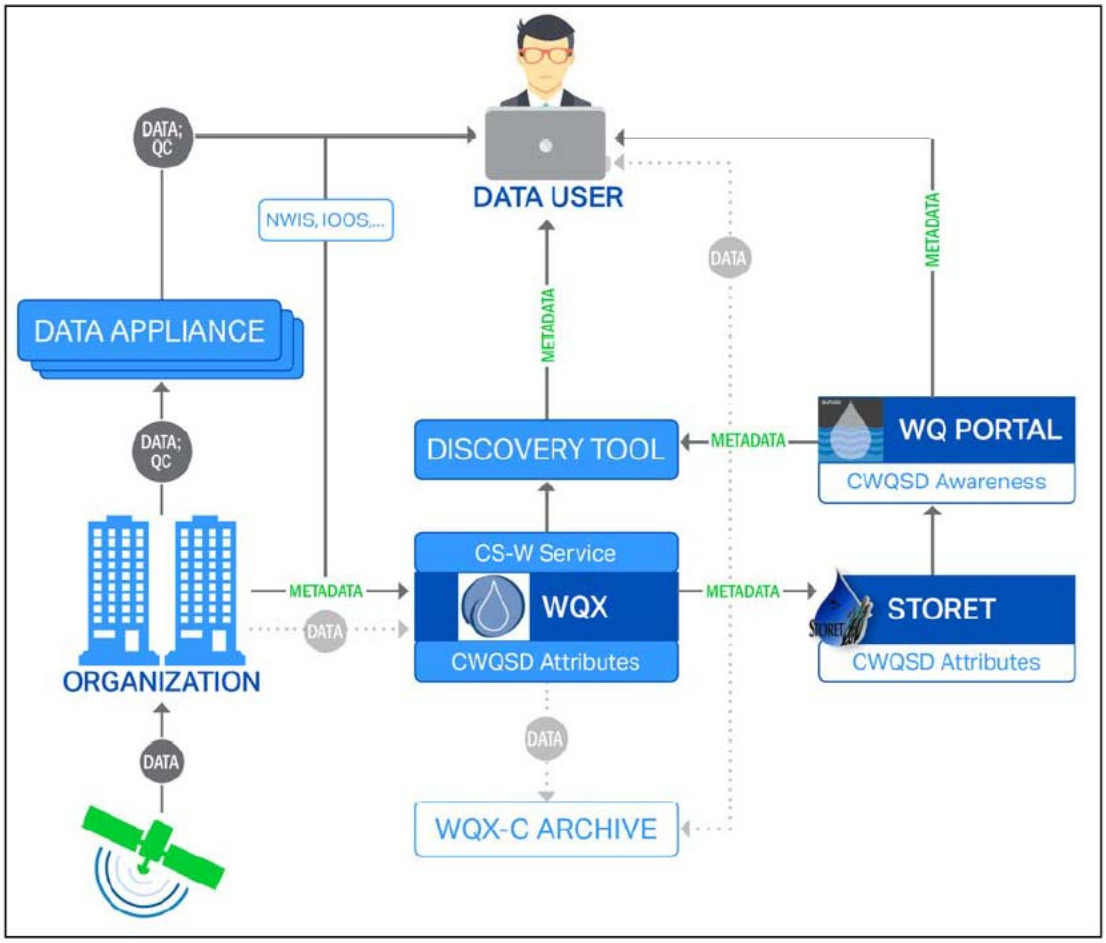

Figure 2. Proposed data flow for both discrete and continuous monitoring data, including current Water Quality Exchange (WQX) with a catalog service for the web (CS-W), STORET, and Water Quality (WQ) Portal relationships, updated to store continuous water quality sensor data (CWQSD) attributes and a new WQX-C (WQX-Continuous) Archive that can store the continuous sensor data (Graphic from Michael Baker International et al., 2015).

C. RECORDS

All participants must provide the required parameters listed in Table 2 of Section E. All information will be recorded in field log books or field data sheets, in addition to completion of all chain of custody forms, labels, etc. Any photographs taken will be documented in the field log book or field sheets. Analytical data will be tabulated by the laboratory and reported to the Project Lead in accordance with the organization's requirements.

Examples of field forms for continuous temperature sensors and pressure transducers can be found in the attachments located on the RMN SharePoint site. If an organization already has field forms for continuous sensors, and those forms are comparable to the forms in the attachments, the organization can continue to use their existing forms. As

protocols, metadata, and required minimum documentation for the network sites are finalized, there is also a consideration of electronic capture of measures not already collected electronically. This will be an ongoing interest, as resources and technical capabilities of participating organizations develop over time.

All calibration, field, and analytical records will be stored by the organization. In the future, some of these metadata may also be entered into the long-term data storage system that is currently being developed.

V. TRAINING

Field personnel are required to attend training and demonstrate proficiency in their roles according to each organization's protocol. All Project Leads and Field Leads are required to document that they have read and understood all applicable protocols and this generic QAPP. Taxonomists should be current on their training and applicable records kept according to the organization's protocols.

VI. REPORTING AND COMMUNICATION

A. ANNUAL REPORT

The EPA and partners are working on developing electronic forms that will allow for more efficient tracking of data collection, equipment and QA/QC procedures at each site (similar to the draft templates shown in Attachment I, located on the RMN SharePoint site). When the templates are finished and approved by the RMN partners, the RMN partners will be asked to submit status updates in this format to the EPA Regional Coordinator on a schedule that is agreed upon by the Organization and the EPA Regional Coordinator.

B. ESTABLISHMENT OF NEW RMNS

Once interest is evident, a series of meetings, conference calls and other means of establishing a workgroup and developing the network is needed. Once established, the number of participating organizations is able to increase, as long as site selections, protocols, data quality objectives, and other project requirements are followed as outlined in this generic QAPP.

The national coordinators will participate in the process to communicate specific criteria and other information to ensure the growing national network remains consistent in all required details.

C. ROUTINE COMMUNICATION

Once networks are established and operating well within an EPA Region, communication will occur through:

- Semi-annual national conference calls with National Coordinator(s)
- Annual meetings (or more frequent if preferred) within each EPA Region
- Other methods, such as emails, webinars, etc.

While this generic QAPP could be considered current for up to five years, it will be reviewed for updates on an annual basis. Standard Operating Procedures may be developed as protocols become finalized, to ensure consistency and continuity among organizations and from year to year. This QAPP is developed during a time when the network operations are still newly in place, and will be amended/updated as changes occur.

Updates to the QAPP or other project information will be posted to the RMN SharePoint site to which all partners have access. Updates also will be shared via email with the regional EPA leads and as appropriate with participating entities.

VII. REFERENCES

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VIII. QAPP REVISION HISTORY

Revision Number	Date Approved	Revision
0	02/23/16	New document