

A-2 -- Table of Contents

[List sections with page numbers, figures, tables, references and appendices – Standard Operating Procedures (SOPs) for example - (attach pages)].

A - Sampling Project Management

A-3 -- Distribution List

[List the individuals and their organizations that need copies of the approved SAPP and any subsequent revisions, including all persons responsible for implementation (e.g. project managers), the QA manager, and representatives of all groups involved. Paper copies need not be provided to individuals if equivalent electronic information systems can be used.]

A-4 -- Sampling Project or Task Organization

[List key personnel and their corresponding responsibilities – some examples are included in the table for clarification only, edit and include your own]

Name	Project Title / Responsibility
	Stakeholders Group (contact)
	Project Manager
	Project QA Officer – SAPP responsibilities
	Field / Sampling Leader
	Laboratory Manager / Leader

A-5 -- Problem Definition / Background – Sampling Needs

[In a narrative, briefly state the problem your monitoring project is designed to address. Include any background information such as previous studies that indicate why this project is needed. Identify how your data will be used and who will use it.]

I – Problem Statement:

II – Intended Use of Data:

A-6 -- Sampling Project or Task Description

I – General Overview of Project

[In general terms, describe the work your sampling crew or volunteers will perform and where it will take place. Identify what kinds of samples will be taken, what kinds of conditions they will measure, which are critical, and which are of secondary importance. Indicate how you will evaluate your results - that is, how you will be making sense out of what you find. For example, you may be comparing your water quality readings to State or

EPA standards, or comparing your macroinvertebrate evaluations to State-established reference conditions or historical information.]

II – Sampling Project Timetable

Activity	Projected Start Date	Anticipated Date of Completion

AND / OR

Major Tasks	J	F	M	A	M	J	J	A	S	O	N	D
<i>volunteer recruitment, training, and re-training</i>												
<i>monthly pH, temp., turbidity, & dissolved oxygen sampling</i>												
<i>seasonal macroinvertebrate & habitat assessments</i>												
<i>lab analysis</i>												
<i>data processing, analysis & reporting</i>												

A-7 -- Data Quality Objectives for Measurement Data

[Data Quality Objectives are intended to accomplish the following:

- *Clarify the data objectives for the project*
- *Define the most appropriate types of data to collect*
- *Determine the most appropriate conditions under which to collect the data*
- *Specify the level of uncertainty that is acceptable as the basis for establishing the quantity and quality of data needed for the project*

Data Quality Objectives (DQOs) are the quantitative and qualitative terms you use to describe how complete your data needs to be to meet your project's objectives. DQOs for measurement data or data quality indicators are precision, accuracy, representativeness,

completeness, comparability, and measurement range. Consult EPA's The Volunteer Monitor's Guide to Quality Assurance Project Plan for further discussion of these terms.

Since it is important to develop a SAPP prior to monitoring, it may not be possible to include actual numbers for some of the data quality measurements within the first version of the document. You will need, however, to discuss your goals or objectives for data quality and the methods you will use to make actual determinations after monitoring has begun. You must also discuss at what point changes will be made if project specifications are not achieved. Data quality indicators should be given for each parameter you are measuring. The easiest way to present quantitative information is in a table. In some types of monitoring, particularly macroinvertebrate monitoring and habitat assessment, some data quality indicators cannot be quantitatively expressed. In that case, you can fulfill this requirement of the SAPP by citing and describing the method used and by providing as many of the data quality indicators as possible (e.g., completeness, representativeness, and comparability) in narrative form.]

I - Data Precision, Accuracy and Measurement Range:

[Provide information on these indicators in quantitative terms.

Precision *is the degree of agreement among repeated measurements of the same characteristic, or parameter. Precision provides information about the consistency of your methods.*

Precision is a measure of reproducibility of test results. A series of measurements on the same sample for the same parameter is compared to the average value of all those samples. Precision is estimated by means of duplicate/replicate samples and analyses. Precision is best expressed in terms of the standard deviation or the relative percent difference (RPD) between field duplicate measurements. From USEPA:

$$RPD = [(x_1 - x_2) / \{(x_1 + x_2)/2\}] \times 100$$

RPD = relative percent difference (%)

x₁ and x₂ = duplicate measurements of the same parameter

The smaller the RPD, the more precise are the measurements. (A simple way to think of standard deviation is how far is the distribution of the data points from the average value.) The usability of duplicate measurements is assessed during data validation. (See Data Validation and Usability Section)

Accuracy *is a measure of confidence that describes how close a measurement is to its "true" value.*

Accuracy is the degree of agreement of a measurement with an acceptable reference or true value. This is accomplished by comparing a measured value to an accepted reference value in a sample of known concentration or by determining the recovery of a known concentration spiked into a sample (USEPA 1998). The Division's Environmental Data Unit DQOs for precision and accuracy are addressed in the CDPHE laboratory's QAPP. Each NPS project

needs to define accuracy or Percent Recovery (%R) according to the laboratory that will be used for the project's data analyzes.

$$\%R = \{100 (x_s - x_u) / K$$

%R = Percent Recovery or Accuracy
x_s = measured value for spiked sample
x_u = measured value for unspiked sample
K = known value of the spike in the sample

EPA decides which constituents are appropriate for spiking and for other measurements and also defines the %R required for proper QA/QC to meet method requirements. Acceptable %R is evidence of accuracy in laboratory data measurements.

Measurement Range is the range of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Matrix is the substance you are sampling from, for example water or sediment].

Matrix	Parameter	Measurement Range	Accuracy	Precision

II - Data Representativeness:

[Representativeness is the extent to which measurements actually represents the true environmental condition. This should be explained in the sampling design – how your sampling effort will represent the “population” or environment you want to characterize. Representativeness measures how close you are to implementing the sampling design and how your samples achieve a “true” distribution of the characteristics of the original population. Provide narrative.

Representativeness expresses the degree for which data accurately and precisely represent the true condition of the investigation. The evaluation of representativeness is a qualitative procedure that addresses the overall design of a sampling program. Representativeness is improved by the selection and use of appropriate numbers of samples, sampling stations and techniques proven to obtain samples reflective of the actual quality of a water body.]

III - Data Comparability:

[Comparability is the degree to which data can be compared directly to similar studies. Using standardized sampling, analytical methods, and units of reporting helps to ensure comparability. Provide narrative.

Comparability is the degree of confidence that data sets are comparable with each other. This is ensured by using SOPs, only using EPA accepted or comparable methods of all analyses, and standard reporting of data. The QA/QC standards necessary to ensure data comparability are a critical element given that water quality investigations can involve different contractors and personnel and may also include new and currently evolving analytical techniques. Strict adherence to the SOPs and periodic training of sampling personnel are crucial steps in achieving comparability.]

IV - Data Completeness:

[Completeness is the comparison between the amount of data you planned to collect versus how much usable data you collected, expressed as a percentage.

Completeness is the percentage of all data collected which are acceptable. For example, data may become unusable due to laboratory error, holding time violations, or errors in field collection procedures (for example incorrect sample preservation). A target of 90% completeness will be considered acceptable. To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for the analytical protocol. Completeness is then determined by the following:

$$\% \text{ Completeness} = (\text{Number of Valid Measurements} / \text{Total Number of Measurements Planned}) \times 100$$

Each NPS project is responsible for establishing measurement criteria for precision and accuracy of the analytical procedures that they conduct.]

Parameter	No. Valid Samples Anticipated	No. Valid Samples Collected and Analyzed	Percent Complete

For Volunteer Sampling Efforts, please include:

A-8 -- Training Requirements and Certification

[Identify any specialized training or certification requirements your volunteers will need to successfully complete their tasks. Discuss how you will provide such training, who will be conducting the training, and how you will evaluate volunteer performance.]

I - Training Logistical Arrangements:

Type of Volunteer Training	Frequency of Training / Certification

II - Description of Training and Trainer Qualifications:

[Provide narrative that includes measures to train and certify staff members involved in the monitoring activities. Also include training in health and safety procedures, such as CPR, first aid and how to deal with hazardous situations and substances, as applicable.]

A-9 -- Documentation and Records

[Identify the field and laboratory information and records you need for this project. These records may include raw data, QC checks, field data sheets, laboratory forms, and voucher collection – chain of custody. Include information on how long and where records will be maintained. Copies of all forms to be used in the project should be attached to the SAPP in an appendix. Some examples of documentation needed include field notes and field data sheets, laboratory submittal form, sample labels, chain-of-custody form and packaging/shipping of samples.]

B - Measurement / Data Generation and Acquisition

B-1 -- Sampling Process Design

I - Rationale for Selection of Sampling Sites:

[Provide narrative: Outline the experimental design of the project including information on types of samples required, sampling frequency, sampling period (e.g., season), and how you will select sample sites and identify them over time. Indicate whether any constraints such as weather, seasonal variations, streamflow or site access might affect scheduled activities, and how you will handle those constraints. Include site safety plans. You may cite the sections of your project's SOPs which detail the sampling design of the project, in place of extensive discussion.]

II - Sample Design Logistics:

	Type of Sample / Parameter / Matrix	Number of Samples	Sample Frequency	Sampling Period
Biological				
Physical				
Chemical				

B-2 -- Sampling Methods

[Describe your sampling methods. Include information on parameters to be sampled, how samples will be taken, equipment and containers used, sample preservation methods used, and holding times (time between taking samples and analyzing them). If samples are composited (i.e., mixed), describe how this will be done. Describe procedures for decontamination and equipment cleaning. (For example, kick nets need to be thoroughly rinsed and examined for clinging organisms between sampling events.) Most of this information can be presented in a table or you may also cite any Standard Operating Procedures (SOPs) that contain this information.]

I - Sampling Needs

Parameter / Matrix	Sampling Method	Sampling Procedures (a)	Sample Container	Sample Preservation	Holding Times

(a) – for example, a grab sample, composite sample, etc

II - Equipment Needs

[Identify how you will calibrate sampling and analytical instruments. Include information on how frequently instruments will be calibrated, and the types of standards or certified equipment that will be used to calibrate sampling instruments. Indicate how you will maintain calibration records and ensure that records can be traced to each instrument. Instrument calibration procedures for biological monitoring programs should include routine procedures that ensure that equipment is clean and in working order.]

Parameter / Matrix	Sampling Equipment	Equipment Decontamination /Cleaning Method	Equipment Inspection / Maintenance (include methods and dates)	Spare Parts / Back-up Equipment Needed

B-3 -- Sample Handling and Custody

[Sample handling procedures apply to projects that bring samples from the field to the lab for analysis, identification, or storage. These samples should be properly labeled in the field. At a minimum, the sample identification label should include sample location, sample

number, date and time of collection, sample type, sampler's name, and method used to preserve sample. Describe the procedures used to keep track of samples that will be delivered or shipped to a laboratory for analysis. Include any chain-of-custody forms and written procedures field crews and lab personnel should follow when collecting, transferring, storing, analyzing, and disposing of samples.]

B-4 -- Analytical Methods Requirements

[List the analytical methods and equipment needed for the analysis of each parameter, either in the field or the lab, if applicable. If your program uses standard methods, cite these (usually EPA methods). If your program's methods differ from the standard or are not readily available in a standard reference, describe the analytical methods or cite and attach the program's SOPs.]

B-5 -- Quality Control Requirements

[QC samples help you identify when and how field or laboratory contamination might occur. For most projects, there is no set number of field or laboratory QC samples which must be taken. The general rule is that 10% of samples should be QC samples. This means that if 20 samples are collected, at least one additional sample must be added as a QC sample. The laboratory must also run its own QC samples. For a new monitoring project or for a new analytical procedure, it is a good idea to increase the number of QC samples (up to 20%) until you have full confidence in the procedures you are using. If you use an outside laboratory, cite or attach the lab's QA/QC plan. QC checks for biological monitoring programs can be described in a narrative and, if appropriate, should include discussion of replicate sample collection, cross checks by different field crews, periodic sorting checks of lab samples, and maintenance of voucher and reference collections. Describe what actions you will take if the QC samples reveal a sampling or analytical problem.]

I - Field QC Checks:

*(i.e. field blanks, equipment blank, split sample, replicate sample and spike sample)
[Provide narrative]*

II - Laboratory QC Checks:

[Provide narrative – request the analytical laboratory to run their own QC checks and report on precision and accuracy of analytical results]

III - Data Analysis QC Checks:

[When the project is over, determine data quality by evaluating the results of all the QC samples and determining precision and accuracy. Lab reported precision and accuracy results can be checked during data validation. The decision to accept data, reject it, or accept only a portion of it should be made after analysis of all QC data.]

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

Describe how inspections and acceptance testing of instruments, equipment and their components affecting quality will be performed and documented to assure their intended use as specified. Identify and discuss the procedure by which final acceptance will be performed by independent personnel (e.g., personnel other than those performing the work) and/or by

the NPS project manager. Describe how deficiencies are to be resolved, when re-inspection will be performed, and how the effectiveness of the corrective action will be determined and documented.

Describe or reference how periodic preventive and corrective maintenance of measurement or test equipment or other systems and their components affecting quality shall be performed to ensure availability and satisfactory performance of the systems. Identify the equipment and/or systems requiring periodic maintenance. Discuss how the availability of critical spare parts, identified in the operating guidance and/or design specifications of the systems, will be assured and maintained.

B-7 -- Instrument / Equipment Calibration and Frequency

[Besides describing how and how frequently you will be calibrating the equipment and instruments, also indicate how you will maintain calibration records and ensure that records can be traced to each instrument. Instrument calibration procedures for biological monitoring programs should include routine procedures that ensure that equipment is clean and in working order. Provide narrative]

Equipment / Instrument Type	Calibration Frequency	Standard or Calibration Instrument Used

B-8 -- Inspection / Acceptance Requirements for Supplies

[Describe how you determine if supplies such as sample bottles, nets, and reagents are adequate for your program's needs.]

B-9 -- Data Acquisition Requirements

*[Identify any types of data your project uses that are **not** obtained through your monitoring activities. Examples of these types of data include historical information, information from topographical maps or aerial photos, or reports from other monitoring groups. Discuss any limits on the use of these data resulting from uncertainty about their quality. Provide narrative]*

B-10 -- Data Management

[Trace the path your data take, from field collection and lab analysis to data storage and use. Discuss how you check for accuracy and completeness of field and lab forms, and how you minimize and correct errors in calculations, data entry to forms and databases, and report writing. Provide examples of forms and checklists. Identify the computer hardware and software you use to manage your data. Include how you will coordinate data exchange with the Colorado Data Sharing Network and/or how you will conduct data uploading into EPA's STORET - National STORAGE and RETRIEVAL data warehouse.]

NOTE -- Please contact the NPS team for more information on how to coordinate data exchange with the Colorado Data Sharing Network.

C - Assessment and Oversight

C-1 -- Assessment and Response Actions

[Discuss how you evaluate field, lab, and data management activities, organizations (such as contract labs) and individuals in the course of your project. These can include evaluations of volunteer performance (for example, through field visits by staff or in laboratory refresher sessions); audits of systems such as equipment and analytical procedures; and audits of data quality (e.g., comparing actual data results with project quality objectives). Include information on how your project will correct any problems identified through these assessments. Corrective actions might include calibrating equipment more frequently, increasing the number of regularly scheduled training sessions, or rescheduling field or lab activities.]

C-2 -- Reports

[Identify the frequency, content, and distribution of reports to data users, sponsors, and partnership organizations that detail project status, results of internal assessments and audits, and how QA problems have been resolved.]

D - Data Validation and Usability

D-1 -- Data Review, Validation and Verification

[State how you review data and make decisions regarding accepting, rejecting, or qualifying the data. All that is needed here is a brief statement of what will be done by whom.]

D-2 -- Validation and Verification Methods

[Describe the procedures you will use to validate and verify data. This can include, for example, comparing computer entries to field data sheets for data entry accuracy; looking for data gaps; analyzing quality control data such as chain of custody information, spikes, and equipment calibrations for completeness and accuracy; checking calculations; examining raw data for outliers or nonsensical readings using simple descriptive statistics; and reviewing graphs, tables and charts. Include a description of how errors, if detected, will be corrected, and how results will be conveyed to data users].

The following steps describe the validation and verification methods that the WQCD Environmental Data Unit uses to verify precision and accuracy and are presented here as a suggestion.

“Unless otherwise specified, acceptable precision for each analytical parameter (e.g., zinc) for a pair of split samples will be < 30%, expressed as relative percent difference (RPD).

$$\text{Precision} = \text{RPD} = \frac{(C - C)}{(C + C)} \times \frac{1}{2} \times 100\%$$

In the event that the difference between split samples is > 30%, data from that site/time will be considered qualified and either deleted or interpreted with caution. Qualified data will be clearly denoted as such in the database.

Estimates of overall precision of a parameter (e.g., zinc) will be derived from the pooled standard deviations (SD) from all individual split pairs. The pooled standard deviation statistic is termed the root mean square and is calculated as:

$$\text{Percent relative standard deviation} = \%RSD = (\text{SD} / \text{Mean}) \times 100\%$$

$$\text{Root mean square} = \text{RMS} = \frac{\%RSD^{0.5} + \%RSD^{0.5} \dots + \text{etc.}^{0.5}}{N}$$

Unless otherwise specified, acceptable RMS for each parameter is < 30%. If RMS is > 30%, then the analysis for that parameter will be deleted from the database or considered as qualified data and interpreted with caution. Qualified data will be clearly denoted in the database.

Concentration of contaminants allowable in field blanks will be project specific. Data from field blanks will be tabulated, reviewed, and interpreted in project reports. If contamination of field blanks occurs, corrective action will be initiated.

The decision process for determining the significance of blank contamination in terms of project and data quality objectives is presented in the following decision criteria:

<u>Field Blank</u>	<u>Reported Analytical Blank</u>	<u>Outcome to Database</u>
1. < Detection limit	> detection limit	no change
2. > Detection limit	< detection limit	no change
3. > Detection limit	< detection limit	no change
4. > Detection limit	> detection limit	qualified data (See below)

The decision to accept or reject qualified data will be based on the following criteria:

- If, after downward adjustment for possible contamination, the analytical values reported for ambient sites still exceed the designated standard (e.g., the stream standard for zinc), then no change in the data base is required.
- If downward adjustment of the ambient site values eliminates exceedance of the designated standards, then the data point(s) are interpreted with caution and re-sampling at the site(s) is appropriate.”

D-3 -- Reconciliation with Data Quality Objectives

[Once the data results are compiled, describe the process for determining whether the data meet project objectives. This should include calculating and comparing the project's actual data quality indicators (precision, accuracy, completeness, representativeness, and comparability) to those you specified at the start of the project, and describing what will be done if they are not the same. Actions might include discarding data, setting limits on the use of the data, or revising the project's data quality objectives.]